City of San Antonio

Hazard Mitigation Action Plan

Table of Contents

Section 1: Introduction 6
Background 6
Scope and Participation 7
Purpose 8
Authority 9
Summary of Sections 9
Section 2: Planning Process 10
Plan Preparation and Development 10
Review and Incorporation of Existing Plans 16
Timeline for Implementing Mitigation Actions 20
Public Involvement 20
Section 3: City Profile 24
Overview 24
Population and Demographics 27
Population Growth 27
Future Development 29
Economic Impacts 30
Section 4: Risk Overview 31
Hazard Identification 31
Hazards and Climate Change 35
Climate Vulnerability 37
Impact of Climate Change 42
Overview of Hazard Analysis 45
Hazard Risk Ranking 46
Section 5: Drought 51
Hazard Description 51
Location 52
Extent 55
Historical Occurrences 57
Probability of Future Events 60
Vulnerability and Impact 62
Section 6: Extreme Heat 69
Hazard Description 69
Location 69
Extent 71
Historical Occurrences 75

Probability of Future Events 77
Vulnerability and Impact 79

Section 7: Flood 86

Hazard Description 86
Location 86
Extent 92
Historical Occurrences 95
Probability of Future Events 101
Vulnerability and Impact 102
National Flood Insurance Program Participation 118
NFIP Compliance and Maintenance 120
Repetitive Loss 121
Flood Risk Assessment 122

Section 8: Wildfire 124

Hazard Description 124
Location 125
Extent 126
Historical Occurrences 130
Probability of Future Events 134
Vulnerability and Impact 135

Section 9: Tornado 142

Hazard Description 142
Location 143
Extent 143
Historical Occurrences 147
Probability of Future Events 151
Vulnerability and Impact 151

Section 10: Extreme Wind 157

Hazard Description 157
Location 158
Extent 158
Historical Occurrences 160
Probability of Future Events 167
Vulnerability and Impact 167

Section 11: Hail 179

Hazard Description 179
Location 179
Extent 179

Historical Occurrences 181
Probability of Future Events 185
Vulnerability and Impact 185

Section 12: Dam Failure 190
Hazard Description 190
Location 191
Extent 195
Historical Occurrences 218
Probability of Future Events 218
Vulnerability and Impact 218

Section 13: Winter Storm 225
Hazard Description 225
Location 227
Extent 227
Historical Occurrences 229
Probability of Future Events 233
Vulnerability and Impact 233

Section 14: Lightening 238
Hazard Description 238
Location 238
Extent 238
Historical Occurrences 240

Section 15: Expansive Soils 245
Hazard Description 245
Location 245
Extent 248
Historical Occurrences 254
Probability of Future Events 254
Vulnerability and Impact 255

Section 16: Terrorism 258
Hazard Description 258
Location 260
Extent 260
Historical Occurrences 261
Probability of Future Events 262
Vulnerability and Impact 262

Section 17: Hazardous Materials 266
Hazard Description 266

Location 267
Extent 270
Historical Occurrences 270
Probability of Future Events 273
Vulnerability and Impact 273

Section 18: Pipeline Failure 277
Hazard Description 277
Location 277
Extent 279
Historical Occurrences 279
Probability of Future Events 281
Vulnerability and Impact 281

Section 19: Infectious Disease 286
Hazard Description 286
Location 290
Extent 290
Historical Occurrences 292
Probability of Future Events 294
Vulnerability and Impact 294

Section 20: Cyberattack 300
Hazard Description 300
Location 302
Extent 303
Historical Occurrences 304
Probability of Future Events 304
Vulnerability and Impact 307

Section 21: Technological Disruption 308
Hazard Description 308
Location 308
Extent 308
Historical Occurrences 317
Probability of Future Events 319
Vulnerability and Impact 319

Section 22: Mitigation Goals 321
Mitigation Goals 321

Section 23: Previous Actions 324
Summary 324

Section 24: Mitigation Actions 458

Summary 458
Section 25: Plan Maintenance 640
Plan Maintenance Procedures 640
Incorporation 640
Monitoring and Evaluation 643
Updating 644
Continued Public Involvement 645
Appendix A: Planning Team 647
Planning Team Members 647
Appendix B: Public Survey Results 651
Overview 651
Public Survey Results 651
Appendix C: Critical Failures 662
Overview 662
Critical Facilities 662
Appendix D: Dam Locations 680
Overview 680
Dam Locations 680
Appendix E: Meeting Documentation 683
Workshop Documentation 683
Public Meeting Documentation 690
Public Notices 692
Appendix F: Capability Assessment 700
Overview 700
City of San Antonio Capability Assessment 701
Expanding and Improving Capabilities 703

Section 1: Introduction

Background

San Antonio, the county seat of Bexar County, is the seventh most populous city in the United States, and the second most populous city in the State of Texas, with a population of 1,533,572, according to the Texas Demographic Center's July 1, 2018, population estimates. It is also one of the fastest growing of the top 10 largest cities in the United States. The city is located in the American Southwest, the south–central part of Texas, and the southwestern corner of an urban region known as the Texas Triangle. This term is derived from the fact that the three main cities in the Texas Triangle are connected by a highway system of Interstate 45, Interstate 10, and Interstate 35, which form a triangle when connected. The Triangle is anchored by the metropolitan areas of Houston, Dallas-Fort Worth, Austin, and San Antonio.

Texas is prone to extremely heavy rains and flooding with half of the world record rainfall rates (48 hours or less).[1] Central Texas, known as Flash Flood Alley, is particularly vulnerable because storms tend to stall out along the Balcones escarpment. While the City of San Antonio is susceptible to a wide range of natural and human-caused hazards, including flooding, tornadoes and wildfires, San Antonio is considered one of the most flash flood prone regions in North America. These life-threatening hazards can destroy property, disrupt the economy, and lower the overall quality of life for individuals.

Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people. Global warming, reaching 1.5° C in the near-term (2021-2040) would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans. According to the Intergovernmental Panel on Climate Change (IPCC) assessment, the planet is expected to pass that threshold as soon as the early 2030s – just a decade or so from now. This will result in more wildfires, extreme heat, and intense hurricanes, along with other cascading impacts.[2]

While it is impossible to prevent a hazard event from occurring, the impact of hazards can be lessened in terms of their effect on people and property through effective hazard mitigation planning and implementation. The Federal Emergency Management Agency (FEMA) defines mitigation as sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.[3] Mitigation differs from emergency preparedness and

---

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

[2] Source: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

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

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.

Communities participate in hazard mitigation by developing hazard mitigation plans. The Texas Division of Emergency Management (TDEM) is required to review the plan before it is sent to FEMA for review and final approval in accordance with the Disaster Mitigation Act of 2000. 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.

In 2015, the City of San Antonio developed its hazard mitigation plan titled, "City of San Antonio Hazard Mitigation Plan, Mitigating Risk for a Safe, Secure, and Sustainable Future". The City began the process of developing an mitigation planning update in order to maintain eligibility for grant funding within the five-year window. The City of San Antonio selected the consultant team of H2O Partners, Inc. to write and develop the updated plan for 2022, hereinafter titled: "City of San Antonio Hazard Mitigation Action Plan (HMAP) Update 2022: Maintaining a Safe, Secure, and Sustainable Community". The HMAP planning process provided an opportunity for the City of San Antonio to evaluate successful mitigation actions and explore opportunities to avoid future disaster loss.

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 update to a hazard mitigation plan addresses hazard vulnerabilities that exist today and in the foreseeable future. Therefore, it is essential that a plan identifies projected patterns of how future development will increase or decrease a community's overall hazard vulnerability.

Scope and Participation

The City of San Antonio's HMAP is a single jurisdictional plan. Numerous entities and businesses participated on the Planning Team, including CPS Energy, the San Antonio Water System, the San Antonio River Authority (SARA), and the United Services Automobile Association (USAA). These groups, and others, provided valuable input into the planning process.

The focus of the HMAP is to mitigate those hazards selected from the State Hazard Mitigation Plan that 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 City to prioritize mitigation actions based on hazards that pose the greatest risk to lives and property in the geographic scope (i.e., planning area).

Purpose

The HMAP, prepared by the City of San Antonio and H2O Partners, Inc., is an opportunity for the City of San Antonio's planning team members to evaluate successful mitigation actions and explore opportunities to avoid future disaster loss. The HMAP is also an opportunity for the City to align mitigation planning and implementation with the San Antonio Climate Ready initiative, to account for how the City will be impacted by climate change and how the City can account for these impacts through hazard mitigation.

In developing the HMAP, the City of San Antonio identified 11 natural hazards and six human-caused hazards to be addressed in developing mitigation projects, as the goal of the HMAP is to minimize or eliminate long-term risk to human life and property from known hazards and identify and implement cost-effective mitigation actions. Therefore, the purpose of the HMAP is to protect people and structures, and to minimize the costs of disaster response and recovery. The planning process is an opportunity for the City of San Antonio, its Planning Team, and the general public to evaluate and develop successful mitigation projects to reduce future risk in the community, including loss of life and property damage throughout the City of San Antonio.

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

Through this process, the City of San Antonio seeks to:

- Provide a comprehensive update to the 2015 HMAP;
- Assess any previous mitigation projects and develop unique mitigation strategies to meet future development and risks;
- Encourage improvements in floodplain management, participation in the National Flood Insurance Program (NFIP); and qualifying for FEMA's Community Rating System, thereby reducing flood insurance premiums for citizens;
- Devise solutions to strengthen emergency management by addressing moderate and high-risk natural hazards; and
- Develop and implement comprehensive mitigation planning activities for the City of San Antonio and integrate these activities into existing planning mechanisms.

Authority

The HMAP is tailored specifically for the City of San Antonio, and plan participants, including Planning Team members and the public, who participated in the HMAP development process. The HMAP 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 HMAP 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). Additionally, the HMAP is 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 HMAP outline the purpose and the process of development, including how Planning Team members and members of the public were involved in the planning process. Section 3 profiles the City of San Antonio in terms of population and economy.

Sections 4 through 21 present a hazard overview and information on individual hazards in the planning area. For each hazard, the HMAP presents a description of the hazard, a list of historical hazard events, and the results of the vulnerability and risk assessment process.

Section 22 presents hazard mitigation goals and objectives. Section 23 gives an analysis for the previous actions and Section 24 presents hazard mitigation actions for the City of San Antonio. Section 25 identifies plan maintenance mechanisms.

The list of Planning Team members is 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 City are located in Appendix F.[4]

[4] 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 city departments and community partners 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 the Planning Team and the public were involved.

OVERVIEW OF THE PLAN

The City of San Antonio hired H2O Partners, Inc. (Consultant Team), to provide technical support and oversee the development of the HMAP. The Consultant Team used the Federal Emergency Management Agency's (FEMA) "Local Mitigation Plan Review Guide" (October 1, 2011) and the "Local Mitigation Planning Handbook" (March 2013) to develop the HMAP. The overall planning process is shown in Figure 1 below.

Figure 1. Mitigation Planning Process

The City of San Antonio and the Consultant Team met in July 2020 to begin organizing resources, identifying Planning Team members, and conducting a Capability Assessment.

PLANNING TEAM

Key members of H2O Partners, Inc. developed the HMAP in conjunction with the Planning Team. The Planning Team was established using a direct representation model. Some of the responsibilities of the Planning Team included: completing capability assessment surveys, providing input regarding the identification of hazards, identifying mitigation goals, and developing mitigation strategies. As shown in Table 1, the Planning Team consisted of key personnel from the city and representatives from both the public and private sector.

Table 1. Planning Team

DEPARTMENT	TITLE
American Red Cross	Disaster Program Manager
CPS Energy	Project Manager
	Senior Manager Electric Operations
Cybersecurity and Infrastructure Security Agency	Protective Security Advisor
Delivery Associates	Delivery Leader
Department of State Health Services	Preparedness Manager
Education Service Center, Region 20	Assistant Director
HAM Operators	Volunteer
Haven for Hope	Director of Life Safety
HEB	Director of Emergency Preparedness
Joint Base San Antonio	Chief Emergency Management
	Technical Sergeant
Local Emergency Planning Committee	Chair
National Weather Service	Warning Coordination Meteorologist
Port San Antonio	Airport Operations Director
San Antonio Airport	Airport Emergency Manager
San Antonio Department of Planning	Assistant Director
San Antonio Development Services	Code Enforcement Manager
	Deputy Director
	Director
San Antonio Economic Development Office	Director
San Antonio Fire Department	Fire Prevention Battalion Chief
	Hazmat Battalion Chief
	Public Information Officer
	Wildland Fire Captain
San Antonio Food Bank	Chief Operating Officer
	Director
San Antonio Information Technology Services Department	Chief Information Security Officer
San Antonio Metropolitan Health District	Emergency Preparedness Coordinator

DEPARTMENT	TITLE
San Antonio Office of Emergency Management	Assistant Emergency Management Coordinator
	Emergency Management Coordinator
	Senior Management Analyst
	Senior Management Analyst (1)
	Senior Management Analyst (2)
	Senior Project Management Specialist
	Special Projects Manager
San Antonio Office of Equity	Director
San Antonio Office of Innovation	Director
San Antonio Office of Sustainability	Deputy Chief Sustainability Officer
	Chief Sustainability Officer
San Antonio Police Department	Captain
San Antonio Public Works	Assistant Director
	Capital Programs Manager
	Special Projects Manager
San Antonio River Authority	Manager
	Watershed Engineer
San Antonio Water System	Emergency Manager
Southwest Texas Fusion Center	Deputy Director
Southwest Texas Regional Advisory Council	Emergency Preparedness and Response Director
Texas A&M Forest Service	Manager
	Regional Fire Coordinator
Texas Division of Emergency Management	District Coordinator
The University of Texas at San Antonio	Business Continuity and Emergency Management Coordinator
	Director of Risk & Emergency Management
Transportation Security Administration	Chief Operating Officer
United Services Automobile Association	Lead Business Continuity Advisor
United Way	211 Disaster Coordinator
VIA Metropolitan Transit	Emergency Coordinator

Based on results of the completed Capability Assessment, the City of San Antonio described methods for achieving future hazard mitigation measures by expanding existing capabilities. For example, the Wildfire ordinance for the City of San Antonio is under development. Other options for improving capabilities include the following:

- Establishing Planning Team members with the authority to monitor the HMAP 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), and by monitoring classes and availability through www.preparingtexas.org.
- Reviewing current floodplain ordinances for opportunities to increase resiliency (above current standards), such as modifying permitting or building codes.
- Developing ordinances that will require all new developments to conform to the higher mitigation standards, exceeding current requirements.

Sample hazard 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 HMAP to further mitigate risk from natural hazards in the future.

The Planning Team developed hazard mitigation actions for mitigating risk from potential flooding and wildfire; these actions include culvert crossing upgrades, as well as drainage improvement projects. The HMAP also includes an action to implement a program to remove dead and downed trees to decrease fire fuels.

PLANNING PROCESS

The process used to prepare the HMAP followed the four major steps included in Figure 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 the City of San Antonio's identified vulnerabilities, 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 25. Participation of Planning Team members, and the public at each of the workshops is documented in Appendix E.

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

- The nature and 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 HMAP;
- Implementation problems, such as technical, political, legal, and coordination issues that may hinder development;
- Anticipated outcomes; and
- How the City of San Antonio, agencies, and partners will participate in implementing the HMAP.

KICKOFF WORKSHOP

The Kickoff Workshop was held via Adobe Connect Webinar on July 13, 2020. The initial workshop informed City officials and the Planning Team about how the planning process pertained to their distinct roles and responsibilities. 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 pertaining to various risks from a list of natural hazards affecting the planning area. Participants ranked hazards from high to low in terms of perceived level of risk, frequency of occurrence, and potential impact.

HAZARD IDENTIFICATION

At the Kickoff Workshop and through e-mail and phone correspondence, the Planning Team conducted preliminary hazard identification. In coordination with the Consultant Team, the Planning 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 planning area overall, the 2018 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 teams identified a total of 11 natural hazards that pose a significant threat to the planning area.

Risk Assessment

An initial risk assessment for the City of San Antonio was completed in September 2020 and results were presented to Planning Team members at the Risk Assessment Workshop webinar held on September 9, 2020. 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.

Potential dollar losses from each hazard were estimated using the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI). The damages given are for property and crop damage. 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 hazard mitigation actions based on potential loss of life and dollar losses. A hazard profile and vulnerability analysis for each of the hazards can be found in Sections 4 through 21.

Mitigation Review and Development

Developing the Mitigation Strategy for the HMAP involved identifying mitigation goals and new mitigation actions. A Mitigation Strategy Workshop webinar was held on October 1, 2020. Regarding hazard mitigation actions, Workshop participants emphasized the desire for actions that addressed flood and hurricane hazards. Additionally, the City was proactive in identifying mitigation actions to lessen the risk of all the identified hazards included in the HMAP.

An inclusive and structured process was used to develop and prioritize new hazard mitigation actions for the HMAP. The prioritization method was based on FEMA's STAPLEE 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 24.

Planning Team members then developed action 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 the following:

- Facilitators listed 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 hazard 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 the 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 the 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 draft HMAP was posted on the City of San Antonio's website for the public to 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 A&M 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 (Sections 5-21) summarize the relevant background information.

SA CLIMATE READY

San Antonio recognizes the importance of incorporating the anticipated impacts of climate change into the mitigation planning process. To do this, the planning team reviewed and incorporated:

- SA Climate Ready Plan
- SA Climate Ready: Vulnerability and Risk Assessment
- SA Climate Ready: Climate Projections for San Antonio

Specific 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 descriptions were identified through NOAA's National Centers for Environmental Information (NCEI). Results of past hazard events were found through searching the NCEI. The 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. The State Demographer webpages were reviewed for population and other projections included in Section 3 of the HMAP. Information from the Texas A&M 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 the City of San Antonio's key departments and provided information pertaining to existing plans, policies, ordinances, and regulations to be integrated into the goals and objectives of the plan. The relevant information was included in a master Capability Assessment, Appendix F.

Planning and Consultant Team members utilized existing projects and studies as a starting point for discussing hazard mitigation actions. For example, the San Antonio River Authority is currently developing Risk Maps. This initiative will allow further projects to be identified. Other plans were reviewed, such as the Community Wildfire Protection Plan and the Capital Improvements Plan. Finally, the 2018 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 2018 State of Texas Mitigation Plan Update was also used as a guidance document along with FEMA materials in the development of the HMAP.

INCORPORATION OF THE HMAP INTO OTHER PLANNING MECHANISMS

Planning Team members will integrate implementation of the plan with other planning mechanisms for the City of San Antonio, such as the Emergency Operations Plan. Existing plans for the City of San Antonio will be reviewed and incorporated into the HMAP as appropriate. This section discusses how the City of San Antonio will implement the HMAP. It also addresses how the HMAP will be evaluated and improved over time, and how the public will continue to be involved in the hazard mitigation planning process.

The City of San Antonio will be responsible for implementing hazard mitigation actions contained in Section 24. Each hazard mitigation action has been assigned to a specific City department that is responsible for tracking and implementing the action.

A funding source has been listed for each identified hazard mitigation 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 City of San Antonio will integrate hazard mitigation actions contained in the HMAP with existing planning mechanisms such as floodplain ordinances, Emergency Operation Plans, Evacuation Plans, and other local and area planning efforts. The City of San Antonio 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 HMAP, Planning Team members from the City of San Antonio will review existing plans along with building codes to guide development and ensure that hazard mitigation actions are implemented. Each of the departments will be responsible for coordinating periodic review of the HMAP with members of the Planning Team to ensure integration of hazard mitigation strategies into these planning mechanisms and codes. The Planning Team will also conduct periodic reviews of various existing planning mechanisms and analyze the need for any amendments or updates in light of the approved HMAP. The City of San Antonio will ensure that future long-term planning objectives will contribute to the goals of the HMAP to reduce the long-term risk to life and property from moderate and high-risk hazards. Within one year of formal adoption of the HMAP, existing planning mechanisms will be reviewed and analyzed as they pertain to the HMAP.

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

Furthermore, the City of San Antonio will work with neighboring jurisdictions to advance the goals of the HMAP as it applies to ongoing, long-range planning goals and actions for mitigating risk from natural hazards throughout the planning area.

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

Table 2. Plan Integration

PLANNING MECHANISM	INCORPORATION OF PLAN
Grant Applications	The Planning Team members will consult the HMAP whenever grant funding is sought for mitigation projects. If a project is not in the HMAP, an amendment may be necessary to include the action in the HMAP.
Annual Budget Review	Various departments and key personnel that participated in the planning process will review the HMAP and mitigation actions therein when conducting their annual budget review. Allowances will be made in accordance with grant applications sought or mitigation actions that will be undertaken according to the implementation schedule of the specific action.
Regulatory Plans	Currently, the City of San Antonio has regulatory plans in place, such as Emergency Management Plans, Continuity of Operations, Disaster Recovery Plans, Economic Development and Evacuation Plans. The HMAP will be consulted when City departments review or

PLANNING MECHANISM	INCORPORATION OF PLAN
	revise their current regulatory planning mechanisms, or in the development of regulatory plans that are not currently in place.
Capital Improvement Plans	The City of San Antonio has a Capital Improvement Plan (CIP) in place. Prior to any revisions to the CIP, City departments will review the risk assessment and mitigation strategy sections of the HMAP, as limiting public spending in hazardous zones is one of the most effective long-term mitigation actions available to local governments.
Comprehensive Plans	The City of San Antonio has a Long-Term Comprehensive Development Plan in place. Since comprehensive plans involve developing a unified vision for a community, the mitigation vision and goals of the HMAP will be reviewed in the development or revision of a Long-Term Comprehensive Development Plan.
Floodplain Management Plans	Floodplain Management Plans include preventative and corrective actions to address the flood hazard. Therefore, the actions for flooding, and information found in Section 7 of this plan discussing the people and property at risk to flood, will be reviewed, and revised when the City of San Antonio updates its Floodplain Management Plans or develops new plans.

Appendix F provides an overview of Planning Team members' existing planning and regulatory capabilities to support implementation of mitigation strategy objectives. Appendix F also provides further analysis of how the City intends to incorporate hazard mitigation actions into existing plans, policies, and the annual budget review as it pertains to prioritizing grant applications for funding and implementation of identified hazard mitigation projects.

It should be noted for the purposes of the update process, the HMAP has been used as a reference when reviewing and updating all plans and ordinances for the City of San Antonio. The Emergency Management Plan, which provides strategic guidance for City departments, is updated every five years, and incorporates goals, objectives and actions identified in the current mitigation plan.

PLAN REVIEW AND PLAN UPDATE

For the development of the HMAP, the City of San Antonio will oversee the review and update process for relevance and to make necessary adjustments. At the beginning of each fiscal year, Planning Team Members will meet to evaluate the plan and review other planning mechanisms to ensure consistency with long-range planning efforts. In addition, planning participants will also meet twice a year by conference call or presentation to re-evaluate prioritization of the hazard mitigation actions and the hazard assessment.

Timeline for Implementing Mitigation Actions

The Planning Team (Appendix A: 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; these goals will be based on prioritization of each action as identified on individual Hazard Mitigation Action worksheets included in the HMAP for the City of San Antonio.

The Planning Team will evaluate and prioritize the most suitable hazard mitigation actions for the community to implement. The timeline for implementation of actions will partially be directed by the City of San Antonio's comprehensive planning process, budgetary constraints, and community needs. The City committed to addressing and implementing hazard mitigation actions that may be aligned with and integrated into the HMAP.

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

Public Involvement

An important component of hazard mitigation planning is public participation. Input from individual citizens 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 are involved, they are more likely to gain a greater appreciation of the risks that hazards may present in their community and take steps to reduce or mitigate their impact.

The public was involved in the development of the HMAP at different stages prior to official HMAP approval and adoption. Public input was sought using three methods: (1) open public meetings; (2) survey instruments; and (3) making the draft HMAP available for public review at the City of San Antonio's website.

The draft HMAP was made available to the public for review and comment on the City of San Antonio website. The public was notified at the public meetings and via social media posts that the draft HMAP would be available for review online. Feedback was received from the public survey and on the draft HMAP available on the City of San Antonio website, and all relevant information was incorporated into the plan. Information that was obtained from the survey assisted in determining the community's concern about risk, which drove the focus of the plan on areas of concern and assisted in the development of mitigation actions.

The HMAP will be advertised and posted on the City of San Antonio's website upon approval from FEMA and a copy will be kept in the offices of the City.

Table 3. Planning Participation

AGENCY	TITLE	PARTICIPATED
American Red Cross	Disaster Program Manager	X
Cybersecurity & Infrastructure Security Agency (CISA)	Protective Security Advisor	X
CPS Energy	Sr Manager Electric Operations	X
CPS Energy	Project Manager	X
Delivery Associates	Delivery Leader	X
Department of State Health Services	Preparedness Manager	X
Education Service Center, Region 20	Assistant Director	
HAM Operators	Volunteer	X
Haven for Hope	Director of Life Safety	X
HEB	Director of Emergency Preparedness	
Joint Base San Antonio	Chief of Emergency Management	
Joint Base San Antonio	Technical Sergeant	X
Local Emergency Planning Committee (LEPC)	Chair	
National Weather Service (NWS)	Warning Coordination Meteorologist	X
Port San Antonio	Airport Operations Director	
San Antonio Food Bank	Director	
San Antonio Food Bank	Chief Operating Officer	X
San Antonio River Authority (SARA)	Watershed Engineer	X
San Antonio River Authority (SARA)	Manager	X
San Antonio River Authority (SARA)	Manager	X
San Antonio River Authority (SARA)	Manager	
San Antonio Water System (SAWS)	Emergency Manager	X
Southwest Texas Regional Advisory Council	Emergency Preparedness & Response Director	
Texas A&M Forest Service	Manager	

AGENCY	TITLE	PARTICIPATED
Texas A&M Forest Service	Regional Fire Coordinator	X
Texas Division of Emergency Management	District Coordinator	
Transportation Security Administration	Chief Operating Officer	
United Way	211 Disaster Coordinator	X
United Services Automobile Association (USAA)	Lead Business Continuity Advisor	X
The University of Texas at San Antonio	Director of Risk & Emergency Management	X
The University of Texas at San Antonio	Business Continuity and EM Coordinator	X
VIA Metropolitan Transit	Emergency Coordinator	

PUBLIC MEETINGS

A series of public meetings were held throughout the planning area to collect public input. Topics of discussion included the purpose of hazard mitigation, discussion of the planning process, and types of natural hazards. Representatives from area neighborhood associations and area residents were invited to participate. Additionally, the City of San Antonio utilized social media sources including Facebook, Twitter, Nextdoor, and the local media to increase public participation in the plan development process. Documentation on the public meetings can be found in Appendix E.

Public meetings were held on the following dates and locations:

- September 10, 2020 – Adobe Connect Webinar
- September 17, 2020 – Adobe Connect Webinar
- September 24, 2020 – GoTo Webinar, as part of the City's annual Citizens Preparedness Workshop
- July – August, 2022 – 42 different public meetings collecting 520 public survey responses

Public Participation Survey

In addition to public meetings, the Planning and Consultant teams developed a public survey designed in both English and Spanish to solicit public input during the planning process from citizens, and to obtain data regarding the identification of any potential hazard mitigation actions or problem areas. The survey was promoted by local officials and a link to the survey was posted on the City of San Antonio's website. A total of 174 surveys were completed online

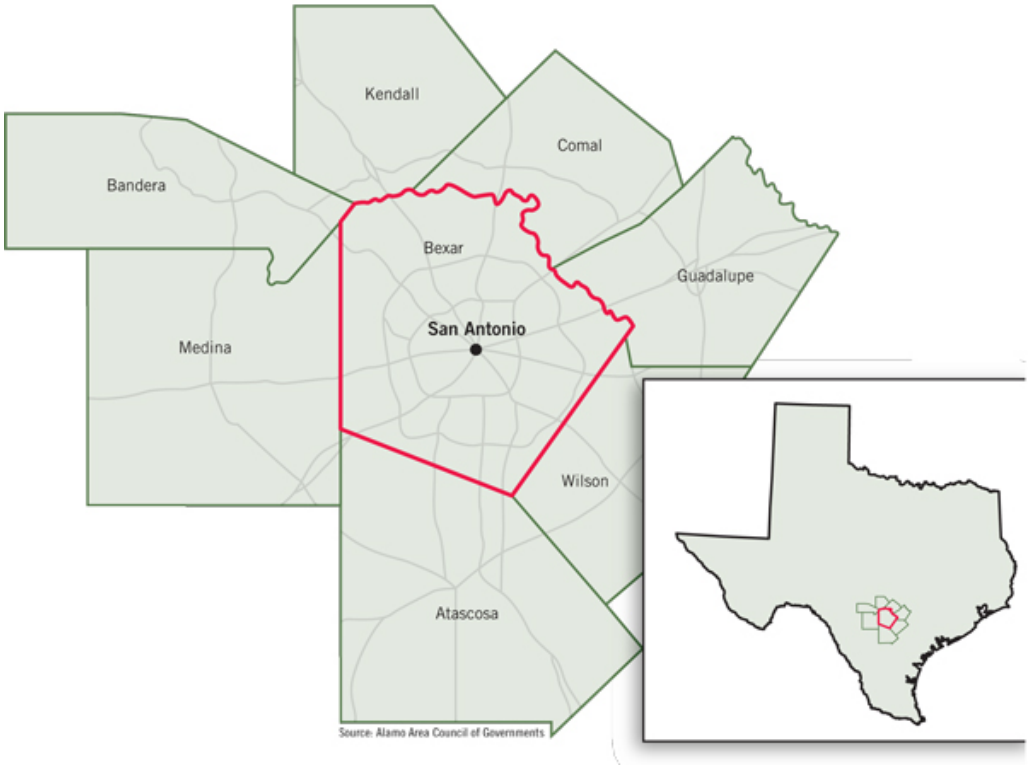
and the results are analyzed in Appendix B. The City of San Antonio reviewed the input from the surveys and decided which information to incorporate into the HMAP as hazard mitigation actions. For example, several surveys suggested better communications and notifications along with trainings for all the hazards. In response to public input, actions were included to implement an education and awareness program to provide mitigation measures to reduce injuries, fatalities, and property damage.

Section 3: City Profile

Overview

The City of San Antonio is the county seat of Bexar County. The City has characteristics of other western urban centers in which there are sparsely populated areas and a low density rate outside the city limits. San Antonio is the center of the San Antonio–New Braunfels Metropolitan Statistical Area, Figure 2.

Figure 2. San Antonio-New Braunfels Metropolitan Statistical Area



Officially, the City of San Antonio is the seventh most populous city in the United States and the second most populous city in the State of Texas, with a 2018 official population estimate of 1,533,572.[5]

This section profiles the City as a whole, providing data, including:

- Population and Demographics;
- Economy and Industry; and
- Land Use and Development Trends.

[5]Source: https://demographics.texas.gov/

Figure 3 shows the general location of the City of San Antonio relative to the Interstate Highway 35 corridor and other area communities within and adjacent to Bexar County.

Figure 3. Location of San Antonio and New Braunfels Metro Area

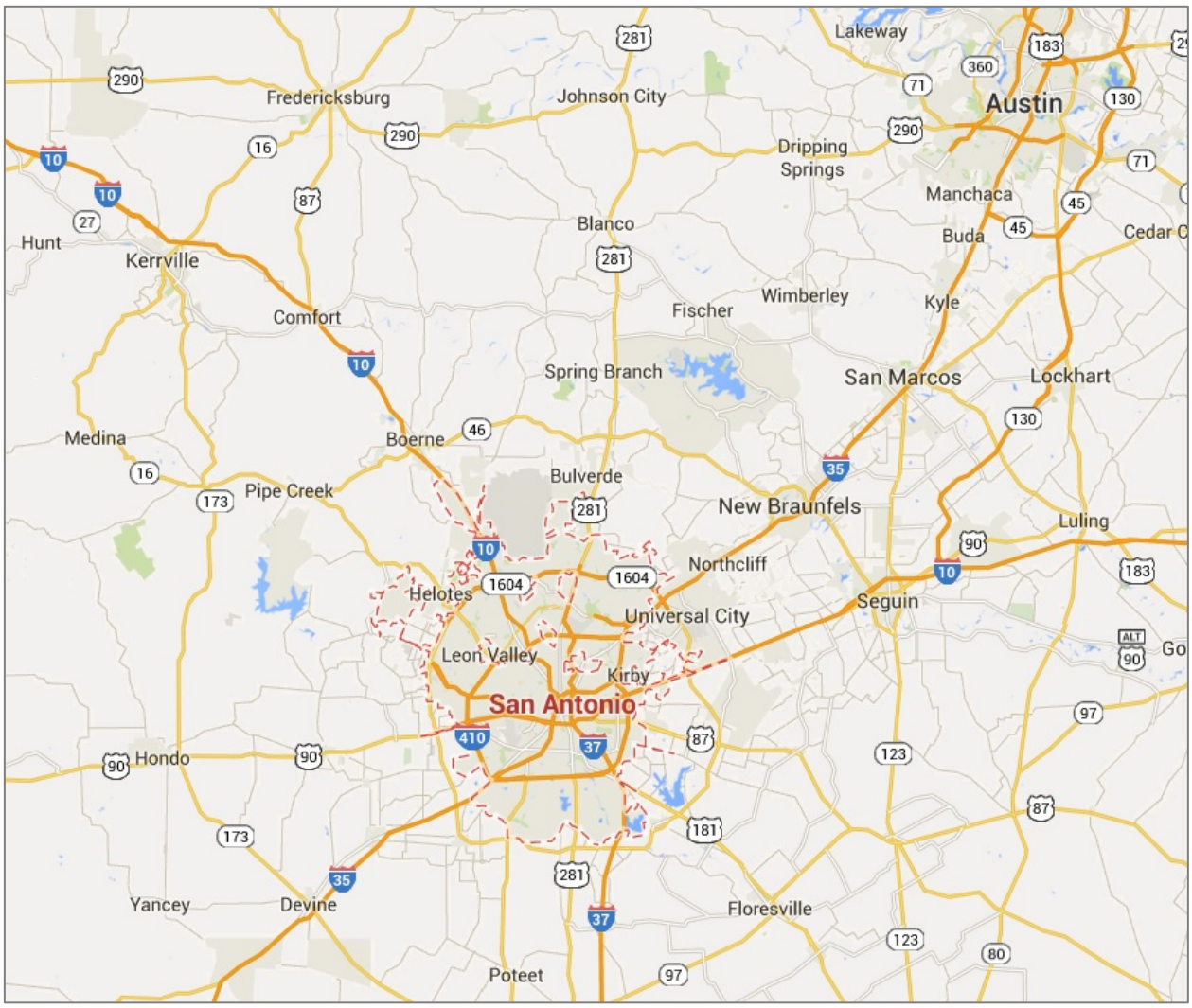
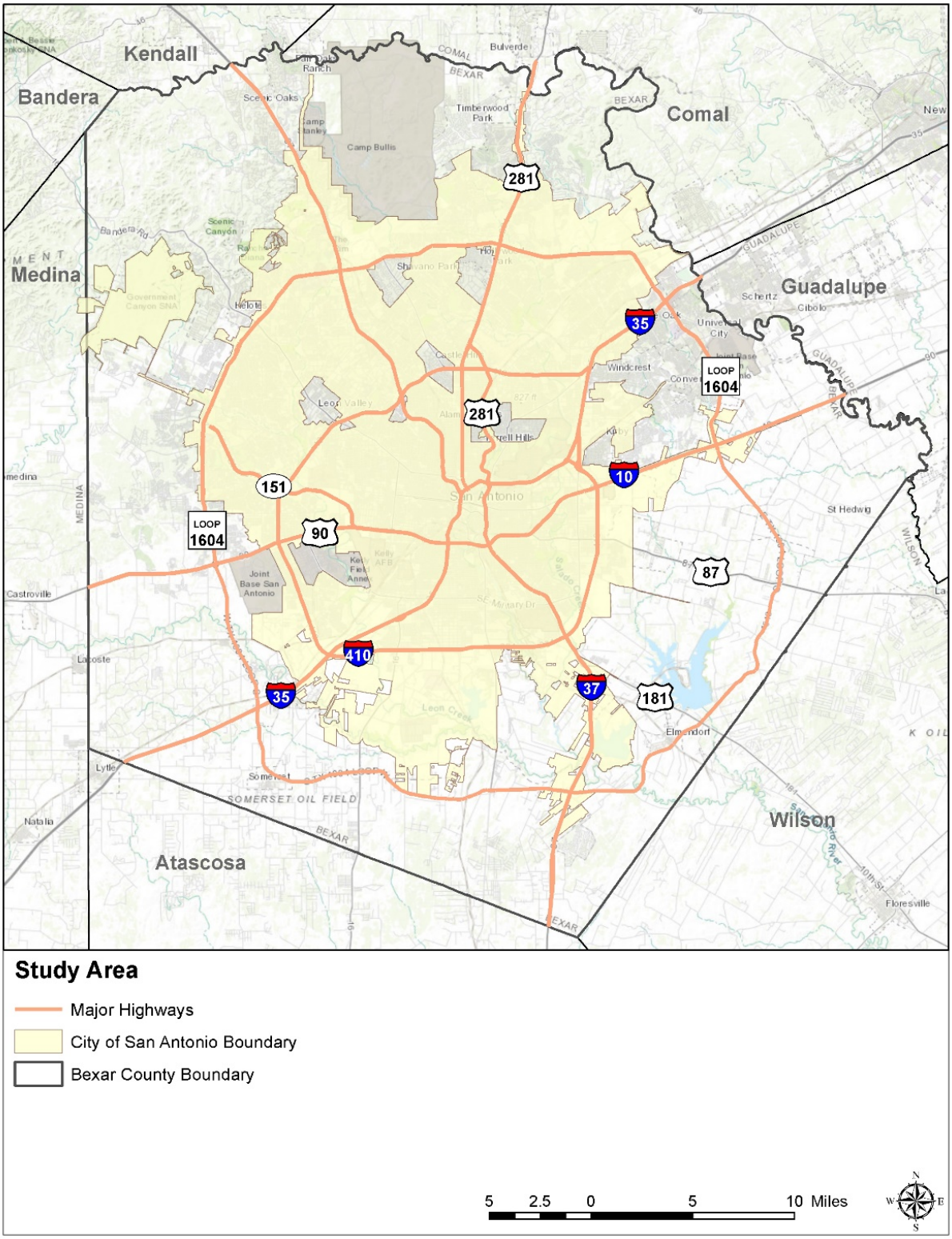


Figure 4 shows the city limits of the City of San Antonio, which makes up the planning area. All areas of the City's corporate limits are covered in the risk assessment analysis of the HMAP.

Figure 4. San Antonio City Limits Study Area



Population and Demographics

In the official Census population count, as of April 1, 2010, San Antonio had 1,327,407 residents. By July 2013, the number had grown to 1,409,019, and by July 2018, the population was 1,533,572. New residential building permits are increasing every month as the general population of Central Texas continues to increase. Table 4 highlights special needs populations in the City of San Antonio.[6]

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.

Table 4. Population Distribution for the City of San Antonio

TOTAL 2010 POPULATION	TOTAL 2018 POPULATION	ESTIMATED VULNERABLE OR SENSITIVE POPULATIONS	
		ELDERLY (OVER 65)	BELOW POVERTY LEVEL
1,327,407	1,533,572	175,230	297,736

Population Growth

Figure 5 indicates the distribution of San Antonio's population. The official 2018 San Antonio population is 1,533,572. Since the 2000 Census, San Antonio's population count has increased by 33.98% from a population of 1,144,554. The population of San Antonio is growing within the city limits. Table 5 provides historic and current growth rates in San Antonio.

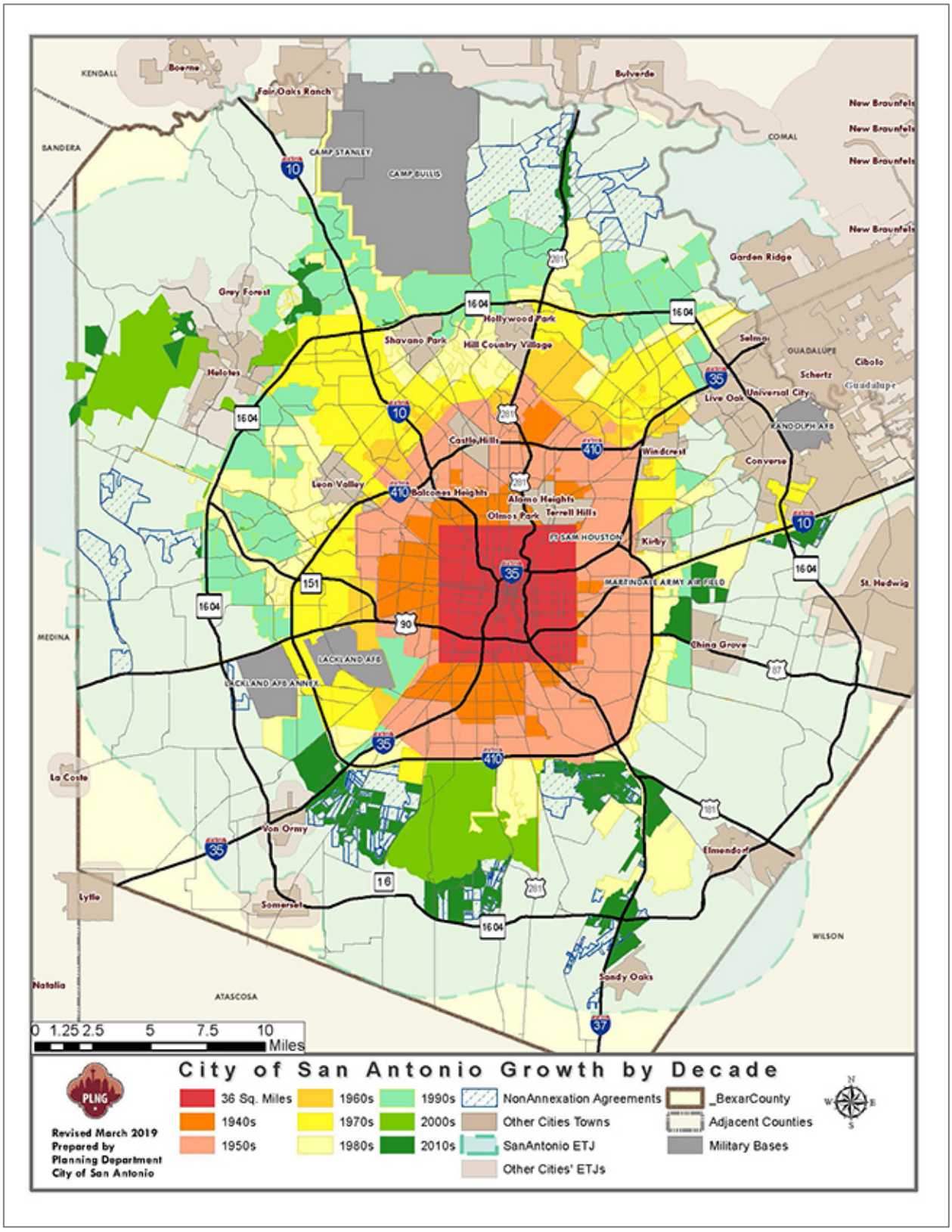
The City of San Antonio experienced an increase in population between 1980 and 2010 by 68.9%, or 541,486 people. The City continued to have population growth between 2000 and 2018 by 33.98% percent, or 389,018 people.

Table 5. Population for the City of San Antonio, 1980-2010

1980	1990	2000	2010	POP CHANGE 1980-2010	PERCENT OF CHANGE	POP CHANGE 2000-2018	PERCENT OF CHANGE
785,921	935,739	1,144,554	1,327,407	541,486	68.89%	389,018	33.98%

[6] Source: https://data.census.gov/

Figure 5. City of San Antonio Growth by Decade



Future Development

To better understand how future growth and development in the City might affect hazard vulnerability, it is useful to consider population growth and 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 and economic development.

Population projections from 2010 to 2040 are listed in Table 6, 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 County, which would mean overall growth for the City of San Antonio.

Table 6. Bexar County Population Projections

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)
1,239.82	1,714,773	1,383.1	2,093,502	1,688.6	2,502,617	2,018.5	2,914,615	2,350.8

In 2014, the City of San Antonio embarked on the momentous effort of developing a modern Comprehensive Plan. Chapter 213 of the Texas Local Government Code enables a municipality to adopt a comprehensive plan for the long-range development of a municipality. A comprehensive plan may include, but does not have to be limited to, provisions on land use, transportation, and public facilities.

The City's current comprehensive plan is the 1997 Master Plan Policies. It is important to review and update comprehensive plans periodically to meet the changing goals and needs of a community. Any future update will include resident and stakeholder input as the Comprehensive Plan is a community-based plan. The primary objective in undertaking the current Comprehensive Plan is to engage the community in the refinement and implementation of growth and development in San Antonio, which was established by the SA2020 process.

The SA2020 vision originated with a series of public forums in 2010 to develop goals for improving San Antonio by the year 2020. Thousands of San Antonians participated in the visioning process, which culminated in a detailed report, released in 2011, outlining a bold

strategic vision for San Antonio's future. The vision reflects the community's desire to support economic development and new jobs while fostering community arts, education, health, and culture. SA Tomorrow is the city's innovative, three-pronged planning effort established to implement the SA2020 vision through 2020 and beyond and includes three concurrent and complementary plans: the updated Comprehensive Plan, a Sustainability Plan, and a Multimodal Transportation Plan. These plans all work in concert to guide the City toward smart, sustainable growth.[7]

Economic Impacts

Building and maintaining infrastructure depends on the economy; therefore, protecting infrastructure from risk due to natural hazards in the planning area is important to the City of San Antonio. Whether it is expanding culverts under a road that washes out during flash flooding, shuttering a fire station, or flood-proofing a wastewater facility, infrastructure must be mitigated from natural hazards to continue providing essential utility and emergency response services in a fast-growing planning area.

Major employers in the area are critical to the health of the economy, as well as effective transportation connectivity.

THE SAN ANTONIO RIVER WALK

In Texas, water has been a lifeline for many generations for centuries. The San Antonio River is a source of a South Texas treasure, The San Antonio River Walk. While boasting as the number one tourist destination in Texas, the River Walk also serves as a complex and effective flood control project. Development of San Antonio and its most popular tourism attraction has come a long way. The San Antonio River Walk is a public park, open 365 days a year. It is a network of walkways along the banks of the San Antonio River, one story beneath approximately five miles of the downtown San Antonio area. Lined by bars, shops, and restaurants, the River Walk is an important part of the City's urban fabric and a tourist attraction in its own right.

The River Walk links the major tourist draws – from the Alamo to Rivercenter Mall, Arneson River Theatre and La Villita, the San Antonio Museum of Art, and the Pearl Brewery. Over 20 events take place on the River Walk every year.[8]

---

[7] Source: https://sacompplan.com/

[8] Source: http://www.thesanantonioriverwalk.com/about/the-san-antonio-river-walk

Section 4: Risk Overview

Hazard Identification

This section begins the risk assessment, which also includes hazard descriptions and vulnerability assessments found in Sections 5 through 21. The purpose of this section is to provide background information for the hazard identification process, as well as descriptions for the hazards identified.

Upon a review of the full range of natural hazards suggested under FEMA planning guidance, the City of San Antonio identified 11 natural hazards and six human-caused hazards that are to be addressed in the HMAP. These hazards were identified through an extensive process utilizing input from Planning Team members, and a review of the current 2018 State of Texas Hazard Mitigation Plan Update. Readily available online information from reputable sources such as federal and state agencies were also evaluated to supplement information as needed. Based on this review, ten natural hazards and one quasi-technological hazard (dam failure) were identified as significant, as shown in Table 7.

In general, there are three main categories of natural hazards: atmospheric, hydrologic, and technological. Atmospheric hazards are events or incidents associated with weather generated phenomenon. Atmospheric hazards identified as significant from Table 7 include: extreme heat, extreme wind, tornado, hail, lightning, 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 include flood, expansive soils, and drought.

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.

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 in that 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 7 for purposes of description.

The human-caused hazards include cyberattack, hazardous materials, infectious disease, pipeline failure, technological disruption, and terrorism.

Table 7. 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.
Extreme Wind	Extreme winds can have gusts of 100 mph or more and are often accompanied by hail or rain. Windstorms have a broader path that is several miles wide and can cover several counties.
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.
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 miles per hour, 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.

HAZARD	DESCRIPTION
Expansive Soils	Expansive soils are soils and soft rock that tend to swell or shrink due to changes in moisture content. Changes in soil volume present a hazard primarily to structures built on top of expansive soils.
Flood	Floods are an 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.
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 even a small dam can cause loss of life and severe property damage if development exists downstream of the dam.
HUMAN-CAUSED	
Cyberattack	A cyberattack is any type of offensive maneuver employed by individuals or whole organizations that targets computer information systems, infrastructures, computer networks, and/or personal computer devices by various means of malicious acts usually originating from an anonymous source that either steals, alters, or destroys a specified target by hacking into a susceptible system.
Hazardous Materials (Transportation & Fixed-Site)	A hazardous material (as solid, liquid, and/or gaseous contaminants) of flammable or poisonous material that would be a danger to life or to the environment if released without precaution.

HAZARD	DESCRIPTION
Infectious Disease	A clinically evident disease resulting from the presence of pathogenic microbial agents. These infecting agents may be transmitted through liquids, food, bodily fluids, contaminated objects, airborne inhalation, or vector-borne dissemination.
Pipeline Failure	Fuel pipeline breach or pipeline failure addresses the rare, but serious hazard of an oil or natural gas pipeline that, when breached, has the potential to cause extensive property damage and loss of life.
Technological Disruption	Technological disruptions can be caused by solar flares, geomagnetic storms, and power disruptions. Solar flares are a sudden, rapid, and intense flash of brightness observed over the sun's surface and they occur when magnetic energy that has built up in the solar atmosphere is suddenly released.
Terrorism	Terrorism incidents involve the application of one or more modes of harmful force to the built environment. These modes may include contamination (chemical, biological, radiological, or nuclear), energy (explosives, arson, electromagnetic waves), or denial of service (sabotage, infrastructure breakdown, and transportation service disruption). Terrorism is categorized as one of two types – domestic or international.

Hazards that were not considered significant and were not included in the HMAP are in Table 8, 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 8. Hazard Identification Process

HAZARD CONSIDERED	REASON FOR DETERMINATION
Coastal Erosion	The planning area is not located on the coast, therefore coastal erosion does not pose a risk.

HAZARD CONSIDERED	REASON FOR DETERMINATION
Earthquakes	According to the 2018 State of Texas Hazard Mitigation Plan Update, 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 community assets or vital services as a result of earthquakes and impact is not expected in the future. Notably, hydraulic fracturing to extract trapped fossil fuels can trigger earthquakes. The most densely populated areas, particularly a narrow section of Eagle Ford between San Antonio and Houston, face the greatest risk of experiencing shaking strong enough to damage buildings or be felt by people.[9] This risk will be reviewed for ongoing HMAP.
Land Subsidence	There are no historical occurrences of land subsidence for the planning area, and it is an area where occurrences are considered rare. There is no history of impact to critical structures, systems, populations, or other community assets or vital services as a result of land subsidence and impact is not expected in the future.

Hazards and Climate Change

The Risk Assessment incorporates considerations of the impact of climate change on hazard scope and impacts. The term "climate change" refers to the change in and increased variability of average climate conditions over time.[10]

Climate change is the most often observed impact of global warming, which describes the rise in average temperature across the Earth.[11] Global warming is caused by greenhouse gases (GHGs) in the atmosphere. GHGs, including methane, carbon dioxide, and nitrous oxide, are the byproducts of human activity, including burning fossil fuels through vehicle gas usage, treating water and wastewater, and processing coal for energy.[12] The increased presence of these gases contributes to what is known as the greenhouse effect, which has increased the average temperature of the planet 1.8°F in the last 150 years of industrialization.[13]

[9] Source: https://news.stanford.edu/press-releases/2021/05/03/local-impacts-fracking-eagle-ford/

[10] Source: https://www.bbc.com/news/science-environment-24021772

[11] Source: https://www.caloes.ca.gov/HazardMitigationSite/Documents/CA-Adaptation-Planning-Guide-FINAL-June-2020-Accessible.pdf

[12] Source: https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[13] Source: https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

The following sections outline the climate change projections specific to the San Antonio region, the populations most vulnerable to climate changes, and how anticipated climate conditions may impact the San Antonio community.

CLIMATE PROJECTIONS

All communities along the Texas coast face similar futures and 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. Most of the state has warmed between one-half and one degree Fahrenheit in the past century.[14]

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.

Texas also has thousands of miles of coastline that are highly vulnerable to the combined impact of sea-level rise and the potential increase of storm intensity. Human-induced climate change has caused substantial damages through increased frequency and severity of extreme events.[15]

[14] Source: https://www.epa.gov/sites/default/files/2016-09/documents/climate-change-tx.pdf

[15] Source: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

Climate Vulnerability

While climate change will impact the whole San Antonio community, there are certain communities that are particularly vulnerable to climate change and will experience disproportionate impacts. These populations include:

- Communities of color;
- Low-income communities;
- Older adults; and
- People with disabilities.[16]

While these populations have strong communities who support them in withstanding disasters, barriers created by marginalization and historic disinvestment may make it more difficult for these populations to prepare for, recover quickly, or reduce the potential impacts of disasters.[17] Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks. Figure 6 shows the socially vulnerable populations in San Antonio using the Social Vulnerability Index (SVI) with 0.76 to 1 representing high vulnerability and 0 to 0.25 representing low vulnerability. The SVI uses U.S. Census data to determine the social vulnerability of every census tract (e.g., subdivisions of counties). The SVI ranks each tract on 15 social factors, including poverty, lack of vehicle access, and crowded housing, and groups the tracts into four related themes.

REDLINING AND FLOOD INSURANCE

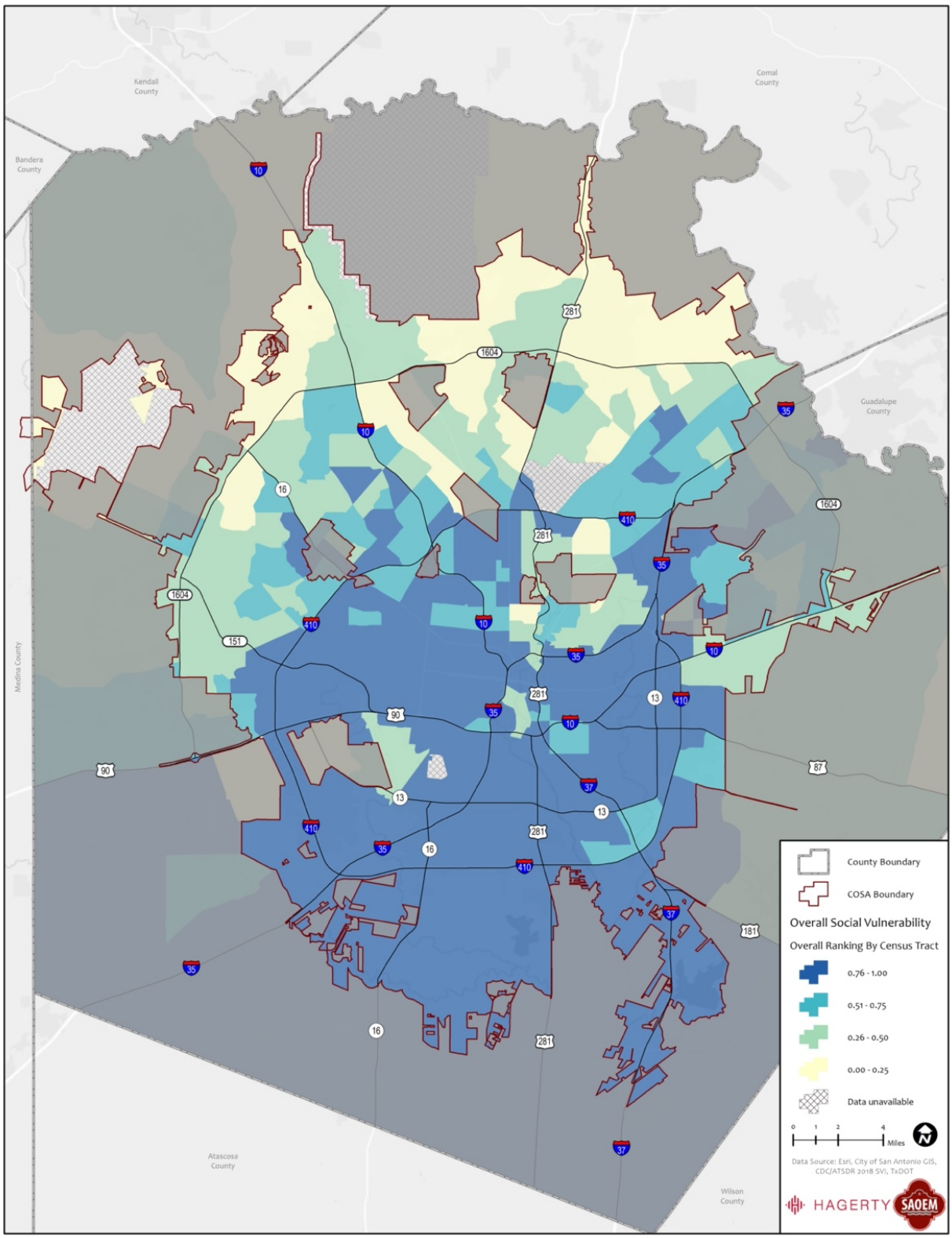
From FEMA's "Guide to Expanding Mitigation: Making the Connection to Equity"

Redlining limited access to federally backed mortgages based on race until the passage of the Fair Housing Act of 1968. Research has shown that formerly redlined areas are on average 5 degrees Fahrenheit warmer than non-redlined areas and summer surface temperatures in some areas can vary by as much as 20 degrees. Recent studies have also shown that within some urban areas, flooding losses have been concentrated in Black and low-income communities. Obtaining flood insurance to offset these impacts is out of reach for our most underserved households.

[16] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/SACRReportOctober2019.pdf

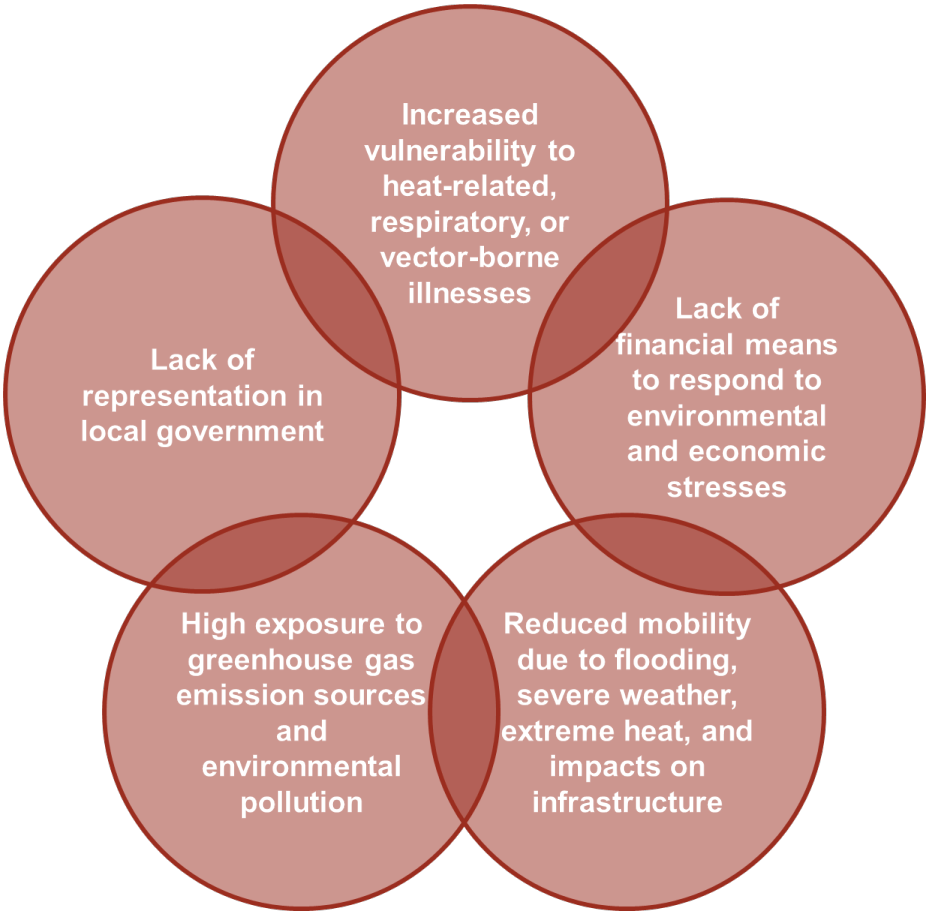
[17] Source: https://www.fema.gov/sites/default/files/2020-09/fema_region-2_guide-connecting-mitigation-equity_09-10-2020.pdf

Figure 6. Socially Vulnerable Populations in San Antonio



These communities possess multiple risk factors that qualify them as more vulnerable to San Antonio's changing climate, as identified in the SA Climate Ready: A Pathway for Climate Adaptation and Implementation.[18] Some common risk factors across these vulnerable population groups are identified in the graphic below.

Figure 7. Common Risk Factors of Populations Vulnerable to Climate Change



Comprehensive mitigation planning requires an understanding and acknowledgement of these communities who may experience disproportionate impacts of climate change. These communities may experience disrupted access to critical resources and may require specific accommodations and additional support to mitigate the impacts of disasters. The table below summarizes data related to these vulnerable populations in the City as it compares to County and State averages, as well as how these statistics impact planning for preparedness and mitigation.[19] The cells are highlighted in each row to compare relative vulnerabilities between San Antonio, Bexar County, and the State of Texas, with light pink representing lower relative risk, red representing average relative risk, and maroon representing higher relative risk.

[18] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/SACRReportOctober2019.pdf

[19] Source: http://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/.

Table 9. Summary of Vulnerable Populations in San Antonio[20]

VULNERABLE POPULATION	CATEGORY	REGION			PLANNING IMPLICATION
		SAN ANTONIO	BEXAR COUNTY	TEXAS	
Communities of Color	Residents who identify as Black, African American, Asian, Pacific Islander, or another minority race	18.4%	18.8%	24.3%	Emergency planning for these communities should be considerate of cultural differences and specific risks that these communities may experience prior to and following a disaster. Emergency planning for individuals who identify as Hispanic or Latino may be a high priority for the City.
	Residents who identify as Hispanic or Latino	64.7%	60.5%	39.4%	
Low-income Communities	Residents living below the poverty line	17.6%	15.6%	14.2%	Emergency planning should consider how to support these individuals who may have a more difficult time recovering from disasters and may not have personal monetary resources to support their recovery. These individuals may require additional financial assistance and support in accessing these resources following a disaster.
	Households living below the poverty line	13.5%	11.9%	10.9%	
	Households experiencing rent burden (i.e., 30% or more of income spent on rent)	50.9%	50.2%	48.0%	
Seniors	Residents who are age 65 or older	12.2%	12.1%	12.6%	Emergency planning should consider additional accommodations and resources that these communities may require to effectively prepare for, respond to, and recover from disasters.
People with Disabilities	Residents who live with a disability	15.1%	14.5%	11.5%	

[20] United States Census Bureau. 2019. "San Antonio, Texas." American Community Survey. http://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/.

VULNERABLE POPULATION	CATEGORY	REGION			PLANNING IMPLICATION
		SAN ANTONIO	BEXAR COUNTY	TEXAS	
Additional Indicators of Vulnerability	Residents who do not have a computer	8.1%	7.1%	7.3%	Emergency outreach and communications methods need to be accessible to effectively reach the community. Specifically, considerations for translated education materials to reach individuals with limited English proficiency and access to information for those without internet access are high priorities.
	Residents who do not have broadband internet access	17.7%	15.8%	14.9%	
	Residents who speak English less than well	12.7%	11.5%	13.3%	
	Households that do not own their residence	46.2%	41.5%	37.7%	Emergency planning should consider how to support these individuals who may have certain difficulties recovering from the impacts of a disaster.
	Residents without health insurance	17.1%	15.9%	17.3%	
	Households who do not have car access	8.1%	6.9%	5.2%	

Impact of Climate Change

The following sections describe how the anticipated increased climate conditions may impact the San Antonio community, including impact on the economy, equity, and migration. This section identifies effects of climate change in an all-hazards approach, whereas these effects on specific hazards are discussed in the hazard profiles.

ECONOMIC IMPACTS

The impacts of climate change are anticipated to disrupt critical infrastructure, property and the environment, labor capacity, and general economic health of communities.[21] San Antonio is expected to experience both direct and indirect economic effects from the increased frequency and severity of hazard events. Disasters enhanced by climate change will likely cause increased infrastructure and property damage and associated repair costs, especially from wildfire and precipitation events.[22] The anticipated unfavorable climate conditions will increase the demand for critical assets, causing these resources (e.g., water, food, electricity) to become more expensive. Additionally, certain industries with a reliance on favorable climates (e.g., agriculture, tourism) will experience negative effects of the evolving conditions.[23]

INCORPORATING CLIMATE RISK INTO CREDIT RATING

From "Miami Beach Receives Strong Credit Ratings on General Obligation Bonds"

The City of Miami Beach received two high-grade ratings on its general obligation bonds from Moody's and S&P recently due to their investment in resilient infrastructure and planning. The credit rating models utilized by Moody's and S&P incorporate considerations of risks from climate change and severe weather events. Both agencies acknowledged and commended the City for their focus on resilient projects, including investments in elevation of sidewalks and roadways, expansion of stormwater infrastructure, and planning for sea-level rise.

The impacts on industries, infrastructure, property, and critical resources will have consequential impacts on the community. Reduced agriculture production will reduce local food security.[24] The decreased availability and increased cost of these resources, impact on industries and employment opportunities, and

[21] Source: https://nca2018.globalchange.gov/

[22] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/Vulnerability-Risk-Assessment.pdf

[23] Source: https://news.climate.columbia.edu/2019/06/20/climate-change-economy-impacts/

[24] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/Vulnerability-Risk-Assessment.pdf

more significant and frequent impact on personal property will increase the economic burden on individual households and their capacity to contribute to the local economy.[25]

Climate change is and will continue to impact how cities are insured and how they choose to finance mitigation projects that also address climate risk. Insurance is a key component in mitigating climate risk. In addition to increasing resilience to the economic impacts of climate risk, insurance can promote awareness of climate risk within the community, provide additional incentives for mitigation, and stimulate economic growth. Maintaining adequate levels of insurance to the anticipated disasters that have been enhanced by climate change will continue to become more prevalent for cities.[26]

Studies have shown that traditional municipal financing mechanisms, including taxes, user fees, and general obligation bonds, may not be sufficient alone to fund these projects, and the approach to funding projects is evolving to better consider climate risks.[27] Different types of bonds are currently used to fund resiliency projects, including green bonds, social bonds, resilience bonds, and catastrophic bonds.[28] These funding sources may become more prevalent in the future as they fill the gap in financial resources for infrastructure projects. Credit issuing agencies are evolving their rating methodologies to award higher ratings for proposals that promote climate resiliency. In this way, cities are encouraged to implement capital projects that increase a community's resiliency to climate change to receive a higher rating and lower associated interest rates.

CLIMATE EQUITY

The San Antonio Climate Ready Plan states "equity means that our policymaking, service delivery, and distribution of resources account for the different histories, challenges, and needs of the people we serve" and that "a climate equity framework prioritizes the communities burdened the most by climate change, those that contribute the least to climate change, and those most socially vulnerable to it."[29] Climate equity is a key consideration for mitigation planning to identify key mitigation projects to support the City's climate equity goals. San Antonio has identified five core components of climate equity: access and accessibility, affordability, cultural preservation, health, and safety and security.[30] The mitigation planning and implementation process will actively seek, include, and prioritize input from vulnerable

---

[25] Source: https://news.climate.columbia.edu/2019/06/20/climate-change-economy-impacts/

[26] Source: https://www.climatepolicyinitiative.org/wp-content/uploads/2021/10/Building-Climate-Resilience-in-Cities-Through-Insurance.pdf

[27] Source: https://www.adaptationclearinghouse.org/resources/financing-climate-resilience-mobilizing-resources-and-incentives-to-protect-boston-from-climate-risks.html

[28] Source: https://treasury.worldbank.org/en/about/unit/treasury/impact/impact-report

[29] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/SACRReportOctober2019.pdf

[30] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/SACRReportOctober2019.pdf

communities, prioritize benefits to these communities; and reduce existing burdens and bar additional burdens to these communities.

CLIMATE MIGRATION

Climate migration describes changes in the patterns of geographic residential areas based on the climate and disasters. Impacts of climate change that may be the most significant cause of migration include the increased scarcity of critical resources, increased unlivable conditions (e.g., extreme heat), and increased vulnerability to disasters. As such, climate change is anticipated to displace populations in areas most vulnerable to changing conditions and cause proactive migration before intense disasters arrive.[31]

The City of San Antonio is anticipated to experience both direct and indirect impacts of climate migration. As the extreme temperatures continue to increase and the San Antonio region experiences more extreme hazard events, populations may choose to move to areas with more favorable climate conditions. The City is additionally at risk for mobility disruption for residents and community members and increased reliance on and demand for emergency management resources.[32]

Additionally, the City will likely receive populations displaced by climate migration for short periods of time and permanently. San Antonio is close to the coast of Texas and coastal communities, which are particularly vulnerable to impacts of climate change related to flooding and sea level rise. Sea level rise is the phenomenon by which the height of oceans increases due to global warming. The increased global average temperature melts ice sheets and glaciers, which then increase the overall volume of liquid water in the oceans. Increased sea level rise leads to more frequent and severe flooding.[33] Galveston, a nearby coastal city, has experienced nearly 19 inches in sea level rise since 1970.[34] As an inland City, San Antonio can anticipate more frequent receptions of evacuees from coastal communities, as well as individuals who choose to permanently resettle from the coast. The influx of population can place an increased burden on critical resources and community systems (e.g., electricity, hospitals, shelters) to support these individuals.

---

[31] Source: https://www.unhcr.org/en-us/climate-change-and-disasters.html

[32] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/Vulnerability-Risk-Assessment.pdf

[33] Source: https://climate.nasa.gov/vital-signs/sea-level/

[34] Source: https://sealevelrise.org/states/texas/

Overview of Hazard Analysis

METHODOLOGIES

This risk assessment was conducted using two distinct methodologies: HAZUS-MH (FEMA's loss estimation software) and a statistical approach. Each approach provides estimates of potential impact by using a common, systematic framework for evaluation.

The HAZUS-MH risk assessment methodology is parametric in that distinct hazard and inventory parameters (e.g., wind speed and building types) were modeled using the HAZUS-MH software to determine the impact (e.g., damages and losses) on the built environment. The HAZUS-MH software was used to estimate losses from flooding.

HAZUS-MH is FEMA's standardized loss estimation software program built upon an integrated geographic information system (GIS) platform. This risk assessment applies HAZUS-MH to produce regional profiles and estimate losses for flooding.

Records retrieved from the National Centers for Environmental Information (NCEI) and National Oceanic and Atmospheric Administration (NOAA) were reported for the City of San Antonio planning area. Remaining records identifying the occurrence of hazard events in the planning area and the maximum recorded magnitude of each event were also evaluated.

Geographic information system (GIS) technology was used to identify and assess risks for the City of San Antonio planning area and evaluate community assets and their vulnerability to the hazards.

COMPONENTS OF HAZARD PROFILES

Each hazard profiled in the Risk Assessment is described through six different parameters:

- Hazard Description: The cause, characteristics, and types of hazard (e.g., meteorological, hydrologic, and agricultural drought).
- Location: Where in the City of San Antonio the hazard may occur.
- Extent: How the magnitude of a hazard event is measured.
- Historical Occurrences: Recent hazard events recorded within the San Antonio region.
- Probability of Future Events: Likelihood of a hazard event occurring.
- Vulnerability and Impact: Description of how a hazard event may impact the San Antonio area, including critical assets that may be affected.

Each Probability of Future Events section includes a frequency of return statement. Frequency of return was calculated by dividing the number of events in the recorded time period for each hazard by the overall time period for which the resource database was recording events, when possible. Where past hazard events are not a strong indicator of future events (e.g., terrorism),

research and best practices were utilized to determine the frequency of return. The frequency of return statements are defined in Table 10.

Table 10. Frequency of Return Statements

PROBABILITY	DESCRIPTION
Highly Likely	Event is probable in the next year.
Likely	Event is probable in the next 2-5 years.
Unlikely	Event is probable in the next 10 years.

Each Vulnerability and Impact section includes an Assessment of Impacts section, which quantitatively analyzes the total assets that may be subject to damages from a hazard. 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 out the percentage of damage each hazard can cause to the community. Hazard vulnerability for the City of San Antonio was reviewed based on recent development changes that occurred throughout the City. To better understand how future growth and development in the City 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.

Hazard Risk Ranking

METHODOLOGY

The Hazard Risk Ranking is a way to evaluate relative risk of hazards in the HMAP. Five metrics were selected to consider in the Hazard Risk Ranking approach, as identified in the figure below.

Figure 8. Hazard Risk Ranking Metrics

These metrics, further defined in the table below, were selected to comprehensively understand how hazards may pose a risk to the overall community on average, how hazards

may impact a small portion of the population more significantly, and how climate change may alter the frequency, magnitude, or impact of hazard events.

Table 11. Definitions of Hazard Risk Ranking Metrics

METRIC	DEFINITION
Hazard Probability	How likely a hazard event is to occur
Generalized Severity	How significantly a hazard impacts the overall San Antonio community
Acute Severity	How significantly a hazard impacts vulnerable populations
Climate Change	How climate change may exacerbate hazard conditions
Community Concern	Community perception of hazard risk

These metrics were applied to each hazard and rated as one of three categories with increasing risk, as identified in Table 12 below. For example, for the Generalized Severity metric, a hazard is rated as Low Impact, Medium Impact, or High Impact depending on the effect of an event on the community. Each rating has a corresponding point score ranging from 1 to 3 with increasing risk (i.e., Low Impact is 1, Medium Impact is 2, High Impact is 3).

The ratings assigned to each hazard were assessed based on information collected through:

- Previous hazard occurrences and known impacts on the community;
- Document review and additional research regarding impacts of hazards and effects of climate change;
- Validation with HMAP Planning Team and the results of public outreach efforts (e.g., survey).

The following table identifies the ratings and associated descriptions for each of the five metrics.

Table 12. Hazard Risk Ranking Metric Approach

RATING	SCORE	RATING DESCRIPTION
HAZARD PROBABILITY		
Unlikely	1	Hazard event occurs less than once every five years.
Likely	2	Hazard event occurs at least once every five years.
Highly Likely	3	Hazard event occurs once or more every year.
GENERALIZED SEVERITY		
Low Impact	1	Limited impact on human life. Critical facilities and services impacted for less than a week. Few properties sustain damage.

RATING	SCORE	RATING DESCRIPTION
Medium Impact	2	Multiple individuals sustain injuries and a few deaths recorded. Critical facilities and services significantly impacted for one to two weeks. Significant portion of building stock sustains damage or is destroyed.
High Impact	3	Multiple deaths recorded. Critical facilities and services impacted for multiple weeks. Significant to most of building stock sustains major damage.
ACUTE SEVERITY		
Low Impact	1	Hazard event does not significantly impact vulnerable populations.
Medium Impact	2	Hazard event damages or significantly impacts vulnerable populations, including impacts on individual wellbeing and critical assets (e.g., school, library, grocery) located in those communities.
High Impact	3	Hazard event significantly impacts vulnerable populations and assets located in their community.
CLIMATE CHANGE		
Low Effect	1	Insignificant effect from climate change on hazard is anticipated. Modeling projections are uncertain on whether there is increased future risk.
Medium Impact	2	Studies and modeling projections indicate a potential for exacerbated hazard conditions due to climate change.
High Effect	3	Studies and modeling projections indicate significant exacerbated conditions/increased future risk due to climate change.
COMMUNITY CONCERN		
Low Concern	1	Residents have little to no concerns regarding the impact of the hazard.
Medium Concern	2	Residents have some concerns regarding the impact of the hazard.
High Concern	3	Residents have significant concerns regarding the impact of the hazard.

Once each hazard was assessed, the scores were multiplied to create a final Composite Hazard Score, where higher composite scores indicate a hazard that is a greater risk. These scores were later grouped into three categories: Low Risk, Medium Risk, and High Risk to reflect the overall risk of the hazard to San Antonio.

RANKING RESULTS

The table below identifies the scoring assigned to each of the hazard risk ranking metrics.

Table 13. Hazard Risk Ranking Scores

HAZARD	HAZARD PROBABILITY	GENERALIZED SEVERITY	ACUTE SEVERITY	CLIMATE CHANGE	COMMUNITY CONCERN[35]	RISK CATEGORY
Cyber Attack	Likely	Medium Impact	Medium Impact	Low Effect	Medium Concern	Medium
Dam Failure	Unlikely	High Impact	Medium Impact	Medium Effect	Low Concern	Low
Drought	Highly Likely	Medium Impact	Medium Impact	High Effect	High Concern	High
Expansive Soils	Unlikely	Low Impact	Low Impact	Medium Effect	Low Concern	Low
Extreme Heat	Highly Likely	Low Impact	High Impact	High Effect	High Concern	High
Extreme Wind	Highly Likely	Medium Impact	Medium Impact	Low Effect	Low Concern	Low
Flood	Highly Likely	High Impact	High Impact	High Effect	Medium/High Concern	High
Hail	Highly Likely	Low Impact	Medium Impact	Low Effect	Medium/High Concern	Low
Hazardous Materials	Highly Likely	High Impact	Medium Impact	Low Effect	Medium Concern	Medium
Infectious Disease	Unlikely	Medium Impact	High Impact	High Effect	High Concern	Medium
Lightning	Highly Likely	Low Impact	Low Impact	Medium Effect	Medium Concern	Low
Pipeline Failure	Highly Likely	Medium Impact	Medium Impact	Medium Effect	Low Concern	Medium

[35] The Community Concern metric was developed through stakeholder meetings in the Spring of 2022 and public surveys conducted during July and August 2022.

HAZARD	HAZARD PROBABILITY	GENERALIZED SEVERITY	ACUTE SEVERITY	CLIMATE CHANGE	COMMUNITY CONCERN[35]	RISK CATEGORY
Technological Disruption	Unlikely	Medium Impact	Medium Impact	Low Effect	Medium Concern	Low
Terrorism	Unlikely	High Impact	Medium Impact	Medium Effect	Medium Concern	Medium
Tornado	Likely	High Impact	Low Impact	Low Effect	Medium/High Concern	Low
Wildfire	Highly Likely	Medium Impact	Medium Impact	High Effect	Medium Concern	High
Winter Storm	Likely	High Impact	Medium Impact	Medium Effect	High Concern	High

Per the results of this analysis, the hazards were ranked into low-, medium-, and high-risk categories, as identified in the table below. The hazards that pose the greatest risk to San Antonio are drought, extreme heat, flood, wildfire, and winter storm.

Table 14. Low-, Medium-, and High-Risk Hazards

LOW RISK	MEDIUM RISK	HIGH RISK
Dam Failure	Cyber Attack	Drought
Expansive Soils	Hazardous Materials	Extreme Heat
Extreme Wind	Infectious Disease	Flood
Hail	Pipeline Failure	Wildfire
Lightning	Terrorism	Winter Storm
Technological Disruption		
Tornado		

Section 5: Drought

Hazard Description

Drought is a period 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, usually a season or more in length. Drought can be classified as meteorological, hydrologic, agricultural, and socioeconomic. Table 15 presents definitions for these different types of drought.

Drought is one of the most complex of all natural hazards as it is difficult to determine its precise beginning or end. In addition, droughts can lead to other hazards such as extreme heat and wildfires. Its impact on wildlife and area farming is enormous, often killing crops, grazing land, edible plants, and even in severe cases, trees. A secondary hazard to drought is wildfire because dying vegetation serves as a prime ignition source. Therefore, a heat wave combined with a drought is a very dangerous situation.

Therefore, a heat wave combined with a drought is a very dangerous situation.

Table 15. Drought Classification Definitions[36]

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.

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

The Edwards Aquifer is San Antonio's main source of drinking water, accounting for 51.2% of the water for the San Antonio Water System. The health of the aquifer defines the region's drought rules. The Edwards Aquifer Authority, which regulates the aquifer's use, declares drought for the San Antonio region when the Edwards' monitoring well drops below an average of 660 feet above sea level for 10 or more days. When the region is in a drought, low water levels threaten local spring flows.[37]

DROUGHT AND CLIMATE CHANGE

In the United States, average temperature has increased by 1.9°F since 1895, with most of the increase occurring in the last 30 years. The Fourth National Climate Assessment highlighted an increased risk of drought and wildfire risk, particularly in the Southwest and Southern Great Plains, including Texas. As air temperatures warm, more water evaporates out of soils, oceans, lakes, rivers, and streams resulting in drier conditions. However, this also means that when a storm comes along, there is more water vapor available for the storm to pick up and dump as precipitation. This relationship explains the increasing risk of stronger droughts and increase in heavy precipitation events observed across the United States and around the world.[38] Climate change is anticipated to increase the frequency, severity, and length of drought in many parts of the U.S, including Texas and San Antonio. Climate change contributes to drought by:[39]

- Enhancing evaporation, which reduces surface water and dries out soils and vegetation. This makes periods with low precipitation drier than they would be in cooler conditions.
- Altering the timing of water availability. Some climate models find that warming increases precipitation variability creating more periods of extreme precipitation and drought.
- Making certain regions drier. The Southwestern U.S. has seen a decrease in annual precipitation since the beginning of the 20th century, a trend is expected to continue.

Location

Drought occurs regularly throughout Texas and San Antonio and is a normal condition. However, drought can vary greatly in intensity and duration. There is no distinct geographic boundary to drought; therefore, therefore it can occur anywhere throughout the City of San Antonio.

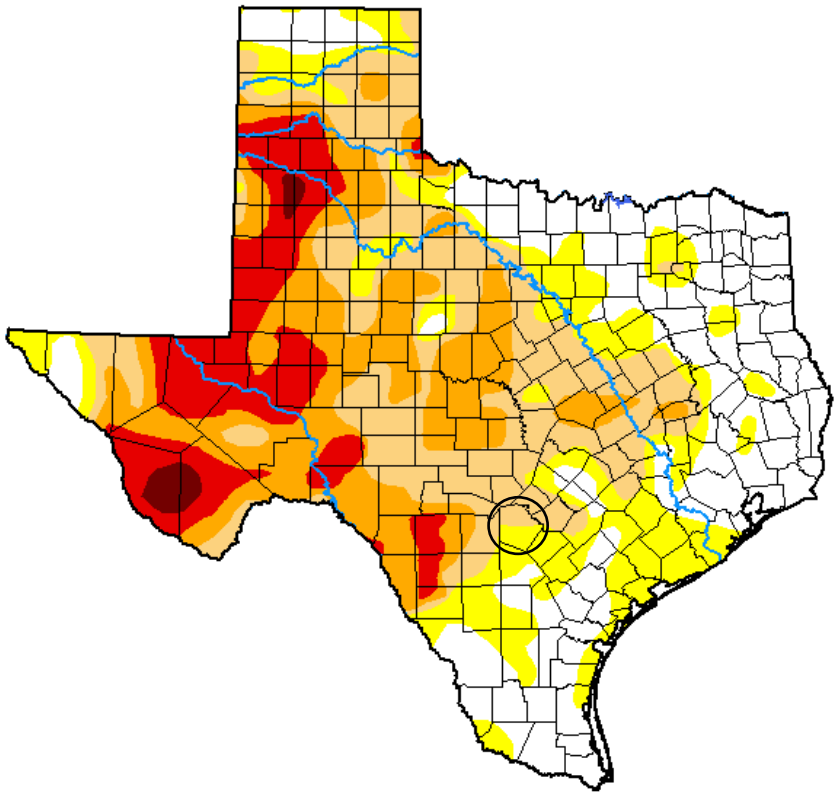
---

[37] https://sanantonioreport.org/san-antonio-longer-drier-droughts-wildfires/

[38] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/SCIPP-SanAntonioClimateTrends.pdf

[39] Drought and Climate Change | Center for Climate and Energy Solutions (c2es.org)

Figure 9. U.S. Drought Monitor, September 2020



U.S. Drought Monitor

Texas

September 1, 2020

(Released Thursday, Sep. 3, 2020)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	26.75	73.25	55.13	32.72	13.09	0.98
Last Week *08-25-2020*	29.44	70.56	57.27	33.49	12.24	0.74
3 Months Ago *06-02-2020*	66.44	33.56	14.17	1.32	0.00	0.00
Start of Calendar Year *12-31-2019*	44.69	55.31	36.12	9.19	0.74	0.00
Start of Water Year *10-01-2019*	31.74	68.26	46.05	22.33	6.32	0.00
One Year Ago *09-03-2019*	33.59	66.41	42.90	10.26	1.73	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

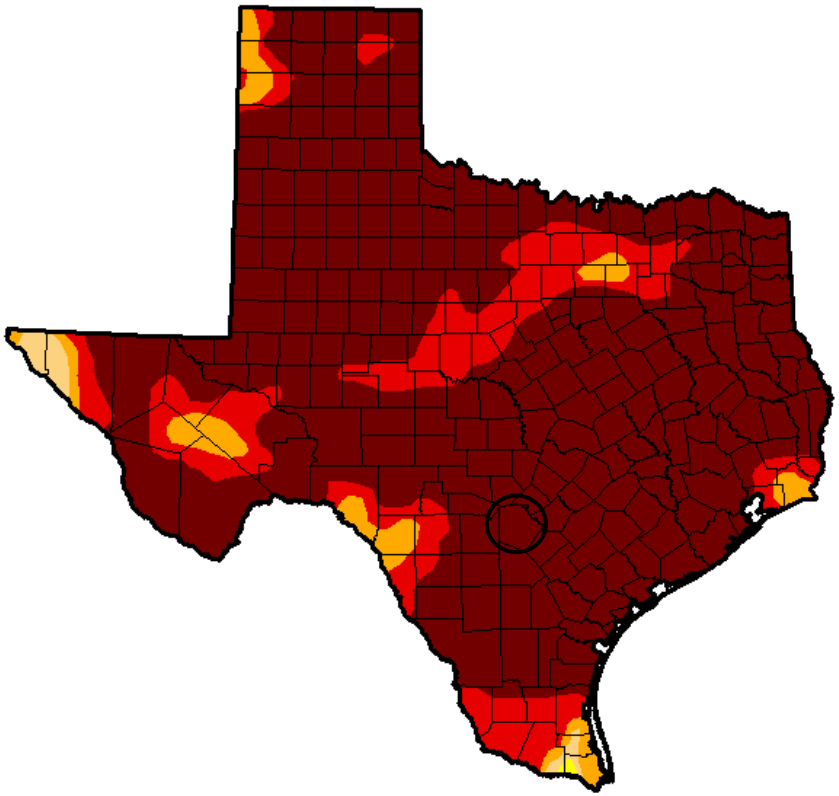
Richard Tinker
CPC/NOAA/NWS/NCEP

droughtmonitor.unl.edu

Figure 10. U.S. Drought Monitor, August 2011

U.S. Drought Monitor

Texas



August 30, 2011

(Released Thursday, Sep. 1, 2011)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	99.92	99.01	95.04	81.08
Last Week 8/23/2011	0.00	100.00	99.93	99.01	94.42	77.80
3 Months Ago 5/31/2011	2.25	97.75	96.07	91.89	81.09	50.65
Start of Calendar Year 1/4/2011	13.55	86.45	66.68	36.30	13.04	0.00
Start of Water Year 9/28/2010	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago 8/31/2010	51.29	48.71	11.50	0.68	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Eric Luebehusen
U.S. Department of Agriculture

http://droughtmonitor.unl.edu/

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, with the intensity of drought during the current month dependent upon the current weather patterns plus the cumulative patterns of previous months. The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop. Table 16 depicts magnitude of drought, while Table 17 describes the classification descriptions.

Table 16. Palmer Drought Severity Index

DROUGHT 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

Table 17. Palmer Drought Category Descriptions[40]

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

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

Based on the historical occurrences of drought and the location of the City of San Antonio in south central Texas between the Edwards Plateau to the northwest and the Gulf Coastal Plains to the southeast, the area can anticipate a range of drought from abnormally dry to exceptional, or D0 to D4, based on the Palmer Drought Category. The entire planning area has experienced exceptional drought conditions. These are the most extreme drought conditions the planning area can anticipate in the future.

[40] Source: National Drought Mitigation Center

Climate change projections indicate that average daily maximum temperatures for San Antonio are set to increase, together with a reduction in annual levels of precipitation and increase in occurrence of drought. Texas has experienced a rise of cumulative dryness since 1975, despite a slight increase of precipitation over the same period. Since 1985, precipitation has become more variable, with 2011 precipitation below 14" and 2015 precipitation above 41". Greater precipitation variability leads to more intense droughts, even if the overall precipitation doesn't change. Although it is impossible to make quantitative projections of drought trends, most factors point towards increased drought severity.[41]

Historical Occurrences

The City of San Antonio may typically experience an extreme drought. Table 18 and Table 19 lists historical events that have occurred in Bexar County, as reported in the National Centers for Environmental Information (NCEI). Historical drought information, as provided by the NCEI, shows drought activity across a multi-county forecast area for each event; therefore, the drought data for the City of San Antonio is included with the Bexar County data. The appropriate percentage of the total property and crop damage reported for the entire forecast area has been allocated to each county impacted by the event.

Table 18. Historical Drought Years, 1996-2020[42]

DROUGHT YEAR	
1996-1997	2013[43]
2000	2014
2011-2012	2019[44]
2012	

Table 19. Historical Drought Events, 1996-2020

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	4/1/1996	0	0	$0	$0
Bexar County	5/1/1996	0	0	$0	$0
Bexar County	6/1/1996	0	0	$0	$0
Bexar County	7/1/1996	0	0	$0	$0

[41] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1990-2036
[42] Data is reported from January 1996 through April 2020.
[43] Two separate events occurred within the same year.
[44] Two separate events occurred within the same year.

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	8/1/1996	0	0	$0	$0
Bexar County	9/1/1996	0	0	$0	$0
Bexar County	10/1/1996	0	0	$0	$0
Bexar County	11/1/1996	0	0	$0	$0
Bexar County	12/1/1996	0	0	$0	$0
Bexar County	1/1/1997	0	0	$0	$0
Bexar County	2/1/1997	0	0	$0	$0
Bexar County	7/1/2000	0	0	$0	$0
Bexar County	8/1/2000	0	0	$0	$0
Bexar County	9/1/2000	0	0	$0	$0
Bexar County	10/1/2000	0	0	$0	$0
Bexar County	5/1/2011	0	0	$0	$0
Bexar County	6/1/2011	0	0	$0	$0
Bexar County	7/1/2011	0	0	$0	$0
Bexar County	8/1/2011	0	0	$0	$0
Bexar County	9/1/2011	0	0	$0	$0
Bexar County	10/1/2011	0	0	$0	$0
Bexar County	11/1/2011	0	0	$0	$0
Bexar County	12/1/2011	0	0	$0	$0
Bexar County	1/1/2012	0	0	$0	$0
Bexar County	6/1/2012	0	0	$0	$0
Bexar County	3/1/2013	0	0	$0	$0
Bexar County	4/1/2013	0	0	$0	$0
Bexar County	8/1/2013	0	0	$0	$0
Bexar County	8/1/2014	0	0	$0	$0
Bexar County	9/1/2014	0	0	$0	$0
Bexar County	10/1/2014	0	0	$0	$0
Bexar County	11/1/2014	0	0	$0	$0

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	3/31/2019	0	0	$0	$0
Bexar County	4/1/2019	0	0	$0	$0
Bexar County	9/1/2019	0	0	$0	$0
Bexar County	10/1/2019	0	0	$0	$0

Based on the list of historical drought events for the City of San Antonio planning area (listed above), four of the events have occurred since the previous HMAP update.

SIGNIFICANT EVENTS

September 1, 2019

Most of South Central Texas received less than 50% of normal precipitation during July, August, and September, and a large part of the region had less than 25%, resulting in drought conditions. Atascosa, Bexar, De Witt, Gonzales, Guadalupe, Hays, Karnes, Kendall, Lee, Medina, Travis, Uvalde, and Val Verde Counties went into Severe (D2) drought. Comal, Frio, Kinney, Llano, Maverick, Williamson, and Wilson Counties went into Extreme (D3) drought. Zavala County remained in D2 and Dimmit County in D3. Stage 2 water restrictions were instituted in parts of Guadalupe and Hays counties. Stage 1 restrictions were in place in Atascosa, Bexar, Comal, Karnes, Kendall, Llano, Medina, Travis, Uvalde, and Williamson counties and voluntary restrictions were encouraged in Bastrop, Dimmit, Gonzales, Lee, Val Verde, Wilson, and Zavala. Burn bans were in place in all the affected counties except Williamson and Uvalde.

August 1, 2013

Except for a small part of the southeast and a few other isolated spots, most of the region received near or below normal rainfall. Atascosa, Bexar, Karnes, Llano, and Wilson counties moved into Stage D2. Fire danger at the end of the month was low to moderate. The Texas Crop and Weather Report issued by Texas A&M agricultural program indicated extremely dry conditions continued in most of the region with rangeland and pastures in poor condition. The Nueces, Rio Grande, Lower Guadalupe, and San Antonio River basins reported below normal (10 to 24 percent) flow. Area lakes and reservoirs continued well below normal pool elevations. The Edwards Aquifer Authority remained in Stage 3 water restrictions as the aquifer dropped to 26 feet below normal, and 8.6 feet below the level at the end of July 2012. This meant that large water users were required to reduce pumping by 35%. The San Antonio Water System remained at Stage 2 water restrictions.

September 1, 2011

El Nino Southern Oscillation conditions moved back into a La Nina phase and the drought continued over South Central Texas. Most of the area remained in exceptional drought conditions (Stage D4). Fire danger in South Central Texas was high to very high and burn bans continued for all of the counties. The Texas A&M Agricultural program report indicated ranchers continued to provide heavy supplemental feeding for livestock or began to liquidate herds. There was little or no sign of appreciable forage growth. At the end of the month, the seven day stream flow average remained in the below or much below normal range for basins across South Central Texas and the Rio Grande Plains. Area lakes and reservoirs remained below normal pool elevations with the Edwards Aquifer 21.5 feet below normal and 32.8 feet below the level from one year ago. The San Antonio Water System (SAWS) and the City of San Marcos remained in Stage 2 water restrictions. Many other communities across South Central Texas continued with some level of water restrictions.

October 1, 1996

Drought persisted October through January across the southwestern part of South Central Texas, although heavy rainfall alleviated conditions over much of the Hill Country near the end of the month in October. Brief periods of light rain, sleet, and snow during the month again added some moisture to soils across the area December through January.

Probability of Future Events

Based on 36 recorded drought events over nine extended time periods within a 24-year reporting period, the City of San Antonio averages one drought event every two to three years. This lends to a highly likely frequency of occurrence, meaning a drought can be expected on an annual year cycle. As global temperature increases by 1, 2, 3 and 4°C, the risk of dry conditions across Texas is projected to increase in the spring. In the summer, Central Texas initially shows little change. However, by the time the earth warms by +3°C, dry conditions are projected to become more frequent in summer as well.[45] The number of consecutive dry days will likely increase slightly over time. Table 20 outlines precipitation projections for the City of San Antonio. Table 21 outlines temperature projections for the City of San Antonio.

[45] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/SCIPP-SanAntonioClimateTrends.pdf

Table 20. Precipitation Projections for the City of San Antonio

PRECIPITATION	BASE LINE (1971-2000) OBSERVED	NEAR-TERM (2011-2040)		MID-CENTURY (2041-2070)		END-OF-CENTURY (2071-2100)	
		LOWER PATHWAY	HIGHER PATHWAY	LOWER PATHWAY	HIGHER PATHWAY	LOWER PATHWAY	HIGHER PATHWAY
Annual precipitation	32.5 inch	29.4 inch	29.8 inch	29.6 inch	29.5 inch	29.7 inch	28.7 inch
Dry days[46]	243.3 days	228.9 days	228.4 days	232.1 days	234.8 days	233.2 days	241.1 days
Longest dry period	63.4 days	46.6 days	43.7 days	46.2 days	49.3 days	54.1 days	56.6 days

Table 21: Temperature Projections for the City of San Antonio

TEMPERATURE	BASE LINE (1971-2000) OBSERVED	NEAR-TERM (2011-2040)		MID-CENTURY (2041-2070)		END-OF-CENTURY (2071-2100)	
		LOWER PATHWAY	HIGHER PATHWAY	LOWER PATHWAY	HIGHER PATHWAY	LOWER PATHWAY	HIGHER PATHWAY
Summer maximum temperature	101.1 °F	105.3 °F	105.5 °F	107.2 °F	108.5 °F	107.8 °F	111.8 °F
Average summer daytime maximum temperature	94.7 °F	97.3 °F	97.3 °F	98.9 °F	100.1 °F	99.5 °F	103.1 °F
Hot days[47]	7 days	30.7 days	31.0 days	46.6 days	61.4 days	55.1 days	101.4 days
Very hot days[48]	0 days	0.06 days	0.12 days	0.39 days	1.08 days	0.64 days	.22 days

[46] Measured as less than 0.01 inches of precipitation in 24 hours.
[47] Defined as days with a maximum temperature greater than 100°F
[48] Defined as days with a maximum temperature greater than 110°F

According to the Fourth National Climate Assessment, there is a *high confidence* (i.e., strong evidence, consistent results, and well documented and accepted methods) that there will be an increased frequency of drought due to climate change.[49]

Vulnerability and Impact

Loss estimates were based on 24 years of statistical data from the NCEI. A drought event frequency-impact was then developed to determine an impact profile on agriculture products and estimate potential losses due to drought in the area. Table 22 shows annualized exposure.

Table 22. Potential Annualized Losses for City of San Antonio

JURISDICTION	PROPERTY & CROP LOSS	ANNUAL LOSS ESTIMATES
City of San Antonio	$0	$0

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 in water shortages and crop/livestock losses on agricultural lands and typically have no impact on buildings.

According to the Fourth National Climate Assessment, the population of Texas is projected to grow by more than 70% between 2020 and 2070, with the majority of the increase projected to occur in urban centers. Increased demand for water will come from municipal, power generation, agriculture, manufacturing, and livestock uses. Over this same period, water availability in the U.S. Southwest is projected to decrease due to a shift to a more drought-prone climate state. As the population of San Antonio increases, more people will become vulnerable to the impacts of drought.[50,51]

Drought presents a significant threat to agricultural property and lands, which are typically dependent on a large, reliable supply of water for irrigation and livestock support. Perhaps the greatest vulnerability to property is the decrease in the supply of water for fire suppression purposes. While fire is not necessarily a result of droughts, the loss of available water, and the resulting loss of available water pressure within delivery systems, makes fire suppression more challenging.

Habitat damage is a vulnerability of the environment during periods of drought, for both aquatic and terrestrial species. The environment also becomes vulnerable during periods of extreme or prolonged drought due to severe erosion and land degradation.

---

[49] https://nca2018.globalchange.gov/chapter/23/

[50] Ibid.

[51] Vulnerability-Risk-Assessment.pdf (sanantonio.gov)

Typical demand can deplete water resources during extreme drought conditions. As resources are depleted, potable water is in short supply and overall water quality can suffer, elevating health concerns for all residents but especially vulnerable populations – typically children, the elderly, the ill, and those living below the poverty level. In addition, potable water is used for drinking, sanitation, patient care, sterilization, equipment, heating and cooling systems, and many other essential functions in medical facilities.

The average person will survive only a few days without potable water, and this timeframe can be drastically shortened for those people with more fragile health – typically children, the elderly, and the ill. An estimated 11.8% of the total population in the City of San Antonio planning area are residents over age 65 and an estimated 7.1% are children under the age of 5 – for an estimated total of 280,364[52] potentially vulnerable residents in the planning area based on age. In addition, an estimated 19.4% of the planning area population live below the poverty level (Table 23) which may contribute to overall health impacts of a drought.

Table 23. Populations at Greater Risk

JURISDICTION	POPULATION 65 AND OLDER	POPULATION UNDER 5	POPULATION BELOW POVERTY LEVEL
City of San Antonio	175,230	105,134	297,736

Drought can produce a complex web of effects spanning many sectors of the economy, reaching well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. If drought extends over several years, the direct and indirect economic impact can be significant.

Habitat damage is a vulnerability of the environment during periods of drought for both aquatic and terrestrial species. The environment also becomes vulnerable during periods of extreme or prolonged drought due to severe erosion and land degradation.

Impact of droughts experienced in the City of San Antonio planning area has resulted in no injuries or fatalities supporting a "Limited" severity of impact, meaning injuries and/or illnesses are treatable with first aid, shutdown of facilities and services for 24 hours or less, and less than 10% of property is destroyed or with major damage. Annualized loss over the 24-year reporting period in Bexar County and the City of San Antonio is considered negligible.

[52] US Census Bureau 2018 data for City of San Antonio

ASSESSMENT OF IMPACTS

The Drought Impact Reporter was developed in 2005 by the University of Nebraska-Lincoln to provide a national database of drought impacts. Drought can have an impact on agriculture; business and industry; energy; fire; plants and wildlife; relief, response, and restrictions; society and public health; tourism and recreation; and water supply and quality. Table 24lists the drought impacts to Bexar County from 2005 to 2020, based on reports received by the Drought Impact Reporter.

Table 24. Drought Impacts, 2005-2020

DROUGHT IMPACTS 2005-2020	
Agriculture	55
Business & Industry	3
Energy	1
Fire	47
Plants & Wildlife	45
Relief, Response & Restrictions	46
Society & Public Health	9
Tourism & Recreation	1
Water Supply & Quality	38

Drought has the potential to impact people in the City of San Antonio. While it is rare that drought, in and of itself, leads to a direct risk to the health and safety of people in the U.S., severe water shortages could result in inadequate supply for human needs. Drought also is frequently associated with a variety of impacts, including:

- Health-related low-flow issues (e.g., diminished sewage flows, increased pollution concentrations, reduced firefighting capacity, cross-connection contamination);
- Public safety from forest/range/wildfires;
- Increase in respiratory ailments;
- Increase in disease due to wildlife concentrations (e.g., rabies, Rocky Mountain spotted fever, Lyme disease);
- Increase in conflict over water use/water rights;
- Increase in political conflicts between municipalities, counties, states, and regions;
- Water management conflicts between competing interests; and
- Increased law enforcement activities to enforce water restrictions.

Potential impacts on response personnel include those that could affect the population as a whole. In addition, response personnel would also be impacted by increased health risks associated with reduced water supplies and in the event of increased conflict or social unrest, either among the members of the population or in inter-jurisdictional disputes or conflicts.

Firefighters would likely be impacted first, as they respond to higher fire risk and may have limited water resources to aid in firefighting and suppression activities. This would likely result in significantly increased risk and frustration as the ability of the personnel to perform their job functions would be decreased. In addition, law enforcement personnel could be called upon to enforce water restrictions or rationing, which would result in an increased workload. Emergency Medical Services (EMS) personnel could also experience an increased workload, as illness and disease related to drought become more common. Finally, City utility personnel would likely be negatively impacted, either through increased workload (e.g., repairs, modification of delivery systems) or through layoffs, which could result from dramatic decreases in revenue as water supplies diminish.

Drought is not an immediate threat to the ability to operate and deliver City services, outside of a few departments and areas (discussed below). While some services may need to be cut back, the actual ability to operate and deliver some level of service should not be at risk for most departments. Firefighting and suppression could be heavily impacted, as the delivery of this service is dependent on the availability of both water and water pressure. As water/water pressure availability decreases, the ability of the fire department to fight or suppress large fires could be compromised at a time of increased probability of fire, as the environment becomes drier. An increase in the number of fires may tax the fire department's ability to respond to fires, which may cause the fire department to increase its reliance on mutual aid agreements. This may be problematic if mutual aid agreements are with communities whose drought conditions are similar, or worse. Though firefighting and suppression activities will continue, the risk is that they will do so at a decreased level and with increased help from outside agencies and communities.

The service that will be the most directly impacted is utilities, both water delivery and electric (for those producers that rely on hydroelectric production or nuclear power generation methods, as some providers in the region do). Without a steady supply of water, utilities may cut back energy generation and service to their customers and possibly to prioritize the service they are able to provide. For example, utility providers may be pressed to provide water or electricity to critical facilities (such as hospitals) before providing power to residential or commercial areas. Smaller providers may be unable to absorb the increase in costs associated with seeking alternate water sources and may be forced to cease operations.

Hydroelectric power generation facilities and infrastructure would likely be affected the most. As the amount of water available for power generation diminishes, the generation equipment will decrease the output, which will result in less electricity produced. Dams simply cannot produce as much electricity from low water levels as they can from high water levels.

Though drought is a naturally occurring phenomenon, it still poses risks to the natural environment. A variety of environmental issues and changes are associated with long-term drought, including:

- Reduction and degradation of fish and wildlife habitat;
- Loss/lack of food and water for animals and livestock;
- Rise in wildlife mortality due to increased contact with agricultural producers as animals seek food/water from farms and producers become less tolerant of intrusions;
- Disease;
- Increased vulnerability to predation (from species gathering in concentrations near water);
- Increased migration and concentration (loss of wildlife in some areas, and too much wildlife in other areas);
- Increased stress to endangered species; and
- Loss of biodiversity.

Plants suffer from long-term drought, possibly resulting in loss of biodiversity and trees from landscapes, shelterbelts, and conservation areas. Wind and water erosion of the soil also poses a long-term risk to plants as they result in reduced soil quality. Air quality is also affected by drought because of an increase in both dust and pollutants. Finally, plants are also exposed to the increased danger of wildfire that may follow long-term drought.

Drought also poses a significant risk to the hydrological environment of the area. Low water levels, reduced flow, loss of wetlands, and increased salinity are all risks to the area's water supply as a result of long-term drought. In addition, the area may subsequently experience increased groundwater depletion, land subsidence, and reduced recharge areas and there may be a decrease in the water quality, by way of increased salinity, temperature, pH, dissolved oxygen, and turbidity.

While the historic/cultural resources of the area are not directly at risk from a drought, the tourism industry they rely on for support may be. As recreational activities that rely on water are curtailed (such as hunting, fishing, and bird watching), fewer tourists may be inclined to visit the area. Less tourism means less revenue, which means less support for those historic and cultural resources that rely on tourism for their maintenance.

Cultural sites that rely on water can also be at risk from drought, such as aqueducts and dams. Some historic and cultural sites and structures could be subject to damage from subsidence or wildfire that can accompany or follow drought.

Drought poses risk to agricultural and livestock producers. Drought is associated with a variety of issues, such as:

- Annual and perennial crop losses;
- Degradation of crop quality;
- Reduced productivity of land and animals;
- Insect infestation, plant/animal disease;
- Increased costs of irrigation; new costs for supplemental water resource development;
- Decreased livestock weight;
- Increased livestock mortality/forced reduction in livestock; and
- Increased costs for feed; closure of land for grazing.

Food suppliers can also anticipate an increase in food costs because of increases in production costs and crop and livestock losses. All these issues lead to a potential reduction in income for these sectors of the economy, which can have an overall negative effect on the economy.

Sectors that rely on timber or timber production also may be impacted by drought. The timber industry is usually directly impacted by drought through wildfires, tree disease, or both, leading to a decrease in supply while the demand level generally remains stable.

Fisheries also will be negatively impacted as they will suffer damage to fish habitats (either natural or manufactured) and a loss of fish and/or other aquatic organisms due to decreased water flows or availability.

The energy sector may see an increase in demand and a reduction in supply due to drought-related water curtailments. This often leads the energy industry, and by extension consumers, to substitute more expensive energy sources, such as oil, for less-available hydroelectric power.

Water suppliers often experience dramatic revenue shortfalls or windfall profits, depending on their level of advance planning for drought conditions. For those that did not plan accordingly and suffer revenue shortfalls, increased costs are also common, resulting from the need for water transport/transfer and/or new/supplemental water resource development.

The general economy can suffer from a variety of drought-related impacts, including:

- Decreased land values;
- Loss to industries directly dependent on agriculture production, such as machinery and fertilizer manufacturers, food processors, dairies, etc.;

- Increase in unemployment from drought-related declines in production;
- Increased strain on financial institutions in the form of foreclosures, increased credit risks, and capital shortfalls;
- Revenue losses to federal, state, and local governments due to reductions in the tax base;
- Reduction of economic development;
- Reduction in agricultural producers, due to bankruptcies, people leaving the profession, etc.; and
- Loss of rural population.

Public dissatisfaction with government drought response will typically increase as water becomes more restricted and/or scarce. Perceptions of inequality in relief, particularly if those inequalities are based on socioeconomic status, ethnicity, age, gender, or position, will lead to increased dissatisfaction with government and leadership, and may result in a weakening of social order. Rationing, if necessary, should be implemented with a clear and fair process to avoid the appearance of bias or impropriety.

The San Antonio Water System has permanently implemented water conservation programs. The agency's public website provides specific, detailed information regarding current water conservation efforts, drought restrictions, rebate programs, and City ordinance information. In addition, the website provides information on landscaping ideas, success stories and best practices, and a mechanism for the public to report water waste. This website serves to keep the public involved in conservation efforts and eliminates "surprise" water use restrictions or conditions. As a result, public confidence in the ability to supply sufficient water resources is maintained.

Section 6: Extreme Heat

Hazard Description

Extreme heat is a prolonged period of excessively high temperatures and exceptionally humid conditions. Extreme heat during the summer months is a common occurrence throughout the State of Texas, including the City of San Antonio. The City of San Antonio typically experiences extended heat waves. A heat wave is an extended period of extreme heat and is often accompanied by high humidity.

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

EXTREME HEAT AND CLIMATE CHANGE

Over the last 150 years, long-term weather station records have documented a near 2°F increase in the Earth's average temperature.[53] Texas will be among the states most severely impacted by climate change temperature increases. As the Earth's climate warms, hotter than usual days and nights are becoming more common and heat waves are expected to become more frequent and intense. Climate change is making Texas hotter, threatening public health, water supply, and the state's infrastructure. Over the past 45 years, the linear trend shows an approximate doubling of the number of triple-digit days at stations in all four regions of Texas.[54,55]

Location

Though deaths from extreme heat have been recorded in Bexar County, there is no specific geographic scope to the extreme heat hazard. Extreme heat could occur in any area of the City

[53] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/SCIPP-SanAntonioClimateTrends.pdf

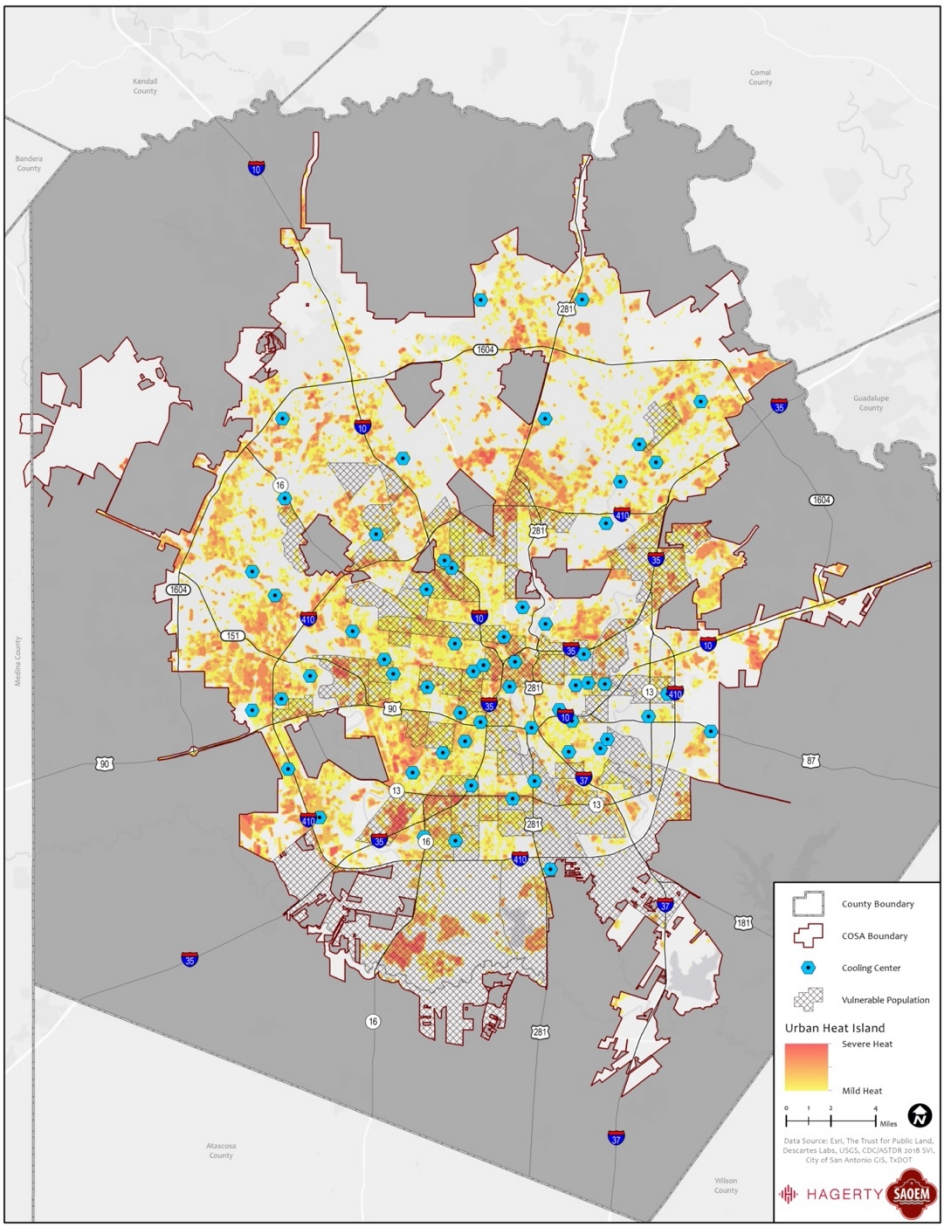
[54] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1990-2036

[55] Climate Change Indicators: Drought | US EPA

of San Antonio. Urban heat islands are developed areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes, such as forests and water bodies. Urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures compared to outlying areas. In general, daytime temperatures in urban areas are about 1-7°F higher than temperatures in outlying areas and nighttime temperatures are about 2-5°F higher.[56] Figure 11 displays the urban heat islands in San Antonio, with the darker red indicating more severe heat.

[56] Heat Island Effect | US EPA

Figure 11: Urban Heat Islands in San Antonio



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 12. This index measures how hot it feels outside when humidity is combined with high temperatures.

Figure 12. Extent Scale for Extreme Summer Heat[57]

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 12 displays varying categories of caution depending on the relative humidity combined with the temperature. For example, when the temperature is at 90 degrees Fahrenheit (F) or lower and the humidity level is at or above 40 percent, caution should be exercised.

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 category of intensity and it indicates when 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 25.

Table 25. Heat Index & Warnings

CATEGORY	HEAT INDEX	POSSIBLE HEAT DISORDERS	WARNING TYPE
EXTREME DANGER	125°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	103 – 124°F	Sunstroke, muscle cramps, and/or heat exhaustion are likely. Heatstroke possible with prolonged exposure and/or physical activity.	

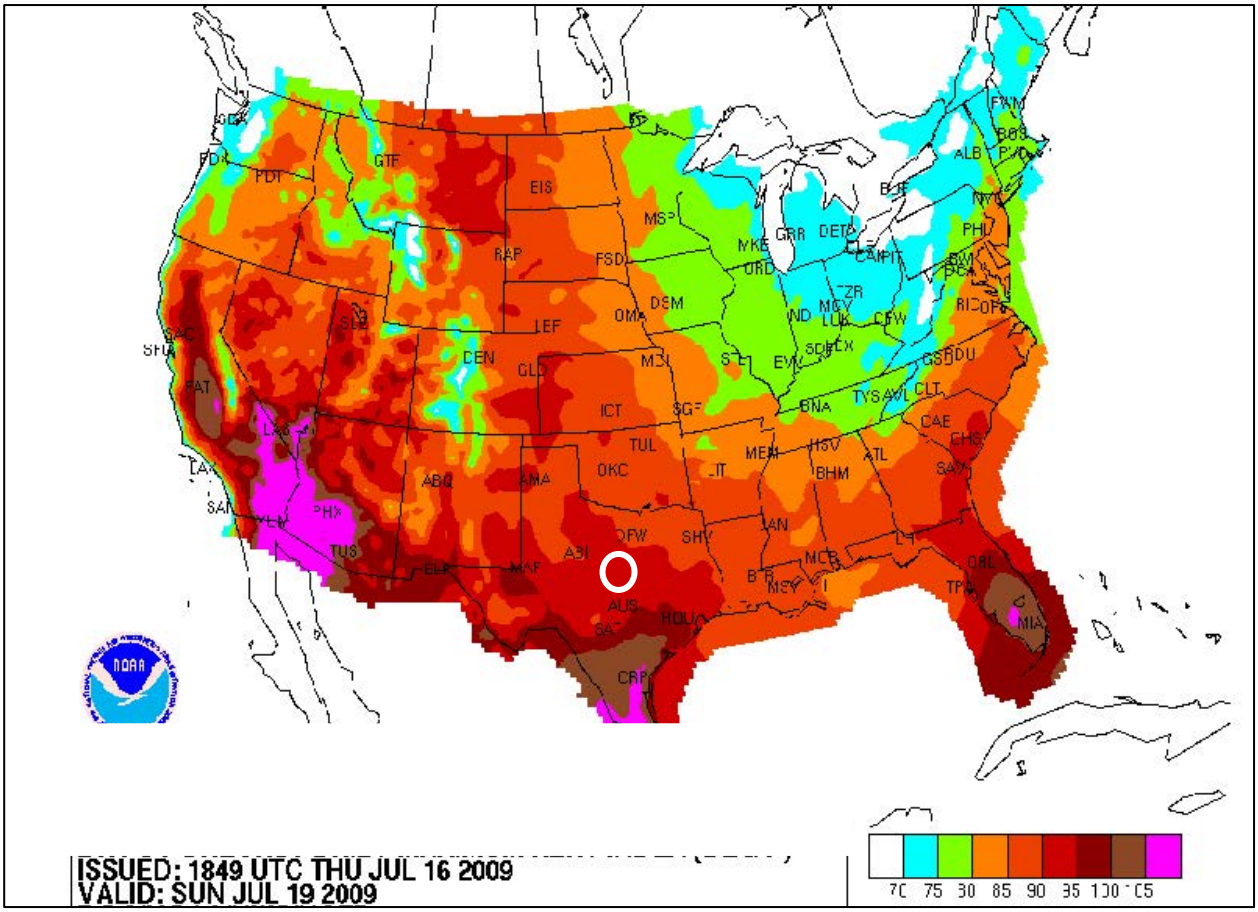
[57] Source: NOAA

CATEGORY	HEAT INDEX	POSSIBLE HEAT DISORDERS	WARNING TYPE
EXTREME CAUTION	90 – 103°F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.	An Excessive Heat Warning is issued if the Heat Index rises above 105°F at least 3 hours during the day or above 80°F at night.
CAUTION	80 – 90°F	Fatigue is possible with prolonged exposure and/or physical activity.	

The City of San Antonio is a gently rolling terrain located in South Central Texas between the Edwards Plateau and the Gulf Coastal Plains. Northwest of the area, the terrain slopes upward to the Edwards Plateau, and to the southeast it slopes downward to the Gulf Coastal Plains. Soils are Blackland clay and silt loam on the Plains and thin limestone soils on the Edwards Plateau. The area is dotted with oak trees, mesquite, and cacti. Due to its geography, and its warm, muggy semitropical climate with hot summers, the City of San Antonio can expect an extreme heat event each summer. 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, those working or remaining outdoors are at risk.

Figure 13 displays the daily maximum heat index as derived from NOAA based on data compiled from 1849 to 2019. The City of San Antonio has an average daily maximum Heat Index of 90-95°F. Using the Heat Index, the City of San Antonio falls within the "Caution" to "Danger" category, meaning the average extent to mitigate for citizens in the planning area is sunstroke, muscle cramps, and heat exhaustion.

Figure 13. Average Daily Maximum Heat Index[58]



Climate change is expected to lead to an increase in average temperatures as well as frequency, duration, and intensity of extreme heat events. Due to the impacts of climate change, the City of San Antonio's average daily maximum Heat Index between 90°F and 95°F is expected to increase to between 100°F and 105°F. Annual average temperatures in the Southern Great Plains are projected to increase by 3.6°F to 5.1°F by the mid-21st century and by 4.4°F to 8.4°F by the late 21st century, and are dependent on future scenarios, with higher levels of greenhouse gas emissions leading to greater and faster temperature increases. Given past and projected temperature trends, there has been a near-doubling of the number of 100°F days between 2001-2020. Extreme summer heat is approaching values not seen since the early part of the 20th Century and is likely to surpass them by 2036. The typical number of triple-digit days by 2036 is projected to be about 40% larger than typical values so far in the 21st Century.[59]

[58] Source: NOAA and the white circle indicates the City of San Antonio.

[59] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1990-2036

The City of San Antonio's Heat Vulnerability Assessment Tool is an interactive map of San Antonio that displays surface temperatures. This tool enables residents to compare surface temperatures by month and locate hot spots in the city.[60]

Historical Occurrences

Every summer, the hazard of heat-related illness becomes a significant public health issue throughout much of the U.S. 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. Data from the Texas Department of State Health Services, Center for Health Statistics suggest that between 2000 and 2019, record high summer temperatures in Texas resulted in 962 heat-related deaths statewide. For privacy reasons, the Center for Health Statistics suppresses the exact number of deaths. Table 26 depicts historical occurrences of mortality from heat from 2000 to 2019 in Bexar County, the asterisk (*) indicates a count between 1-9 deaths per year.

Table 26. Extreme Heat Related Deaths in Bexar County and Texas[61]

YEAR	BEXAR COUNTY	TEXAS
2000	1	64
2001	*	26
2002	*	38
2003	2	44
2004	1	44
2005	1	65
2006	1	55
2007	0	20
2008	1	35
2009	2	45
2010	*	64
2011	*	122
2012	*	40

[60] Source: https://www.sasustainability.com/category/climate-adaptation

[61] 2003 through 2008 provided by Texas Health and Human Services via : https://www.dshs.texas.gov/chs/vstat/Hotcolddths/occcounty.shtm. Additional data from 2000 through 2020 provided by NCEI.

YEAR	BEXAR COUNTY	TEXAS
2013	*	33
2014	0	24
2015	0	37
2016	1	53
2017	10	36
2018	0	46
2019	1	71

According to the San Antonio Metropolitan Health District (Metro Health), between 2011 and 2019 the City of San Antonio has reached Readiness Levels II or III every summer, meaning the heat index value was 105°F or greater for at least two hours. For heat related incidents located solely within Bexar County, there are six heat waves[62] on record according to the National Centers for Environmental Information (NCEI) (Table 27). 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 and crop damage reported for the entire forecast area has been allocated to each county impacted by the event.

Table 27. Historical Extreme Heat Events, 2000-2020

JURISDICTION	DATE	DEATHS (DIRECT)	DEATHS (INDIRECT)	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	5/27/2000	1	0	0	$0	$0
Bexar County	7/2/2009	2	0	0	$0	$0
Bexar County	8/12/2016	0	1	0	$0	$0
Bexar County	7/22/2017	0	10	0	$0	$0
Bexar County	7/23/2018	0	0	0	$0	$0
Bexar County	9/21/2019	0	1	0	$0	$0

Based on the list of historical extreme heat events for the City of San Antonio planning area (listed above), four of the events have occurred since the previous HMAP update.

[62] Even though the City experiences heat waves each summer, National Centers for Environmental Information (NCEI) data only records events reported. Based on reports, only two events are on record.

SIGNIFICANT EVENTS

July 2, 2009

A prolonged heat wave from the end of June through early July brought record temperatures and heat advisories to South Central Texas. 82-year-old twins died in their home in San Antonio. The cause of death was heat stroke according to the medical examiner. The twins did not want to use a fan or air conditioning, stating that they were on a fixed income and were trying to save money. High temperatures were at or near 100°F in San Antonio that day and previous days as well.

July 23, 2018

Strong high pressure settled over South Central Texas and temperatures soared to record levels. The heat wave started on July 19, 2018, in Burnet, Frio, Llano, Medina, Travis, and Williamson Counties with high temperatures reaching 105°F and higher. The hot temperatures spread across the region reaching its greatest extent on the 23rd. During this time, Austin Bergstrom International Airport had record highs each day from July 20-23, Austin Camp Mabry from July 21-23, and San Antonio from July 22-23. Both Austin sites set the all-time record high for the month on the 23rd, Bergstrom 109°F and Camp Mabry 110°F. The extreme heat broke on the 24th when highs dropped closer to 100°F.

Probability of Future Events

Annual and seasonal temperatures are expected to increase for the United States and the State of Texas over the 21st century. By the end of this century, projected data indicate increases in annual temperatures across the South-Central Great Plains with an average +5-6 °F under the lower pathway and +9-10 °F under the higher pathway.[63] Bexar County, including the City of San Antonio, experiences an extreme heat event every year – according to historical records, the NOAA average daily maximum heat index, and local data by Metro Health. Hence, the future probability of excessive summer heat in the City of San Antonio is highly likely. Summer maximum temperatures, average summer daytime maximum temperatures, number of warm nights (over 80 °F), and number of hot days (over 100 °F) are projected to increase over time. Additionally, very hot days (over 110 °F) will occur in the future and will increase in frequency over time and the number of cold nights (below 32 °F) is projected to decrease over time. Table 28 outlines temperature projections for the City of San Antonio. [64]

[63] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/San-Antonio-Climate-Projections.pdf

[64] https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/San-Antonio-Climate-Projections.pdf

Table 28: Temperature Projections for the City of San Antonio

TEMPERATURE	BASE LINE (1971-2000) OBSERVED	NEAR-TERM (2011-2040)		MID-CENTURY (2041-2070)		END-OF-CENTURY (2071-2100)	
		LOWER PATHWAY	HIGHER PATHWAY	LOWER PATHWAY	HIGHER PATHWAY	LOWER PATHWAY	HIGHER PATHWAY
Summer Maximum Temperature	101.1 °F	105.3 °F	105.5 °F	107.2 °F	108.5 °F	107.8 °F	111.8 °F
Average summer daytime maximum temperature	94.7 °F	97.3 °F	97.3 °F	98.9 °F	100.1 °F	99.5 °F	103.1 °F
Cold nights[65]	21.8 days	15.9 days	15.5 days	12.6 days	10.0 days	10.9 days	5.7 days
Warm nights[66]	0.30 nights	2.1 nights	2.2 nights	6.5 nights	15.9 nights	10.1 nights	55.6 nights
Hot days[67]	7 days	30.7 days	31.0 days	46.6 days	61.4 days	55.1 days	101.4 days
Very hot days[68]	0 days	0.06 days	0.12 days	0.39 days	1.08 days	0.64 days	8.22 days

[65] Defined as days with a minimum temperature less than 32°F
[66] Defined as days with a maximum temperature greater than 80°F
[67] Defined as days with a maximum temperature greater than 100°F
[68] Defined as days with a maximum temperature greater than 110°F)

There is great certainty in projected increases in extreme annual and seasonal temperatures and increased frequency of high-temperature extremes. These trends are already being experienced throughout the United States and are expected to continue over the century.[69] According to the Fourth National Climate Assessment, there is a very high confidence (i.e.., strong evidence, consistent results, and high consensus) that extreme heat will increase in frequency and intensity. Increasing average temperatures as well as increasing frequency, duration, and intensity of extreme heat events will occur in Texas by the middle and end of this century, with higher CO2 emissions leading to greater and faster temperature increases. The expected number of extreme heat days is likely to double. At the global scale, additional temperature increases between 3.6°F and 9°F are expected by the end of the century, depending on the amount of carbon emissions humans produce.[70]

Vulnerability and Impact

There is no defined geographic boundary for extreme heat events. While all the planning area is exposed to extreme temperatures, existing and future buildings, infrastructure, and critical facilities are not considered vulnerable to significant damage caused by extreme heat events. Therefore, estimated property losses associated with extreme heat are anticipated to be minimal across the planning area.

Extreme temperatures do however present a significant threat to life and safety for the population of the city 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 frequently 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. Children may also be more vulnerable if left unattended in vehicles. Homeless populations are also extremely vulnerable to heat events due to direct exposure due to a lack of shelter.[71] In addition, populations living below the poverty level are unable to run air-conditioning on a regular basis and are limited in their ability to seek medical treatment. Another segment of the population at risk are those whose jobs consist of strenuous labor outdoors. Additionally, livestock and crops can become stressed, decreasing in quality or in production, during times of extreme heat.

Extreme heat is a major public health concern in San Antonio. The trend of increasing frequency and duration of heat events ("heat waves") is expected to continue in the future due

---

[69] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/SAClimateReady/San-Antonio-Climate-Projections.pdf

[70] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/SCIPP-SanAntonioClimateTrends.pdf

[71] Source: https://www.fredvictor.org/2021/06/06/seven-ways-you-can-help-the-homeless-during-hot-weather/#:~:text=Homeless%20people%20can%E2%80%99t%20escape%20the%20heat%20themselves.%20Extreme,headache%2C%20rapid%20breathing%20and%20heartbeat%2C%20and%20extreme%20thirst.

to the impacts of climate change. Exposure to extreme heat can cause a variety of health problems, including heat stroke and even death. Heat is a concern for many people but primarily older individuals and those who work outside. According to the CDC, the heat seems to take the hardest toll on those who are retirement age (65 and older).[72] Additionally, economically disadvantaged households are also more likely to dwell in older, substandard housing that is poorly insulated and/or uses inefficient HVAC equipment and other appliances. This cost burden can compel families to endure unsafe temperatures rather than incur a bill they cannot afford, which puts lower income communities at a greater risk of heat related illnesses.[73]

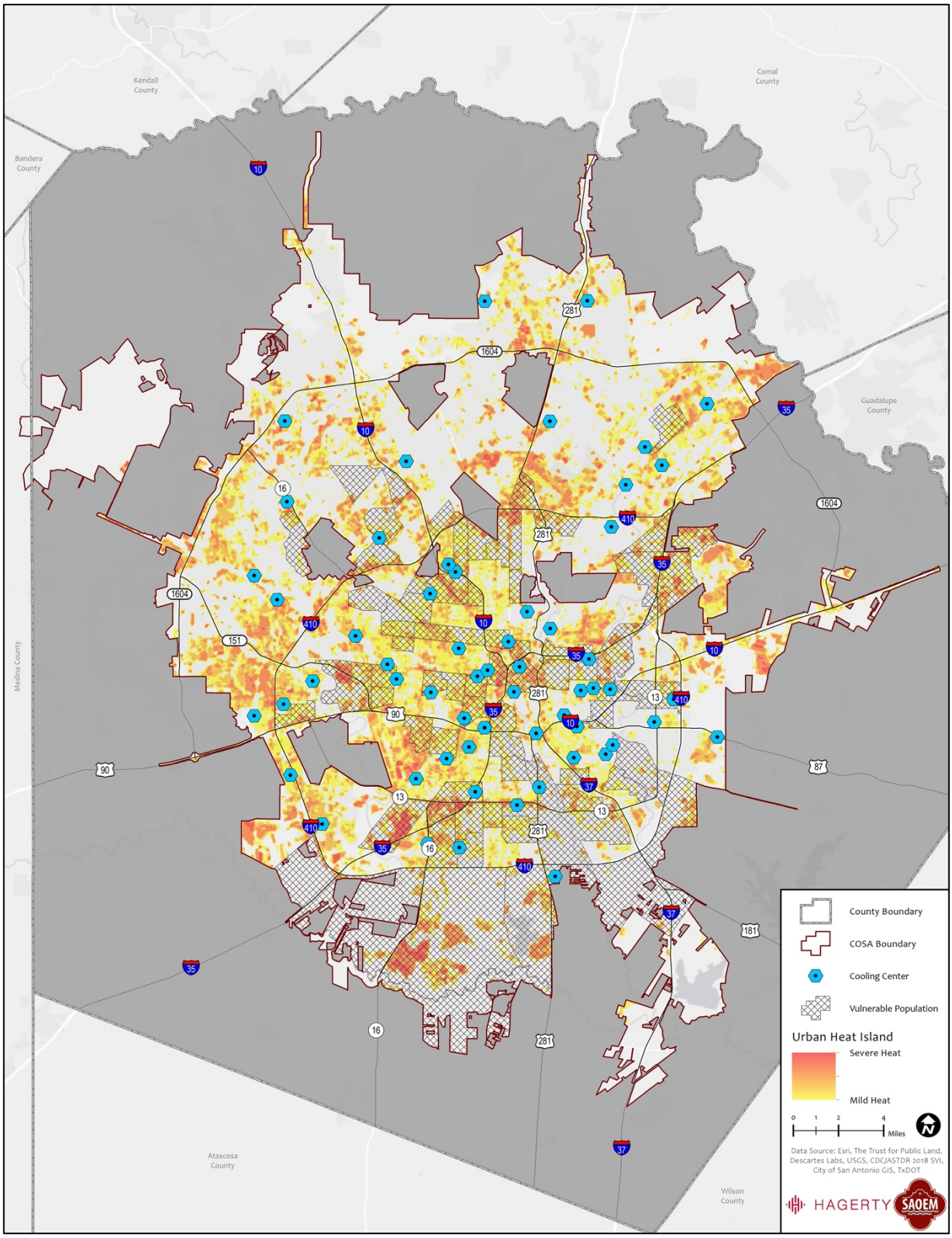
San Antonio has taken a variety of measures to protect the public from high temperatures, including cooling centers. The use of cooling centers, a cool site, or air-conditioned building designated as a safe location during extreme heat, is an effective strategy.[74] Figure 14 displays the urban heat islands in San Antonio overlayed with cooling centers and vulnerable populations to outline how these three factors align.

[72] Source: https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/ClimateChangeImpact-Report-THC.pdf

[73] https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/ClimateChangeImpact-Report-THC.pdf

[74] The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation (cdc.gov)

Figure 14: Urban Heat Islands, Cooling Centers, and Socially Vulnerable Populations in San Antonio



An estimated 11.8% of the total population in the City of San Antonio planning area are residents over age 65 and an estimated 7.1% are children under the age of 5 – for an estimated total of 280,364 potentially vulnerable residents in the planning area based on age. In addition, an estimated 19.4% of the planning area population live below the poverty level (Table 29) which may contribute to overall health impacts of extreme heat.

Table 29. Populations at Greater Risk

JURISDICTION	POPULATION 65 AND OLDER	POPULATION UNDER 5	POPULATION BELOW POVERTY LEVEL
City of San Antonio	175,230	105,134	297,736

Extreme high temperatures can have significant cascading impacts, leading to droughts, water shortages, increased fire danger, and excessive demands for energy. Typically, more than 12 hours of warning time would be given before the onset of an extreme heat event. Only minor property damage would result. The potential impact of excessive summer heat is considered "Minor" as injuries and/or illnesses do not result in permanent disability.

In terms of vulnerability to structures, the impact from extreme heat would be negligible. It is possible that critical facilities and infrastructure could be shut down for 24 hours if cooling units are running constantly, leading to a temporary power outage. Less than 10 percent of residential and commercial property could be damaged if extreme heat events lead to structure fires.

The potential impact of extreme heat for the City of San Antonio can be considered "Minor," resulting in few injuries and minimal disruption to the quality of life. Based on historical records over a 14-year period, annualized losses for the City of San Antonio are negligible.

ASSESSMENT OF IMPACTS

The greatest risk from extreme heat is to public health and safety. Exposure to high temperatures, even indoors, can cause serious or life-threatening health problems, particularly for children and the elderly, who are less able to regulate body temperature than healthy adults. Human health concerns associated with hot temperatures include hyperthermia; heat cramps; heat exhaustion; and heat stroke (or sunstroke). Hot weather and crime are positively correlated, particularly violent crimes. Scientists have predicted that every 1° Celsius increase in temperature can lead to an average 6% increase in homicides. Women are most likely to bear the greatest burden of increased violence.[75]

[75] https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/ClimateChangeImpact-Report-THC.pdf

Response personnel are subject to the same risks and impacts as the general public. For this hazard, the risk to response personnel includes utility workers, public works personnel, and any other professions where individuals are required to work outside. Response personnel would be more affected by extreme heat than the general population since their exposure would be greater.

The services that will be the most directly impacted are energy utilities. Extreme heat can overwhelm transmission lines and even cause them to sag – a result of the metal inside of them expanding. These factors, coupled with a surge in demand, can lead to partial outages, rolling blackouts, and potential grid failure.[76] The Electric Reliability Council of Texas (ERCOT) manages the flow of electric power to 23 million Texas customers. According to ERCOT, air conditioning drives summer peak demands. During hot summer days, residential consumers use more than half the power consumed. These high demand periods can outpace the supply of energy. ERCOT urges conservation from consumers during these heat-related events. If supply exceeds demand, rolling brownouts could be necessary. Heat can also be linked to drought, which can create challenges for hydropower and thermal plants that rely on water for temperature control. Thermoelectric generation such as coal and nuclear, which utilize water for cooling, can be heavily impacted by drought and hot water temperatures. The efficiencies of the plant also decrease if it is not sufficiently cooled.[77] Additionally, energy rolling brownouts and blackout can impact water delivery.

Highways, roads, airport runways, and railway lines are damaged by excessive heat causing asphalt roads to soften and melt.[78] Concrete roads have been known to "explode," lifting three-to-four-foot pieces of concrete from the surface. During the 1980 heat wave, hundreds of miles of highways buckled.[79] Extreme heat can also make train travel dangerous by causing railroad tracks to bend. When temperatures rise, steel tracks will expand. Heat expansion places a lot of stress on the ties, ballasts, and rail anchors that keep the tracks fixed to the ground. Eventually, the tracks can buckle under the force.[80] Heat stress is also placed on automobile cooling systems, diesel trucks, and railroad locomotives, which can ultimately lead to an increase in mechanical failures. Additionally, rail refrigerated goods experience a significantly greater rate of spoilage due to extreme heat.

The environment can be affected if extreme heat is combined with a drought. Habitat damage is possible during periods of drought, for both aquatic and terrestrial species. Severe and

---

[76] Source: https://www.cnn.com/2022/07/11/weather/record-heat-texas-power-grid-wxn/index.html

[77] Source: https://www.eenews.net/articles/3-issues-to-watch-as-heat-strains-the-grid/

[78] Source: https://www.cnn.com/2022/07/21/weather/global-infrastructure-its-so-hot-extreme-heat/index.html

[79] Source: National Oceanic and Atmospheric Administration

[80] Source: https://www.businessinsider.com/why-train-tracks-buckle-in-extreme-heat-2013-7

prolonged drought can result in the reduction of a species or cause the extinction of a species altogether. This is especially true for those species and habitats that are already experiencing distress from other factors, such as urbanization. There are also air quality impacts associated with rising temperatures.

The term "air pollution" refers to a number of different possible pollutants. Particulate matter (PM) pollution, includes particles of soot and dirt from coal combustion, diesel engines, or fires. PM, combined with carbon monoxide or sulfur dioxide, adds to air pollution. Extreme heat increases "ground-level ozone." Ground-level ozone "smog" is formed by the photochemical reaction of sunlight, heat, and nitrogen oxides, facilitated by photochemically reactive hydrocarbons produced by vehicles, power plants, and other sources. If there is more sunlight and heat, there will be more ground-level ozone in the air. This has a direct impact on respiratory illnesses.

The San Antonio area is home to many cultural and historic resources. These cultural and historic resources are largely immune to the effects of extreme heat. The City's historic and cultural resources are a significant draw for tourists and visitors to the area and help to generate revenue through taxes and fees. This revenue in turn pays for services and programs, which benefit residents and the community. If the demand for energy exceeds supply, it could lead to rolling brownouts. If an interruption in tourism occurs because of an extreme heat event, it is likely to be short lived and have a temporary impact on historic and cultural resources that depend on tourism. All these issues lead to a potential reduction in income for these sectors of the economy, which can have an overall negative impact on the economy.

The economic and financial impacts of extreme heat on the City of San Antonio will depend on the duration of the event, demand for energy, drought associated with extreme heat, and many other factors. If the demand for energy exceeds the supply, it could lead to rolling brownouts. Food suppliers can anticipate an increase in food costs due to increases in production costs and crop and livestock losses because of extreme heat.

Sectors that rely on timber or timber production may also be negatively impacted by drought as a result of extreme heat. The timber industry is usually directly impacted by wildfires, tree disease, or both, which leads to a decrease in supply, while the demand generally remains stable.

Fisheries can also be negatively impacted by extreme heat, suffering damage to fish habitats (either natural or manufactured) and a loss of fish and/or other aquatic organisms due to decreased water flows or availability.

Water suppliers can experience dramatic revenue shortfalls or windfall profits, depending on their level of advance planning for such conditions. For suppliers that did not plan accordingly,

increased costs can result from the need for water transport/transfer and/or new/supplemental water resource development.

The level of preparedness and the amount of planning done by businesses and citizens will also impact the overall economic and financial conditions before, during, and after an extreme heat event.

Public dissatisfaction with government could result from higher energy utility bills, water scarcity, and other economic and financial impacts as a result of the reduction of services by local government due to extreme heat. Perceptions of inequality in relief, based on socioeconomic status or ethnicity, could lead to increased dissatisfaction with government and leadership.

Section 7: Flood

Hazard Description

Floods generally result from excessive precipitation. The severity of a flood event is 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. Typically, floods are long-term events that may last for several days.

The primary types of general flooding are inland and coastal flooding. Due to the City of San Antonio's inland location, only inland flooding is profiled in this section. 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.

FLOODING AND CLIMATE CHANGE

Climate change is expected to impact the intensity and frequency of precipitation in San Antonio. Rainstorms are becoming more intense, and flooding is becoming more severe. Climate change has resulted in increased ocean temperatures of about 1.5°F since 1901. Warmer oceans increase the amount of water that evaporates into the air. When more moisture-laden air moves over land or traverses a storm system, it can produce more intense precipitation. During the last 50 years, the amount of rain falling during the wettest four days of the year has increased about 15 percent in the Great Plains. Over the next several decades, the amount of rainfall during the wettest days of the year is likely to continue to increase.

Location

Zone A locations of flood zones A, AE, AO, and the 0.2% Annual Chance Flood Hazard in the City of San Antonio based on the Digital Flood Insurance Rate Map (DFIRM) from FEMA, are illustrated in Figure 15 through Figure 18 below.

Figure 15. Estimated Flood Zones in the City of San Antonio

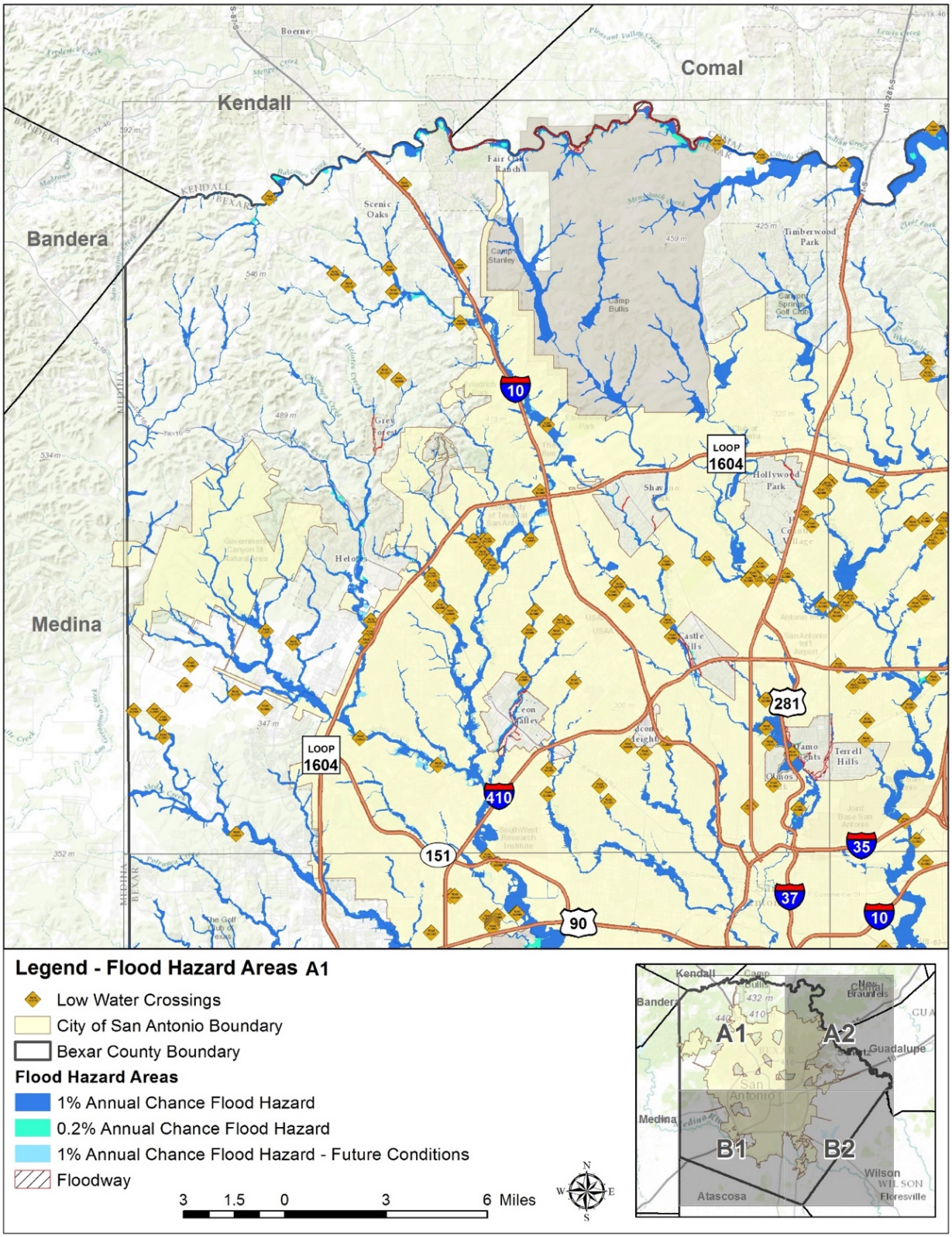


Figure 16. Estimated Flood Zones in the City of San Antonio

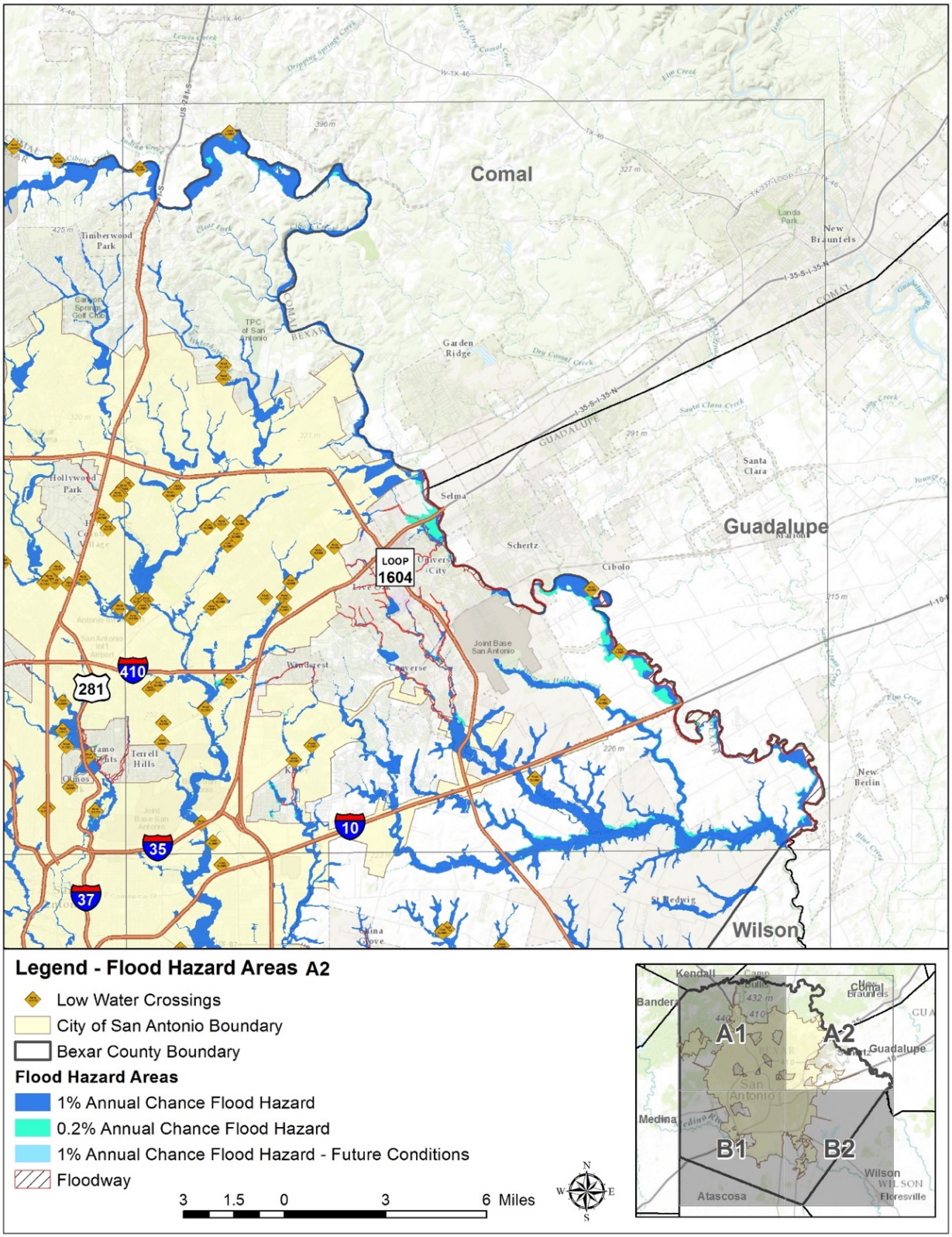


Figure 17. Estimated Flood Zones in the City of San Antonio

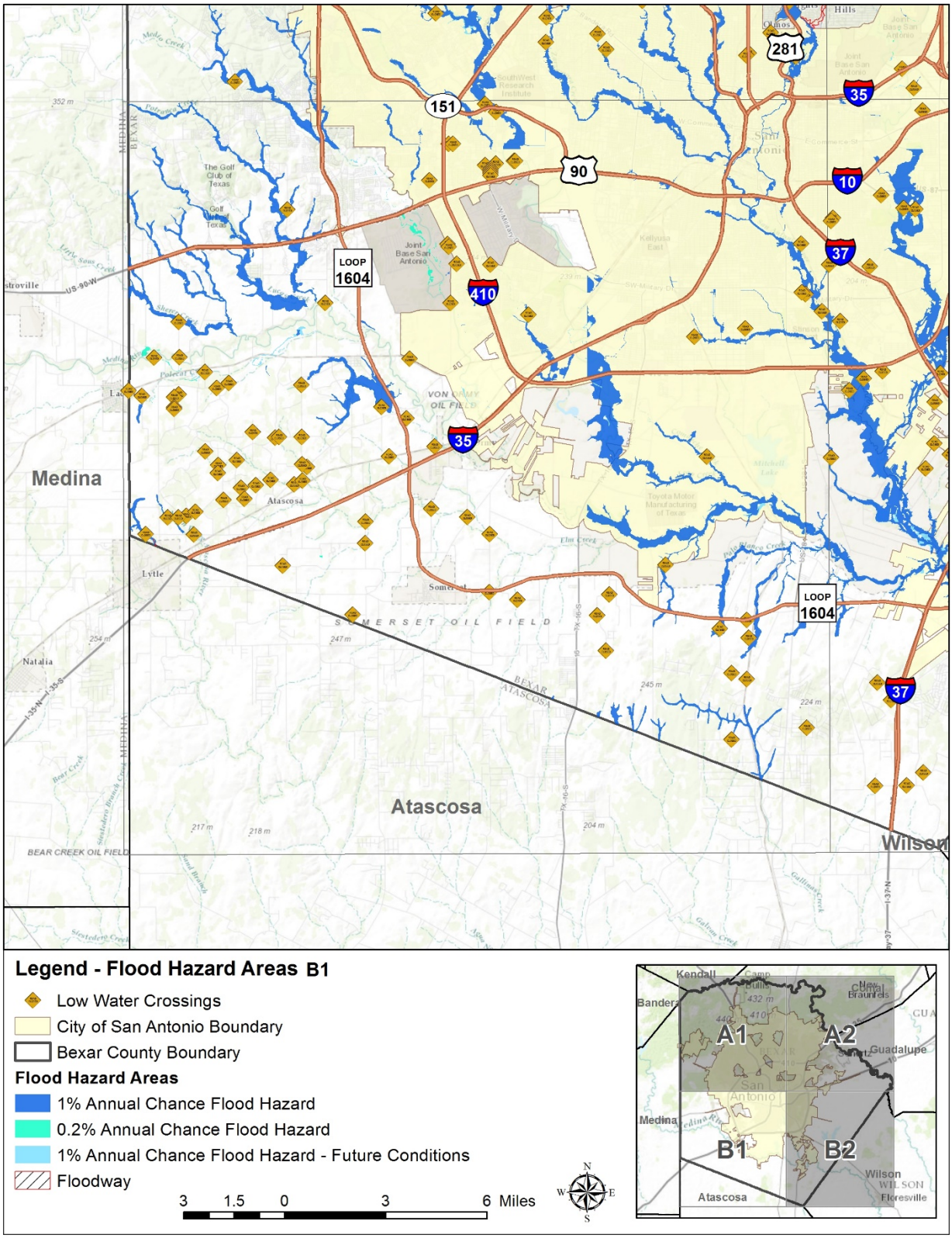
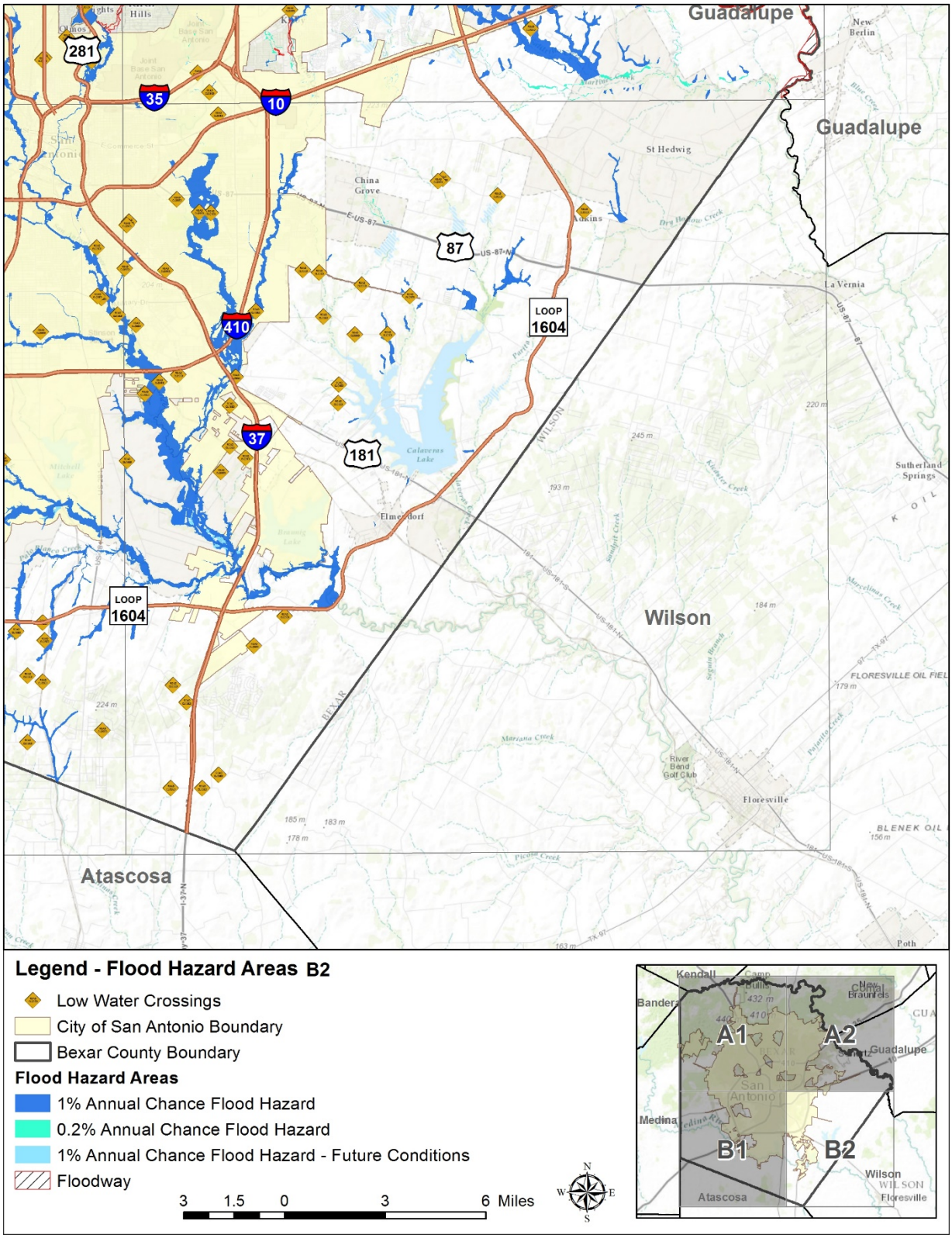
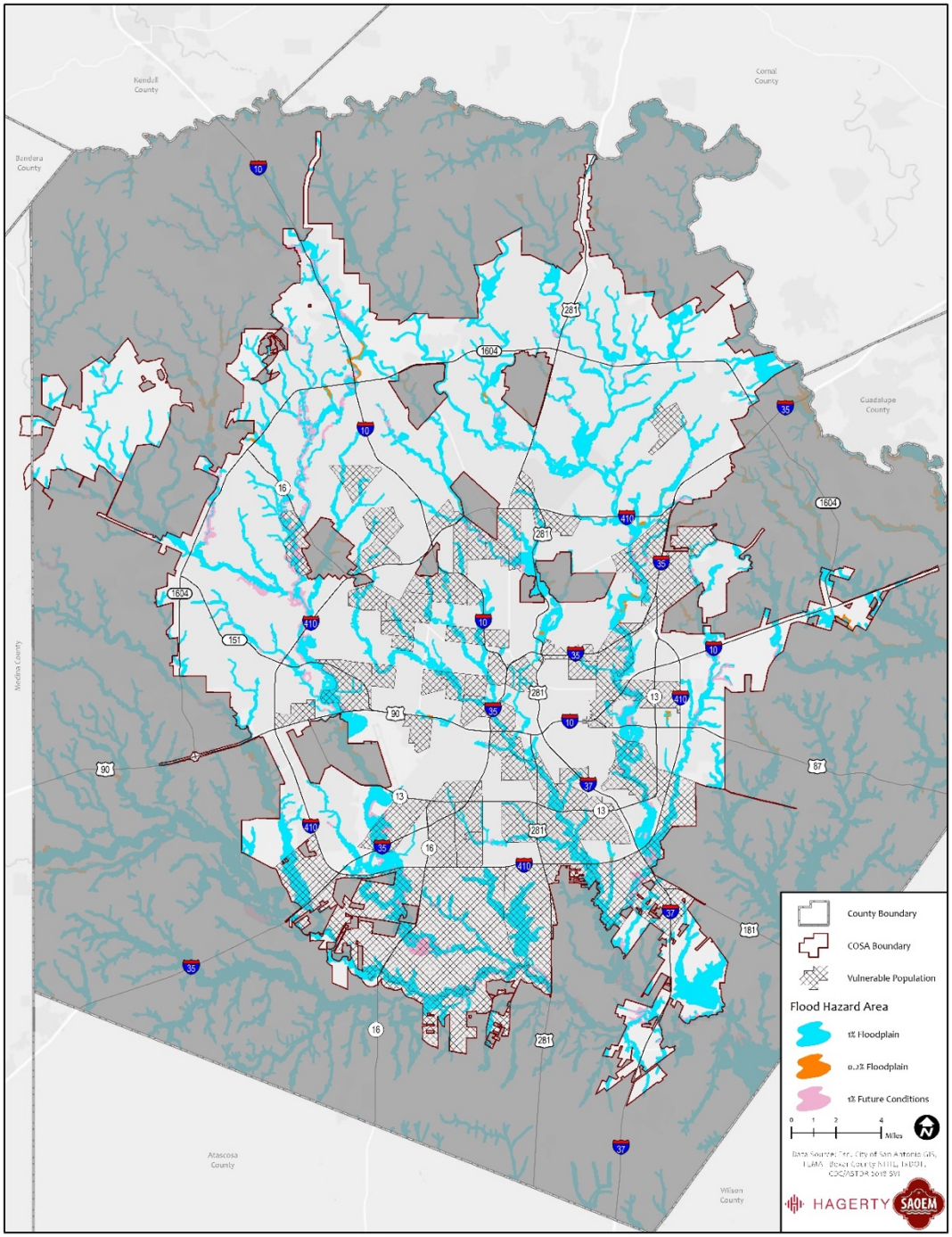


Figure 18. Estimated Flood Zones in the City of San Antonio



Location of FEMA flood zones overlayed with socially vulnerable populations is illustrated in Figure 19. FEMA classifies Zone A as a Special Flood Hazard Area, which has a 1% annual risk of a major flood, also known as the base flood or 100-year flood. Moderate flood zones are labeled to reflect a 0.2% annual chance of a flood (i.e., 500-year flood). The 1% future flood conditions represents a 500-year flood zone that is anticipated to become a 100-year flood event (i.e., future conditions for a 100-year flood event) given the impacts of climate change.

Figure 19: Estimated Flood Zones and Socially Vulnerable populations in San Antonio



Extent

The severity of a flood event is 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. Typically, floods are long-term events that may last several days.

Determining the intensity and magnitude of a flood event is dependent upon the flood zone and location of the flood hazard area, and the depths of floodwaters. FEMA categorizes areas on the terrain according to how the area will convey floodwater. Figure 15 through Figure 18 should be read in conjunction with the extent for flooding in Tables 7-1, 7-2, and 7-3 to determine the intensity of a potential flood event.

Table 30. Flood Zones

INTENSITY	ZONE	DESCRIPTION
HIGH	ZONE A	Areas with a 1% annual chance of flooding and a 26 percent 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 one percent or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from one to three 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 one percent annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from one to three feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood

INTENSITY	ZONE	DESCRIPTION
		elevations derived from detailed analyses are shown at selected intervals within these zones.
	ZONE A99	Areas with a one percent 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.
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 one foot or with drainage areas less than one square mile; or an area protected by levees from 100-year flooding.

Zone A is interchangeably referred to as the 100-year flood, the 1% annual chance flood, or the Special Flood Hazard Area (SFHA), or more commonly, the base flood. This is the area that will convey the base flood and constitutes a threat to the planning area. The impact from a flood event can be more damaging in areas that will convey a base flood.

Structures built in the SFHA are subject to damage by rising waters and floating debris. Moving floodwater 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.

The intensity and magnitude of a flood event is also determined by the depth of floodwaters. Table 31 below describes the category of risk and potential magnitude of an event in correlation to water depth. The water depths depicted in Table 31 are an approximation based on elevation data (above sea level). Table 32 describes the extent associated with stream gauge data provided by the United States Geological Survey (USGS).

Table 31. 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 32. Extent for the City of San Antonio

JURISDICTION	ESTIMATED SEVERITY PER FLOOD EVENT[81]	PEAK FLOOD EVENT
San Antonio	Action Stage, 16 to 23 feet, 28.83	Major Action Stage: Medina River at San Antonio had floodwaters reach 49.47 feet in October 1999 and San Antonio River at Loop 410 had floodwaters reach 34.21 feet in May 2013.

The range of flood intensity that the City can experience is high, or Zone A. Based on reporting from the USGS peak MSL data, the City's average flood event places the City at the "Action Stage" as shown in Tables 7-2 and 7-3. However, the City of San Antonio has experienced flooding over 33 feet MSL. Based on historical occurrences, the planning area could experience nine to 16 inches of water within a 24-hour period due to flooding.

[81] Severity estimated by averaging floods at certain stage level over the history of flood events.

The data described in Tables 7-1 through 7-3, together with Figure 15 through Figure 18and historical occurrences for the area, provides an estimated potential magnitude and severity for the City of San Antonio. The City may experience a range of flooding events from below 15 feet to above 33 feet or from "Below Flood Stage" to almost a "Major Flood Stage."

Extreme rainfall and flooding have become more severe and are expected to worsen. As a result, there will be a significant increase in urban flooding – as much as 30-50% more than occurred over the last half of the 20th century. As climate conditions continue to change, the 1% annual chance floods are likely to become more common.

Historical Occurrences

Historical evidence indicates that areas within the City 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; therefore it is likely that additional flood occurrences have gone unreported before and during the recording period. Table 33identifies historical flood events that resulted in damages, injuries, or fatalities within the City of San Antonio. For countywide historical events, the events include damages on a countywide level; therefore 77.4 percent of property damages and 38.7 percent of crop damages have been allocated to the City of San Antonio.

Historical Data is provided by the National Centers for Environmental Information (NCEI) for the planning area.

Table 33. Historical Flood Events, 1993-2020[82]

DATE	TIME	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
5/5/1993	-	0	0	$691,548	$34,577
10/7/1994	-	0	0	$13,486	$0
6/6/1997	5:00 PM	0	0	$18,766	$0
6/21/1997	7:00 AM	0	0	$31,276	$0
6/22/1997	2:30 AM	0	10	$3,753,166	$31,276
10/7/1997	6:00 PM	0	0	$99,279	$0
1/6/1998	2:00 PM	0	0	$6,205	$0
1/31/1998	11:00 AM	0	0	$18,615	$0

[82] Historical events are reported from January 1993 through April 2020. Damages are reported in 2020 dollars.

DATE	TIME	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
2/21/1998	5:00 PM	0	0	$6,193	$0
3/16/1998	1:00 AM	0	0	$37,092	$0
8/6/1998	7:45 AM	0	0	$31,714	$0
8/14/1998	4:05 PM	0	3	$61,366	$0
8/22/1998	7:30 AM	0	0	$31,366	$6,137
8/23/1998	5:00 PM	0	10	$12,273	$0
9/11/1998	10:30 AM	0	0	$18,387	$0
10/17/1998	5:30 AM	11	600	$9,782,643	$61,142
6/15/1999	9:00 AM	0	0	$46,769	$0
6/15/1999	9:30 PM	0	0	$15,590	$0
6/21/1999	10:00 AM	0	0	$15,590	$0
4/3/2000	12:30 AM	0	0	$15,123	$0
5/19/2000	8:20 PM	0	0	$11,694	$0
10/17/2000	1:30 PM	0	8	$34,577	$0
10/23/2000	3:30 AM	0	0	$57,628	$5,763
11/2/2000	8:00 PM	0	0	$57,595	$0
4/23/2001	7:30 AM	0	0	$90,693	$0
8/30/2001	10:00 AM	0	2	$56,491	$0
8/31/2001	4:00 AM	0	0	$33,895	$0
8/31/2001	8:00 PM	0	0	$45,193	$11,298
9/5/2001	5:30 PM	0	0	$89,981	$0
11/15/2001	7:00 AM	0	10	$113,046	$0
4/8/2002	1:30 AM	0	0	$115,284	$72,053
6/30/2002	9:30 AM	0	0	$16,721	$0
7/1/2002	4:30 PM	4	0	$0	$0
9/8/2002	3:45 AM	0	0	$55,399	$0
9/8/2002	4:30 PM	0	2	$88,638	$0

DATE	TIME	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
9/19/2002	2:00 PM	0	2	$55,399	$0
10/23/2002	2:50 AM	0	4	$88,492	$0
10/24/2002	5:30 AM	0	0	$55,307	$0
12/9/2002	4:30 AM	0	0	$5,543	$0
7/5/2003	6:30 AM	0	0	$10,905	$0
7/15/2003	10:30 PM	0	0	$10,905	$0
9/5/2003	12:30 PM	0	0	$108,285	$0
9/22/2004	9:00 PM	1	0	$0	$0
11/16/2004	6:30 PM	1	0	$0	$0
11/22/2004	1:30 AM	1	0	$0	$0
6/16/2007	9:30 PM	0	0	$28,876	$0
6/28/2007	8:00 AM	0	0	$48,126	$0
8/16/2007	12:00 PM	2	0	$14,468,094	$0
8/20/2008	2:20 AM	0	0	$9,154	$0
2/4/2010	12:00 AM	1	0	$0	$0
5/25/2013	6:00 AM	2	0	$0	$0
11/4/2014	8:18 PM	0	0	$42,461	$0
11/4/2014	9:50 PM	0	0	$42,461	$0
5/18/2015	8:40 AM	1	0	$0	$0
6/2/2016	3:30 AM	1	0	$0	$0

Table 34. Summary of Historical Flood Events, 1993-2020

EVENTS	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
240 events	25	651	$29,842,256	$187,669

Based on the list of historical flood events for the City of San Antonio planning area (listed above), 111 of the events have occurred since the previous HMAP update.

SIGNIFICANT EVENTS

Flash Flood on June 2, 2016 – City of San Antonio

A cold front moved into South Central Texas and encountered a very moist boundary layer. This front generated thunderstorms that produced large hail, damaging wind gusts, and heavy rain that led to flash flooding, closing the lower level of I-35 in both directions in San Antonio. Newspaper reports show that a body of a man was recovered near the 700 block of Camaron in San Pedro Creek. The body was recovered early on Friday morning, but the man drowned early Thursday morning as he and a friend were skateboarding in the creek drainage tunnel. Heavy rain caused a surge of water down the tunnel and both men were swept down the creek. One person was able to save himself.

Flash Flood on May 18, 2015 – City of San Antonio

Thunderstorms developed early in the morning producing flash flooding across the eastern areas of the county warning area. These storms exited the area by mid-morning. More storms developed in the evening as well across the Edwards Plateau and Hill Country. On Monday, May 18, around 8:50 a.m., a woman died in her Honda SUV after her vehicle was swept off a flooded road and lodged underneath a small bridge on the other side of the highway. This happened on the southwest side of San Antonio along the I-35 frontage road near Cassin Road. The vehicle drove around a barricade onto the flooded access road which was at least 2-3 feet underwater. Her body was recovered around 5 p.m. after floodwaters receded. Many roads and low water crossings remained flooded across San Antonio due to heavy rains that occurred early Sunday morning, the previous day.

Flash Flood on November 4, 2014 – City of San Antonio

Moisture from tropical storm Vance moved across northern Mexico into southern Texas ahead of a cold front. When the front moved through the region, it produced heavy rain that led to flash flooding. Flash flooding on multiple roadways across north-central and central Bexar County, including the City of San Antonio, was reported by the Highway Department. Road closures were reported at Cave Lane, Oak Glen Drive, Vance Jackson, McCullough Avenue, Rio Seco Drive, Sleepy Hollow Drive, and Bulverde Road. Other roadways were reported to have high water across the northern part of the City of San Antonio. Road closure reports included East Houston Street, Brook Hollow Road, George Road, Dreamland Drive, Southwell Road, Stahl Road, Encino Park Road, and Evers Road. All road closures were due to high water on the roadways. These closures encompassed mostly north central San Antonio. Flash flooding resulted in $100,000 of property damage.

Flash Flood on May 25, 2013 – City of San Antonio

Thunderstorms produced heavy rain that caused flash flooding in and around San Antonio and Bexar County. There was record rainfall in the San Antonio area with the San Antonio International Airport recording 9.87 inches of rain (2nd highest 24-hour total record) and Community Collaborative Rain, Hail and Snow Network observers reporting over 11 inches. Most of the rain fell in about six hours with four inches in one hour between 6:00 and 7:00 a.m. A USGS stream and rain gauge on Olmos Creek and Dresden Drive reported 2.58 inches in 15 minutes between 6:15 and 6:30 a.m. The gauge reported 6.13 inches in one hour, 9.46 inches in two hours, and totaled 15.31 inches in five hours. A 24-hour total at this gauge was 17 inches of rain. This led to massive flooding in the Olmos Basin/Creek just inside Loop 410 near the Quarry. Most of the flooding across the City was in north central and northwest San Antonio along and just inside Loop 410. This rain event occurred a day after another heavy rain event, with parts of the City receiving over two inches. This resulted in major flooding of Olmos Creek, the Medina River, Leon Creek, the San Antonio River, and Salado Creek, all of which reached major flood stage. There were many roads closed, including Hwy 281 at Olmos Creek, which remained closed for several days. At 10:00 a.m., there was one foot of water over Ingram and Callaghan roads. San Antonio creeks and streams saw big rises in water levels, which led to additional flooding downstream in the southern portion of Bexar County. Areas that were hit the hardest included the Espada Road area near the San Antonio River and Loop 410 intersection. A mobile home park on Plumnear Road, off Leon Creek on the southwest side of the City, was flooded. Several hundred rescues and calls for rescue occurred during the morning of the 25th. Two fatalities occurred inside Bexar County. A woman was killed when her car was swept away in floodwaters along Leon Creek at the 5800 Block of U.S. Highway 90. Another woman was killed when her car was swept away in the 400 Block of Rhapsody Drive at about 7:30 a.m. In all, the City of San Antonio and Bexar County Emergency Management agencies found over 350 impacted residences, with 15 of those being destroyed and 27 suffering major damage. The other residences suffered minor damages. Most of the destroyed residences were in the Espada area along the San Antonio River in southeast Bexar County.

Flash Flood on August 16, 2007 – City of San Antonio

The area of extremely heavy rainfall associated with the remains of Tropical Storm Erin continued to spread northwestward across Bexar County, with a general four-to-five-inch rain over the county. Totals of up to eight inches were reported at several locations in the south and west parts of San Antonio as well as between Helotes and Leon Springs. By 2:00 p.m., most roads in the northwest part of the county were closed. By 3:30 p.m. that afternoon, more than 39 high water rescues were reportedly underway in San Antonio. Water was almost waist deep at Southcross Boulevard in San Antonio. Floodwaters were so deep and running so swiftly at

the San Antonio High School West Campus that they collapsed a masonry wall and filled the school with almost five feet of muddy water. Hallways were flooded, and desks, computers and boxes were tossed and thrown together. The students were moved to classrooms in another building across the district. A young man was driving to work in the midafternoon of August 16 when his vehicle struck a guardrail on Southwest Military Drive and was knocked into Six Mile Creek near South Flores Street. The young man called his family to say he had been in an accident, then exited the vehicle but drowned as he attempted to move to higher ground. Near midnight a young woman was driving with three friends and a baby near North Star Mall when she accidentally drove her sport utility vehicle into deeper water where it was slammed against a bridge and then swept into a drainage ditch. The three other adults in the vehicle were able to get the baby out of the vehicle through the window and escape. But when the three looked back for the driver, she was gone. Her body was found later by emergency responders when the water receded. Flash flooding resulted in $15,000,000 of property damage.

Flash Flood on October 23, 2002 – City of San Antonio

A line of thunderstorms moving eastward across Bexar County stalled just after midnight, producing general one-inch rainfall with isolated totals up to three inches. The City of San Antonio reported several rescues along US 90 in the downtown area. Numerous roads were closed across the City due to flash flooding through the early morning hours.

Flash Flood on April 8, 2002 – City of San Antonio

Flash flooding erupted over large sections of San Antonio as general two-inch rain amounts fell over the northern part of the County, with up to four inches in the north central portion. Damage was mainly to roads across the City.

Flash Flood on October 17, 1998 – City of San Antonio

In advance of a very slow-moving upper-level trough of low pressure over West Texas, a cold front drifted slowly southeastward into West Central Texas during the evening of Friday, October 16. Deep moisture was in place across South Central Texas as the two systems approached, being fed at the mid and upper levels by two nearly stationary hurricanes—Madeline near the tip of Baja Mexico, and Lester, anchored just off Acapulco, Mexico—and in the low levels, by a strong flow from the Gulf of Mexico. A very moisture-rich environment was in place across South Central Texas as the flood event developed. Near 3:00 a.m., with the cold front still west of San Angelo, scattered showers and thunderstorms began to break out over Bexar County beneath the mid- and upper-level moisture plume and quickly became widespread as a low-level rain-cooled boundary formed along the south and east edge of the County. It was upon this boundary that subsequent showers and thunderstorms continued to

form and the deep convection became sustained. A level of 10.63 inches of rain was measured at the airport in the first few hours.

All rivers, creeks, and streams along and east of a San Antonio to Austin line remained at or above flood stage from Saturday, October 17, through Sunday, October 18, with a majority continuing to flood through Monday, October 19. The rainfall amount varied from ten inches as a base throughout San Antonio and reached 19 inches in certain areas.

This event broke rainfall records across South Central Texas, producing 18 floods of record in South Central Texas streams. October became the wettest of any month in climate records for San Antonio since 1885. October 17 became the wettest day and wettest 24-hour period in San Antonio climatic records, nearly doubling both previous records.

The event was widespread and impacted the safety of all emergency services personnel throughout the City of San Antonio. The storm taxed all resources available to the Police and Fire departments, and other public safety entities in the surrounding communities. The SAPD received 5,184 calls for service and handled 123 major accidents. Unlike any other incident, this event resulted in 192 water rescues by the Fire Department, saving 461 men, women, and children from rising waters. Unfortunately, 11 deaths occurred when vehicles in the flooded areas were swept away.

The floodwaters also caused substantial damage to more than 1,150 dwelling units and 49 commercial properties. There was over $115 million in damages to public and private property throughout San Antonio, including utilities, roadways, and communication systems, and more than $71 million to City of San Antonio facilities. The extensive runoff resulted in the collection of 480 tons of debris from 576 miles of street. Also collected were 21,375 tons of debris from approximately eight miles of channels such as creeks, tributaries, and rivers.

Probability of Future Events

Based on recorded historical occurrences and extent within the San Antonio planning area, flooding is highly likely, and an event will occur within the next year.

According to the Fourth National Climate Assessment, there is a medium confidence (i.e., suggestive evidence, methods emerging) in an increased frequency of flooding. This increase is attributed both to the expectation of increased precipitation in the State of Texas and the increase of extreme rainfall incidents.

Vulnerability and Impact

A property's vulnerability to a flood depends on its location and proximity to the floodplain. Structures that lie along banks of a waterway are the most vulnerable and are often repetitive loss structures.

San Antonio falls in an area known as Flash Flood Alley, a belt across Texas where flooding is more frequent and can be more severe.[83] Due to the generally flat terrain of Bexar County, homes and businesses in the floodplain remain at risk of flash flooding. During periods of heavy rainfall, homes and businesses located in some areas of the City experience rapid runoff and are vulnerable to flooding from the San Antonio River and other major creeks and minor waterways. Texas had the most flood-related fatalities of any state in the U.S. from 1958-2008. A 15 percent increase in flooding events is expected to cost an additional two fatalities and three injuries.[84]

Although the City of San Antonio has encouraged development outside of the floodplain, impact for flood could be "Substantial" with multiple fatalities. A flood event in the City could result in the shutdown of facilities for 30 days or more, depending on the scale of the storm and more than 50 percent of property destroyed or with major damage.

[83] https://www.sanantonio.gov/Portals/0/Files/Sustainability/News/ClimateChangeImpact-Report-THC.pdf

[84] Ibid.

Figure 20. Critical Facilities Vulnerable to Flooding

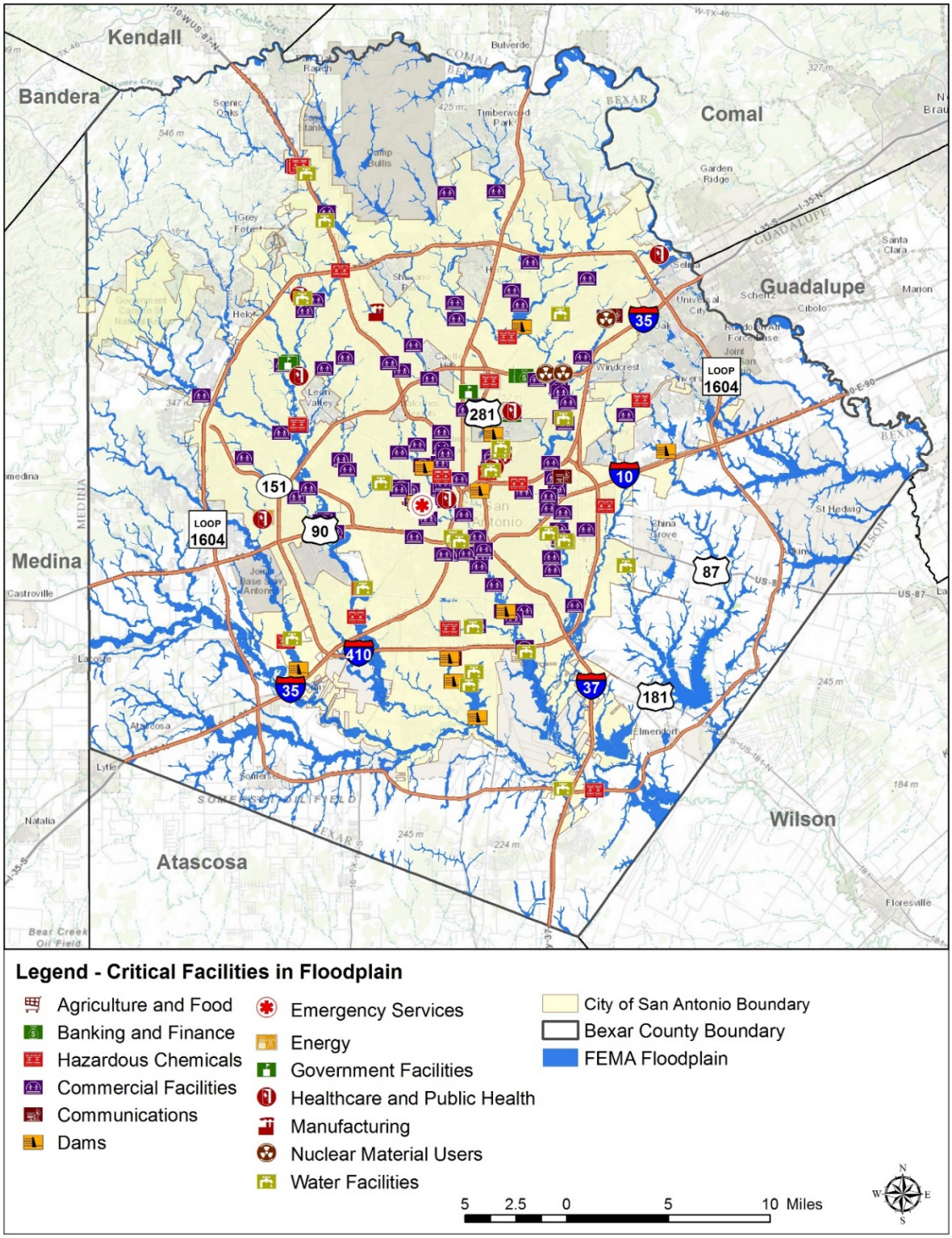


Table 35. Critical Facilities Located within the Floodplain

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	-
Banking and Finance	6
Chemical and Hazardous Materials Industry	16
Defense Industrial Base	N/A
Energy	2
Emergency Services	3
Information Technology	N/A
Communications	3
Postal and Shipping	-
Healthcare and Public Health	6
Transportation	-
Water	16
National Monuments and Icons	-
Commercial Facilities	91
Government Facilities	3
Dams	14
Nuclear Reactors, Materials, and Waste	3
Manufacturing	-

There are 9,449 structures in the floodplain in Bexar County of which 6,783 (72%) are within the City of San Antonio. Historic loss estimates due to flood (in 2020 dollars) in the City of San Antonio total $30,029,925, with an approximate annual loss estimate of $1,112,219. Historic loss estimates are based on recorded data; therefore there could be damages that were not included in the estimates because they were not reported. Considering 240 flood events over a 27-year period, frequency is approximately eight to nine events every year.

ASSESSMENT OF IMPACTS

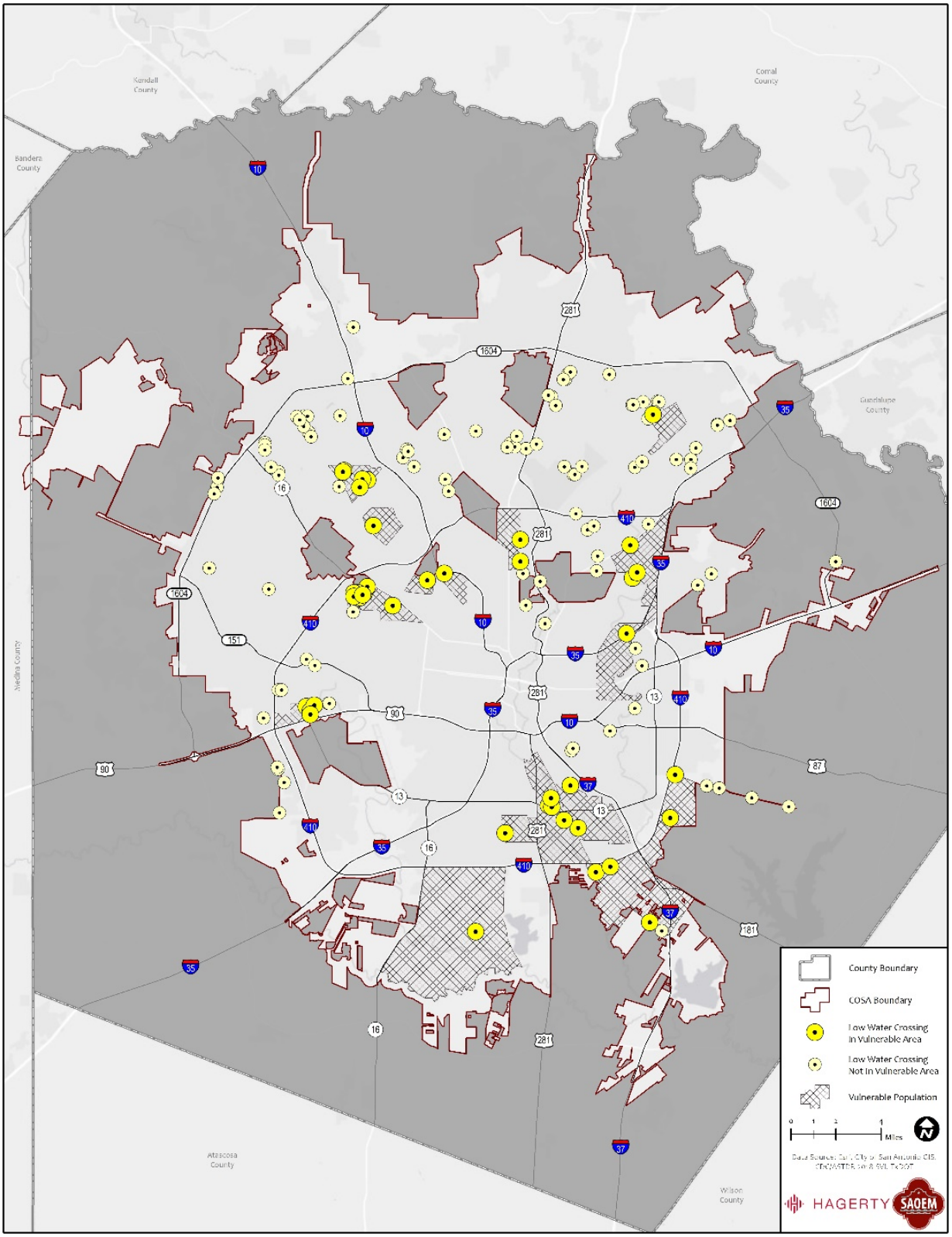
Flooding is the deadliest natural disaster that occurs in the U.S. each year, and it poses a constant and significant threat to the health and safety of the people in the San Antonio area. According to FEMA and the NWS, the majority of deaths attributed to flooding occur in

vehicles; the City of San Antonio is no exception to this statistic. According to the NWS, the City of San Antonio and Bexar County area hold the highest number of fatalities resulting from flash flooding in Texas, with at least 29 fatalities attributed to flooding/flash flooding since 1996, of which 24 were in the City of San Antonio. Additionally, more than 651 injuries have been sustained due to flooding in the same time period. As watersheds are urbanized, much of the vegetation is replaced by impervious surfaces (i.e., solid surfaces of building and streets), which can reduce the area where water infiltration to groundwater can occur. This can result in stormwater runoff and more severe flooding.[85]

Flood-related rescues often occur at swift water and low water crossings. Swift water rescues are rare, since most calls for assistance are related to stalled or stranded vehicles in or near low water crossings. New low water crossings may and do emerge as a result of increased development or changes to the hydrology and floodplain of an area. Figure 21 illustrates low-water crossings and socially vulnerable populations in San Antonio. Low-water crossings in vulnerable areas can magnify existing vulnerabilities, posing a risk to the residents and potentially damaging local infrastructure.

[85] https://www.usgs.gov/special-topics/water-science-school/science/impervious-surfaces-and-flooding

Figure 21: Low-water Crossings and Socially Vulnerable populations in San Antonio



Flooding can also pose health risks and threats to people after the floodwaters have receded. Mold spores will grow in wet, organic materials, such as bedding, clothing, or wall insulation. Untreated sewage and hazardous chemicals may be present in flooded buildings, homes, and automobiles; these toxins may also be present as a layer of residue over property. Water and food sources may be contaminated by floodwaters and the pollutants they bring; electric power is often interrupted temporarily. While some flooding situations may cause little more than a clean-up effort and a short-term utility interruption, even those situations will have an impact on the overall quality of life for people and can present a long-term safety threat if left unresolved or untreated.

Other impacts include the potential need to evacuate a location because of rising floodwaters and the potential for displacement from residences because of flood damage.

Response personnel are exposed to greater risks and impacts than the general public in a flood event because of their roles. They are responsible for performing high and swift water rescues when flooding occurs and may encounter hazards in floodwaters, including submerged or water-borne debris and hazardous materials. A total of 3,810 flood related rescues (high and swift water rescues, high water investigations, high water rescue investigations, and technical water rescues) have been performed by first responders from January 2000 through December 2019 in Bexar County, of which 98.4% (3,749 rescues) were located within the City of San Antonio. Analysis of the data shows that the months May through November appear to have higher numbers of water rescues compared to the rest of the year.

Flooding is a threat to operations and service delivery and has the potential to significantly impact City operations. While the San Antonio Office of Emergency Management (SAOEM) has a protected facility from which to operate, the facility may not be accessible to all staff, as they may be unable to leave their neighborhood due to roadway debris or other obstructions. Staff members unable to access the protected facility would be limited to performing work with the resources accessible to them from their remote location.

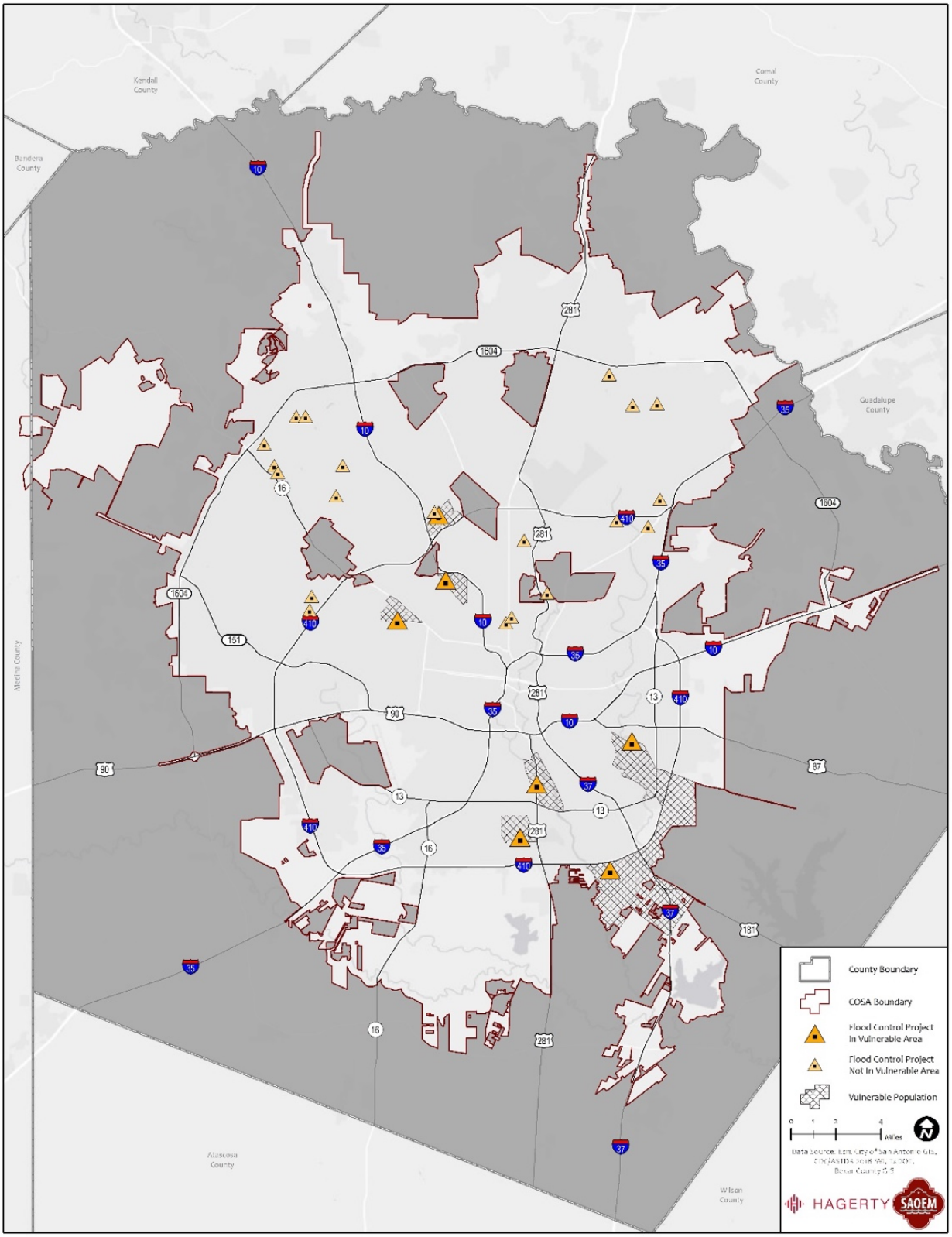
Other City departments may not be as protected as the SAOEM and may suffer more interruptions as a result of flooding. If files (hard or electronic) are damaged, destroyed, or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. This interruption could have significant impacts throughout the City and could negatively impact its ability to respond to and recover from the flooding event. Without a Continuity of Operations (COOP) Plan that takes these issues into account and considers how best to work around them, and without regular exercise of that COOP, city departments may not be able to function, and may be unable to provide necessary services.

Additionally, private sector entities on which the City and its residents rely, such as utility providers, financial institutions, and medical care providers should have specific plans that are

routinely exercised. For example, if flooding resulted in the closure of roadways over a large area, this would result in a temporary halt to repair of damaged infrastructure, delayed emergency response activities, and interruption in the normal delivery of goods and services. Flooded electrical substations, downed power lines, contaminated wells, and broken pipelines are common occurrences during flood events, and would impact the City's normal operations and service delivery. It is imperative that both public and private entities plan for these events and address how they will be able to function and provide services until normal operating conditions can be resumed.

The City, state, and federal governments have invested heavily in flood control infrastructure in the City of San Antonio area. This investment has significantly reduced the potential impacts and vulnerability of City property, facilities, and infrastructure to riverine, flash flooding, and storm water flooding, but it has not eliminated it entirely. Figure 22 illustrates current flood control projects overlayed with socially vulnerable populations in San Antonio. Flood control projects mitigating risk to socially vulnerable populations work towards the City's goal of climate equity.

Figure 22: Flood Control Projects and Socially Vulnerable Populations in San Antonio



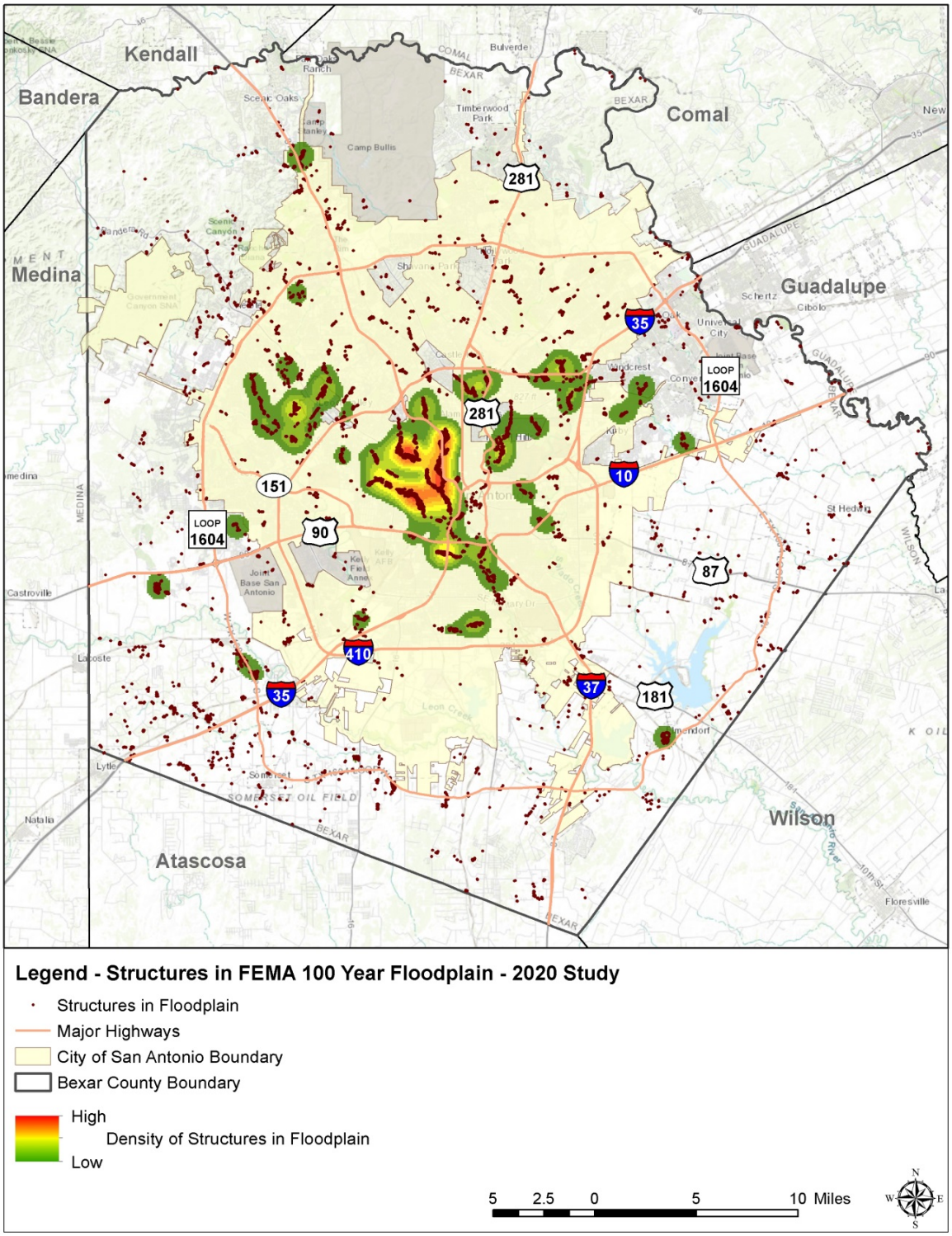
SAOEM performed an analysis to determine how many structures are in the floodplain, excluding miscellaneous residential improvements, such as detached open porches, detached garages, detached carports and sheds; electrical transformers, canopies, gas station canopies, gazeboes, and small trailers (Figure 23). The results show that 9,449 structures are within Bexar County and 6,783 of those structures are located in the City of San Antonio and are within or intersect with the FEMA 100-year floodplain. The results show that there are 9,449 structures in the FEMA 100-year floodplain in Bexar County, of which 6,783 (72%) are within the City of San Antonio limits. Out of 6,783 structures in San Antonio, 83.36% are categorized as residential, 12.35% as commercial, and 4.29% fall within other parcel use categories (Table 35)[86].

The quantitative risk assessment of a flood event for San Antonio, based on a HAZUS-MH model, is presented below. HAZUS-MH is a regional multi-hazard loss estimation model that was developed by FEMA and the National Institute of Building Sciences (NIBS). The primary purpose of HAZUS-MH is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates are then used primarily by local, state, and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The model run for the City of San Antonio is based on the 1% annual chance flood event, or base flood. The damages in these conditions are significant, as would be expected in a flood of this magnitude; in addition, this is the level of flooding for which NFIP regulations are written and enforced.

[86] Source: San Antonio Office of Emergency Management, 2020 Structures in Floodplain Study

Figure 23. Structures located in FEMA 100 Year Floodplain, 2020[87]



[87] Source: San Antonio Office of Emergency Management, 2020 Floodplain Study.

Table 36. Structures in Floodplain by Parcel Land Use[88]

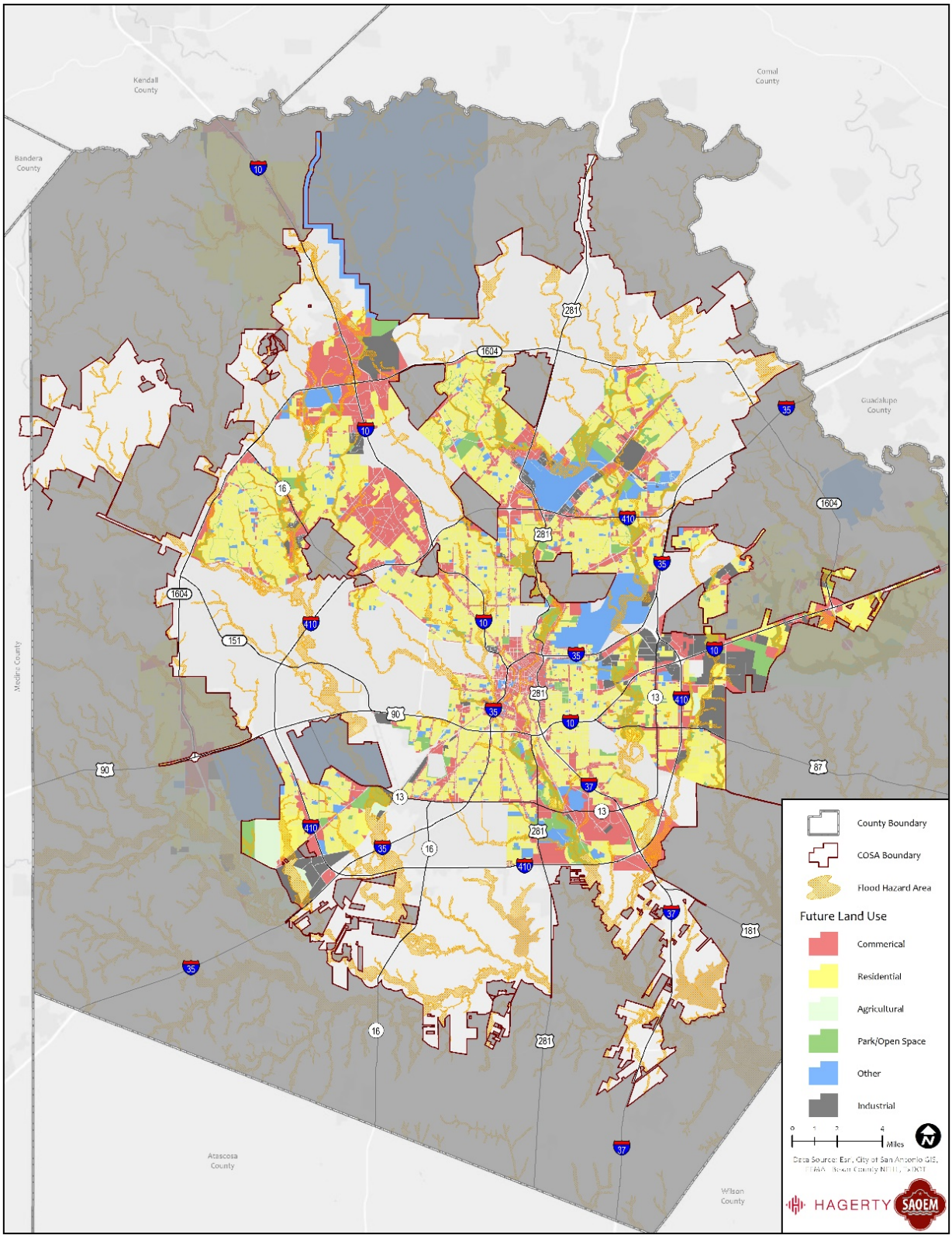
PARCEL USE DESCRIPTION	NUMBER OF STRUCTURES (% OF TOTAL)
1. Residential	5,654 (83.36%)
2. Commercial	838 (12.35%)
3. Other	
• Vacant	107 (1.58%)
• Unknown	52 (0.77%)
• Industrial	51 (0.75%)
• Improved Rural Land	50 (0.74%)
• Agricultural	20 (0.29%)
• Exempt	9 (0.13%)
• Residential Inventory (Improved)	1 (0.01%)
• Subsurface Interests in Land	1 (0.01%)
TOTAL	**6,783**

The most similar historical event to compare the simulation to is the 1998 flood. However, the 1998 flood was documented as being a one percent flood in most areas of San Antonio and Bexar County, with some areas reaching 0.2 percent levels; therefore, the actual flooding in 1998 exceeded what the HAZUS-MH model forecast, at least in some areas. The following is a summary of the HAZUS-MH flood evaluation followed by a description of the impacts from 1998 floods and a comparison analysis.

There are 17,155 properties in San Antonio that have greater than a 26% chance of being severely affected by flooding over the next 30 years. This represents 4% of all properties in the city. In addition to damage on properties, flooding can also cut off access to utilities, emergency services, and transportation, and may impact the overall economic well-being of an area. Figure 24 illustrates future land use conditions and the flood hazard area in San Antonio.

[88] Source: San Antonio Office of Emergency Management, 2020 Structures in Floodplain Study

Figure 24: Future Land use and flood hazard area in San Antonio



Flooding is a natural occurrence, and is often beneficial for the environment, as it aids in the nourishment of the soil and helps to maintain the water table. However, floodwaters are not limited to water; they also contain all the human artifacts that were encountered upstream of the flood's current location. This can include household chemicals and toxins, household items, industrial materials, agricultural products, and untreated sewage. Long-term environmental hazards, such as hazardous chemicals, toxins, or sewage that are left behind by the floodwaters can create an unsafe environment for workers and can have negative consequences for the natural environment.

The impacts to the environment from a major flood event could include:

- Scour of stream or river banks;
- Damage to overwhelmed flood control structures;
- Loss of native plants and animals; and
- Contamination from chemicals, sewage, and other noxious materials picked up, transported, and deposited by floodwaters.

The contamination of rivers, watersheds, and the flooded landscape from chemicals and debris from agriculture, homes, and businesses is a serious potential problem. Industrial chemicals, oil and gas, sewage, old tires, etc., can pollute the landscape where they come to rest as the water recedes. Many of these materials may take years, decades, or even longer to break down and become harmless and some materials may never fully break down. Until these materials become harmless, they can continue to degrade the environment, and in some cases, leach into ground water, spreading contamination away from the site. Without proper clean-up, these materials may continue to harm the environment for years.

The HAZUS-MH run was performed to aid in quantifying the amount and type of damage that a 1% annual chance floods could generate in Bexar County. HAZUS-MH determined the following information, regarding debris.

Debris Generation

HAZUS-MH estimated the amount of debris that would be generated by the flood. The model breaks debris into three general categories:

1. Finishes (dry wall, insulation, etc.);
2. Structural (wood, brick, etc.); and
3. Foundations (concrete slab, concrete block, rebar, etc.).

The categories are based on the different types of equipment required to handle the debris.

The model estimated that a total of 229,358 tons of debris will be generated. Of the total amount, "finishes" comprise 39% of the total and "structural" comprises 30% of the total. If the

debris tonnage is converted into an estimated number of truckloads, it will require 9,174 truckloads (25 tons/truck) to remove the debris generated by the flood.

The amount and type of debris that is likely to be generated by a 1% annual chance flood vent would certainly have environmental ramifications, though what exactly those ramifications would be depends on the areas that were inundated by floodwaters.

Regarding impact to the environment, not all flooding of rivers is bad. Floods are natural events that have changed the course of rivers, flooded low areas, and uprooted or drowned vegetation as part of the changing natural environment. When a river changes course, lakes and ponds can form, attracting waterfowl and other animals. Where the river once ran, the river gravels gradually develop a layer of topsoil forming a perfect area for flora and fauna to flourish. These species attract a growing diversity of animal life that continues to change, along with the landscape.

Floodwaters traditionally have replenished the soil by bringing silt from upstream areas and depositing it across the landscape in the downstream areas of watersheds, adding a new quantity of nutrients to the soil. This contributes to the fertility of the lower watershed, aiding the growth of both natural vegetation and agricultural products.

The San Antonio area is home to many cultural and historic resources. These resources, and the history they represent, are significant to the area because they remind the community of its past and help to define its persona. The City's historic and cultural resources are a significant draw for tourists and visitors to the area and help to generate revenue through jobs, taxes, and fees. This revenue pays for services and programs, which benefit residents and the community.

Many of the City's historic homes and neighborhoods could be impacted by flooding. Property damage to a historic neighborhood could have long-term economic impacts both for the property owners and for the City, since historic neighborhoods often attract tourists and generate revenue, and tourists and visitors are unlikely to want to visit flood-damaged historic structures and neighborhoods.

The financial and economic risks associated with flooding depend on the scale and location of the flooding and can be serious. While the flood damage to an individual residential structure can be significant or devastating to the residents, it has a negligible economic impact on the community's overall economic health. However, after a significant flood event, such as the 1998 flood, a large number of structures can be damaged or destroyed by flooding and pose serious economic and financial consequences for a community.

The City of San Antonio planning area could sustain significant economic impacts from a 1% annual chance flood event. HAZUS-MH estimated the total economic loss for such an event at more than $276.2 million, or slightly more than 20% of the total replacement value of the

buildings in the scenario. For any jurisdiction, an economic loss equal to one-fifth of existing stock would be difficult to absorb and would almost certainly require outside assistance from the state and/or federal governments.

Large-scale flood events can cause significant property damage to homes, businesses, industrial properties, and government buildings. This can result in a significant negative alteration of the tax base for that community; at the same time the community must fund unbudgeted expenses such as infrastructure repair and restoration, temporary services and facilities, and overtime pay for responders, in addition to normal day-to-day operating expenses. Lost business days and resulting lost wages can also affect the local economy in the form of reduced tax receipts. While there are often state and federal programs that can help with these expenses, most of these programs are reimbursement programs, meaning the community must still fund the initial expenses out of pocket.

Significant flood events can also result in dramatic population fluctuations, as people are unable to return to their homes or jobs and possibly seek shelter and/or work outside of the community. They may require temporary relocation assistance, and some of them may choose not to return to the community.

Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community. A loss of jobs affects the financial and economic health and stability of the community and could result in an increase in the unemployment rate.

Flooding typically damages the infrastructure of a community, including roads, bridges, power lines, and plants. It can take a significant amount of time to fully repair these facilities and infrastructure, depending on the nature of the damage and the resources available that can be dedicated to the project. Damage to infrastructure will generally slow down the economic recovery of the community and the re-opening of businesses and can limit the cleanup effort. Damage from a flood event can force some businesses to close temporarily, even those that were not directly impacted by the flooding. For some businesses, the loss of infrastructure can result in the termination of their business.

Some businesses are more heavily reliant on utility infrastructure than others. For example, grocery stores are typically reliant on electricity to maintain the safety of their food supply. Some larger chain stores may have emergency power generators and fuel on hand, but smaller, independent stores often do not.

The economic and financial impacts of flooding will ultimately depend on the scale of the flooding, 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 businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of flooding.

Public confidence in local government may be impacted by how the response and recovery efforts resulting from the flood event are handled. A response demonstrating that the City, its leaders, and officials were prepared for the event, anticipated the magnitude, and understood what could happen, will boost the City's reputation and standing with its residents. However, if the perception developed, correctly or incorrectly, that the response was slow, that needs or complaints of residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence will decline.

HAZUS-MH RESULTS

General Building Stock Damage

HAZUS-MH estimates that there are 457,149 buildings in the region, which have an aggregate total replacement value of $85.033 million (2006 dollars). HAZUS-MH estimated that about 10,653 buildings will be at least moderately damaged. This is over 40 percent of the total number of buildings in the scenario. There are an estimated 1,073 buildings that will be completely destroyed.

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 6,636 hospital beds available for use. On the day of the scenario flood event, the model estimated that 6,243 hospital beds were available in the region.

Table 37. Expected Damage to Essential Facilities

CLASSIFICATION	TOTAL DESTRUCTION	MODERATE DAMAGE	SUBSTANTIAL DAMAGE	FACILITIES EXPERIENCING LOSS OF USE
Fire Stations	28	2	0	2
Hospitals	30	2	0	2
Police Stations	40	3	0	3
Schools	566	21	1	16

1998 Flood Summary

The following information was obtained from the City of San Antonio and a United States Army Corps of Engineers (USACE) study from 2001.

Flood level

Data indicated that the water flow measured 66,000 cubic feet per second (cfs) in Salado Creek during the peak period of the storm. The Salado Creek Watershed Study adopted in 1997 indicated a 100-year flood flow of 57,946 cfs and a 500-year discharge rate of 73,634 cfs[89].

During a flooding event in 1998, an estimated 17 inches of rainfall was recorded within a 30-hour period. The devastation from that flood event resulted in 11 deaths and more than 1,150 homes and 49 businesses damaged or destroyed in the City of San Antonio, with significant damage occurring along the Leon Creek Watershed. Flood damage was estimated at $300 - $500 million in the City of San Antonio and the surrounding county area[90].

Debris removal, as documented in December 1998 in the after-action report, included:

- 480 tons of debris collected from 576 miles of streets; and
- 21,375 tons of debris collected from approximately eight miles of channels.

Analysis

The simulation provided fairly accurate information when it came to structures damaged in a 1% annual chance flood event, with approximately 1,100 structures forecasted as substantially damaged compared to approximately 1,200 substantially damaged in the 1998 event. Even though property values are variable, the costs associated are similar.

The amount of debris projected in the simulated flood produced significantly more tonnage. A possible explanation for the difference may be the result of variances in building stock and building codes between the City of San Antonio, and the way those differences are accounted for in the stock data found in HAZUS-MH.

The simulation, while considering a larger area, closely follows one of San Antonio's most significant flood events, providing additional understanding of potential impacts to property.

National Flood Insurance Program Participation

The City of San Antonio is a current participant in the National Flood Insurance Program (NFIP). Flood insurance offered through the NFIP is the best way for home and business owners to protect themselves financially against a flood hazard. Serious flooding continues to be present in San Antonio, prompting the City to develop a public education and flood preparedness program called the SAFE (San Antonio Flood Emergency) System. SAFE may be accessed via

[89] Source: City of San Antonio Office of Emergency Management

[90] Source: City of San Antonio Office of Emergency Management

the City's website. The mission of SAFE is to educate the public on actions necessary to protect life and property.

As an additional indicator of floodplain management responsibility, communities may choose to participate in FEMA's Community Rating System (CRS). This is an incentive-based program that allows communities to undertake flood mitigation activities that go beyond NFIP requirements. The City of San Antonio is not currently participating in CRS, but has begun the application process, including documenting tasks and projects to prevent and reduce flood losses. These include measures such as updating codes as a preventative measure, acquisition of flood-prone structures, and implementation of other structural flood control projects. The City has acquired over 300 flood-prone or repetitive flood loss properties in previous years and has plans to acquire additional structures that have previously experienced one or more floods, in an effort to protect open space adjacent to floodplains. Additionally, the City has identified and included over 85 flood mitigation projects in the current hazard mitigation plan underway. Based on current and proposed activities that qualify for CRS credit, the City of San Antonio is positioned to become a CRS community in the near future, which will provide flood insurance incentives to expand the community's current NFIP policy base, reduce risk through adoption of higher regulatory standards and other flood mitigation measures, and reduce flood insurance premiums to residents.

The legislature of the State of Texas has, in Section 16.315, Texas Water Code, delegated the responsibility of local government units to adopt regulations designed to minimize flood losses. The City of San Antonio has adopted ordinances to regulate the floodplain, or any land area susceptible to being inundated by water from any source.

The flood hazard areas of San Antonio are subject to periodic inundation, which may result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, and extraordinary public expenditures for flood protection and relief, which adversely affect public safety.

Overall loss resulting from a flood event is caused by the cumulative effect of floodwaters to obstructions in floodplains; flood hazard areas; habitats vulnerable to floods; and hazardous to other landforms that are inadequately elevated, flood-proofed, or otherwise protected from flood damage. For example, flood plain obstructions cause an increase in floodwater heights and velocities.

It is the purpose of the City to promote the public health, safety, and general welfare of residents and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

- Protect human life and health;
- Minimize expenditure of public money for costly flood control projects;

- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
- Minimize prolonged business interruptions;
- Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, and streets and bridges located in floodplains;
- Help maintain a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to minimize future flood blight areas; and
- Ensure that potential buyers are notified that property is in a flood area.

To accomplish these tasks, the City of San Antonio follows these guidelines:

- Restrict or prohibit uses that are dangerous to health, safety, or property in times of flood, such as filling or dumping, that may cause excessive increases in flood heights or velocities;
- Require that uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction, as a method of reducing flood losses;
- Control the alteration of natural floodplains, stream channels, and natural protective barriers, which are involved in the accommodation of floodwaters;
- Control filling, grading, dredging and other development, which may increase flood damage; and
- Prevent or regulate the construction of flood barriers, which will unnaturally divert floodwaters or may increase flood hazards to other lands.

NFIP Compliance and Maintenance

As part of continual compliance with the NFIP, the City has developed a Floodplain Management Plan and has a current NFIP ordinance. The City also works closely with the San Antonio River Authority in public outreach efforts, including periodically conducting education programs for area homebuilders, business organizations, and through public contact with citizens to bring awareness to the FEMA requirements for floodplain management.

As part of the NFIP, and in conjunction with developing new mitigation actions to include in the mitigation plan, the City has implemented previous mitigation projects related to compliance and maintenance associated with the NFIP.

The City of San Antonio has also developed new mitigation actions that relate to NFIP compliance. These actions can be found in Section 24.

During hazard ranking activities at the Risk Assessment Workshop, flooding was identified by the Planning Team as a high-risk hazard and many of the mitigation actions were developed with flood mitigation in mind. A majority of these flood actions address reducing flood risk

through structural alterations and drainage projects and implementing flood awareness programs. The City of San Antonio recognizes the need and is adopting higher NFIP regulatory standards to further minimize flood risk in the community.

The prioritization method for implementing actions was based on FEMA's Social, Technical, Administrative, Political, Legal, Economic, Environmental (STAPLEE) criteria. As a result of this exercise, an overall priority was assigned to each mitigation action by each team member. The overall priority of each action is reflected in the mitigation actions found in Section 24 of the HMAP. In prioritizing actions, a community must consider many factors. Of primary consideration is targeting specific mitigation actions for implementation following a major disaster. Other factors that determine prioritization are ease of implementation by the community, cost of the project compared to perceived benefit, timeframe for implementing the action, and available personnel to oversee and implement the project.

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 severe repetitive loss residential structures insured under the NFIP. The Texas Water Development Board (TWDB) administers the SRL grant program for the State of Texas.

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 $5,000.00 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.[91] Table 38 shows repetitive loss and severe repetitive loss properties for the City of San Antonio.

[91] Source: Texas Water Development Board

Table 38. Repetitive Loss and Severe Repetitive Loss Properties

JURISDICTION	BUILDING TYPE	NUMBER OF STRUCTURES	NUMBER OF LOSSES
City of San Antonio	Single Family	84	210
City of San Antonio	Other Non-Residential	20	61

Flood Risk Assessment

The flood risk assessment for private structures in San Antonio is based on an analysis of National Flood National Flood Insurance Program (NFIP) data on repetitive loss (RL), severe repetitive loss (SRL) and all NFIP flood claims in San Antonio. There are three categories in the Community Rating System for communities with repetitive loss properties. Categories A, B, and C are communities defined by having no unmitigated RL properties, having 1 to 49 unmitigated RL properties, and having 50 or more unmitigated RL properties, respectively. San Antonio is a Category C community.

The Community Rating System Coordinator's Manual defines a repetitive loss property to have two or more claims of more than $1,000 paid by the National Flood insurance Program (NFIP) within any 10- year period since 1978. A severe repetitive loss is defined as properties with four or more claims of more than $5,000 or two to three claims that cumulatively exceed the building's value. Table 39 shows the RL and SRL insurance statistics for the City of San Antonio.

Table 39. Repetitive Loss Flood Insurance Statistics – Non-Mitigated

TYPES OF CLIAMS	BUILDING PAYMENTS	CONTENT PAYMENTS	TOTAL PAYMENTS	AVERAGE PAYMENTS	LOSSES	PROPERTIES
RL Claims	$1,850,691	$544,421	$2,395,112	$12,434	201	85
SRL Claims	$1,425,116	$803,466	$2,228,582	$63,744	32	6
TOTAL	**$3,275,807**	**$1,347,887**	**$4,623,694**	**$76,179**	**233**	**91**

Additional flood claims not qualified to be categorized as RL or SRL have been paid in San Antonio since 1976 according to the data. The total losses are shown in Table 40.

Table 40. NFIP Flood Losses in San Antonio

YEAR	PROPERTIES RECEIVING CLAIM PAYMENT	PAID OUT CLAIMS	AVERAGE PAYMENT	TOTAL PAYMENTS
1976 – 1977	7	7	$1,251	$8,755
1978 – 2007	505	673	$20,586	$13,854,123
2008 – 2014	173	195	$24,971	$4,869,317
2015 – 2017	52	58	$11,009	$638,547
TOTAL	**737**	**933**	**$14,454**	**$19,370,742**

Thirteen repetitive flood loss subareas were identified in the San Antonio Repetitive Loss Area Analysis (RLAA). These areas consist of repetitive loss properties and the surrounding properties that experience the same or similar flooding conditions, whether or not the buildings on those surrounding properties have been damaged by flooding. The subareas were selected based on the following criteria: cluster of repetitive flood loss properties in the neighborhood, the location of the repetitive flood loss properties in relation to a body of water, and the approximation of each identified repetitive flood loss property.

Section 8: Wildfire

Hazard Description

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, due to increased frequency of wildfires and increased development across the state. 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.

WILDFIRE AND CLIMATE CHANGE

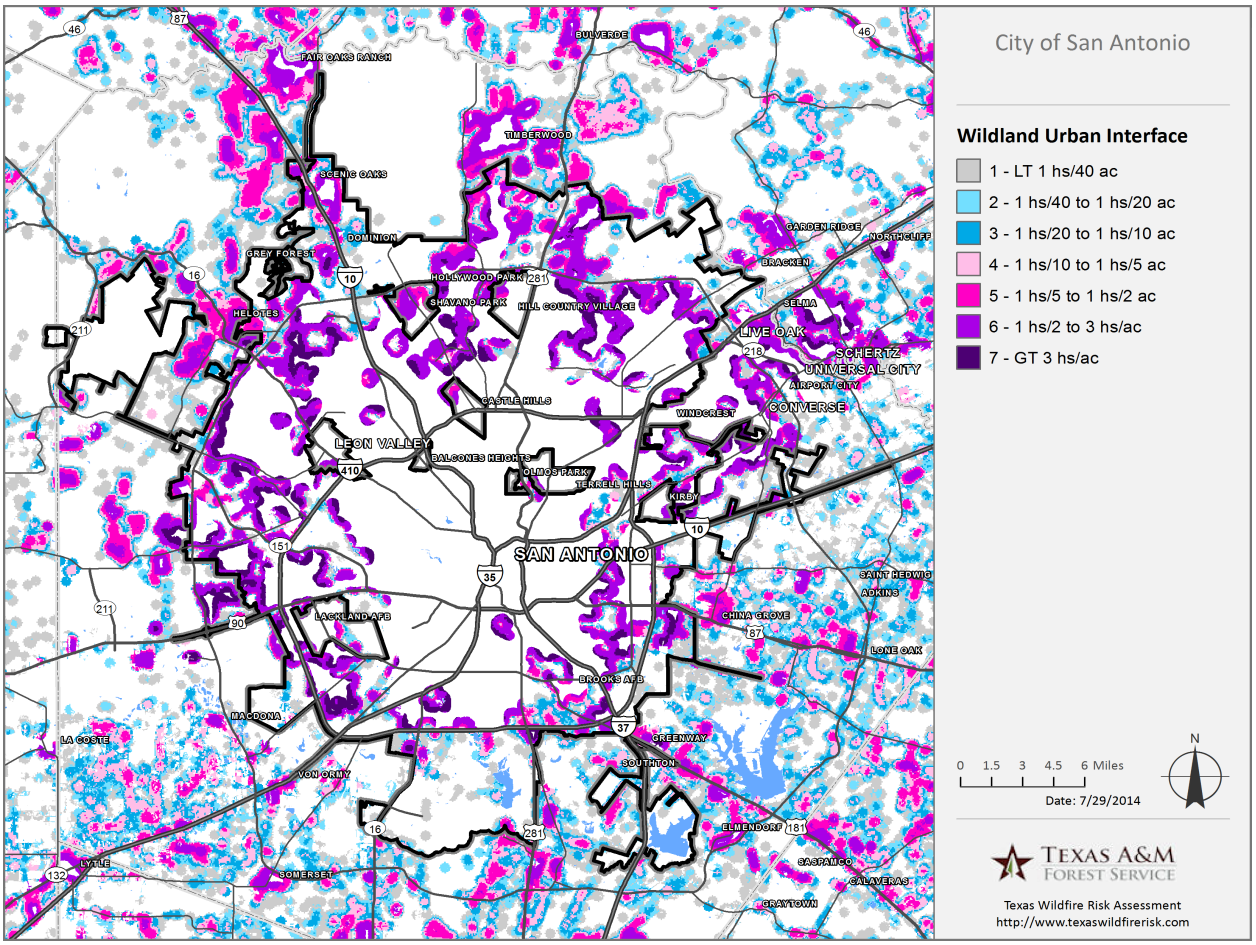
From 1950 to current day, the wildfire season has extended from five to seven months due to warmer springs, longer summer dry seasons, and drier soils and vegetation. These trends of longer wildfire seasons and larger wildfire size are predicted to continue as more frequent and longer droughts occur. In addition to climate change, other factors—land use, large-scale insect infestation, fuel availability, and management practices, including fire suppression, play an important role in wildfire frequency and intensity.

Rising temperatures and more sporadic precipitation are expected to increase the wildfire risk and duration of the fire season in the Southern Great Plains region. Climate models show that these types of wildfire events could become more common.

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. (Figure 25). It is estimated that 22 percent of the total population in the City of San Antonio live within the WUI. However, the entire City of San Antonio planning area is at some risk for wildfires.

Figure 25. Wildland Urban Interface Map – City of San Antonio

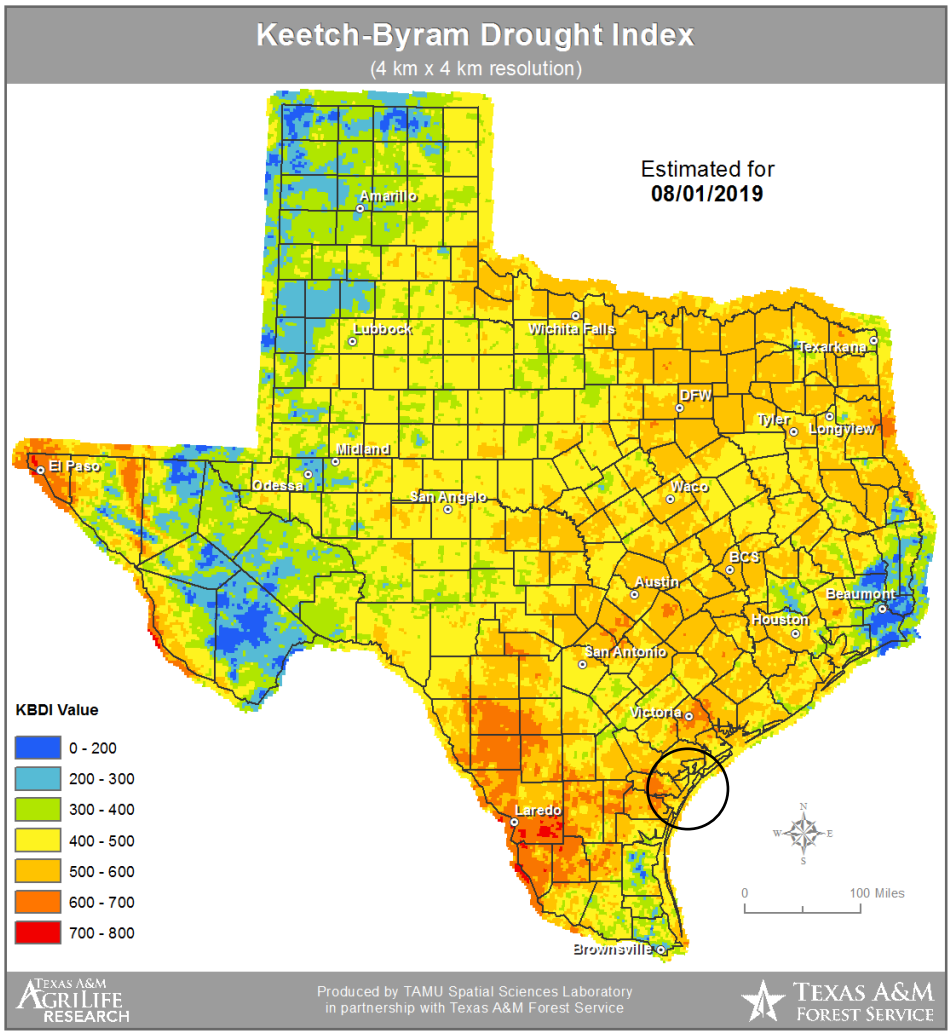


Extent

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 26 represents the drought index at that location. The drought index ranges from 0 to 800. A drought index of 0 represents no moisture depletion, and a drought index of 800 represents absolutely dry conditions.

Figure 26. Keetch-Byram Drought Index for the State of Texas, 2019[92]



[92] The City of San Antonio is located within the black circle.

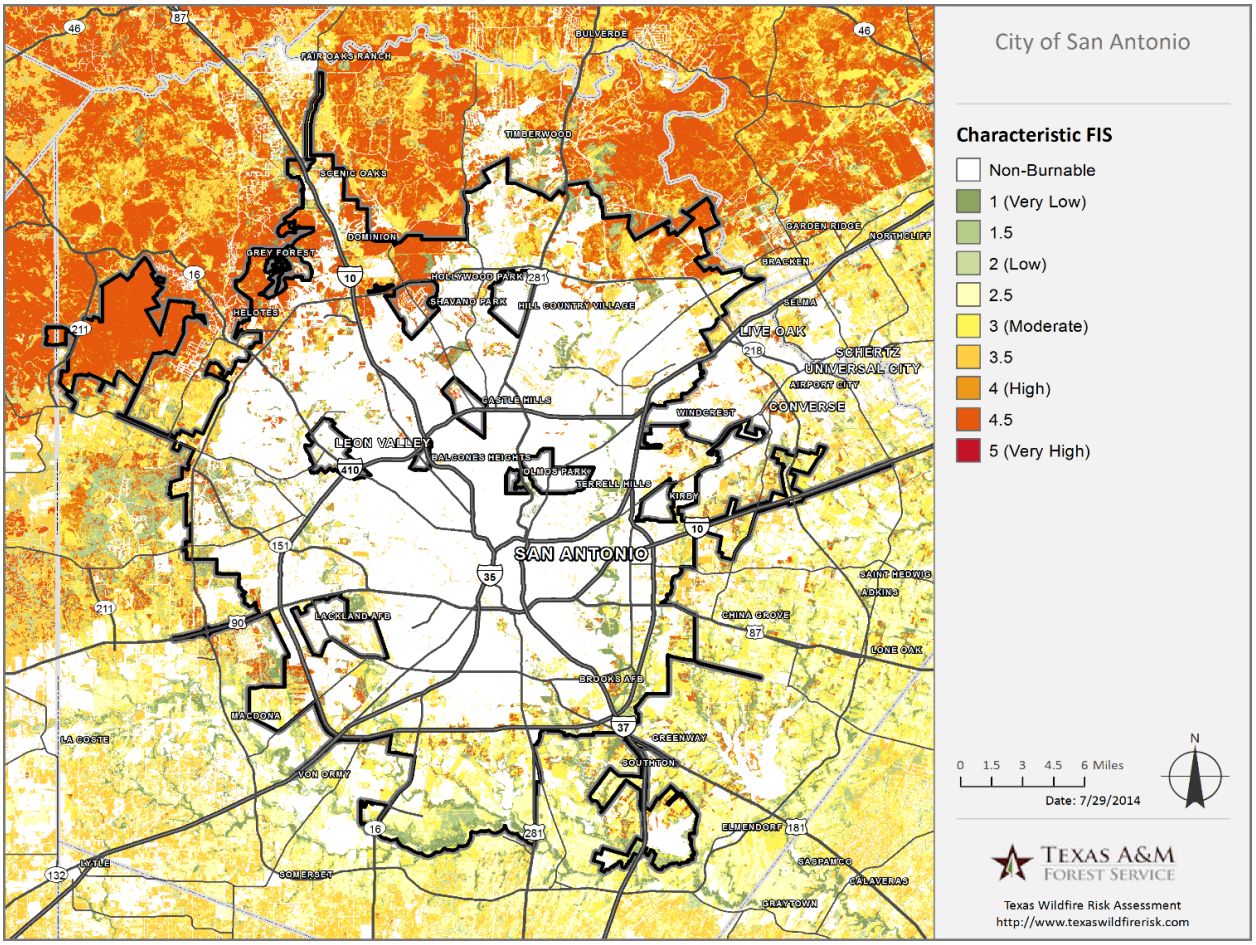
Fire behavior can be categorized at four distinct levels on the KBDI:

- 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.
- 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.

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 exercised in dryer, hotter conditions.

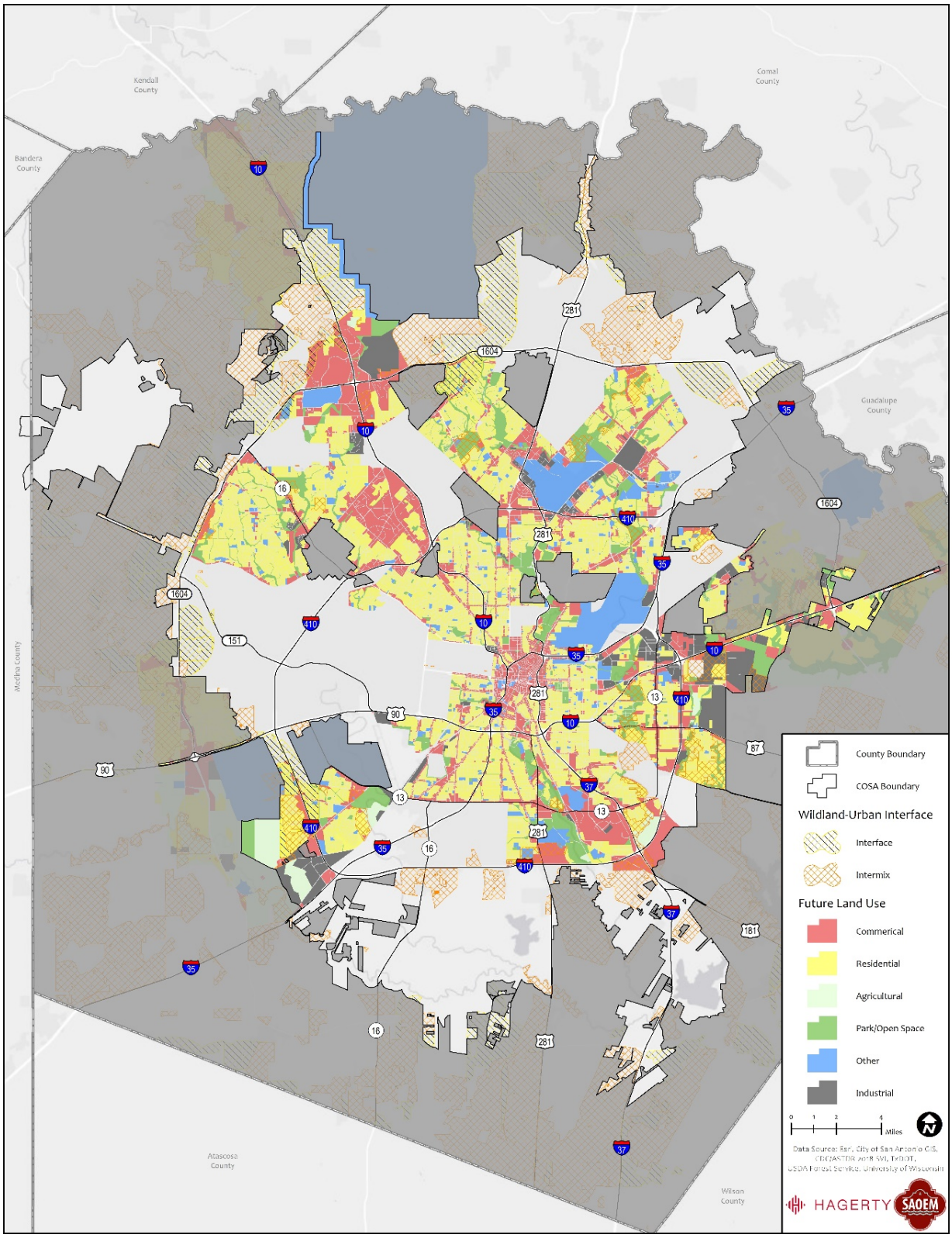
The range of intensity for the City of San Antonio in a wildfire event is within 600 to 800. The average extent to be mitigated for the City of San Antonio planning area is a KBDI of 605. At 605 KBDI, fires will burn readily, exposing mineral soils. Wildfires will burn through the night and heavier fuels will actively burn and contribute to wildfire intensity. Figure 27 identifies the wildfire intensity for the City of San Antonio.

Figure 27. Fire Intensity Scale Map – City of San Antonio



Weather and climate drivers of wildfire risk are projected to increase the risk of wildfires throughout the state, primarily due to increased rates of drying and increased fuel load. Increased dryness is expected to extend the wildfire season in places where the fire season is presently constrained by low levels of aridity, such as eastern Texas. On average, more than one percent of land in Texas has burned each decade since 1984. Within the San Antonio metropolitan area, it is estimated that there are 15,649 homes in areas of high wildfire risk and an additional 117,409 homes in areas of medium wildfire risk. In total, this represents an estimated $16.6 billion of property value in areas of considerable wildfire risk. Figure 28 illustrated the WUI and future land use by category (e.g., commercial, residential) in the San Antonio planning area.

Figure 28: Wildland Urban Interface (WUI) and Future Land Use



Historical Occurrences

The San Antonio Fire Department reported 137 wildfire events between 2007 and December 2019 and two wildfire events reported by the National Centers for Environmental Information (NCEI) in 2011 and 2014, which resulted in $250,000 of property damages. The Texas Forest Service (TFS) started collecting wildfire data in 1985 and volunteer fire departments started reporting events until 2005. Due to a lack of recorded data for wildfire events prior to 2007, frequency calculations are based on a 13-year period, using only data from recorded years. Figure 29 illustrates the approximate locations of wildfires according to the San Antonio Fire Department. Tables 8-1 and 8-2 identify the number of wildfires, ignition cause, and acreage of suppressed wildfire by year, according to the TFS.

Figure 29. Location and Historic Wildfire Events for San Antonio

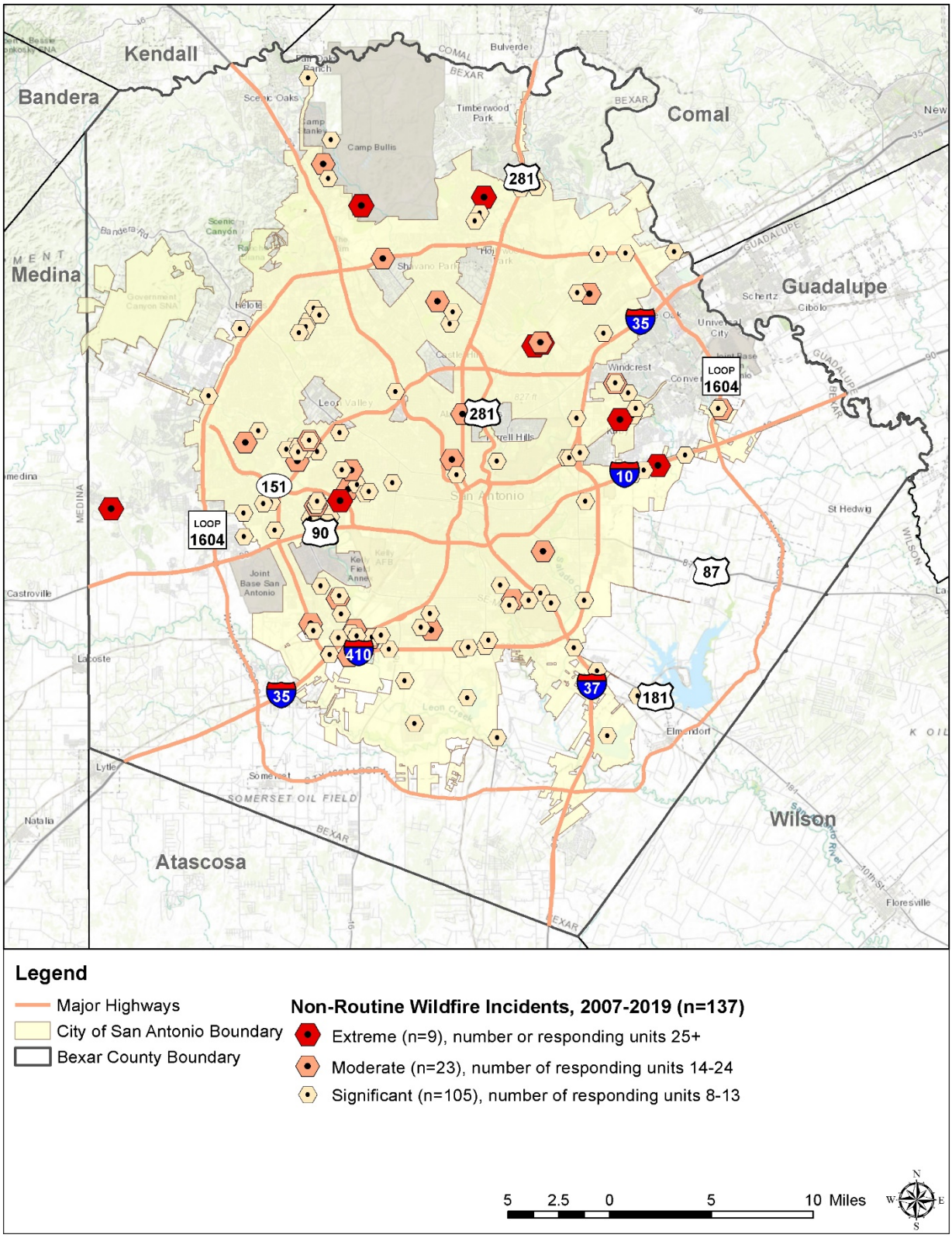


Table 41. Number of Wildfires by Cause for San Antonio

CAUSE	NUMBER
Debris, Vegetation Burn	2
Equipment Use	1
Incendiary	3
Natural source	1
Other Cause	3
Smoking	3
Undetermined	35
Data Not Available	89
TOTAL	**137**

Table 42. Acreage of Suppressed Wildfire by Year

YEAR	ACRES
2007	0
2008	45
2009	19
2010	0
2011	24
2012	401
2013	5
2014	35
2015	68.01
2016	6
2017	5.45
2018	26.2
2019	81.61

Based on the above list of historical wildfire events for the City of San Antonio planning area, 54 of the events have occurred since the previous HMAP update.

SIGNIFICANT EVENTS

September 11, 2011 – Wetmore Wildfire

More than 100 firefighters worked to contain a fast-moving fire, which ignited on September 11, 2011, around 1:00 p.m., behind homes in the 10000 block of Merritime Court, near Wetmore Road and Broadway. Winds blowing from south to north intensified the flames through the greenbelt until the wind shifted to the east.

The wind caused the fire to spread through a densely populated residential area. Many residents were seen watering their yards to avoid the spread of fire, and San Antonio police officers drove through neighborhoods with loudspeakers announcing mandatory evacuations. Several structures were damaged, and several hundred people were evacuated from their homes. The San Antonio Area Chapter of the American Red Cross opened a temporary shelter at 10700 Nacogdoches Road.

A CPS Energy primary line experienced an outage near where the fire originated. According to CPS Energy, 3,200 customers were without power.

A number of volunteer fire departments and the Texas Forest Service also responded to the fire, and a helicopter assisted by spraying liquid over the area.

September 9, 2011 – Potranco Wildfire

Firefighters from more than a dozen agencies worked to contain a 250-acre brush fire on September 9, 2011, in west Bexar County. There was no threat to structures during the wildfire event, but the event triggered a series of precautionary evacuations. The fire originated in rugged, hilly terrain near the intersection of Zeta Drive and Potranco Road at about 1:30 p.m. Texas State Highway 211 from U.S. 90 to Potranco Road was closed to traffic until 10 a.m. the following morning.

York Duncan, president of the Texas Research and Technology Foundation, and Jim Dublin, its board chairman, said they rushed to the nearby Texas Research Park and helped evacuate more than 70 apartments, the University of Texas Health Science Center research facilities, and bioscience and technology companies.

As the fire moved west, about 100 residents in the Pioneer Estates neighborhood and along Mechler Road were evacuated to Medina Valley High School. Citibank also closed its campus, evacuating 2,600 employees. The wildfire then turned to the north, and another 100 residents along Landa Road and in the Potranco Run subdivision were ordered to leave. No injuries were reported.

The Texas Forest Service provided aerial assistance dropping fire retardant on the blaze.

September 7, 2011 – Camp Bullis Wildfire

Flames erupted at Camp Bullis on Thursday, September 7, 2011, around 4:15 p.m., in an area where a grass fire had previously ignited Tuesday afternoon. The fire had burned about 150 acres, but no structures were damaged. Aircrafts were dropping retardant on the eastern portion and fire crews were preparing to abate the rest of the blaze overnight. It was predicted to take four days to fully contain the fire.

Residents were evacuated from about 100 homes in Fair Oaks Ranch within a quarter-mile of Wednesday's fire, along Ralph Fair Road, Pimlico Lane and Ruffian Drive. According to the CPS Energy, the utility had to reduce power at the Fair Oaks Ranch substation to allow firefighters to continue working, affecting about 4,500 customers.

Although Camp Bullis has its own fire department, firefighters from San Antonio, Bexar County, and numerous other agencies assisted.

September 5, 2011 – Stone Oak Wildfire

On September 5, 2011, a wildfire fire started around 1:30 p.m. near Stone Oak Parkway and Evans Road on the north side of San Antonio. There were reportedly several fires burning in the area. Winds at 21 miles per hour with gusts of up to 35 miles per hour were making it more difficult for firefighters to extinguish the flames.

A San Antonio Water System truck that accidentally caught fire around 1:30 p.m. sparked the Stone Oak wildfire. The fire spread quickly to Stone Oak Parkway and Evans Road, prompting mandatory evacuations at The Abbey at Stone Oak Apartments, The Estates at Canyon Ridge Apartments, and Champion Village Apartments. Smoke from the fire slowed down traffic on U.S. 281. Parts of Stone Oak Parkway and Canyon Gulf Road were closed. According to the CPS Energy outage map, at least 2,000 people were left without power.

Firefighters from 75 units contained the blaze by 5:00 p.m., then helicopters arrived to drop water from the sky. The San Antonio Chapter of the American Red Cross set up a temporary shelter at Barbara Bush Middle School for those displaced.

Probability of Future Events

With 137 events in a 12-year period, an event within the City of San Antonio is highly likely and an event is probable within the next year. Wildfires can occur at any time of the year. As the City grows and develops into wild land, the potential area for a wildfire event increases.

Climate change is expected to increase the frequency and intensity of wildfires in the region, with hot and dry conditions conducive to wildfires becoming more common. The Fourth

National Climate Assessment projects an increase in wildfire risk throughout the Southern Great Plains as temperatures continue to rise and the duration of the fire season increases.

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 residing in woodland settings have an increased risk of being affected by wildfire.

The heavily populated urban areas of the City of San Antonio are not likely to experience large, sweeping fires. Areas outside of the City in the unincorporated areas of Bexar County are vulnerable. Unoccupied buildings and open spaces that have not been maintained have the greatest vulnerability to wildfire. The main area of concern for wildfires is located mostly along the perimeter of the WUI. Figure 30 illustrates the WUI overlayed with population density in San Antonio. Figure 31 illustrates the WUI overlayed with socially vulnerable populations in San Antonio. There are two main types of WUI: intermix and interface. Intermix WUI are areas where housing and vegetation intermingle; interface WUI are areas with housing in the vicinity of contiguous wildland vegetation.

Figure 30: Wildland-Urban Interface (WUI) and Population Density in San Antonio

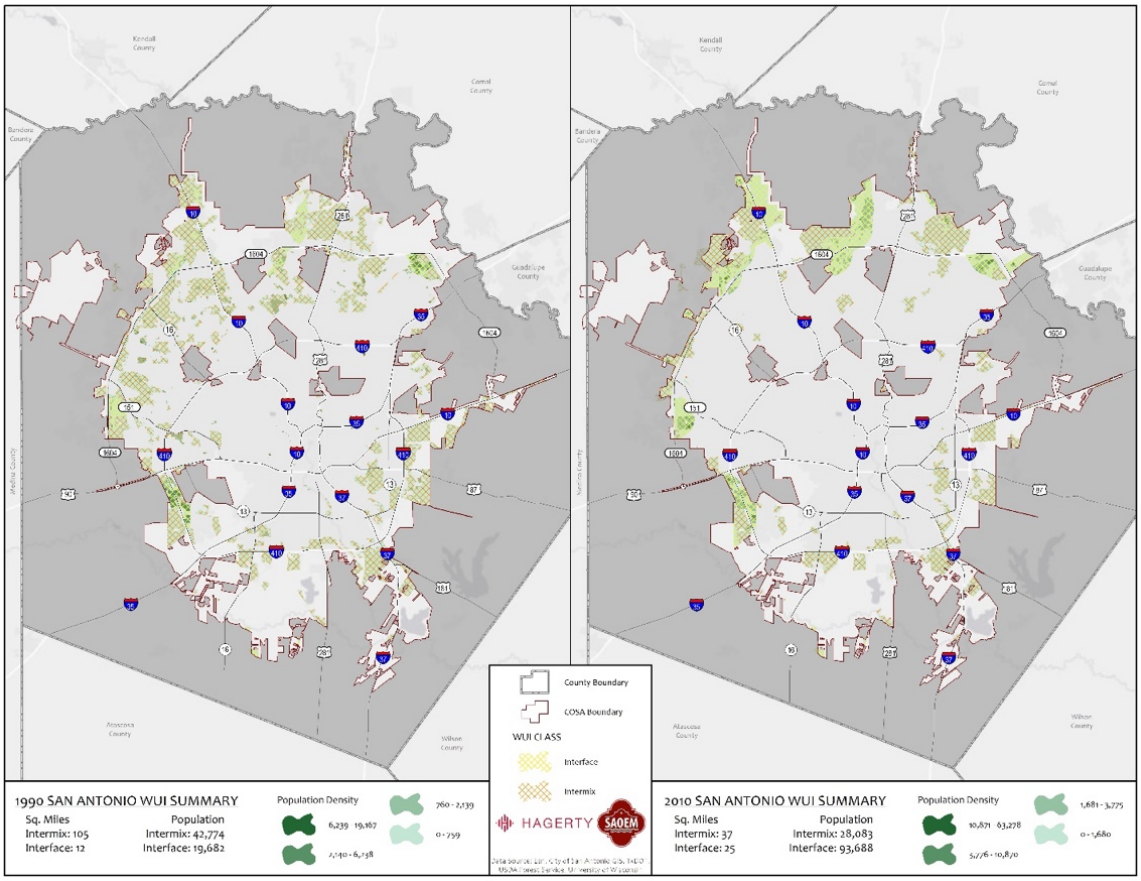
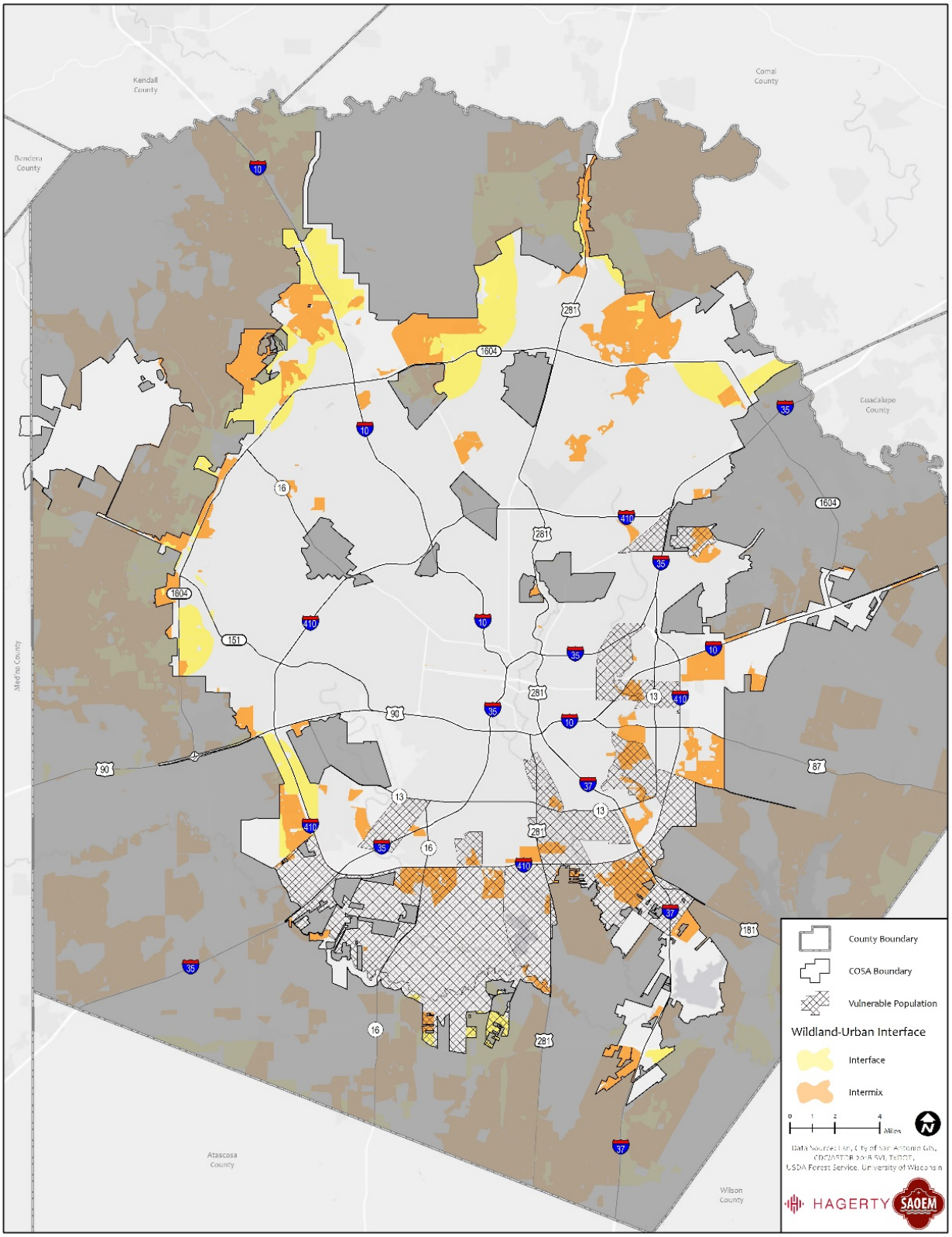


Figure 31: Wildland-Urban Interface (WUI) and Socially Vulnerable Populations in San Antonio

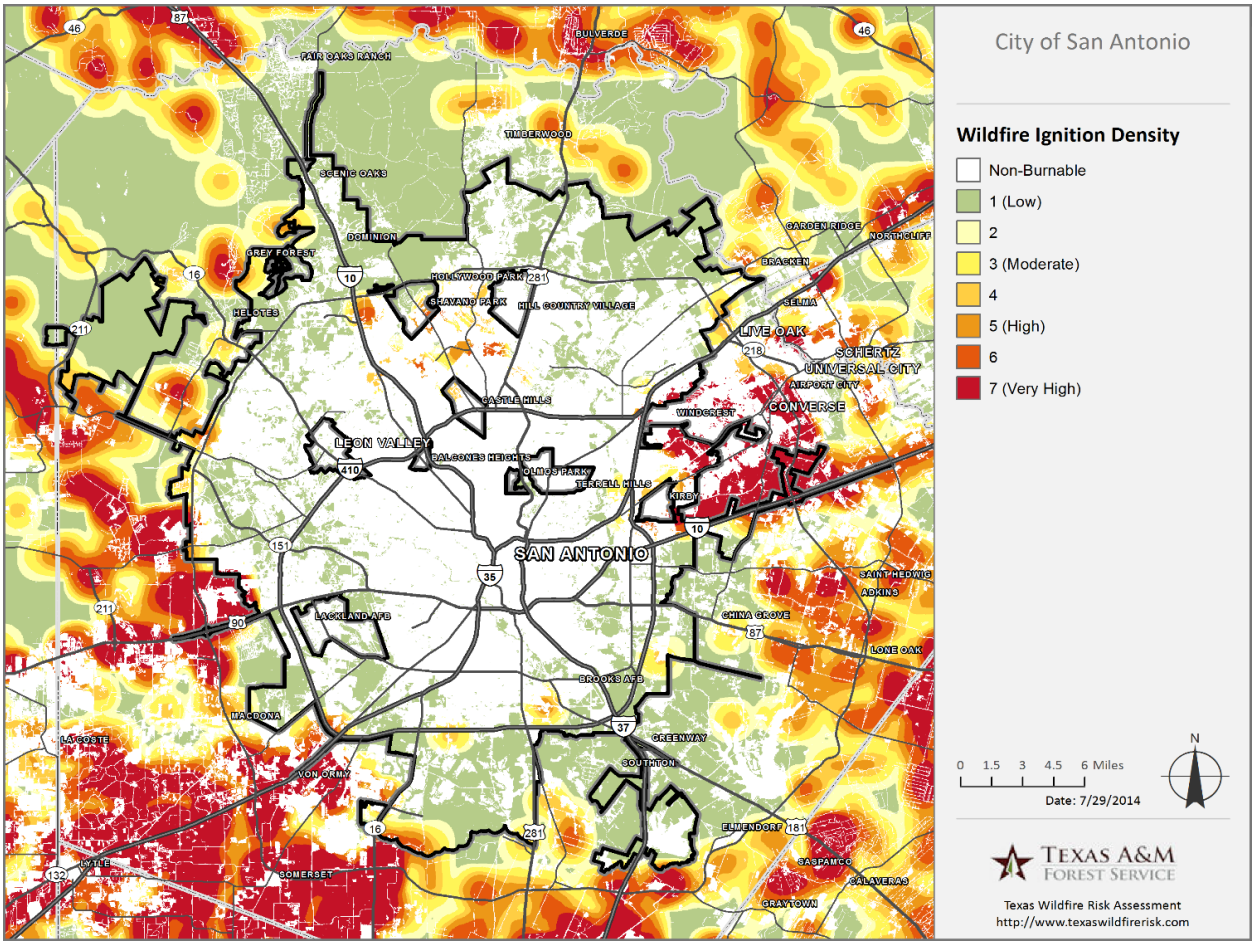


Within the City of San Antonio, a total of 137 fire events were reported from 2007 to 2019. All these events were suspected wildfires. Historic loss and annualized loss estimates due to wildfires are presented in Table 43. The frequency is approximately 11 events every year. Figure 32 illustrates the likelihood of a wildfire event in the City of San Antonio.

Table 43. Historic Loss Estimates Due to Wildfire[93]

JURISDICTION	NUMBER OF EVENTS	ACRES BURNED	INJURIES	DEATHS	ANNUAL ACRE LOSSES
San Antonio	137	716.27	0	0	55.09

Figure 32. Likelihood of Wildfire Starting – City of San Antonio



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

[93] Events divided by 12 years of data.

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. The City of San Antonio has an estimated 337,386 people or 22% of the total population that live within the Wildland Urban Interface (WUI). The impact to the planning area from a wildfire event can be considered "Minor," and injuries are possible but may not result in permanent disability, complete shutdown of critical City area facilities for more than one week, and more than 10% 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. Persons in the area at the time of the fire are at risk for injury or death from the variety of threats present during a wildfire event. Burns to the human body and smoke inhalation are the foremost threats.

Response personnel face the same potential impacts as the public. Response personnel can also be at increased risk of physical injury because the nature of their responsibilities may bring them closer to the hazard. Response personnel can experience more long-term impacts resulting from prolonged exposure to smoke, chemicals, and heat. Heart disease, respiratory problems, and related illnesses can develop in response personnel after repeated and concentrated exposure.

Depending on the characteristics and location of the wildfire event, operations and service delivery could be impacted by a wildfire. While the San Antonio Office of Emergency Management (SAOEM) has a protected facility from which to operate, the facility may not be accessible in the event of a fire near the facility. If the SAOEM office is inaccessible, staff members would be limited to performing work with the resources that are accessible to them from their remote location.

Other City departments may not be as protected as the SAOEM and may suffer more interruptions as a result of damages from a wildfire. If hard or electronic files are damaged, destroyed or otherwise inaccessible, a department may be unable to perform its assigned tasks

and deliver its designated services. This interruption could have significant impacts throughout the City and could negatively impact its ability to respond to and recover from the wildfire event. Without a Continuity of Operations (COOP) Plan that considers department-specific issues, or regular exercise of that COOP, critical departments may not be able to function and provide necessary services.

Damage from a wildfire can even impact utility infrastructure. This could result in a temporary loss of function for businesses in the planning area that rely on utilities for operation, even if those businesses were not directly impacted by the fire. Additionally, businesses can suffer interruption from closed or blocked roadways. For example, firefighters may need to close a roadway if a wildfire grows outs of control or shifts unexpectedly. This could negatively impact other businesses in the area that were not otherwise damaged.

Most property, facilities, and infrastructure within the planning area are at risk from damage or destruction from a wildfire event, including residential and commercial structures and their supporting utilities, vehicles and transportation infrastructure, and community buildings, such as hospitals, police stations, and schools. Table 44 identifies City's critical facilities according to their location within the WUI. These facilities were mapped in relation to the High Density Intermix Area and High-Density Interface Zones.

Table 44. Critical Facilities Located within the Wildland Urban Interface

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	9
Banking and Finance	24
Chemical and Hazardous Materials Industry	12
Defense Industrial Base	N/A
Energy	-
Emergency Services	9
Information Technology	N/A
Communications	-
Postal and Shipping	-
Healthcare and Public Health	125
Transportation	1
Water	16
National Monuments and Icons	-

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Commercial Facilities	320
Government Facilities	33
Dams	-
Nuclear Reactors, Materials, and Waste	1
Manufacturing	-

Roadways in or near the WUI could also be impacted by wildfire because of damage or closure resulting from smoke and limited visibility.

Wildfires are often a natural phenomenon and part of the normal cycle of the natural environment. Wildfires can result in significant deforestation, wildlife death, and cause water and air pollution. Environmental damage caused by a wildfire event may take decades, or longer, to become fully restored.

Wildfire also performs a variety of environmentally beneficial functions to the burned area. Fire returns nutrients to the soils, encourages growth of more fire-resistant fauna and trees, and promotes the establishment of seedlings. Many wildlife species thrive in the aftermath of wildfire. The grasses, seedling shrub, and trees that reestablish in a burned area provide an ideal environment for many small seed-eating mammals and birds, such as voles and sparrows. The abundance of small prey attracts predators like foxes, hawks, and weasels. Burned trees provide sites for cavity-nesting birds like flickers, kestrels, and chickadees, and woodpeckers thrive on the insects that inhabit fire-killed trees[94].

The San Antonio planning area is home to many cultural and historic resources. Many of the historic neighborhoods may be at risk from a wildfire event because they are of a construction type and material that is more vulnerable to fire. Historic homes are generally exempt from modern building code requirements, which may require fire suppression equipment in the structure, and these homes are often constructed close together. In addition, the City's historic and cultural resources are a significant draw for tourists and visitors to the area and help to generate revenue through taxes and fees. This revenue in turn pays services and programs, which benefit residents and the community.

The financial and economic impacts associated with a wildfire event may be significant. A major fire, where a large number of structures are damaged or destroyed, can have serious economic and financial consequences for a community. These consequences will depend on what is

[94] Source: Property and Environment Research Center

damaged, the extent of the damage, and the services the damaged structures provided to the community.

The economic and financial impacts of a wildfire event on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of a wildfire event.

Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. A response demonstrating that the City, its leaders, and officials were prepared for the event, anticipated the magnitude, and understood what could happen, will boost the City's reputation and standing with residents. However, if the perception develops, correctly or incorrectly, that the response was slow, needs or complaints of its residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence may decline.

A wildfire that is responded to and handled with little damage to structures or infrastructure can enhance public perception. Visual images of the firefighting and suppression effort can be a powerful tool to aid in the public trust and confidence regarding firefighting and public safety.

Section 9: Tornado

Hazard Description

Tornadoes are among the most violent storms on the planet. A tornado is a rapidly 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 more than one mile wide and 50 miles long.

The most powerful tornadoes are produced by "Supercell Thunderstorms." Supercell 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 45. Variations Among Tornadoes

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 • May last 20 minutes or longer • Winds 110 – 205 mph	• 2% of all tornadoes • 70% of all tornado deaths • Lifetime can exceed one hour • Winds greater than 205 mph

TORNADOES AND CLIMATE CHANGE

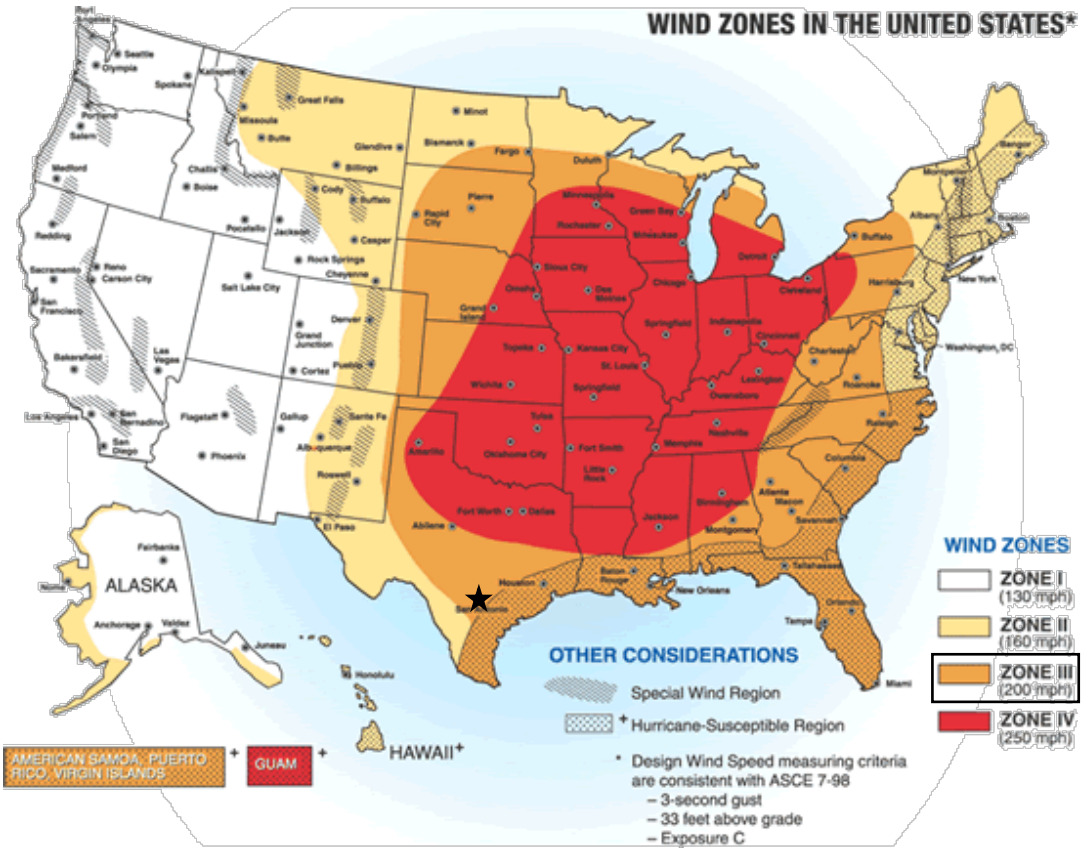
Climate change projections for San Antonio do not address the occurrence of tornadoes as there is a lack of confidence in climate models projecting the impacts of climate change on this severe weather phenomena. The growing intensity and frequency of severe weather events like extreme rainfall, extreme heat, and drought can be directly attributed to climate change, but the link between tornadoes and climate change is currently not fully understood. Tornado

records date back only to the 1950s in the United States, and vary significantly from year to year, making it difficult to identify long-term trends.

Location

As with thunderstorms, tornadoes do not have any specific geographic boundary and can occur throughout the City. It is assumed that the City of San Antonio planning area is uniformly exposed to tornado activity. The City of San Antonio is located in Wind Zone III (Figure 33), where tornado winds can be as high as 200 mph.

Figure 33. FEMA Wind Zones in the United States[95]



Extent

The destruction caused by tornadoes ranges from light to inconceivable 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 (particularly mobile homes).

[95] The City of San Antonio is indicated by the star.

Table 46. The Fujita Tornado Scale[96]

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; damages sign boards.	None Estimated
F1	Moderate Tornado	73 – 112	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; 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; light object missiles generated.	50% – 100%
F3	Severe Tornado	158 – 206	Roofs and some walls torn off well-constructed houses; trains overturned; 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; 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 in excess of 330 yards; trees debarked; steel reinforced concrete badly damaged.	100%

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

Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale (Table 46). Since February 2007, the Fujita Scale has been replaced by the Enhanced Fujita Scale (Table 47), which retains the same basic design and six strength categories as the previous scale. The newer scale reflects more refined assessments of tornado damage surveys, standardization, and damage consideration to a wider range of structures.

Table 47. 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; damages sign boards.	
EF1	Weak	86 – 110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; 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; light object missiles generated.	

STORM CATEGORY	DAMAGE LEVEL	3 SECOND GUST (MPH)	DESCRIPTION OF DAMAGES	PHOTO EXAMPLE
EF3	Severe	136 – 165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.	
EF4	Devastating	166 – 200	Well-constructed homes leveled; structures with weak foundations blown off some distance; cars thrown; large missiles generated.	
EF5	Incredible	200+	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles flying in excess of 330 yards; trees debarked; steel reinforced concrete badly damaged.	

Both the Fujita Scale and Enhanced Fujita Scale should be referenced in reviewing previous occurrences as tornado events prior to 2007 will follow the original Fujita Scale. The largest magnitude reported within the City of San Antonio planning area is F4 on the Fujita Scale, a "Severe Tornado." Based on this data, the planning area could experience anywhere from an EF0 to an EF5 depending on the wind speed.

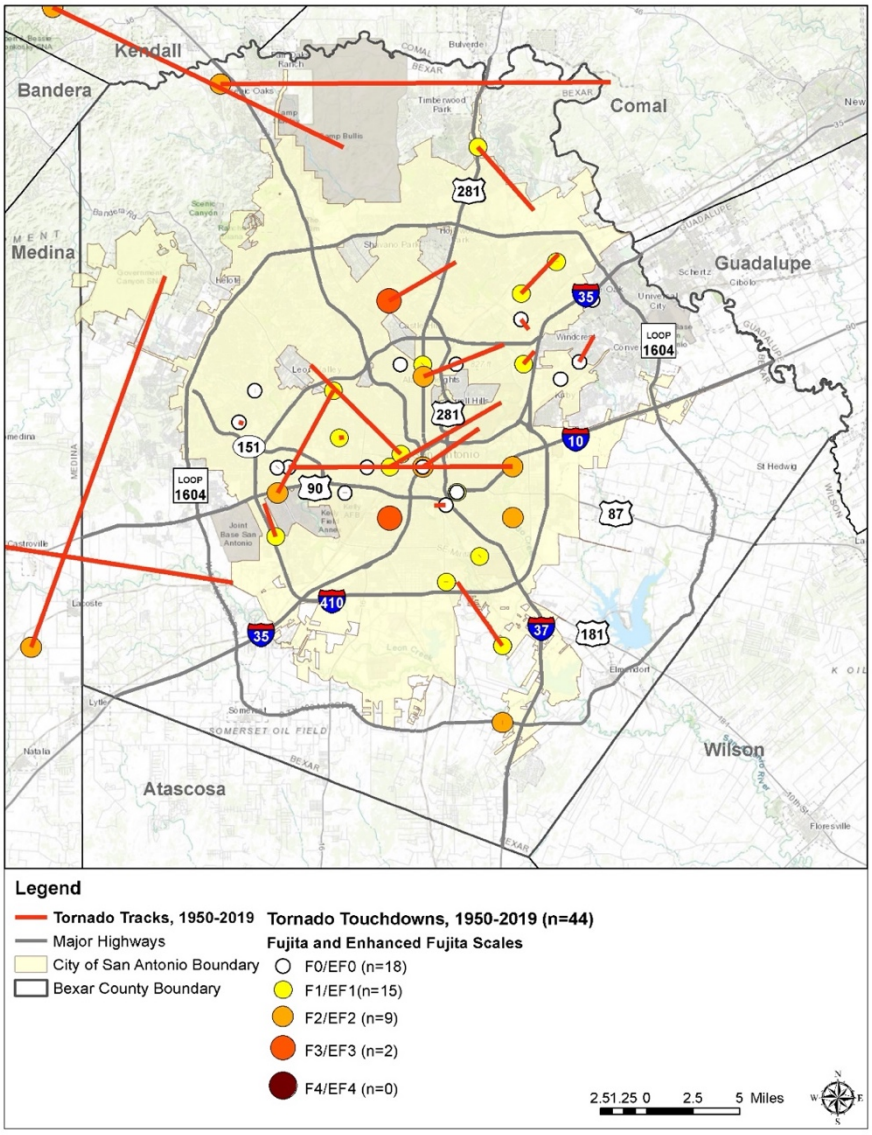
Although the City has experienced tornadoes as devastating as an F4 on the Fujita Scale, most storms only reach levels EF0, EF1, or EF2 (Table 48). Therefore, the range of intensity that the City of San Antonio planning area can expect to mitigate is a tornado event of moderate to high risk, an EF0 to EF5.

Historical Occurrences

Only reported tornadoes were factored into the Risk Assessment. It is likely that a high number of occurrences have gone unreported over the past 70 years. Historical tornado data for the County and City is provided on a jurisdiction-wide basis per the NCEI database.

Figure 34 identifies the locations of previous occurrences in Bexar County and the City of San Antonio planning area from 1950 through April 2020. A total of 73 events have been recorded by the Storm Prediction Center (NOAA) and NCEI databases for the Bexar County area, including the City of San Antonio planning area.

Figure 34. Spatial Historical Tornado Events, 1950–2020[97]



[97] Source: NOAA Records

Table 48. Historical Tornado Events, 1950-2020[98]

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
5/15/1950	F2	0	0	$274,762	$0
4/28/1953	F4	2	15	$0	$0
5/2/1958	F2	0	0	$2,253,235	$0
5/3/1958	F2	0	0	$224,136	$0
11/22/1961	F3	0	0	$21,592	$0
6/21/1965	F1	0	0	$204,985	$0
9/24/1967	F1	0	0	$19,278	$0
9/9/1968	F1	0	2	$18,454	$0
5/3/1969	F2	0	0	$1,779,540	$0
5/16/1969	F2	0	3	$1,779,540	$0
5/14/1970	F1	0	1	$167,812	$0
9/13/1970	F2	0	0	$16,524	$0
7/18/1971	F1	0	0	$159,996	$0
9/26/1972	F1	0	0	$15,386	$0
4/15/1973	F1	0	0	$1,493,544	$0
11/1/1977	F1	0	0	$1,046,450	$0
8/10/1980	F2	0	2	$777,614	$0
8/10/1980	F1	0	0	$77,761	$0
2/12/1984	F0	0	0	$63,257	$0
2/12/1984	F0	0	0	$633	$0
2/12/1984	F0	0	0	$6,326	$0
9/17/1988	F1	1	1	$5,406,949	$0
9/17/1988	F2	0	3	$54,069,491	$0
9/17/1988	F1	0	3	$54,069,491	$0
3/29/1992	F0	0	0	$46,501	$0
3/27/1994	F0	0	0	$880	$880

[98] Damages reported in 2020 dollars.

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
5/19/2000	F0	0	0	$60,432	$0
10/23/2000	F0	0	0	$74,454	$0
7/15/2007	EF1	0	0	$62,194	$0
7/24/2008	EF0	0	0	$942,340	$0
10/9/2011	EF1	0	0	$1,144,333	$0
5/25/2013	EF0	0	0	$111,228	$0

Table 49. Summary of Historical Events, 1950-2020[99]

JURISDICTION	NUMBER OF EVENTS	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
City of San Antonio	44	F4 (Max Extent)	3	30	$126,389,117	$880

Based on the list of historical tornado events for the City of San Antonio planning area (listed above), four of the events have occurred since the previous HMAP update.

SIGNIFICANT EVENTS

February 19, 2017 - City of San Antonio

A tornado formed near San Pedro Ave. at the San Pedro Golf course and moved northeastward while strengthening to an EF1 near Jackson-Keller Road. As it reached Linda Drive, it strengthened, and the damage path was its widest at near 600 yards. The tornado moved due east along Linda Drive and Sharon Drive where it had peak winds of near 120 mph, making it an EF2 tornado. A few homes in this area had their roofs completely removed. The tornado crossed Highway 281 near the Alamo Quarry Market shopping center as an EF1 and continued on an east-northeast track through Alamo Heights. Along its path, numerous homes had roof damage and major tree damage with large oak trees snapped and uprooted. Several apartment buildings had roof damage. The rest of the track was mainly EF0 damage with a few smaller pockets of EF1 damage. The tornado crossed near the Nacogdoches/New Braunfels Avenue intersection, moved east-northeast, crossing Harry Wurzbach Road, and finally dissipating near the I-410/Salado Creek area. Final assessment indicated two homes had been destroyed, 77 had major damage, 55 had minor damage, and 120 homes were affected.

[99] Damages reported in 2020 dollars.

October 9, 2011 – City of San Antonio

A tornado touched down on the southwest side of San Antonio near the intersection of Loop 410 and Medina Base Road. The tornado moved toward the north-northwest and dissipated near the intersection of Allenhurst Drive and Springvale Drive. The path of the tornado was 1.9 miles long with a maximum width of 50 yards. The damage from the tornado was rated EF1 with maximum winds estimated at 90 to 100 mph. The tornado caused roof damage to a number of homes along its path, including homes in the Ridgestone subdivision, along Parallel Drive, near the intersection of Cedarhurst Drive and Gage Drive, and on north to the end of the path. It also hit near the United States Postal Service Post Office at 5510 SW Loop 410 where it destroyed 15 postal trucks and damaged seven others. In addition, it damaged two office buildings on Valley Hi Drive and damaged the roof and a new building at Sam Rayburn Middle School. In all, over 71 properties were impacted by the tornado and three homes received major damage. No injuries or deaths were reported.

September 17, 1988 – City of San Antonio

A tornado hit Kelly Air Force Base (Base) and stayed on the ground for about two miles. It continued northwest for three more miles, moving off and on the ground, and resulting in scattered damage to residential homes. The tornado first touched down just outside the Base on the east side and then moved northwest over the Base. The hardest hit structures were rows of warehouse storage buildings. About 12 of the buildings in the path suffered major damage. Damage was mostly to roofs and a few outside walls. Two of the warehouses, or large sections of them, were destroyed, which supported a borderline F2 assessment. The warehouses were constructed of concrete block and large wooden support beams for the roofing. Scarring of outside walls by flying debris suggested an intense vortex. However, most of the damage could be considered as F1. At least 20 vehicles were damaged. There were roughly 15 employees in the warehouse area and three were injured. They were treated at a local hospital and released. Base officials stated that it was extremely fortunate that the tornado hit on a Saturday. On weekdays, 1,500 employees are usually in the warehouse area. Estimated damage at the Base was near $28 million ($3 million to warehouses and $25 million to contents).

March 15, 1972 – City of San Antonio

A small tornado threaded its way through a northeast San Antonio mobile home park (near Selma) and caused $20,000 in damages to structures. A couple was standing 30 feet apart when the small funnel swept between them. The tornado then shredded the walls and roof of their 47-foot mobile home before lifting to hopscotch across the Mobile View Estates Trailer Park on I-35 just south of Doser Lane. Nine other mobile homes were damaged by the erratic funnel, which disappeared into the cloud after ten minutes of destruction.

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 period can emerge in the fall during the brief transition between the warm and cold seasons. According to historical records, the City of San Antonio experiences a tornado touchdown every one to two years. Hence, the probability of future tornado occurrences affecting the City of San Antonio planning area is highly likely and an event may occur within the next year.

Vulnerability and Impact

Existing and future buildings, facilities, and populations in the City of San Antonio are considered to be exposed to tornadoes and could potentially be impacted. Tornadoes often cross jurisdictional boundaries, typically causing damage as a result of high wind velocity, wind-blown debris, and large hail.

The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction. Consequently, vulnerability of humans and property is difficult to evaluate since tornadoes form at different strengths, in random locations, and create relatively narrow paths of destruction. 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 with large spans, such as shopping malls, gymnasiums, and factories.

Tornadoes can cause a significant threat to people as they could be struck by flying debris, falling trees/branches, utility lines, and poles. Blocked roads could prevent first responders from responding to calls. Tornadoes commonly cause power outages, which could present health and safety risks to residents and visitors, as well as to patients in hospitals.

The City of San Antonio planning area features multiple mobile or manufactured home parks throughout the planning area. These parks are typically more vulnerable to tornado events than typical site-built structures. In addition, manufactured homes are located sporadically throughout the planning area (outside of manufactured home parks), which would also be more vulnerable. The US Census data indicates a total of 8,156 manufactured homes located in the City of San Antonio planning area (1.5%, Table 50). In addition, 47% (approximately 255,735 of the single family residential [SFR] structures in the entire planning area) were built before 1980. These structures would typically be built to lower or less stringent construction

standards than newer construction and may be more susceptible to damages during significant tornado events.

Table 50. Structures at Greater Risk in the City of San Antonio

JURISDICTION	MANUFACTURED HOMES	SFR STRUCTURES BUILT BEFORE 1980
City of San Antonio	8,156	255,735

While all citizens are at risk to the impacts of a tornado, forced relocation and disaster recovery drastically impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. An estimated 19.4% of the planning area population live below the poverty level (Table 51).

Table 51. Populations at Greatest Risk[100]

JURISDICTION	POPULATION BELOW POVERTY LEVEL
City of San Antonio	297,736

The following critical facilities would be vulnerable to tornado events in the planning area:

Table 52. Critical Facilities at Risk

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	102
Banking and Finance	382
Chemical and Hazardous Materials Industry	638
Defense Industrial Base	N/A
Energy	90
Emergency Services	197
Information Technology	N/A
Communications	101
Postal and Shipping	4
Healthcare and Public Health	1,047
Transportation	22
Water	275
National Monuments and Icons	8

[100] US Census Bureau 2018 data for the City of San Antonio.

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Commercial Facilities	2,272
Government Facilities	527
Dams	34
Nuclear Reactors, Materials, and Waste	74
Manufacturing	1

The average loss of property and crop from tornadoes has been estimated at $126,389,117 (in 2020 dollars), having an approximate annual loss estimate of $1,805,571. Based on historic loss and damages, the impact of tornadoes on the City of San Antonio planning area can be considered "Major," with more than 25% of property destroyed or with major damage, injuries and/or illnesses resulting in permanent disability, and critical facilities shut down for at least two weeks.

Table 53. Potential Annualized Losses

JURISDICTION	PROPERTY & CROP LOSS	ANNUAL LOSS ESTIMATES
City of San Antonio	$126,389,998	$1,805,571

The current scientific understanding of the relationship between climate change and the frequency and intensity of tornadoes is not developed enough to confidently project future trends of this phenomena.

ASSESSMENT OF IMPACTS

Tornadoes have the potential to pose a significant risk to the population and can create dangerous situations during which providing and preserving public health and safety is difficult. Individuals who are exposed to the storm can be struck by flying debris, falling limbs, or downed trees. Residential structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.

Large amounts of debris, such as downed trees, can result in emergency response vehicles being unable to access areas of the city. 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 power outages over widespread areas. Individuals who rely on power for health and/or life safety, such as those on life support systems, could be placed in jeopardy if no generator is available. Also, 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.

In addition to the potential impacts faced by the general public, response personnel must enter the damage area shortly after the tornado passes to begin rescue operations and to organize cleanup and assessment efforts. During these efforts, response personnel are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.

Tornadoes are a threat to operations and service delivery in the San Antonio area and have the potential to significantly impact the continuity of operations. While the San Antonio Office of Emergency Management (SAOEM) has a protected facility from which to operate, the facility may not be accessible to all staff, as they may be unable to leave their neighborhood due to roadway debris or other obstructions. Staff members unable to access the protected facility would be limited to performing work with the resources that are accessible to them from their remote location.

Other City departments may not be as protected as the SAOEM and may suffer more interruptions as a result of damages from tornadoes. If files (hard or electronic) are damaged, destroyed, or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. This interruption could have significant impacts throughout the City and could negatively impact the City's ability to respond to and recover from the tornado event. Without a plan that considers department-specific issues, and regular exercise of that plan, critical departments may not be able to function and provide necessary services.

Additionally, private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers, should have specific plans that are routinely exercised. For example, if debris produced by tornadoes resulted in the closure of roadways over a large area, this would result in a temporary halt to any repair of damaged infrastructure; impede emergency response activities; and interrupt the normal delivery of goods and services. Damaged electrical substations, downed power lines, and roadway obstructions are common occurrences after tornadoes, and all of these will impact the City's normal operations and service delivery. It is imperative that both public and private entities plan for these events and address how they will be able to function and provide services until normal operating conditions can be resumed.

Tornadoes typically damage the infrastructure of a community, including buildings, facilities, roads, bridges, power lines, and power plants. It can take a significant amount of time to fully repair these facilities and infrastructure, depending on the nature of the damage and the

availability of resources dedicated to the project. During Hurricane Dolly in 2008, an EF0 tornado damaged 84 properties in the San Antonio area. This is typical, as the historical record shows fairly low intensity tornado events, as is expected for the region, but relatively high property damage levels in relation to intensity.

Damage to infrastructure will generally slow down the economic recovery of the community and the re-opening of businesses and can limit the cleanup effort. It can force some businesses to close temporarily, even those that were not directly impacted by the event. For some businesses, loss of infrastructure can result in the failure of the business.

Some businesses rely more heavily on utility infrastructure than others. For example, grocery stores are typically reliant upon electricity to maintain the safety of their food supply. Some larger chain stores may have emergency power generators and fuel on hand, but smaller, independent stores often do not.

While tornadoes pose a risk to the environment, it is not so much the hazard itself as the effect of the hazard on the built environment that poses the risk. Tornadoes are a natural phenomenon and are unlikely to result in catastrophic or prolonged natural or environmental damage. Damages to the built environment, however, may result in both catastrophic and prolonged damage. For example, a chemical facility that is damaged by a tornado and leaks hazardous or dangerous chemicals into the environment could pose a significant and long-term risk. Depending on what is affected, the living organisms that rely directly and indirectly on that environment for health and survival may also be affected. Some harmful materials may take years, decades, or longer to become harmless and some materials may never fully break down. Until the chemicals break down into harmless products, they can continue to degrade the environment, and potentially leach into a water course or ground water, thus spreading contamination away from the site. Without clean-up, this may continue for years.

The San Antonio area is home to many cultural and historic resources. These resources are a significant draw for tourists and visitors to the area and help to generate revenue through taxes and fees. This revenue pays for services and programs, which benefit residents and the community.

The potential financial and economic risks associated with tornadoes may be significant for the City. While an individual residential structure that is damaged by a tornado can be devastating to the residents, the damage and cost of repair has a negligible impact on the community's overall economic health. However, a major tornado, where many structures are damaged or destroyed, can have serious economic and financial consequences for a community.

Large or intense tornadoes can cause significant property damage, to homes, businesses, industrial properties, and government buildings, resulting in significant economic impact on the affected area. A community affected by significant property damage would need to fund

infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses. While there are often state and federal programs that can help with these expenses, the majority of these programs are reimbursement programs, and require the local government to fund the initial expenses.

Large or intense tornadoes can also result in dramatic population fluctuations, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area. They may require temporary relocation assistance, and some of them may choose not to return to the community. Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community. A loss of jobs affects the financial and economic health and stability of the community and may result in an increase in the unemployment rate.

In addition to property damage and revenue interruptions, tornadoes often result in additional unexpected costs to the local government. Debris removal, staff overtime, additional personnel, services, and repairs to damaged structures will result in unexpected costs. Even with the best financial planning and management, unanticipated expenses will have an impact on the financial condition of a municipality.

The economic and financial impacts of a tornado in the City of San Antonio will depend 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 planning, including continuity planning that is accomplished by the City, businesses, and residents will contribute to the overall economic and financial conditions after an tornado event.

Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. A response demonstrating that the City, its leaders, and officials were prepared for the event, anticipated the magnitude, and understood what could happen, will boost the City's reputation and standing with residents. However, if the perception developed, correctly or incorrectly, that the response was slow, needs or complaints of City residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence will decline.

Section 10: Extreme Wind

Hazard Description

Extreme wind events include thunderstorms, hurricanes, and straight-line winds. Wind is the horizontal motion of 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 low pressure also determines how fast the moving air is accelerated.

THUNDERSTORMS

Thunderstorms are created when heat and moisture near the Earth's surface are transported to the upper levels of the atmosphere, producing clouds, precipitation, and wind.

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.

HURRICANES / TROPICAL STORMS

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 greater. 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 can be equally problematic without ever becoming a hurricane, 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 of wind speeds and potential damage. Tropical storm-force winds are strong enough to be a danger as well.

STRAIGHT-LINE WINDS

Straight-line winds can have gusts of 100 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.

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.

EXTREME WIND AND CLIMATE CHANGE

Climate change projections for San Antonio do not address the occurrence of extreme wind as there is a lack of confidence in climate models projecting the impacts of climate change on this severe weather phenomena.

Location

Extreme wind events can develop in any geographic location and are considered a common occurrence in Texas. An extreme wind event could occur at any location within the City of San Antonio's planning area. These storms develop randomly and are not confined to any geographic area within the City. It is assumed that the City of San Antonio is uniformly exposed to the threat of extreme winds.

Extent

The Beaufort Wind Scale measures the extent and magnitude of a thunderstorm event. Table 54 describes the different intensities of wind in terms of speed and the World Meteorological Organization (WMO) Classification of storm effects, from calm to violent and destructive.

Table 54. Beaufort Wind Scale[101]

FORCE	WIND (MPH)	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

[101] Source: World Meteorological Organization

FORCE	WIND (MPH)	WMO CLASSIFICATION	APPEARANCE OF WIND EFFECTS
2	4-8	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	9-14	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	15-21	Moderate Breeze	Dust, leaves, and loose paper lifted; small tree branches move
5	22-28	Fresh Breeze	Leaves in small trees begin to sway
6	29-36	Strong Breeze	Larger tree branches moving, whistling in wires
7	37-44	Near Gale	Whole trees moving, resistance felt walking against wind
8	45-53	Gale	Whole trees in motion, resistance felt walking against wind
9	54-62	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	63-72	Storm	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	73-83	Violent Storm	If experienced on land, widespread damage
12	84+	Hurricane	Violence and destruction

Hurricanes are categorized by wind strength and intensity, using the Saffir-Simpson Hurricane Scale (Table 55). A Category 1 storm has the lowest wind speeds, and a Category 5 hurricane has the highest. Lower category storms can inflict more significant damage than higher category storms depending on where they strike, the amount of storm surge, other weather interaction, and how slowly they move.

Table 55. Extent Scale for Hurricanes[102]

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

[102] Source: National Hurricane Center

CATEGORY	MAXIMUM SUSTAINED WIND SPEED (MPH)	MINIMUM SURFACE PRESSURE (MILLIBARS)	STORM SURGE (FEET)
3	111–130	964–945	9–12
4	131–155	944–920	13–18
5	155 +	Less than 920	19+

On average, the planning area experiences three to four thunderstorm wind events every year. The City of San Antonio planning area has experienced a significant wind event or an event with winds in the range of "Force 11" on the Beaufort Wind Scale. This is the most significant event that can be expected in the future for the planning area. However, the average measurement of severe winds related to a thunderstorm in San Antonio is a "Force 9," with winds at 54-62 miles per hour. The City can experience a range of wind speeds that cause widespread damage.

Based on the historical storm tracks for hurricanes and the location of the City of San Antonio outside of the hurricane wind hazard area, the average extent to be mitigated for the planning area is tropical storm winds.

Historical Occurrences

Tables 10-3 and 10-4 depict historical occurrences of thunderstorm events for the City of San Antonio according to the National Centers for Environmental Information (NCEI) data. Since January 1960, 241 severe thunderstorm events are known to have impacted Bexar County, based upon NCEI records, with 72 of those events occurring in the City of San Antonio. Table 56 presents information on known historical events impacting the City of San Antonio, with resulting damages. High wind events associated with tornadoes are not accounted for in this section.

Table 56. Historical Thunderstorm Wind Events, With Reported Damages, 1960-2020[103]

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
3/27/1994	56	0	0	$681,196	$68,120
3/8/1995	50	0	0	$66,230	$0
6/3/1995	0	0	0	$0	$16,990
7/3/1995	56	0	0	$6,575	$0

[103] Historic events are reported from January 1955 through April 2020. Damages are reported in 2020 dollars.

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
7/3/1995	0	0	0	$33,980	$3,398
4/28/1996	Unknown	0	0	$116,040	$16,577
6/2/1996	Unknown	0	0	$33,070	$0
7/25/1996	Unknown	0	0	$49,510	$0
5/27/1997	106	0	0	$62,631	$0
5/27/1997	62	0	0	$32,367	$0
9/9/1997	Unknown	0	0	$48,220	$0
2/21/1998	Unknown	0	0	$160,038	$16,004
2/21/1998	Unknown	0	0	$16,004	$0
3/16/1998	Unknown	0	0	$47,923	$0
3/27/1999	Unknown	0	0	$78,515	$0
4/25/1999	Unknown	0	0	$77,949	$0
5/17/1999	Unknown	0	0	$77,949	$0
5/1/2000	Unknown	0	0	$45,324	$0
11/2/2000	Unknown	0	0	$119,058	$0
11/5/2000	Unknown	0	0	$223,235	$0
5/17/2002	Unknown	0	0	$576,420	$0
5/17/2002	Unknown	0	0	$72,053	$0
12/23/2002	Unknown	0	0	$71,614	$0
6/10/2003	55	0	0	$70,523	$0
6/13/2003	55	0	9	$42,314	$0
8/8/2003	60	0	0	$42,107	$0
8/6/2006	65	0	0	$63,536	$0
4/24/2007	70	0	0	$62,680	$0
7/15/2007	80	0	0	$99,511	$0
5/14/2008	50	0	0	$4,629	$0
8/19/2008	50	0	0	$915	$0

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
8/20/2008	52	0	0	$9,154	$0
6/2/2010	56	0	0	$138,011	$0
6/2/2010	52	0	0	$9,201	$0
6/2/2010	43	0	0	$11,778	$0
7/26/2010	43	0	0	$920	$0
7/26/2010	65	0	0	$1,177	$0
9/2/2010	43	0	0	$45,904	$0
9/2/2010	43	0	0	$23,723	$0
9/18/2011	50	0	0	$22,097	$0
7/13/2012	39	0	0	$438	$0
8/10/2012	65	0	0	$8,705	$0
8/10/2012	52	0	0	$8,705	$0
4/29/2013	43	0	0	$862	$0
5/10/2013	50	0	0	$862	$0
5/10/2013	61	0	0	$8,609	$0
7/18/2014	43	0	0	$8,417	$0
4/25/2015	56	0	0	$4,238,060	$0
6/17/2015	43	0	0	$420	$0
6/17/2015	43	0	0	$420	$0
5/30/2017	61	0	0	$8,194	$0
5/30/2017	74	0	0	$163,888	$0
6/13/2018	65	0	0	$3,979	$0
6/13/2018	56	0	0	$796	$0
4/7/2019	52	0	0	$785	$0
4/7/2019	61	0	0	$1,570	$0
4/13/2019	52	0	0	$3,942	$0
5/14/2019	48	0	0	$1,566	$0

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
6/6/2019	61	0	0	$3,915	$0
6/6/2019	52	0	0	$1,566	$0
6/6/2019	61	0	0	$19,573	$0
6/6/2019	61	0	0	$78,294	$0
6/6/2019	61	0	0	$7,829	$0
6/6/2019	61	0	0	$1,011,548	$0
6/6/2019	52	0	0	$101,115	$0
9/19/2019	52	0	0	$3,905	$0
9/19/2019	52	0	0	$1,562	$0
9/19/2019	52	0	0	$100,912	$0
1/10/2020	65	0	0	$19,435	$0

Table 57. Summary of Historical Thunderstorm Wind Events, 1960-2020

JURISDICTION	NUMBER OF EVENTS	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE[104]	CROP DAMAGE
City of San Antonio	72	106 (Max Extent)	0	9	$9,153,953	$121,089

Based on the list of historical thunderstorm wind events for the City of San Antonio planning area (listed above), 26 of the events have occurred since the previous HMAP update.

Although hurricanes and tropical storms have appeared at various magnitudes and categories in the City of San Antonio area, the storms have usually weakened to tropical storms or depressions by the time they near the end of their life cycle. When reduced winds occur, extreme rainfall is the hazard of concern. Table 58 lists storm tracks through the planning area, as shown in Figure 35.

[104] Countywide damages have been adjusted to reflect only a percentage (77.4%) of the damages attributed to the City of San Antonio.

Table 58. Historic Hurricanes and Tropical Storms

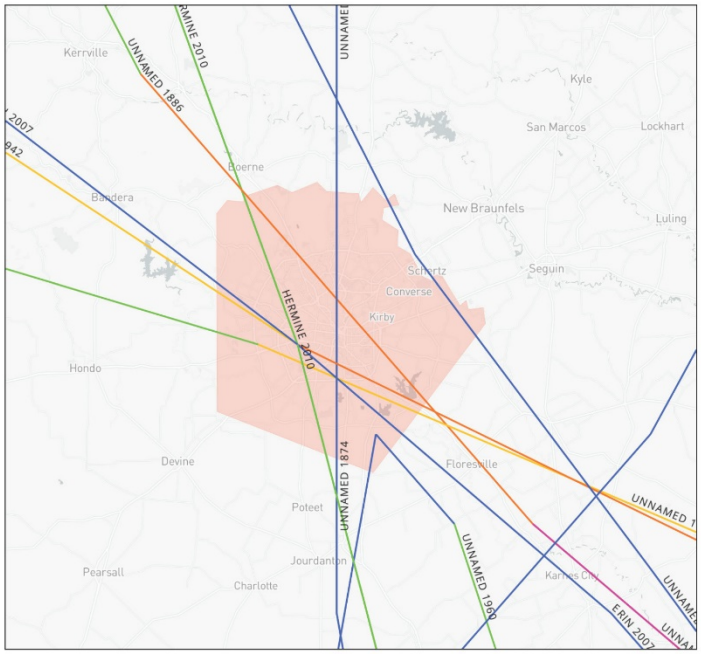
YEAR	STORM NAME	CATEGORY
1874	Not Named	Tropical Depression
1881	Not Named	Tropical Depression
1886	Not Named	Category 2
1929	Not Named	Category 1
1960	Not Named	Tropical Storm
2007	Erin	Tropical Depression
2010	Hermine	Tropical Storm

Based on the list of historical hurricane and tropical storm events for the City of San Antonio planning area (listed above), none of the events have occurred since the previous HMAP update.

Figure 35. Hurricane / Tropical Storm Tracks

Historical Hurricane Tracks

Hurricane List



Search Filter Criteria

Location: Bexar County, Texas, USA

Categories: H5, H4, H3, H2, H1, TS, TD, ET
Months: ALL
Years: ALL
El Niño-Southern Oscillation (ENSO): ALL
Minimum Pressure (mb) below: 1150
Include Unknown Pressure Rating: TRUE

STORM NAME	DATE RANGE	MAX WIND SPEED	MIN PRESSURE	MAX CATEGORY
HERMINE 2010	Sep 04, 2010 to Sep 10, 2010	60	989	TS
HERMINE 2010	Sep 03, 2010 to Sep 10, 2010	60	989	TS
ELEVEN 2010	Sep 03, 2010 to Sep 04, 2010	30	1004	TD
ERIN 2007	Aug 15, 2007 to Aug 19, 2007	50	995	TS
UNNAMED 1960	Jun 22, 1960 to Jun 28, 1960	50	1000	TS
UNNAMED 1942	Aug 23, 1942 to Sep 01, 1942	100	950	H3
UNNAMED 1929	Jun 27, 1929 to Jun 30, 1929	80	982	H1
UNNAMED 1886	Aug 12, 1886 to Aug 21, 1886	130	925	H4
UNNAMED 1881	Aug 11, 1881 to Aug 14, 1881	40	-1	TS
UNNAMED 1874	Sep 02, 1874 to Sep 07, 1874	50	-1	TS

SIGNIFICANT EVENTS

June 6, 2015 – City of San Antonio

A thunderstorm produced wind gusts estimated at 70 mph that blew across much of the downtown area of San Antonio. A large tree on King William Street was blown down and this is just one of hundreds of trees that were severely damaged or uprooted across the city during the late afternoon hours. Some of the downed trees fell on homes and cars causing structural damage adding to the overall monetary loss for the event, which does include an estimate of insured losses as well as city cleanup.

September 07, 2010 – City of San Antonio

Tropical Storm Hermine made landfall near the Texas/Mexico border on the night of September 6. The storm moved northward through South Texas into South Central Texas. Strong winds and flooding rain began in South Central Texas on September 7. On September 8, the winds subsided, but the flooding rain continued as the remnants of Hermine moved northward into Oklahoma. South Central Texas was hit very hard with widespread rains of 8-12 inches across much of the I-35 corridor from Austin down to San Antonio. The hardest hit areas were north Austin, Round Rock, Cedar Park, and Georgetown. Sixteen inches of rain fell in Georgetown, with the Georgetown Co-op observer reporting 16.37 inches for the two-day rain event. Williamson County reported 637 homes damaged by floodwaters, with most having minor to major damage. No damage estimate from these residences is available. Damage estimates are near $8 million dollars for County infrastructure, including roads, bridges, public buildings, and parks.

March 15, 2007 – City of San Antonio

A short, curved line of thunderstorms, approaching from the northwest, intersected near 1:25 a.m. with a second line of thunderstorms building westward from Seguin and Gonzales. For the next 20 minutes, the storms appeared to strengthen near this intersection and spread southwestward. By 1:50 a.m., the storms at this intersection began moving toward the southeast, and by 1:55 a.m., all storms were weakening rapidly. The greatest damage was located along Knollcreek Drive on the north side from Jung Road to Classen Road. On the south end, the damage was located parallel to and about one quarter mile northwest of Nacogdoches Road from its intersection with Bell Drive to its intersection with O'Connor Road. The most typical kind of damage over the area consisted of broken tree limbs and branches that had been tossed toward the southeast, indicating wind gusts of 45 to 60 mph. However, in severala of locations, large trees were snapped off or knocked over. A few trees showed

signs of weak root systems, but most of the trees were healthy. This level of damage indicated wind gusts of 80 to 100 mph.

May 27, 1997 – City of San Antonio

Severe downburst winds estimated in excess of 100 mph produced widespread damage across much of the southwest part of San Antonio. Widespread minor damage was reported to roofs and outbuildings, windows, signs, and trees in the area. Wind gusts to 62 knots were measured by an NWS employee at his home in San Antonio. Power lines were blown down, with power out for several hours to over 100,000 persons.

March 27, 1994 – City of San Antonio

Hail first began falling in extreme northwestern Bexar County near 12:30 p.m., increasing to golf ball-size by 12:50 a.m. At 12:56 a.m., winds gusted to 56 knots at the San Antonio International Airport. Shortly after 1:00 a.m., residents in north-central San Antonio reported hearing a "roaring train" sound near the airport. Power lines were downed in the area, trees were blown over, and a sturdy metal sign was knocked down. Windows were blown out at Broadway and Interstate 410. Shortly afterward, wind gusts to 58 knots were recorded at Randolph Air Force Base. Leaves were stripped from trees in north Bexar County. Considerable damage was reported to roofs of homes and windows of cars and houses across the northern half of Bexar County. Some of the roof damage was due to broken tree branches being blown over onto houses. Power was knocked out to 30,000 homes and businesses for several hours.

Probability of Future Events

During the spring, most thunderstorms occur in March, April, and May, and in the fall, during September. Even though extreme wind events' intensity is not always damaging for the City, the frequency of occurrence for a severe wind event is highly likely, meaning that an event is probable within the next year for the City of San Antonio planning area.

Based on historical occurrences and the infrequency of significant wind events, the probability of future events is unlikely for the City of San Antonio planning area, meaning it is possible the site may be impacted by a hurricane event in the next 10 years.

Vulnerability and Impact

Vulnerability is difficult to evaluate since extreme wind events can occur at different strength levels, in random locations, and can create relatively narrow paths of destruction. Hurricane-force winds can cause major damage to large areas. Due to the randomness of these events,

all existing and future structures and facilities in the City of San Antonio 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 extreme wind events. More severe damage involves windborne debris; in some instances, patio furniture and other lawn items have been reported to have been blown around by the 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, there have been reports of roofs torn off buildings. The portable buildings typically used at schools and construction sites would be more vulnerable to thunderstorm wind events than typical site-built structures and could potentially pose a greater risk for wind-blown debris.

The US Census data indicates a total of 8,156 manufactured homes (approximately 1.5%) located in the City of San Antonio planning area (Table 59). In addition, 47% (approximately 255,735 structures) of the residential structures in the City of San Antonio planning area were built before 1980. These structures would typically be built to lower or less stringent construction standards than newer construction and may be more susceptible to damages during significant wind events.

Table 59. Structures at Greater Risk[105]

JURISDICTION	MANUFACTURED HOMES	SFR STRUCTURES BUILT BEFORE 1980
City of San Antonio	8,156	255,735

While all citizens are at risk to the impacts of thunderstorm wind, forced relocation and disaster recovery drastically impact low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. An estimated 19.4% of the planning area population lives below the poverty level (Table 60).

Table 60. Populations at Greatest Risk

JURISDICTION	POPULATION BELOW POVERTY LEVEL
City of San Antonio	297,736

[105] US Census Bureau 2018 data for the City of San Antonio.

The following critical facilities would be vulnerable to extreme wind events in the City of San Antonio:

Table 61. Critical Facilities at Risk

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	102
Banking and Finance	382
Chemical and Hazardous Materials Industry	638
Defense Industrial Base	N/A
Energy	90
Emergency Services	197
Information Technology	N/A
Communications	101
Postal and Shipping	4
Healthcare and Public Health	1,047
Transportation	22
Water	275
National Monuments and Icons	8
Commercial Facilities	2,272
Government Facilities	527
Dams	34
Nuclear Reactors, Materials, and Waste	74
Manufacturing	1

An extreme wind event can also result in traffic disruptions, injuries, and in rare cases, fatalities. The impact of extreme wind events experienced in the City of San Antonio planning area would be "Minor," and injuries and illnesses do not result in permanent disability. The quality of life lost would be minor, and facilities would be shut down for more than one week. Overall, the average loss estimate (in 2020 dollars) is $9,275,042, having an approximate annual loss estimate of $154,584.

Table 62. Potential Annualized Losses

JURISDICTION	PROPERTY & CROP LOSS	ANNUAL LOSS ESTIMATES
City of San Antonio	$9,275,042	$154,584

While hurricane and tropical storm track data is available for the past 150 years, property and crop loss data is only available from 1950 to the present for this hazard. Therefore, the average annual loss estimate for the City of San Antonio is considered negligible. The potential severity of impact from a hurricane for the City of San Antonio planning area is classified as limited, meaning injuries would be treatable with first aid, critical facilities would not be shut down for more than 24 hours, and less than ten percent of the property would be destroyed.

ASSESSMENT OF IMPACTS

Extreme wind and hurricane events have the potential to pose a significant risk to people and create dangerous and difficult situations for public health and safety officials. Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees. Residential structures can be damaged or crushed by falling trees, resulting in physical harm to the home's occupants.

Large amounts of debris, such as downed trees, can result in emergency response vehicles unable to access areas of the City planning area. Downed power lines may result in roadways being unsafe for use, preventing first responders from responding to calls for assistance. During heavy wind events, first responders may be prevented from responding to calls, as the winds may reach a speed at which their vehicles and equipment are unsafe to operate.

Extreme wind and hurricane events often result in power outages over widespread areas. Individuals who rely on power for health and life safety, such as those on life support systems, could be placed in jeopardy if generators are not available. Also, 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.

Response personnel are subject to the health and safety concerns that can impact the general public. In addition, downed power lines, damaged structures, hazardous spills, and unrecognizable or unusual debris that often accompany an extreme wind event can pose a significant risk to response personnel.

Extreme wind and hurricane events are a threat to operations and service delivery within the City and have the potential to significantly impact local government's continuity of operations. While the San Antonio Office of Emergency Management (SAOEM) has a protected facility from which to operate, the facility may not be accessible to staff unable to leave their

neighborhood due to roadway debris or other obstructions. In that case, those staff members would be limited to performing work with available resources from their remote location.

Other City departments may not be as protected as the SAOEM and may suffer more interruptions as a result of damages from extreme winds. If files (hard or electronic) are damaged, destroyed, or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. An interruption could have significant impacts throughout the planning area and could negatively impact response and recovery from extreme wind and hurricane events. Without a Continuity of Operations (COOP) Plan that takes these issues into account and a training program to regularly practice COOP procedures, departments may not be able to function and provide necessary services.

The same is true for private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers. If, for example, debris downed by extreme winds results in the closure of roadways over a large area, this would lead to a temporary halt to any repair of damaged infrastructure, impede emergency response activities, and interrupt the standard delivery of goods and services. Damaged electrical substations, downed power lines, and roadway obstructions are all common occurrences during extreme wind events, and all will impact a community's normal operations and service delivery. It is imperative that the community—both public and private entities—plans for these events and addresses how it will function and provide services until normal operating conditions can be resumed.

While extreme wind does pose a risk to the environment, it is not so much the hazard itself that poses a threat; rather, it is the hazard on the built environment that poses a risk. Extreme winds are a natural phenomenon and are unlikely to result in catastrophic or prolonged natural or environmental damages. However, damage to the built environment may result in both catastrophic and prolonged damage to the natural environment. For example, a chemical facility that is damaged by extreme winds and begins leaking hazardous chemicals into the environment could pose a significant and long-term risk to the environment and, depending on the effects, to the humans, animals, and plants that rely on that environment for health and survival. Some of these materials may take years, decades, or even longer to break down and become harmless; some materials may never fully break down. Until the chemicals break down, they can continue to degrade the environment where they have come to rest, in some cases leaching back into the watercourse or groundwater, spreading contamination away from the site. Without clean-up, this may continue for years.

San Antonio is home to many cultural and historic resources. Many of the historic neighborhoods may be at risk from an extreme wind event, as they are of a construction type and material that is more vulnerable to extreme winds. These historic and cultural resources

are a significant draw for tourists and visitors to the area and generate revenue through taxes and fees. This revenue, in turn, pays for City services and programs, which benefit residents and the community.

Extreme wind and hurricane events can also present potentially significant financial and economic risks for the planning area. While an individual residential structure damaged by wind can be devastating to the residents, it has a negligible impact on the community's overall economic health. However, a significant extreme wind event, where many structures are damaged or destroyed, can have severe economic and financial consequences for a community.

Large-scale wind events can cause significant property damage to homes, businesses, industrial properties, and government buildings. This can have a significant economic impact on the affected area. It must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses. While there are often state and federal programs that can help with these expenses, most of these programs are reimbursement programs, meaning that the local government must still fund the initial costs out of pocket.

Significant wind events can also result in dramatic population fluctuations. People will be unable to return to their homes or jobs and seek shelter and work outside of the affected area. They may require temporary relocation assistance, and some may choose not to return to the community. Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community. This loss of employment affects the community's financial and economic health and stability and may increase the unemployment rate.

Extreme wind and hurricane events typically damage the community's infrastructure, including roads, bridges, power lines, and power plants. It can take a significant amount of time to fully repair such facilities and infrastructure, depending on the nature of the damage and resources available that can be dedicated to the project. Damage to infrastructure will generally slow down the community's economic recovery, as it often slows the re-opening of businesses and can limit the clean-up effort. Infrastructure damage can force some businesses to close temporarily, even those that were not directly impacted by the event. For some companies, the loss of infrastructure can result in the loss of their business.

Some businesses rely more on utility infrastructure than others. For example, groceries typically depend on electricity to maintain the safety of their food supply. Some larger chain stores may have emergency power generators and fuel on hand, but smaller, independent stores often do not.

The economic and financial impacts of extreme wind 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 businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of an extreme wind event.

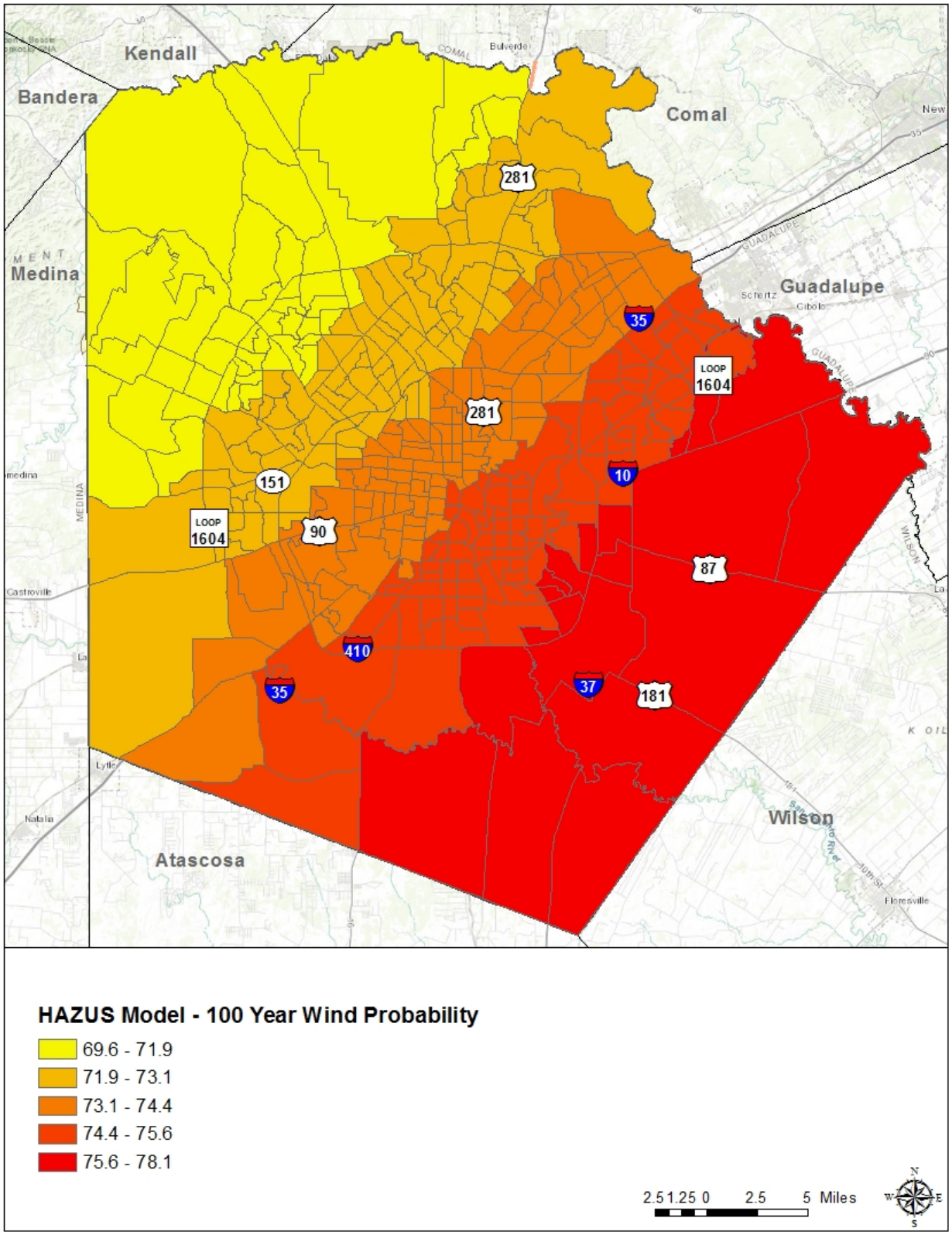
Public confidence in local government may be impacted by the perception of the City's response to an extreme wind event, depending on how the event was handled. A response that demonstrates to residents that the City and its leaders/officials were prepared for the event, anticipated the magnitude, and responded appropriately, will promote goodwill among its citizens. Conversely, public confidence will decline if residents' perception is that the City was not prepared, response was slow, and needs of residents were ignored.

HAZUS RESULTS

The impact assessment for the San Antonio planning area is based on a HAZUS-MH model. The model run is based on a probabilistic 100-year wind event scenario. The historical event most like the simulation, for comparison, is the 1886 Indianola Hurricane, which did impact the San Antonio planning area with at least tropical-storm-force winds.

The following map was generated from the HAZUS and shows the peak wind gusts associated with the scenario. As illustrated in this image, the entire area would be subject to tropical-storm-force winds, with a significant portion of it subject to hurricane-force winds.

Figure 36. HAZUS Wind Speed Results - Peak Gusts



General Building Stock Damage

HAZUS estimates that there are 544,636 buildings in the region, which have an aggregate total replacement value of 160,081,201 dollars, excluding contents. An estimated 93% of the buildings are associated with residential housing, which accounts for the building value estimate. Other categories of buildings are estimated as follows:

Table 63. Building Value Estimate Percentages

Agricultural - 0.2%	Education - 1.4%	Industrial - 3%
Commercial - 1.5%	Government - 0.4%	Religious - 1.6%

HAZUS estimated that approximately 157 buildings will be moderately damaged and that 0 of those buildings will be destroyed. The table below shows the expected building damage by occupancy type, as determined by HAZUS.

Table 64. Expected Building Damage by Occupancy Type

OCCUPANCY	NO DAMAGE		MINOR		MODERATE		SEVERE		DESTRUCTION	
	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%
Agriculture	997	98.74	11	1.16	.83	.08	1	.02	0	0
Commercial	23,197	99.02	216	.93	12.9	.06	0	0	0	0
Education	823	99.19	6	.80	0	.01	0	0	0	0
Government	464	99.21	3	.78	0	.01	0	0	0	0
Industrial	5,328	99.14	45	.84	2	.02	0	0	0	0
Religion	1,918	99.25	14	.72	.04	.02	0	0	0	0
Residential	508,088	99.32	3,361	.66	142	.03	1	0	.06	0
TOTAL	**540,815**		**3,656**		**158**		**2**		**0.06**	

The table below shows the expected building damage by construction type, as determined by HAZUS.

Table 65. Expected Building Damage by Construction Type

OCCUPANCY	NO DAMAGE		MINOR		MODERATE		SEVERE		DESTRUCTION	
	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%
Concrete	5,098	98	60	1.16	1	.02	0	0	0	0
Masonry	67,018	98.86	700	1.03	70	.10	0	0	0	0

OCCUPANCY	NO DAMAGE		MINOR		MODERATE		SEVERE		DESTRUCTION	
	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%
Mobile Home	20,841	99.94	9	0.04	3	.02	0	0	1	0
Steel	9,871	98.78	114	1.15	8	.08	0	0	0	0
Wood	438,124	99.41	2,551	0.58	43	.01	1	0	2	0
TOTAL	**540,952**		**3,434**		**125**		**1**		**3**	

As evident in the above table, mobile homes are expected to suffer most of the damage in a 100-year wind event in the San Antonio planning area. Mobile homes are more susceptible to the effects of extreme winds and are more prone to failure from these events. Wood frame homes would also suffer damage, though most of it is expected to be minor.

Essential Facility Damage

Before the event analyzed in this scenario, the region had an estimated 56 hospitals, with an estimated 8,084 beds available for use. HAZUS estimated 727 schools, 88 fire stations, and 61 police stations. On the day of the scenario event, the model estimated that all hospital beds were available in the region.

Table 66. Expected Damage to Essential Facilities

CLASSIFICATION	TOTAL AVAILABLE	PROBABILITY OF AT LEAST MODERATE DAMAGE (>50%)	PROBABILITY OF COMPLETE DAMAGE (>50%)	EXPECTED LOSS OF USE (<1 DAY)
EOCs	5	0	0	5
Fire Stations	88	0	0	88
Hospitals	56	0	0	56
Police Stations	61	0	0	61
Schools	727	0	0	727

As demonstrated by the scenario, essential facilities are expected to fare well in an event like that of the scenario.

Debris Generation

Based on the scenario event, HAZUS estimates the amount of debris that would be generated by the extreme wind event. The model breaks debris into three general categories:

1. Brick/wood;
2. Reinforced concrete/steel; and
3. Trees.

This distinction is made due to the different types of equipment required to handle the debris.

The model estimates that a total of 16,358 tons of debris will be generated. Of the total estimated amount, 11% will be brick/wood, 0% reinforced concrete/steel, and the remainder–approximately 89% of all debris generated–tree debris.

If the building debris tonnage is converted to an estimated number of truckloads, it will require 653 truckloads (at 25 tons per truck) to remove the debris generated by the scenario event.

Shelter Requirement

HAZUS estimated the number of households that could be expected to be displaced from their homes due to the scenario event and the number of displaced people that will require accommodations in temporary public shelters.

The model estimates that no one will displaced due to the event and no one will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the scenario event is 186 million, which represents 0.12% of the total replacement value of the region's buildings.

Building Related Economic Loss

HAZUS estimated building related economic losses, broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to buildings and their contents. The business interruption losses are the losses associated with inability to operate because of the damage sustained during the scenario event. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the event.

The total property damage losses were estimated to be $186 million, with 2% of the estimated losses related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies, which made up over 95% of the total loss. The table below provides a summary of the losses associated with the building damage.

Table 67. Building-Related Economic Loss Estimates (in thousands of dollars)

CATEGORY	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	OTHER	TOTAL
PROPERTY DAMAGE					
Building	175,414.21	4,336.65	712.88	808.62	**181,272.36**
Contents	808.17	63.03	26	11.58	**908.78**
Inventory	0	0.47	5.45	1.10	**7.02**
Subtotal	***176,222.38***	***4,400.15***	***744.33***	***821.30***	***182,188.16***
BUSINESS INTERRUPTION LOSS					
Income	0	62.8	0	0	**$62.8**
Relocation	2,623.84	129.70	3.77	8.60	**$2,765.91**
Rental	920.94	28.02	0	0.13	**$949.09**
Wage	0	22.35	0	0	**$22.35**
Subtotal	***3,544.78***	***242.87***	***3.77***	***8.73***	***$3,800.15***
TOTAL	**179,767.16**	**4,643.02**	**748.10**	**830.03**	**$185,988.31**

Analysis

The scenario demonstrated that, except for mobile homes and wood frame structures, the building stock should fare well in a 100-year extreme wind event, based on the scenario peak gusts. However, it is important to note that these winds are not tornadic and would not exert the same type of pressure or force on the existing building stock as tornadic winds. Business losses, however, could be significant, particularly if the businesses affected were uninsured or underinsured.

Section 11: Hail

Hazard Description

Hailstorm events are a potentially damaging outgrowth of severe thunderstorms. During 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 is 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 by-product of heating on the Earth's surface. Higher temperature gradients above Earth's surface result in increased suspension time and hailstone size.

HAIL AND CLIMATE CHANGE

Climate change projections for San Antonio do not address the occurrence of hail as there is a lack of confidence in climate models projecting the impacts of climate change on this severe weather phenomena. However, the IPCC report warns that the water cycle has been intensifying and will continue to intensify as the planet warms, leading to more extreme events and intense storms.[106]

Location

Hailstorms are not confined to any specific geographic location and can vary greatly in size, location, intensity, and duration. All areas of the City of San Antonio are considered equally exposed to this hazard.

Extent

The National Weather Service (NWS) classifies a storm as "severe," if there is hail three-quarters of an inch in diameter or greater, based on radar intensity or as seen by observers. The intensity category of a hailstorm depends on hail size and the potential damage it could cause, as depicted in the National Centers for Environmental Information (NCEI) Intensity Scale in Table 68.

[106] https://www.pbs.org/newshour/science/ipcc-report-warns-intensifying-water-cycle-spells-more-intense-storms-flooding

Table 68. Hail Intensity and Magnitude[107]

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 intensity scale in Table 68 ranges from H0 to H10, with increments of intensity or damage potential in relation to hail size, texture, fall speed, speed of storm translation, and strength of the accompanying wind. Based on available data regarding the area's previous occurrences for the area, the City of San Antonio planning area may experience hailstorms ranging from an H0 to an H10. The largest hail event in or near the City of San Antonio planning area resulted in hail measuring 4.5 inches in diameter, or an H10, Super Hailstorm. This is the worst extent

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

the planning area can anticipate in the future. The City can mitigate a storm from low risk or hard hail to a severe, super hailstorm with baseball-sized hail that leads to extensive structural damage and could cause fatal injuries.

Historical Occurrences

Historical evidence shown in Figure 37 shows that the planning area is vulnerable to hail events overall, which typically result from severe thunderstorm activity. A total of 429 reported historical hail events impacted the City of San Antonio area between 1955 and 2020. Only events with reported damages, injuries, or fatalities have been included in Table 69. These events were reported to NCEI and NOAA databases and may not represent all hail events during the past 65 years. Only those events for Bexar County with latitude and longitude available are shown (Figure 37).

Figure 37. Spatial Historical Hail Events, 1955–2020

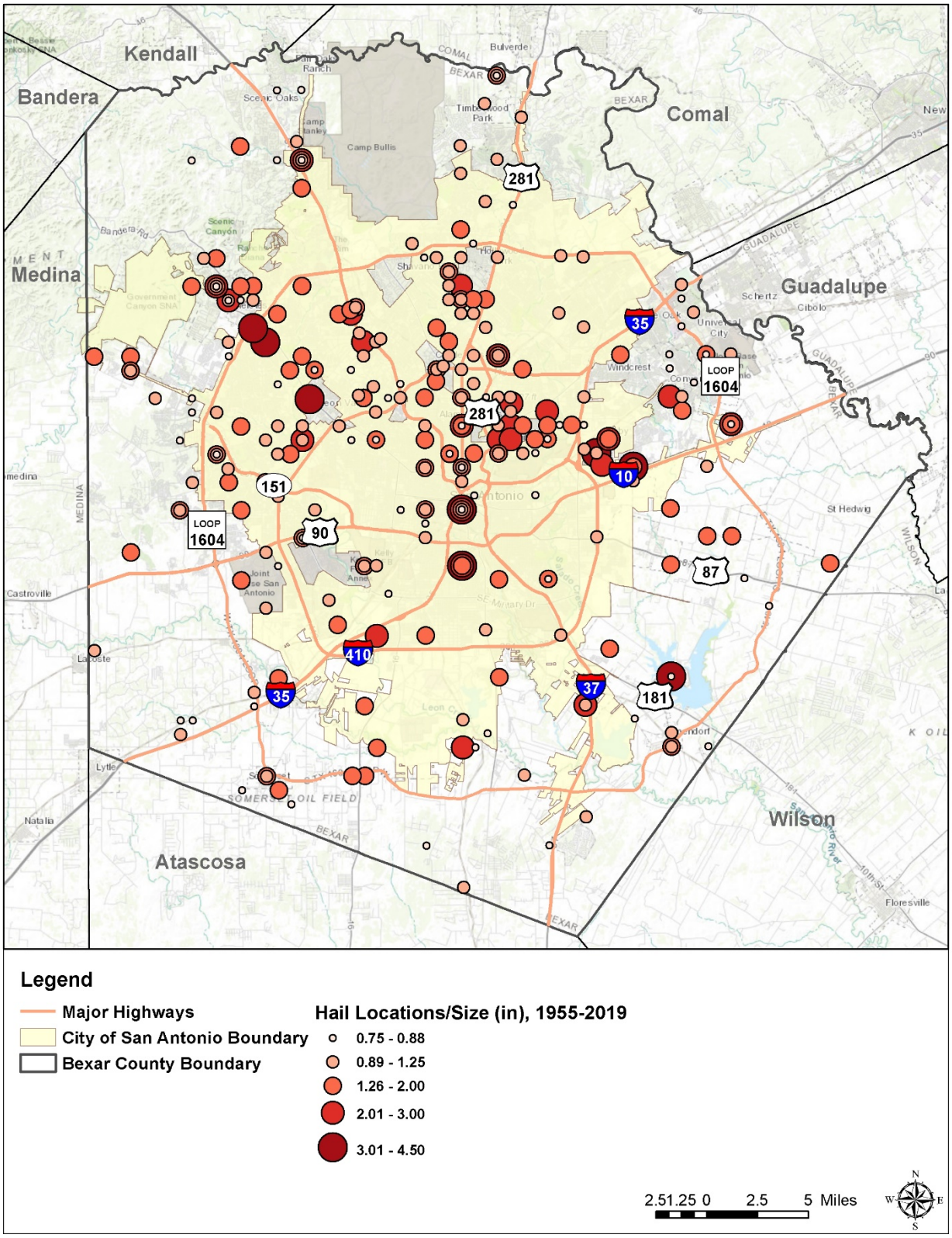


Table 69. Historical Hail Events, 1955-2020

JURISDICTION	DATE	MAGNITUDE (INCHES)	DEATHS	INJURIES	PROPERTY DAMAGE (2020 DOLLARS)	CROP DAMAGE (2020 DOLLARS)
City of San Antonio	3/27/1994	1.75	0	0	$8,800,985	$88,010
City of San Antonio	3/27/1994	1	0	0	$880,099	$88,010
City of San Antonio	4/5/1994	0.88	0	0	$87,890	$87,890
Bexar County	2/10/1998	1.75	0	0	$16,004	$80,019
City of San Antonio	3/16/2000	1.25	0	0	$75,672	$0
City of San Antonio	3/16/2000	2.5	0	0	$75,672	$0
Bexar County	3/28/2000	2.75	0	0	$7,567,202	$0
City of San Antonio	5/6/2001	4	0	0	$174,969,724	$43,742,431
Bexar County	12/23/2002	4.5	0	0	$71,614	$0
Bexar County	4/12/2016	4.5	0	0	$1,472,773,916	$0
Bexar County	4/13/2019	3.0	0	0	$10,139	$0

Table 70. Summary of Historical Hail Wind Events, 1955-2020

JURISDICTION	NUMBER OF EVENTS	MAGNITUDE	INJURIES	FATALITIES	PROPERTY DAMAGE	CROP DAMAGE
City of San Antonio	429	4.5 inches (Max Extent)	0	0	$1,665,328,918	$44,086,360

Based on the list of historical hail events for the City of San Antonio planning area (listed above), 221 of the events have occurred since the 2015 Plan.

SIGNIFICANT EVENTS

April 12, 2016 – City of San Antonio

An upper-level low-pressure system over the Desert Southwest combined with a stationary front to produce thunderstorms across South Central Texas. Some of these storms made large-to-giant hail. The enormous hailstorm moved across north Bexar County, crossing the north half of San Antonio. Damage costs in San Antonio are estimated at $1.36 billion making this the costliest hailstorm ever in the state of Texas, according to the Insurance Council of Texas. Estimates do not include commercial losses, which would push the losses higher, especially when including two other hailstorms at the end of the month. Estimates were provided by the Insurance Council of Texas and include damage to 136,000 vehicles and 125,000 homes.

March 31, 2013 – City of San Antonio

On March 31, 2013, a weak cold front and upper-level short wave trough combined to cause thunderstorms across South Central Texas. Some of these storms produced large hail, mainly over the western half of the area.

May 6, 2001 – City of San Antonio

In May 2001, a storm developed into one of the most devastating hail-and-wind storms in San Antonio's history. Hail in sizes up to four inches, accompanied by winds estimated over 60 mph, destroyed roofs of hundreds of homes, severely damaged hundreds of vehicles, and broke thousands of windows in houses. The damage was reported to have been the worst in the northwestern part of the City, where hail reached at least four inches in diameter. Damages were estimated to reach at least $60,000,000 for homes, and an additional $60,000,000 for cars. Additional severe thunderstorm wind struck the western part of Bexar County just before 8 p.m. and destroyed about a dozen power lines along Grissom Road near Culebra.

March 27, 1994 – City of San Antonio

On March 27, 1994, hail began falling in northwestern Bexar County near 12:30 p.m., increasing to golf ball-size by 12:50 a.m. At 12:56 a.m., winds gusted to 56 knots at the San Antonio International Airport. Shortly after 1 a.m., residents in north-central San Antonio reported hearing a "roaring train" sound near the airport. Power lines were downed in the area, trees were blown over, and a sturdy metal sign was knocked down. Windows were blown out at Broadway and Interstate 410. Shortly afterward, wind gusts to 58 knots were recorded at Randolph Air Force Base. Leaves were stripped from trees in north Bexar County. Considerable damage was reported to roofs of homes and windows of cars and houses across the northern

half of Bexar County. Some of the roof damage was due to broken tree branches being blown over onto houses. Power was knocked out to 30,000 homes and businesses for several hours.

Probability of Future Events

Based on the 429 reported events over the last 65 years (1955–2020), a hail event is a highly likely occurrence with approximately six to seven events each year. Most hailstorms occur during the spring months of March, April, and May, and in the fall during 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. The most prevalent hail damage is to vehicles, roofs of buildings and homes, and landscaping.

It is now estimated that in the U.S., hailstorms cause an average of $15 billion in damage to homes, cars, and crops each year. This total has dramatically increased in recent decades; the estimate for the 1990s was $1.2 billion per year, and that itself was an increase over prior decades. Some factors behind the rapid increase include population growth in hail-prone areas, such as Denver and Dallas–Fort Worth, and the larger size of many newer homes. The costliest year to date was 2017 when insurers reported $22 billion in hail damage.

The City of San Antonio planning area features mobile or manufactured home parks throughout the planning area. These parks are typically more vulnerable to hail events than site-built structures. In addition, manufactured homes, which are more vulnerable to hail events, are located sporadically throughout the planning area. The US Census data indicates a total of 8,156 (1.5%) manufactured homes located in the City of San Antonio planning area (Table 71). In addition, 47.0% (approximately 255,735) of the single family residential (SFR) structures in the City of San Antonio planning area were built before 1980. These structures typically were built to lower or less stringent construction standards than newer construction and may be more susceptible to damages during significant hail events.

Table 71. Structures at Greater Risk

JURISDICTION	MANUFACTURED HOMES	SFR STRUCTURES BUILT BEFORE 1980
City of San Antonio	8,156	255,735

While all citizens are at risk to the impacts of a hail event, forced relocation and disaster recovery drastically impact low-income residents who lack the financial means to travel, afford

a long-term stay away from home, and rebuild or repair their homes. An estimated 19.4% of the planning area population lives below the poverty level (Table 72).

Table 72. Populations at Greatest Risk[108]

JURISDICTION	POPULATION BELOW POVERTY LEVEL
City of San Antonio	297,736

The following critical facilities would be vulnerable to hail events in the City of San Antonio:

Table 73. Critical Facilities at Risk

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	102
Banking and Finance	382
Chemical and Hazardous Materials Industry	638
Defense Industrial Base	N/A
Energy	90
Emergency Services	197
Information Technology	N/A
Communications	101
Postal and Shipping	4
Healthcare and Public Health	1,047
Transportation	22
Water	275
National Monuments and Icons	8
Commercial Facilities	2,272
Government Facilities	527
Dams	34
Nuclear Reactors, Materials, and Waste	74
Manufacturing	1

Hail has been known to cause injury to humans and occasionally has been fatal. Overall, the average loss estimate of property and crops (in 2020 dollars) is $1,709,415,277, with an

[108] US Census Bureau 2018 data for the City of San Antonio.

approximate annual loss estimate of $26,298,697. Based on historic loss and damages, the impact of hail damages on the City of San Antonio planning area can be considered a "Minor" severity of impact, meaning injuries and illness do not result in permanent disability; City area facilities shut down for more than one week; and more than ten percent of property is destroyed or has major damage.

Table 74. Potential Annualized Losses

JURISDICTION	PROPERTY & CROP LOSS	ANNUAL LOSS ESTIMATE
City of San Antonio	$1,709,415,277	$26,298,697

ASSESSMENT OF IMPACTS

Hail events have the potential to pose a significant risk to people and can create dangerous situations and difficulty for first responders in providing for or preserving public health and safety. Individuals exposed to the storm can be struck by hail, falling branches, or downed trees. Residential structures can be damaged by falling trees, which can result in physical harm to occupants.

Hail events can result in power outages over widespread areas. Individuals who rely on power for health and life safety, such as those on life support systems, could be placed in jeopardy if no generator is available. An extended power outage can cause an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.

Response personnel are subject to health and safety concerns that can impact the general public. Downed power lines, damaged structures, hazardous spills, and debris often accompany hail events and can pose a significant risk to response personnel because they may come into closer contact with these hazards during response operations.

Large debris, such as downed trees, can hinder access to the City for emergency response vehicles. 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 hail, first responders may be prevented from responding to calls, as the hail may be so large that it is unsafe to operate vehicles and equipment.

Hail is a threat to operations and service delivery in the San Antonio planning area and has the potential to significantly impact the continuity of operations. While the San Antonio Office of Emergency Management (SAOEM) has a protected facility from which to operate, the facility may not be accessible to all staff, and they may be unable to leave their neighborhood due to

roadway debris or other obstructions. The situation may result in the inability of staff members to reach residents that need help.

Other City departments may not be as protected as the SAOEM and may suffer more interruptions as a result of damages from a hail event. If hard or electronic files are damaged, destroyed, or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. These interruptions could have significant impacts throughout the City and could negatively impact the City's ability to respond to and recover from the hail event. Without a specific plan within each critical department that takes these department-specific issues into account and considers how best to work around them, and without regular exercise of that plan, departments may not be able to function and provide necessary services.

The same is true for private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers. For example, if debris downed by hail resulted in the closure of roadways over a large area, this could temporarily halt any repair of damaged infrastructure, impede emergency response activities, and interrupt the normal delivery of goods and services. Damaged electrical substations, downed power lines, and roadway obstructions are common occurrences during and after a hail event, impacting a community's normal operations and service delivery. It is imperative that the community, including public and private entities, plan for service interruptions and address how they will function and provide services until normal operating conditions can be resumed.

Hail typically causes damage to the infrastructure of a community, including buildings, facilities, and power lines. It can take a significant amount of time to fully repair damaged facilities and infrastructure, depending on the nature of the damage and the resources available that can be dedicated to the project.

Damage to infrastructure will generally slow down the economic recovery of the community, delaying the re-opening of businesses and limiting the cleanup effort. Damage from a hail event can force some businesses to close temporarily, even those that were not directly impacted by the event. For some businesses, loss of infrastructure can result in the failure of their business. Some businesses rely more heavily on utility infrastructure than others, such as grocery stores, which are typically reliant on electricity to maintain the safety of their food supply. Some larger chain stores may have emergency power generators and fuel on hand, but smaller, independent stores often do not.

Damages from a hail event to the natural environment may result in both catastrophic and prolonged damage. For example, a chemical facility that is damaged by hail and begins leaking hazardous chemicals into the environment could pose a significant and long-term risk. Some hazardous materials may take years, decades, or even longer to break down and

become harmless, and some materials may never fully break down. Until hazardous materials fully break down, they can continue to degrade the environment where they have come to rest, in some cases leaching back into the watercourse or into ground water, spreading contamination away from the site. Without proper remediation, contamination into the environment may continue for years.

The San Antonio planning area is home to many cultural and historic resources. Many of the historic neighborhoods may be at risk from a hail event, as they are of a construction type and material that is more vulnerable to hail. The City's historic and cultural resources are a significant draw for tourists and visitors to the area and help to generate revenue through taxes and fees. This revenue in turn pays for services and programs that benefit residents and the community.

The financial and economic risks associated with hail may be significant. While an individual residential structure damaged by hail can be a substantial or devastating financial loss to the residents, it has a negligible impact on the community's overall economic health. However, a significant hail event, where a large number of structures are damaged or destroyed, can have serious economic and financial consequences for a community.

Large-scale hail events can cause property damage to homes, businesses, industrial properties, and government buildings. While there are often state and federal programs that can help offset expenses, most of these programs are reimbursement programs, and the community must still fund the initial expense out of pocket.

Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community. A loss of jobs affects the financial and economic health and stability of the community and may result in an increase in the unemployment rate.

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 businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of any hail event.

Public confidence in local government may be impacted by the perception of the response to the event and how the recovery from the event is handled. A response that demonstrates to residents that the City's leaders and officials were prepared for the event, anticipated the magnitude, and responded appropriately, will promote goodwill among citizens. Conversely, public confidence will decline if residents perceive that the City was not prepared, the response was slow, and the needs of residents were ignored.

Section 12: 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 can cause rapid and unexpected flooding downstream, resulting in loss of life and substantial property damage. A devastating effect on the 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 90,580 dams is 56 years. Currently, the number of deficient high-hazard potential dams is more than 2,170. There are deficient dams in almost every state. The risk of failure only increases as dams across the nation age. According to statistics released in 2020 by the Association of State Dam Safety Officials, by 2025, 7 out of 19 dams will be over 50 years old. Without the needed

upgrades and rehabilitation, these dams cannot be expected to withstand current flood predictions.[109] In addition to the continual aging 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 estimates that $20.42 billion will be needed to repair all high-hazard dams. The State budget continues to fund the Texas Commission on Environmental Quality (TCEQ)'s Dam Safety Program to inspect the most critical dams, increasing funding for this program from $2 million in 2012 to $2.5 million in 2017. In 2015, the Legislature provided an additional $15 million to repair or rehabilitate dams built by the USDA's Natural Resources Conservation Service (NRCS). However, the inventory of existing dams in Texas continues to age; along with increases in hazard classification of 217 dams, the estimated costs of rehabilitation have risen from $380 million in 2012 to $812 million in 2017. Additionally, in 2013 the Legislature amended the Texas Water Code to exempt 3,222 dams from meeting the requirements related to dam safety, which is almost 45% of the nonfederal dams listed in the Inventory of Dams in Texas.[110]

DAM FAILURE AND CLIMATE CHANGE

Aging and deteriorating dams and levees represent an increasing hazard when exposed to extreme, or in some cases, even moderate rainfall. Climate change is increasing the frequency of extreme rainfall events and therefore, the risk for filling and overtopping dams, which is the predominant mechanism of dam failure.

Location

Texas has 7,215 dams, all regulated by the Texas Commission on Environmental Quality (TCEQ). Of these, 1,244 are considered "high-hazard," 433 are considered "significant-hazard,"

[109] Source: www.damsafety.org, State Performance and Current Issues

[110] Source: www.infrastructurereportcard.org, 2017 Report Card for Texas' Infrastructure, developed by the Texas Section of the American Society of Civil Engineers

and 5,538 are considered "low-hazard." For dams in the City of San Antonio, location, volume, elevation, condition, and classification information was factored into the risk ranking in Figure 38, which illustrates general locations for each dam in the area. Currently, there are 34 dams located in the San Antonio planning area: 21 are classified as "high-hazard", 11 as "low-hazard", and two "N/A" dams. All dams are listed in Table 75, along with regulation information.

Figure 38. Dam Locations in San Antonio

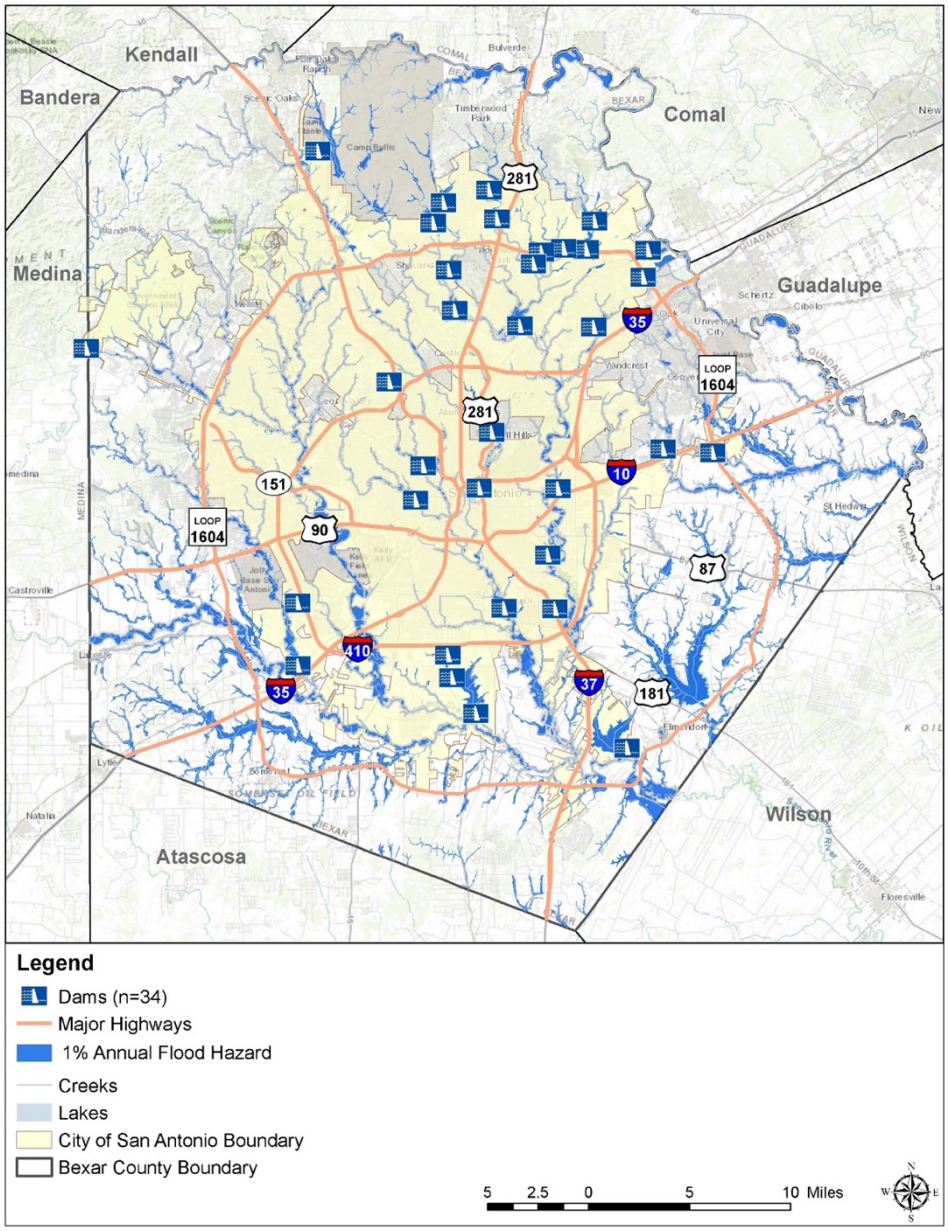


Table 75. City of San Antonio Dam Survey

JURISDICTION	DAM NAME	HEIGHT (FT.)	STORAGE (ACRE FT.)	CONDITION[111]	POTENTIAL HAZARD CLASSIFICATION
San Antonio	Ballasetal Lake Dam	14	450	N/A	Low
San Antonio	Brooklyn Street Lock And Dam	14	28	Good	High
San Antonio	Canvasback Lake Dam	19	730	Poor	Low
San Antonio	Circle Dot Dam	14	157	Good	High
San Antonio	Crea Brothers Lake Dam	18	80	N/A	Low
San Antonio	Denman Park Dam	20	19	Good	High
San Antonio	El Dorado Lake Dam	5	78	Poor	Low
San Antonio	Elmendorf Lake Dam	10	105	Good	High
San Antonio	Hidden Springs Dam	25	46	N/A	Low
San Antonio	Lions Park Lake Dam	32	145	Good	Low
San Antonio	Martinez Creek Ws Scs Site 2 Dam	27	1,085	Fair	High
San Antonio	Martinez Creek Ws Scs Site 3 Dam	31	1,620	Fair	High
San Antonio	Mission Trails Rv Park Detention Dam	14	28	N/A	Low
San Antonio	Mitchell Lake Dam	10	5,000	Poor	Low

[111] Condition provided if available.

JURISDICTION	DAM NAME	HEIGHT (FT.)	STORAGE (ACRE FT.)	CONDITION[111]	POTENTIAL HAZARD CLASSIFICATION
San Antonio	New Espada Lake Dam	12	120	N/A	Low
San Antonio	Olmos Dam	58	21,970	Good	High
San Antonio	Or Mitchell Lake 1 Dam	32	520	N/A	Low
San Antonio	Red Berry Estates Dam	0	0	N/A	N/A
San Antonio	Salado Creek Ws Nrcs Site 15r Dam	49	8,741	Good	High
San Antonio	Salado Creek Ws Scs Site 4 Dam	58	3,957	Good	High
San Antonio	Salado Creek Ws Scs Site 5 Dam	56	5,807	Good	High
San Antonio	Salado Creek Ws Scs Site 6 Dam	62	2,830	Good	High
San Antonio	Salado Creek Ws Scs Site 7 Dam	47	6,864	Good	High
San Antonio	Salado Creek Ws Scs Site 8 Dam	62	7,100	Poor	High
San Antonio	Salado Creek Ws Scs Site 9 Dam	50	2,612	Good	High
San Antonio	Salado Creek Ws Scs Site 10 Dam	66	4,063	Good	High

JURISDICTION	DAM NAME	HEIGHT (FT.)	STORAGE (ACRE FT.)	CONDITION[111]	POTENTIAL HAZARD CLASSIFICATION
San Antonio	Salado Creek Ws Scs Site 11 Dam	64	6,318	Good	High
San Antonio	Salado Creek Ws Scs Site 12 Dam	61	7,837	Good	High
San Antonio	Salado Creek Ws Scs Site 13a Dam	42	3,053	Good	High
San Antonio	Salado Creek Ws Scs Site 13b Dam	46	1,898	Good	High
San Antonio	San Geronimo Creek Recharge Dam	22	307	Good	Low
San Antonio	Solana Ridge Detention Pond Dam	0	0	N/A	N/A
San Antonio	Victor Braunig Dam	76	32,324	Good	High
San Antonio	Woodlawn Lake Dam	20	460	Good	High

Extent

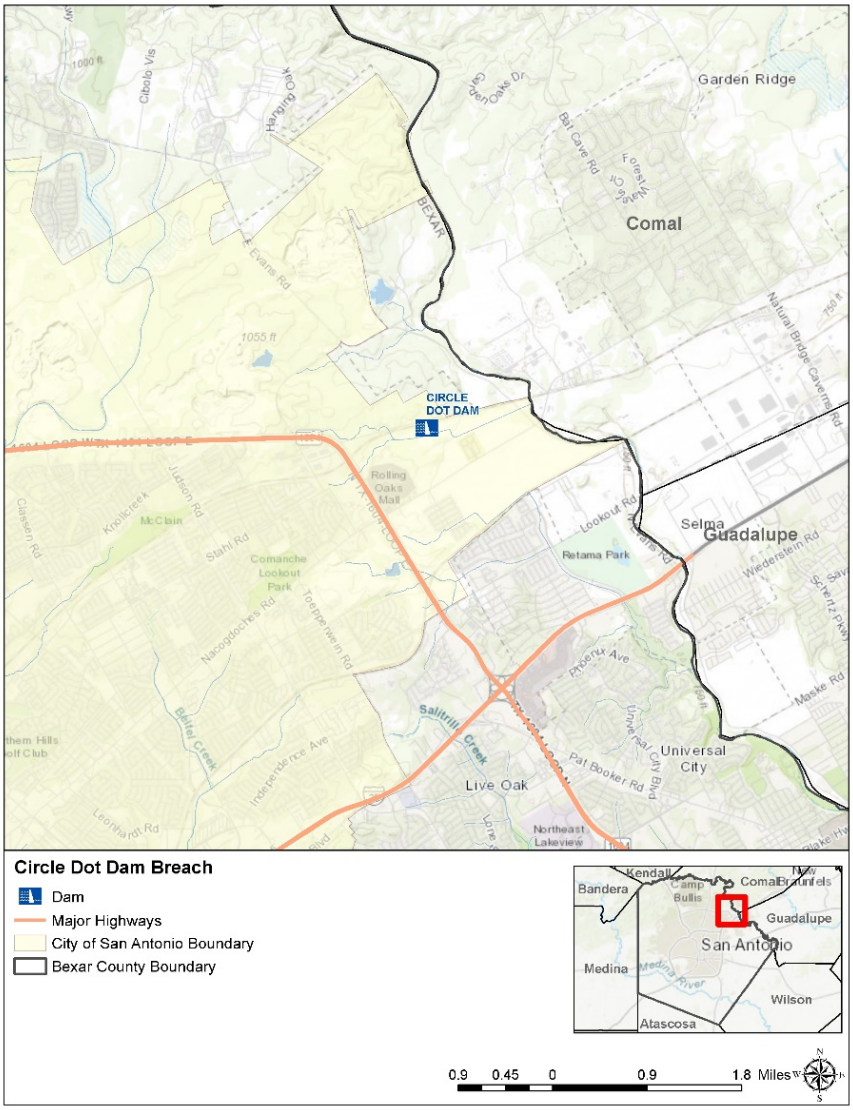
The extent or magnitude of a dam failure event is described in terms of the classification of damages resulting from a dam's failure, not the probability of failure. The national Interagency Committee on Dam Safety defines high hazard dams as those where failure or mis-operation would cause loss of human life. Figure 39 through Figure 59 are inundation maps that show the flood risk areas for each high hazard dam. An estimated depth for dam breach is indicated in the paragraph below Figure 39 through Figure 59.[112]

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

Figure 39. Brooklyn Street Lock and Dam Flood Risk Areas

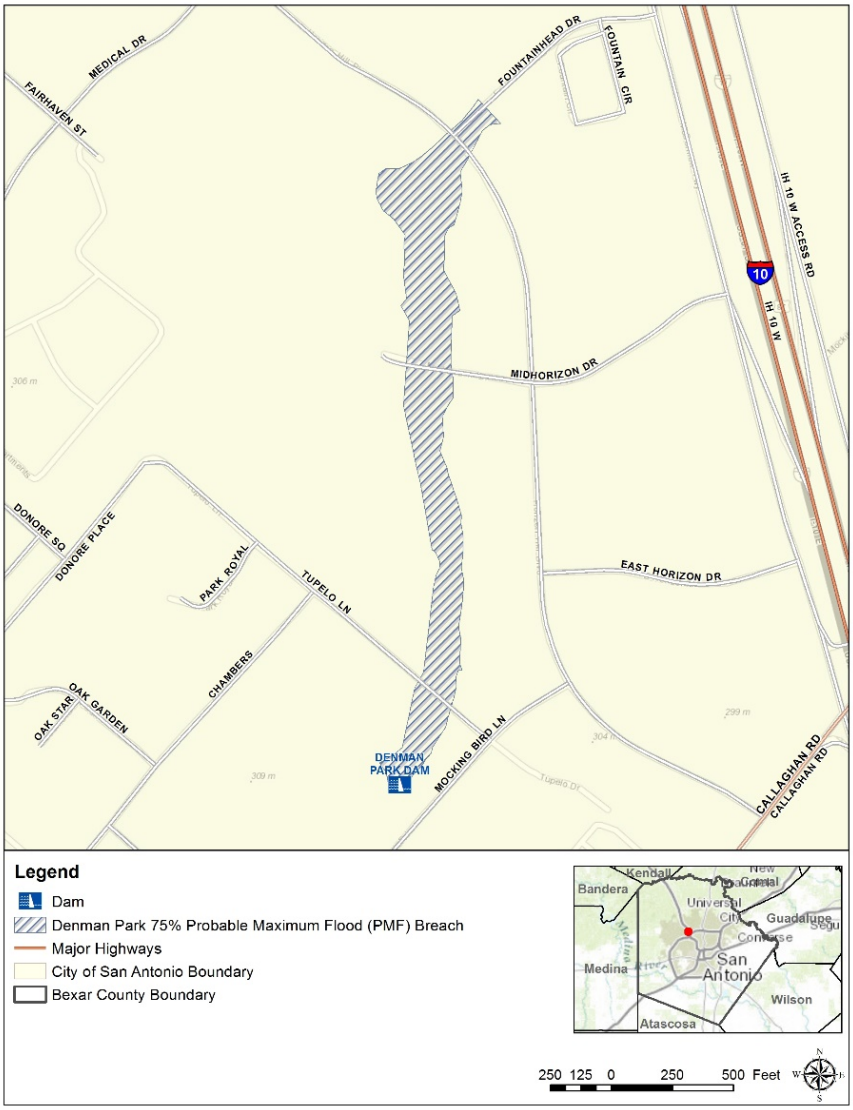
Brooklyn Street Lock and Dam are on the San Antonio River and part of the River Walk in the City of San Antonio. The lock and dam is owned and operated by the San Antonio River Authority and was constructed in 2009. The extent classification is considered high, although a breach would follow the river course. Therefore, populations, buildings, and infrastructure would not be vulnerable to dam failure. In the event of a breach, it is estimated the average breach width would be 49.9 feet with a maximum breach flow of 5,376 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of 0 to 15 feet.

Figure 40. Circle Dot Dam Flood Risk Areas



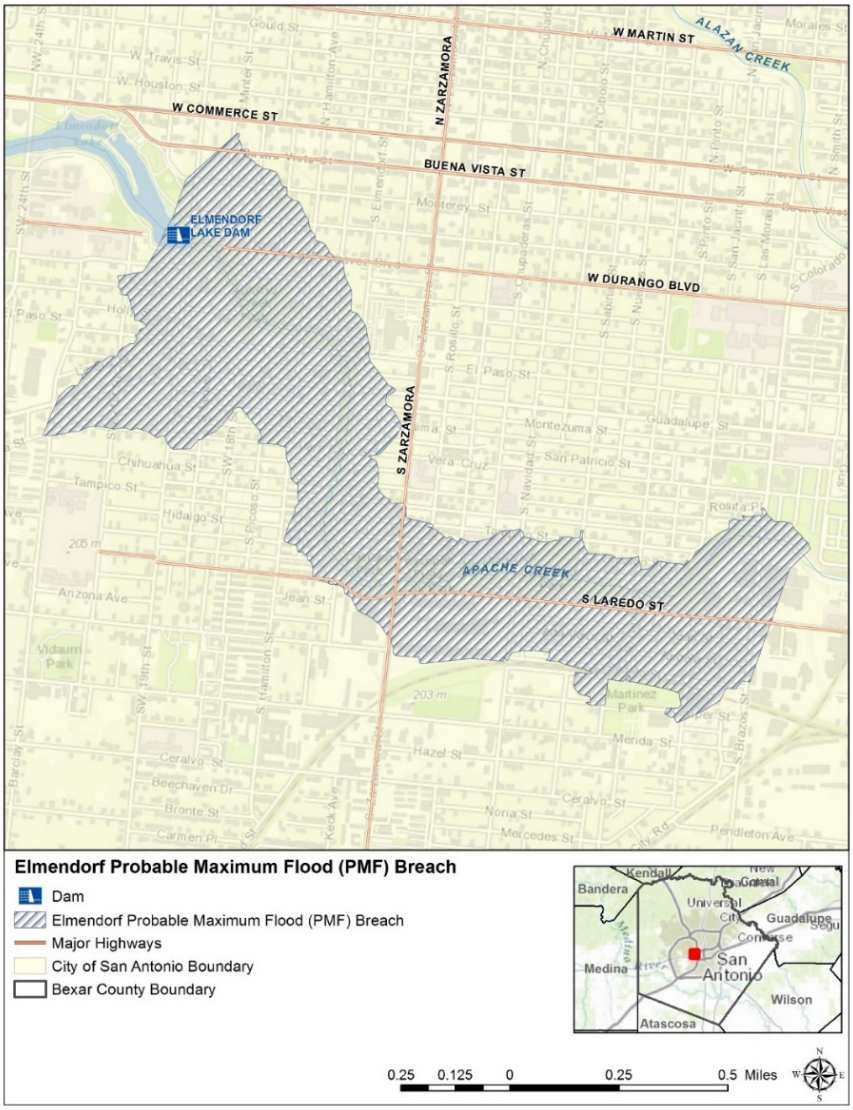
Circle Dot Dam is an earthen dam in the City of San Antonio located northeast of Rolling Oaks shopping mall. The high hazard classification is due to its proximity to the adjacent railroad line. It has a height of 14 feet and a maximum storage capacity of 157 acre-feet and is therefore considered a small dam based on storage capacity. There is currently no breach data on file for this dam.

Figure 41. Denman Park Dam Flood Risk Areas



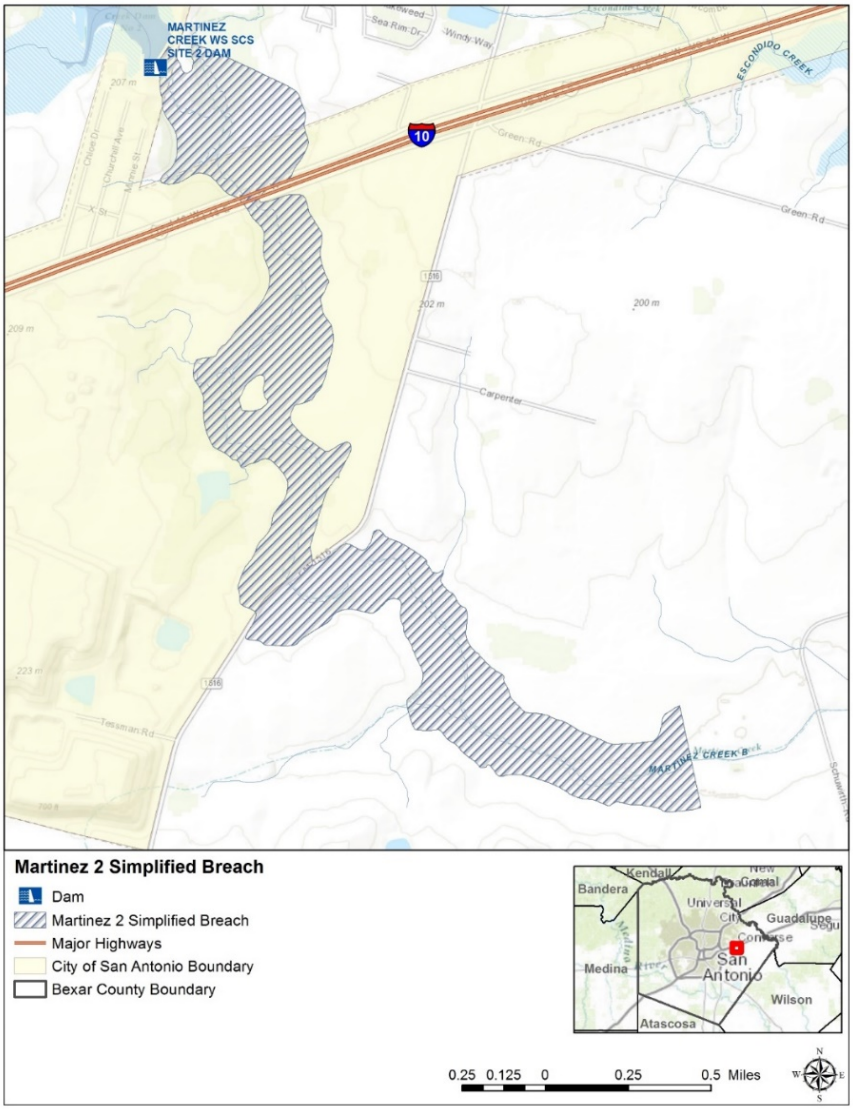
Denman Dam is located at Denman Estate Park, in the City of San Antonio, about seven miles northwest of downtown San Antonio. The earthen embankment dam has a top of dam elevation of 996.1 ft-msl, is approximately 320 feet long, and has a maximum height of 20 feet above grade at the controlling breach section. There is a deteriorated low flow gate valve on the downstream toe that is not functioning. Denman Dam is designed for a normal operating pool elevation of 996.1 ft-msl. If a breach occurs, the following will be affected by the flooding: one residence, two apartment complexes, one local roadway (Tupelo Lane) with a school bus route, and one local roadway (Midhorizon Drive) that serves as an access road to Dr. Martha Mead Elementary School. In the event of a breach, it is estimated the average breach width would be 42.0 feet with a maximum breach flow of 1,910 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of 0 to 10 feet.

Figure 42. Elmendorf Lake Dam Flood Risk Areas



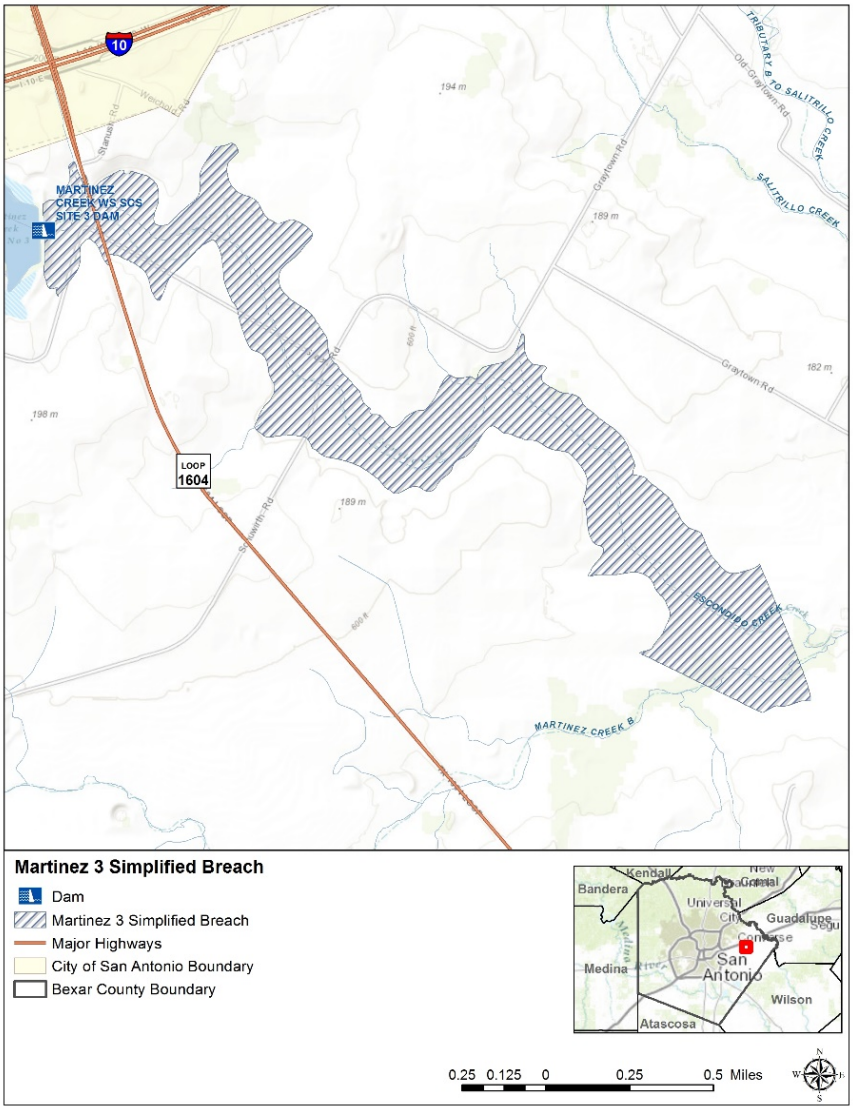
Elmendorf Lake Dam is formed by Elmendorf Lake on Apache Creek in the City of San Antonio and is used for recreational purposes. It is owned by the City of San Antonio and was constructed in 1967. It is a concrete structure with a foundation of rock and soil. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 4,053 people, 1,319 housing units, two chemical and hazardous materials facilities, two emergency services facilities, and seven commercial facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 54.1 feet with a maximum breach flow of 4,645 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of 0 to 25 feet.

Figure 43. Martinez Creek WS SCS Site 2 Dam Flood Risk Areas



Martinez Creek Watershed SCS Site 2 Dam is on a tributary of Martinez Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1964. The extent classification is considered high, and the area located near the dam is a rural area. In the event of dam failure, there would be one person and one housing unit vulnerable. In the event of a breach, it is estimated the average breach width would be 124.3 feet with a maximum breach flow of 50,941 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of 0 to 25 feet.

Figure 44. Martinez Creek WS SCS Site 3 Dam Flood Risk Areas



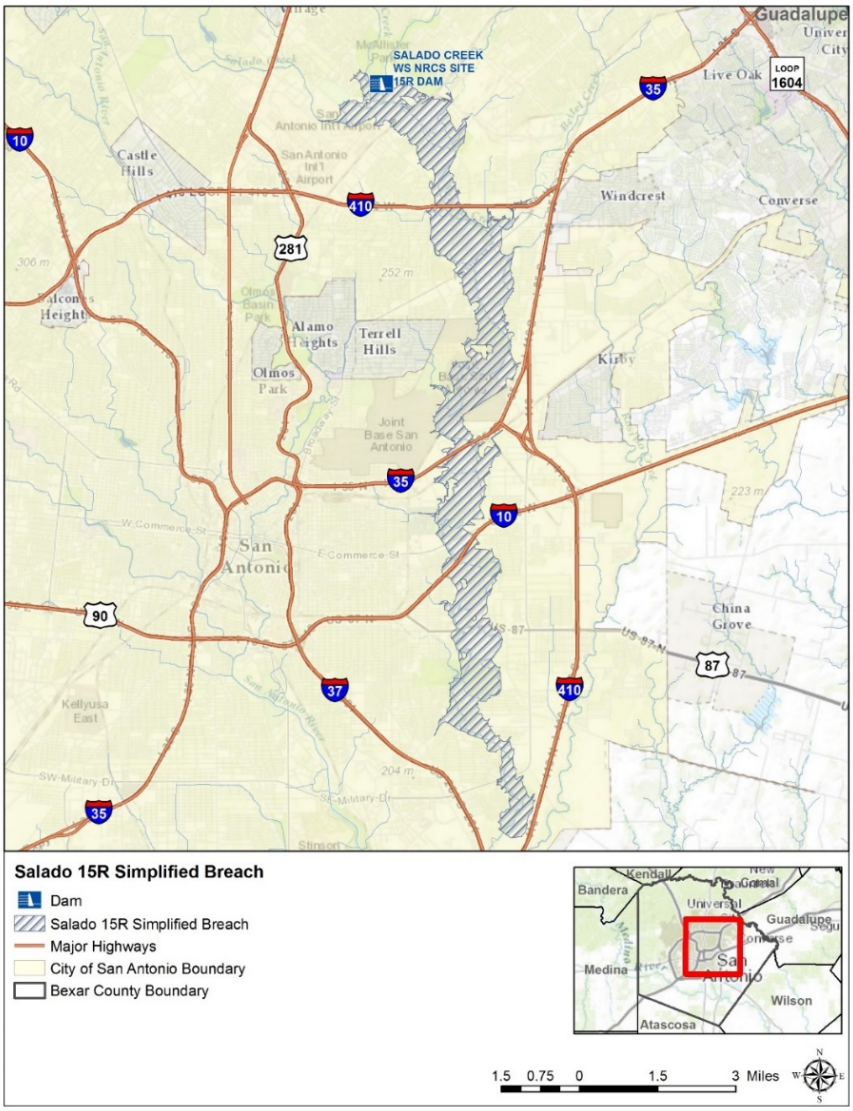
Martinez Creek Watershed SCS Site 3 Dam, a.k.a. Escondido Creek Dam, is a high hazard dam on a tributary of Martinez Creek and is used for flood control purposes. Escondido Creek Dam is made from earthen material. Its length is approximately 1,882 feet; its height is 37.1 feet. The earthen dam is jointly owned by the San Antonio River Authority and Alamo Soil and Water Conservation District. The service and emergency spillways drain into the downstream channel of Escondido Creek, which flows into Martinez Creek then into Cibolo Creek. The dam was constructed in 1964. In the event of dam failure, there would be more than 100 persons / 30 residential structures vulnerable. In the event of a breach, it is estimated the average breach width would be 93 feet with a maximum breach flow of 57,961 cubic feet per second according to the Simplified Breach Method. A dam breach could result in depths ranging from 7 to 19 feet along the inundation zone.

Figure 45. Olmos Dam Flood Risk Areas

Olmos Dam is on the Olmos Creek in the City of San Antonio and is used for flood control purposes. The dam is owned by the City and was constructed in 1926 as a gravity dam, with a rock and soil foundation. The extent classification is considered high, and the area near the dam is a densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 32,534 people, 14,409 housing units, one agriculture and food facility, 22 banking and finance facilities, 44 chemical and hazardous materials facilities, six energy facilities, 26 emergency services facilities, 11 communication facilities, 50 healthcare and public health facilities, three transportation facilities, 17 water facilities, three national monuments and icons, 201 commercial facilities, 31 government facilities, two dams, seven nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 319.2 feet with a maximum breach flow of

427,230 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 25 feet.

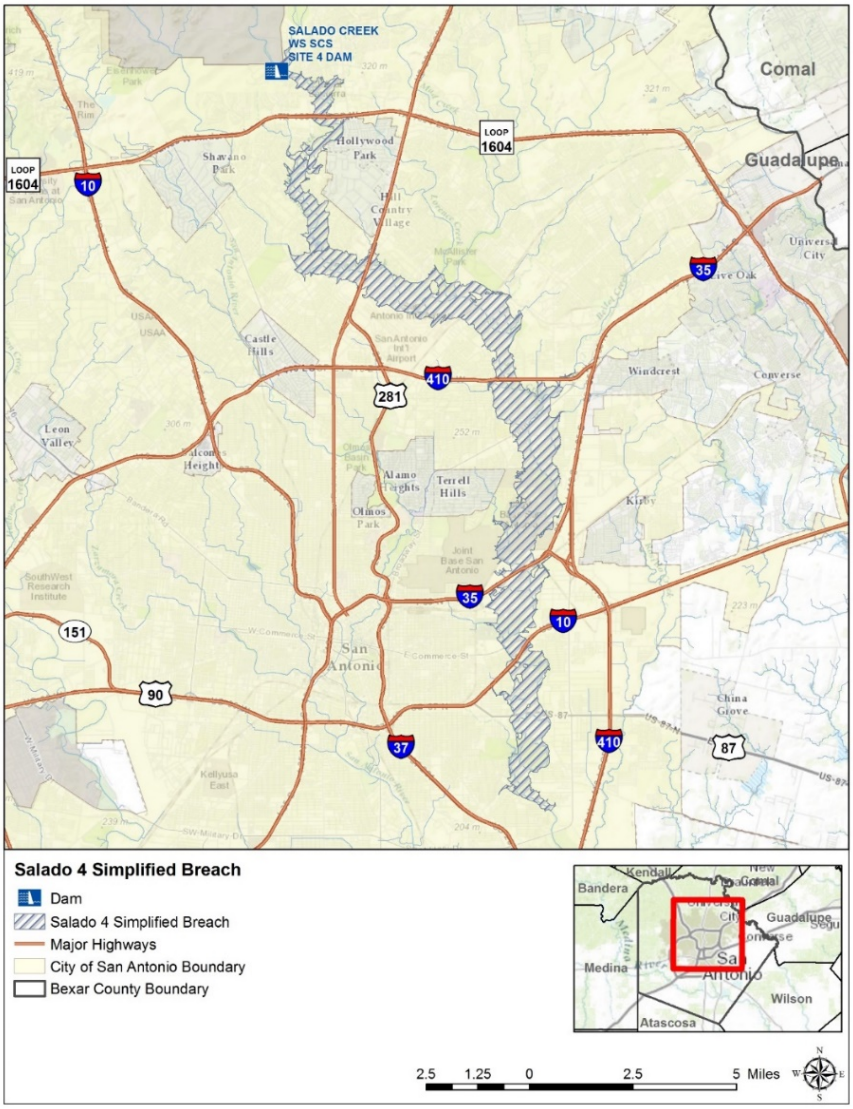
Figure 46. Salado Creek WS NRCS Site 15R Dam Flood Risk Areas



Salado Creek Watershed NRCS Site 15R Dam is located in the City of San Antonio in McAllister Park and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 2004. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 21,326 people, 9,781 housing units, one banking and finance facility, 10 chemical and hazardous materials facilities, two energy facilities, four emergency services facilities, six communication facilities, 27 healthcare and public health facilities, 10 water facilities, 44 commercial facilities, six government facilities, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is

estimated the average breach width would be 243 feet with a maximum breach flow of 250,724 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.

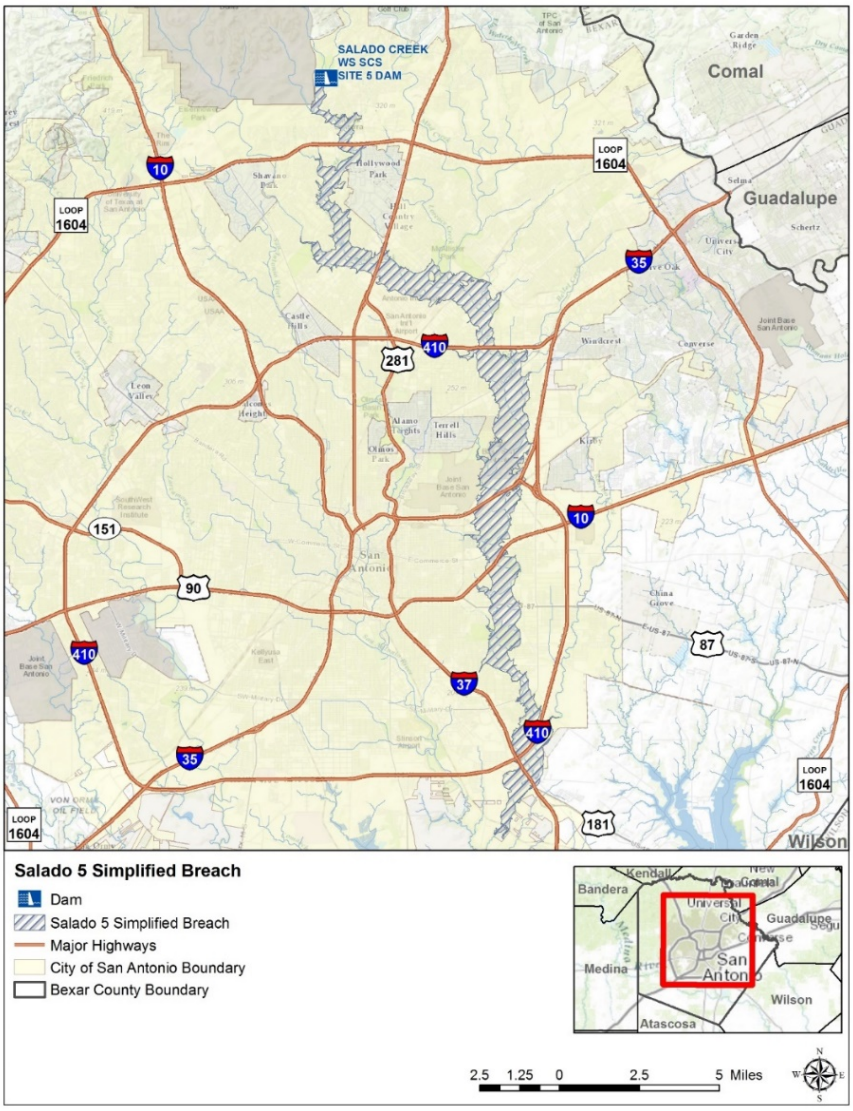
Figure 47. Salado Creek WS SCS Site 4 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 4 Dam is on the Panther Springs Creek in the City of San Antonio and is used for flood control purposes. The dam is owned by the San Antonio River Authority and was constructed in 1972 by earthen construction. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 31,141 people, 14,743 housing units, five banking and finance facilities, 18 chemical and hazardous materials facilities, three energy facilities, four emergency services facilities, six communication facilities, 30 healthcare and public health facilities, one transportation facility, nine water facilities, 56

commercial facilities, six government facilities, and six nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 207 feet with a maximum breach flow of 266,216 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.

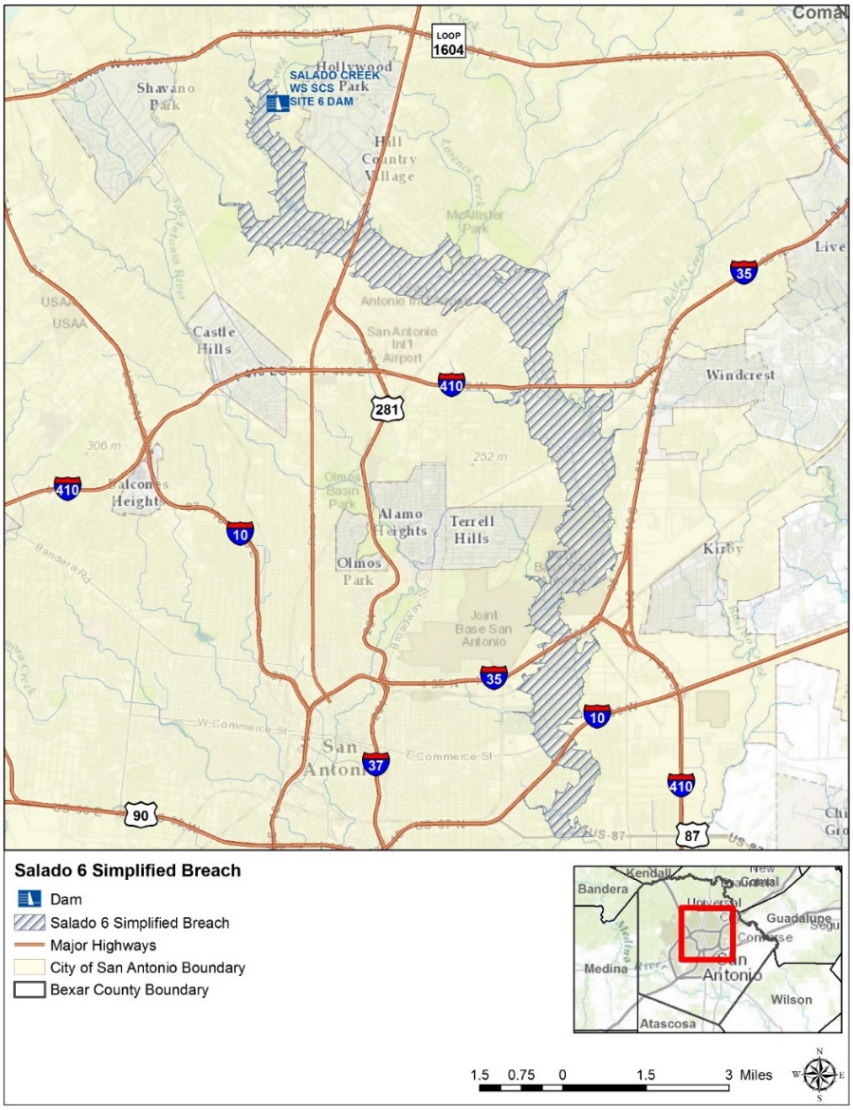
Figure 48. Salado Creek WS SCS Site 5 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 5 Dam is on the Panther Springs Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1976. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 39,575 people, 19,181 housing units, five banking and finance facilities, 24 chemical and hazardous materials facilities, four energy

facilities, six emergency services facilities, six communication facilities, 32 healthcare and public health facilities, one transportation facility, 11 water facilities, 67 commercial facilities, eight government facilities, three dams, and six nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 227.9 feet with a maximum breach flow of 294,102 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.

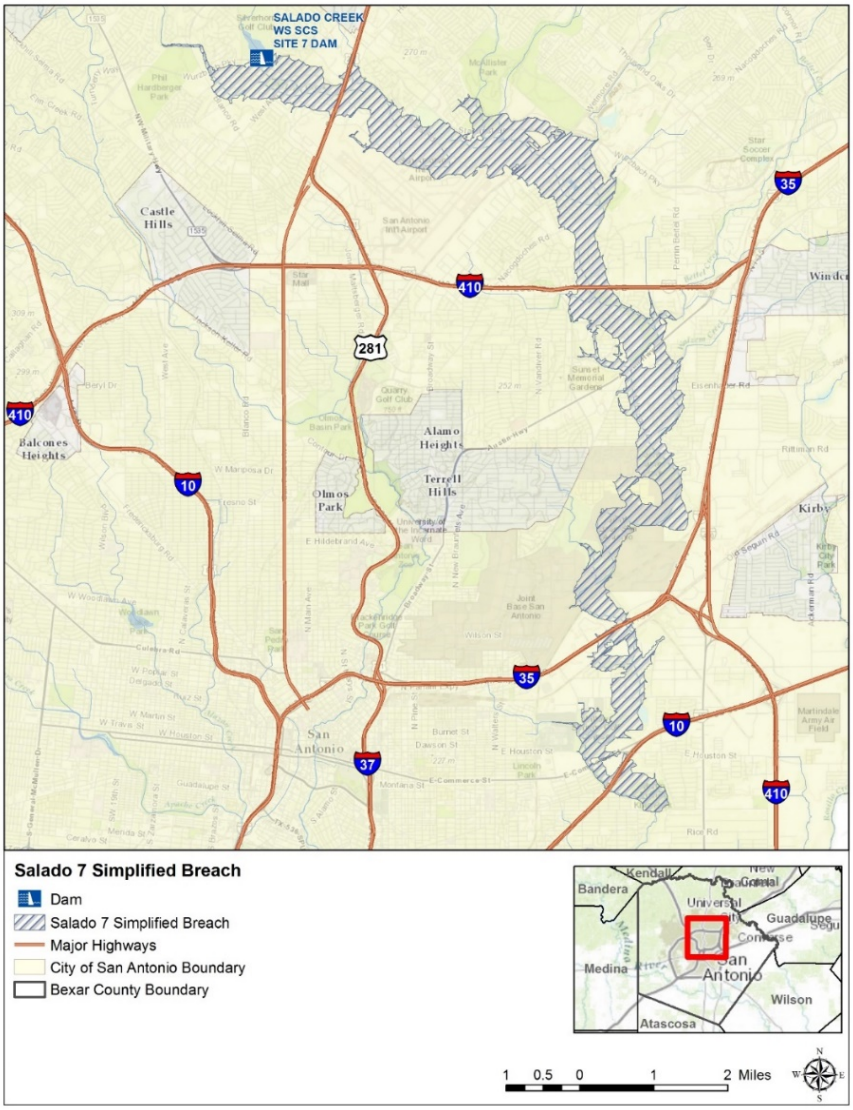
Figure 49. Salado Creek WS SCS Site 6 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 6 Dam is on the Panther Springs Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1979. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages

and disrupt utility systems. There would also be 24,008 people, 11,876 housing units, four banking and finance facilities, 16 chemical and hazardous materials facilities, two emergency services facilities, six communication facilities, 27 healthcare and public health facilities, one transportation facility, five water facilities, 47 commercial facilities, four government facilities, one dam, and six nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 194.4 feet with a maximum breach flow of 282,758 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.

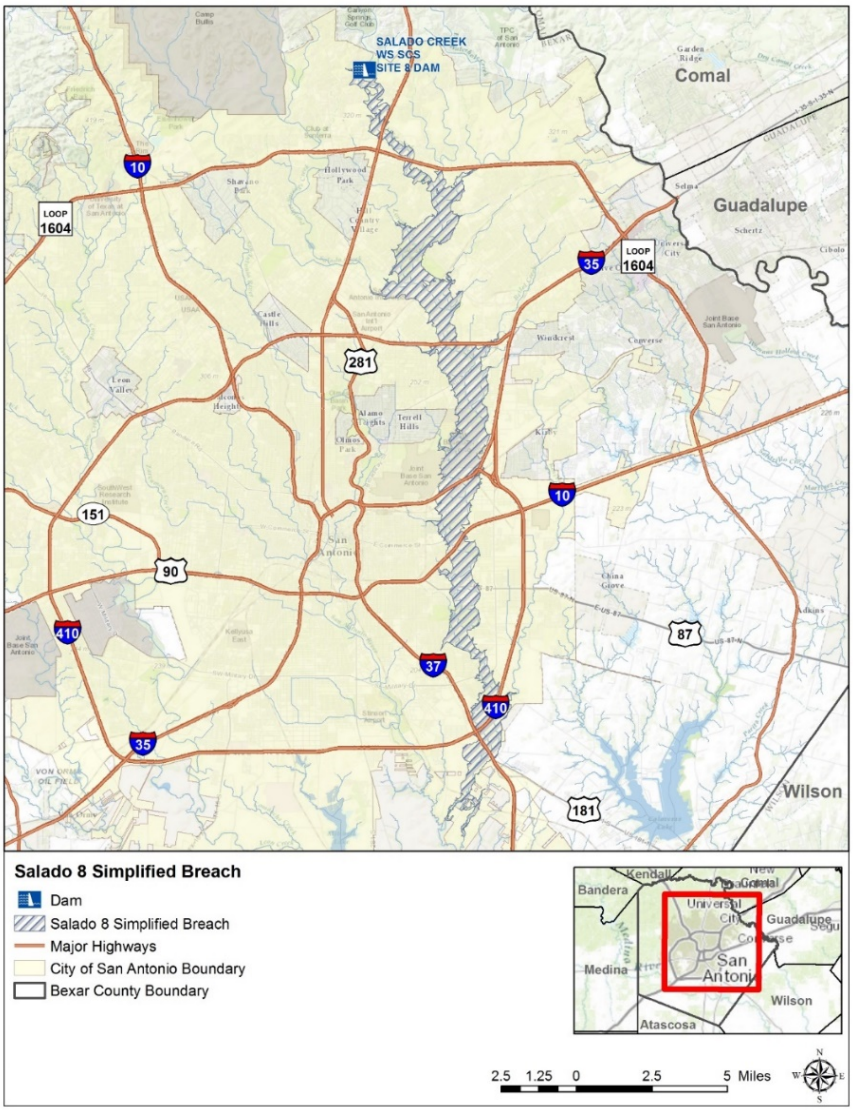
Figure 50. Salado Creek WS SCS Site 7 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 7 Dam is on the Panther Springs Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1987. The extent classification is considered high, and

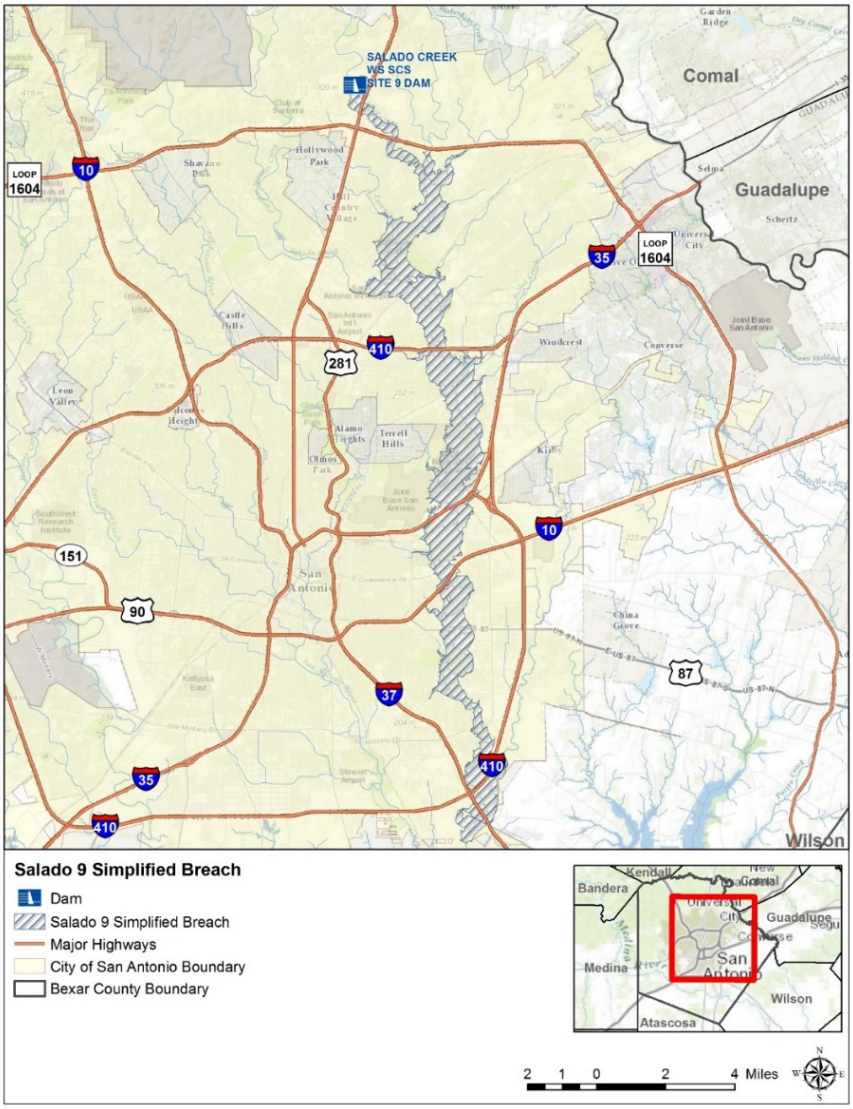
the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 12,408 people, 6,081 housing units, four banking and finance facilities, six chemical and hazardous materials facilities, one energy facility, three emergency services facilities, six communication facilities, 14 healthcare and public health facilities, one transportation facility, one water facility, 25 commercial facilities, two government facilities, and four nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 181.4 feet with a maximum breach flow of 178,122 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 51. Salado Creek WS SCS Site 8 Dam Flood Risk Areas



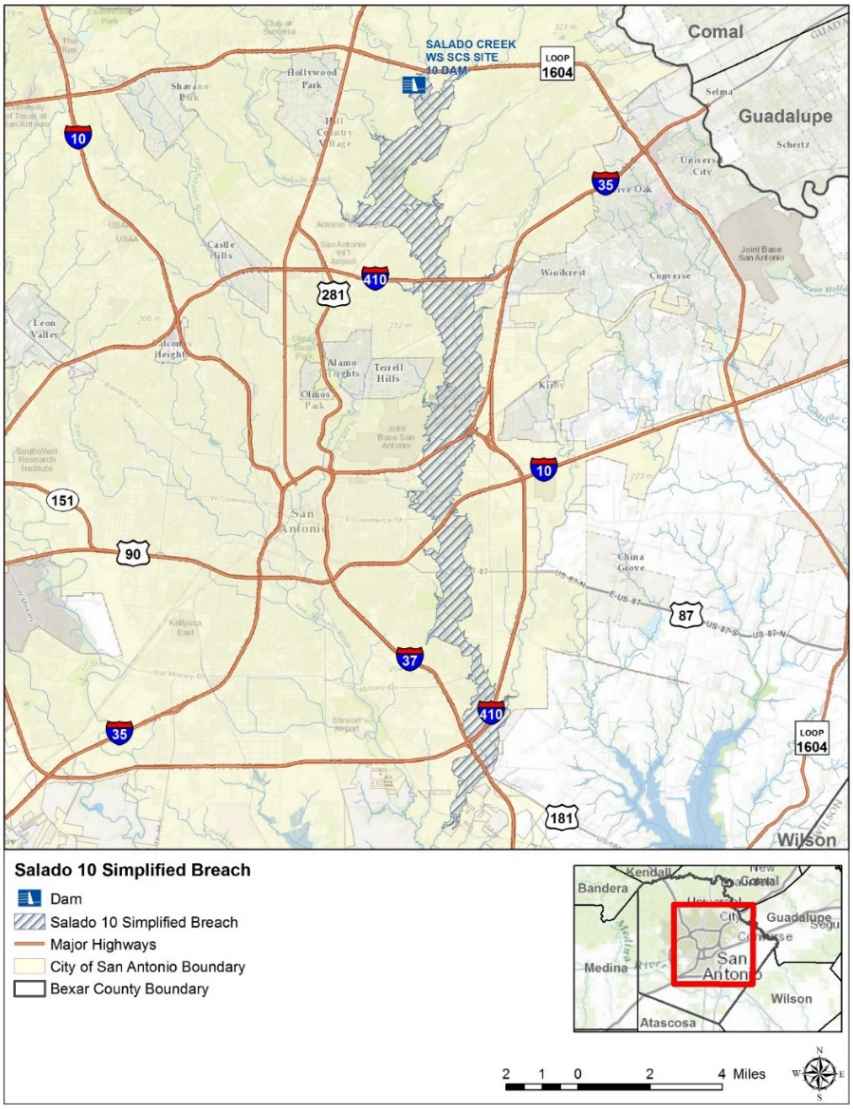
Salado Creek Watershed SCS Site 8 Dam is on the Mud Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1973. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 42,418 people, 17,886 housing units, one agriculture and food facility, four banking and finance facilities, 21 chemical and hazardous materials facilities, four energy facilities, six emergency services facilities, six communication facilities, 38 healthcare and public health facilities, 12 water facilities, 66 commercial facilities, eight government facilities, two dams, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 243.7 feet with a maximum breach flow of 348,979 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 52: Salado Creek WS SCS Site 9 Dam Flood Risk Area



Salado Creek Watershed SCS Site 9 Dam is on the Mud Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1979. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 35,175 people, 15,051 housing units, two banking and finance facilities, 17 chemical and hazardous materials facilities, three energy facilities, six emergency services facilities, six communication facilities, 31 healthcare and public health facilities, 10 water facilities, 56 commercial facilities, seven government facilities, two dams, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 180.6 feet with a maximum breach flow of 189,766 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.

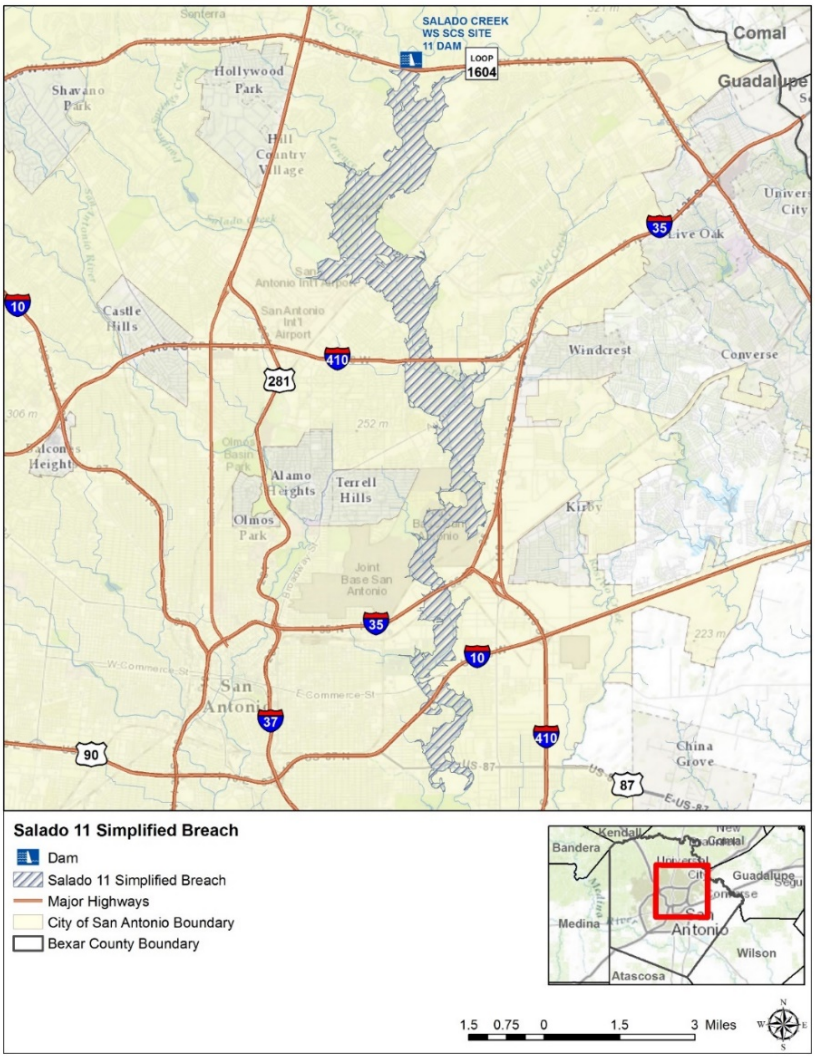
Figure 53. Salado Creek WS SCS Site 10 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 10 Dam is on the Mud Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1994. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 38,976 people, 16,786 housing units, one agriculture and food facility, three banking and finance facilities, 21 chemical and hazardous materials facilities, four energy facilities, six emergency services facilities, six communication facilities, 38 healthcare and public health facilities, 10 water facilities, 64 commercial facilities, eight government facilities, two dams, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 215.4 feet with a maximum breach flow of 337,572 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.

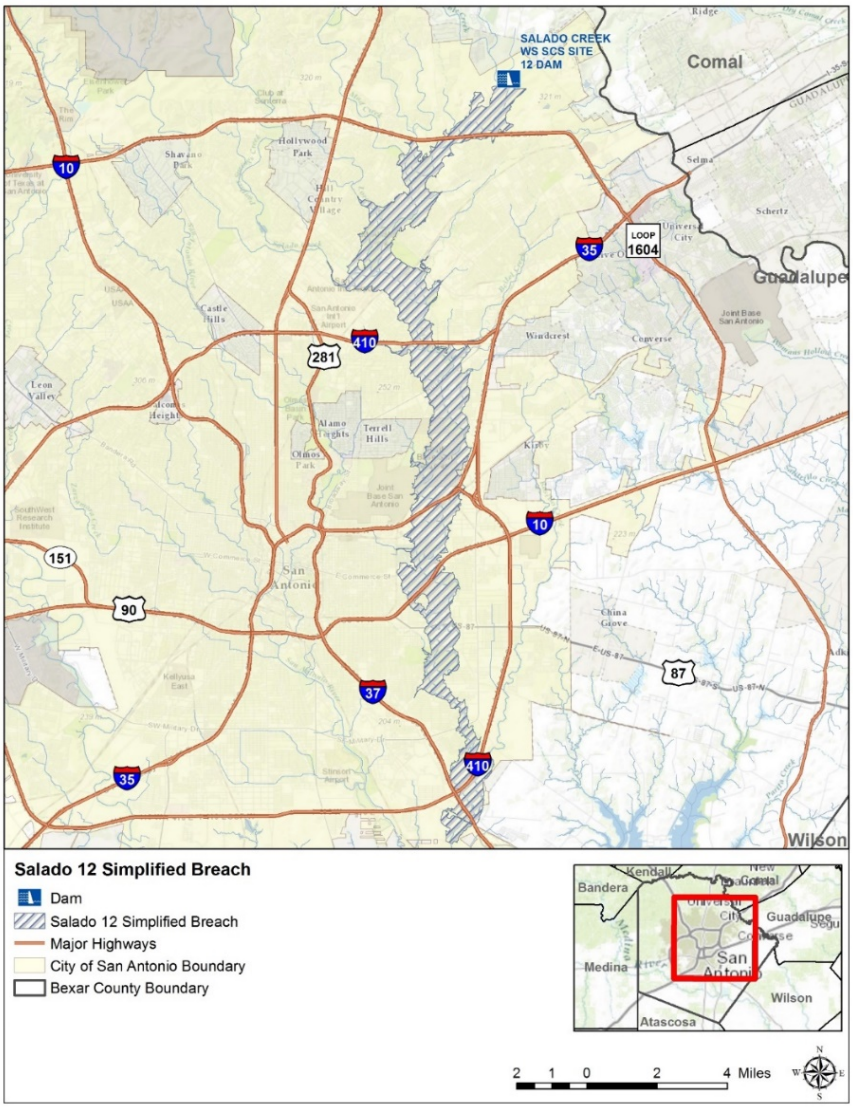
Figure 54. Salado Creek WS SCS Site 11 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 11 Dam is on the Elm Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1979. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 24,055 people, 10,678 housing units, two banking and finance facilities, five chemical and hazardous materials facilities, three emergency services facilities, five communication facilities, 25 healthcare and public health facilities, one water facility, 33 commercial facilities, three government facilities, one dam, and four nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 239.6 feet with a maximum breach flow of 368,365 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.

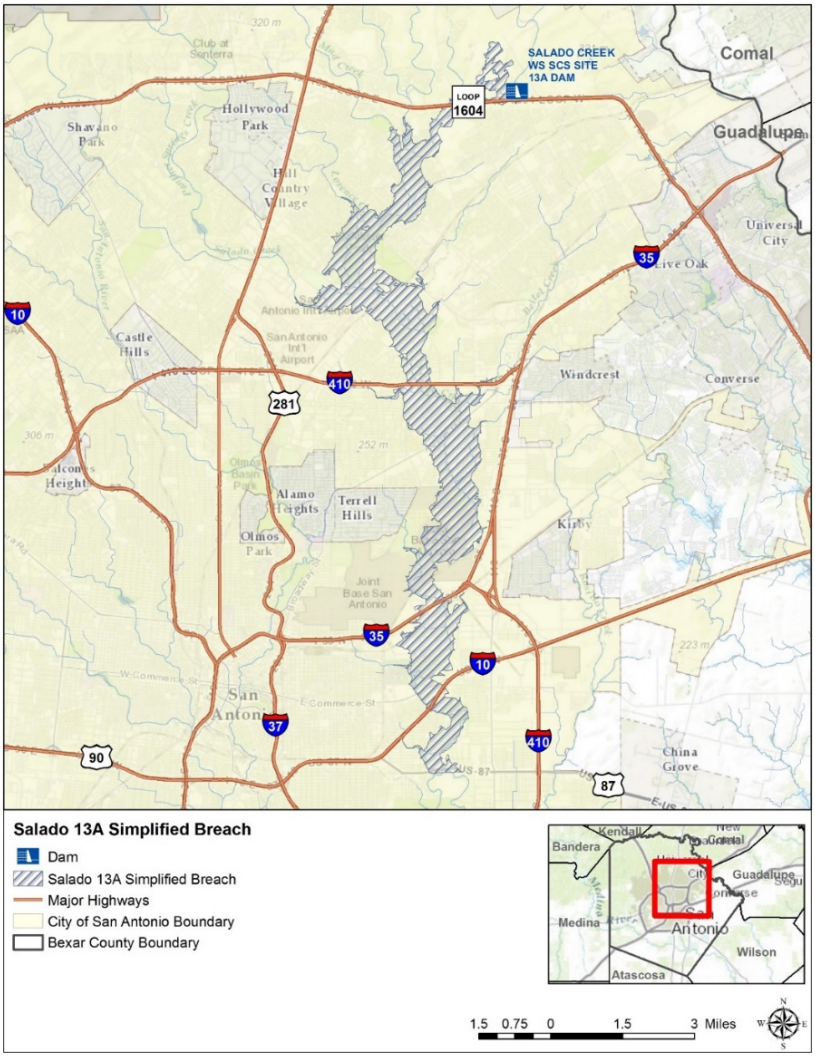
Figure 55. Salado Creek WS SCS Site 12 Dam Flood Risk Areas



Salado Creek Watershed SCS Site 12 Dam is on the Long Creek in the City of San Antonio and is used for flood control purposes. The earthen dam is owned by the San Antonio River Authority and was constructed in 1974. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 45,885 people, 19,494 housing units, two agriculture and food facilities, three banking and finance facilities, 25 chemical and hazardous materials facilities, five energy facilities, six emergency services facilities, six communication facilities, 39 healthcare and public health facilities, 10 water facilities, 78 commercial facilities, 10 government facilities, five dams, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 259.5

feet with a maximum breach flow of 467,275 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.

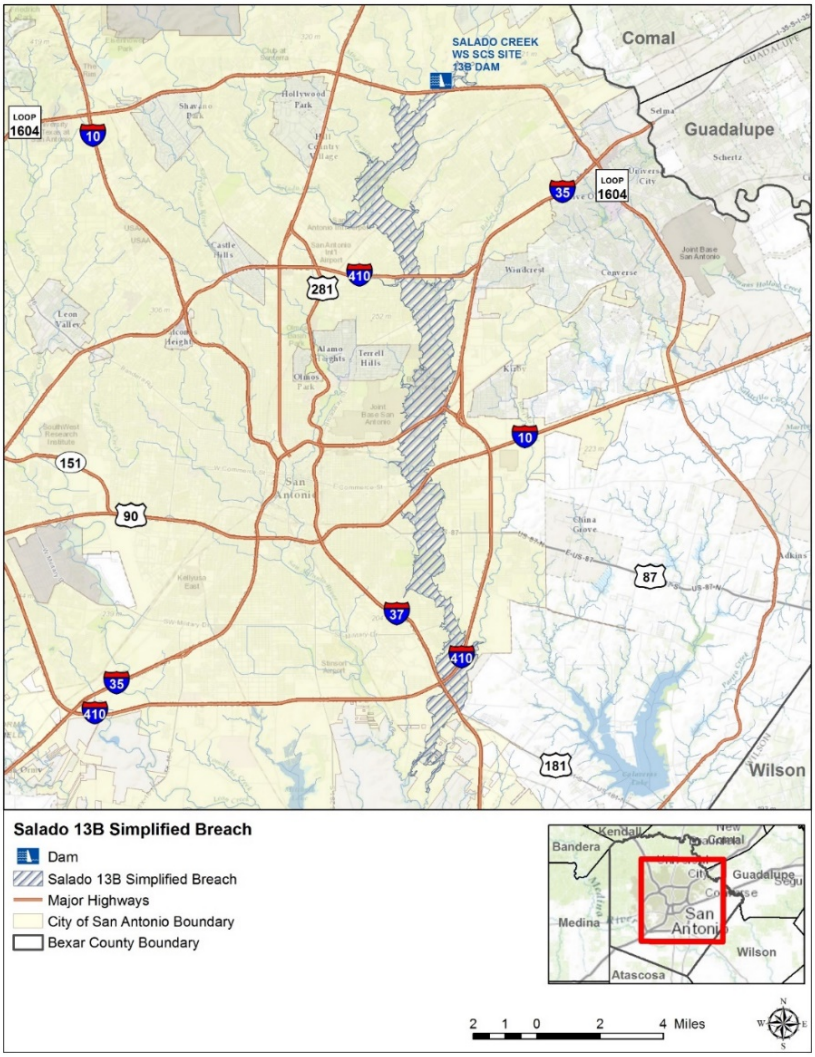
Figure 56. Salado Creek WS SCS Site 13A Dam Flood Risk Areas



Salado Creek Watershed SCS Site 13A Dam is on the Elm Waterhole Creek in the City of San Antonio and is used for flood control purposes. The dam is owned by the San Antonio River Authority and was constructed in 1976 by earthen construction. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 26,869 people, 11,821 housing units, three banking and finance facilities, 12 chemical and hazardous materials facilities, one energy facility, six emergency services facilities, six communication facilities, 30 healthcare and public health facilities, five water facilities, 38 commercial facilities, six government facilities, one dam, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the average breach width would be 179.8

feet with a maximum breach flow of 145,523 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.

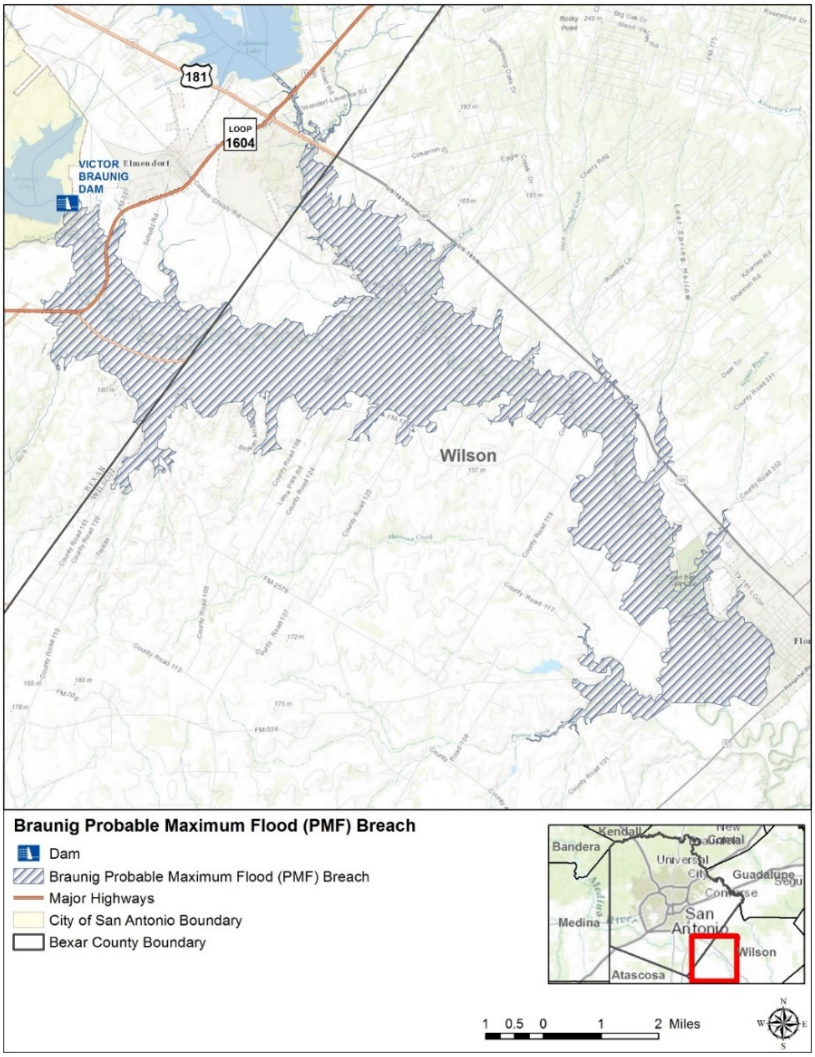
Figure 57. Salado Creek WS SCS Site 13B Dam Flood Risk Areas



Salado Creek Watershed SCS Site 13B Dam is on a tributary of Elm Waterhole Creek in the City of San Antonio and is used for flood control purposes. The dam is owned by the San Antonio River Authority and was constructed in 1976 by earthen construction. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 36,384 people, 15,579 housing units, one agriculture and food facility, three banking and finance facilities, 20 chemical and hazardous materials facilities, four energy facilities, four emergency services facilities, six communication facilities, 36 healthcare and public health facilities, 10 water facilities, 59 commercial facilities, eight government facilities, two dams, and five nuclear reactors, materials, and waste facilities vulnerable. In the event of a breach, it is estimated the

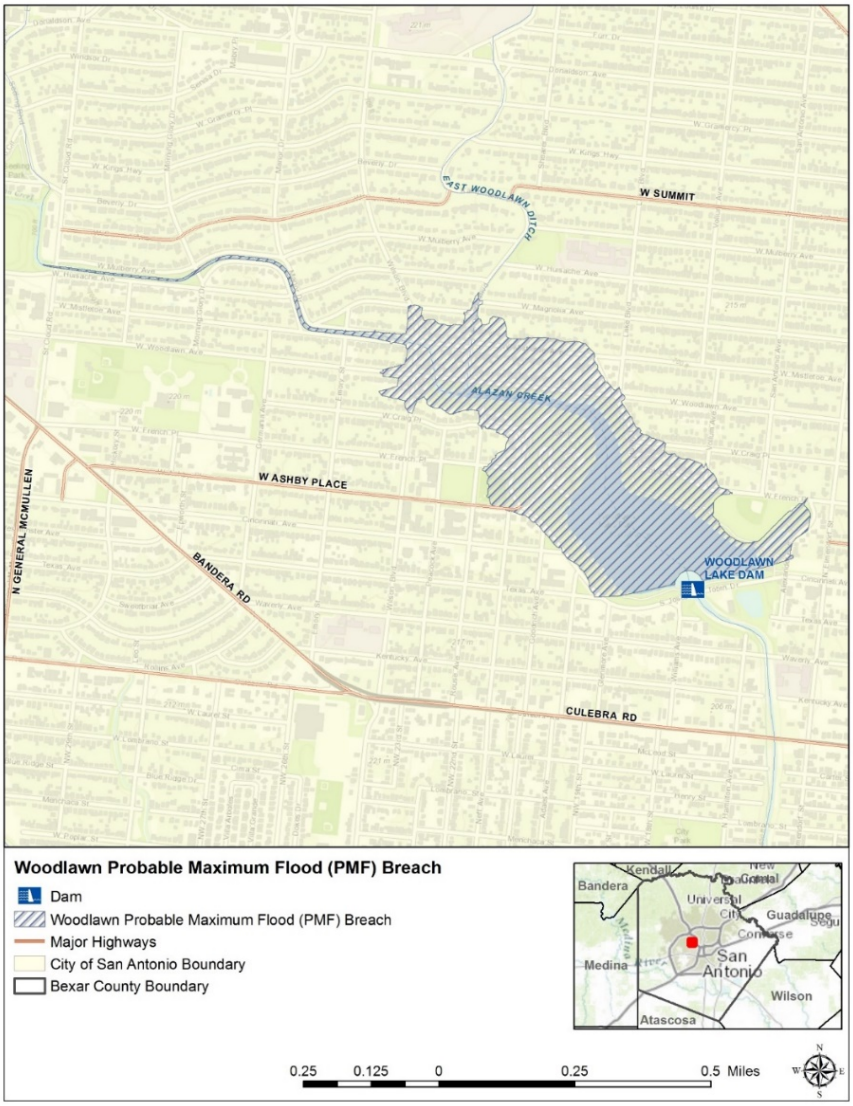
average breach width would be 163.3 feet with a maximum breach flow of 150,734 cubic feet per second according to the National Weather Service (NWS) Dam Break Equation. A dam breach could result in an estimated depth of up to 15 feet.

Figure 58. Victor Braunig Dam Flood Risk Areas



Victor Braunig Dam is on the Arroyo Seco River in the City of San Antonio and is used for recreation purposes. The dam is owned by the City of San Antonio and was constructed in 1963 by earthen construction. The extent classification is considered high, and the area located near the dam is a semi-densely populated area. A dam failure could cause power outages and disrupt utility systems. There would also be 1,559 people, 615 housing units vulnerable. In the event of a breach, it is estimated the average breach width would be 376.1 feet with a maximum breach flow of 757,519 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 25 feet.

Figure 59. Woodlawn Lake Dam Flood Risk Areas



Woodlawn Lake is on the Alazan Creek in the City of San Antonio and is used for recreation purposes. Woodlawn Lake Dam is earthen construction, owned by the City of San Antonio, and was built in 1961. The extent classification is considered high, and the area located near the dam is densely populated. A dam failure could cause power outages and disrupt utility systems. There would also be 3,485 people, 1,193 housing units, and one commercial facility vulnerable. In the event of a breach, it is estimated the average breach width would be 93 feet with a maximum breach flow of 23,841 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 25 feet.

Dam failure presents a low to moderate threat for the city. While some utilities, structures, and infrastructure could be impacted, the greatest threat in the event of a dam breach would be localized flooding. Critical facilities would not be impacted. Some infrastructure and utilities

could be impacted. Economic loss would be limited due to the limited capacity of the dams profiled in the plan.

Historical Occurrences

There are approximately 90,580 dams in the United States today.[113] 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 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.

The State of Texas 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 more significant.

There has been one reported historical occurrence for dam failure in Bexar County, which occurred in 2002. There have been no historical occurrences recorded for the City of San Antonio.

Probability of Future Events

No historical events of dam failure have been recorded in the City of San Antonio planning area, though the risk of dam failure is monitored closely. Due to the lack of historical occurrences, the probability of a future event is unlikely.

Extreme precipitation events are projected to increase in a warming climate and may lead to more severe floods and greater risk of infrastructure failure in some regions. There is *high confidence* that deteriorating water infrastructure (e.g., dams, levees) compounds the climate risk faced by society.

Vulnerability and Impact

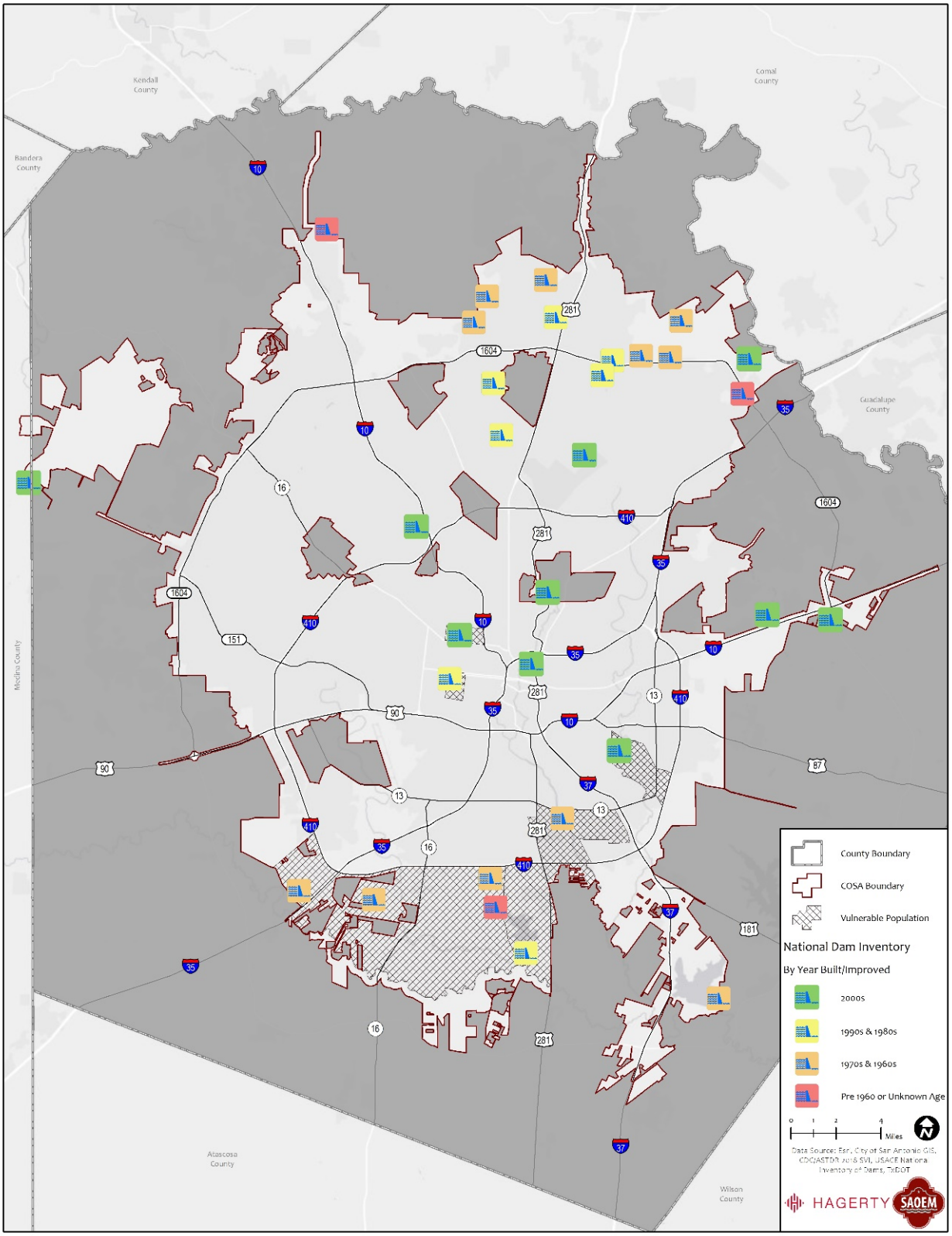
There are 34 dams in the City of San Antonio planning area: 11 considered low hazard dams, two new dams with no data available yet, and 21 regarded as high hazard dams based on their classification.

Flooding is the most prominent effect of dam failure. If the dam failure is extensive, a large amount of water will enter the downstream waterways, forcing them out of their banks. There

[113] Federal Emergency Management Agency, Dam Safety Program, available at: http://www.fema.gov/hazards/damsafety/

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, which could result in school closures. Figure 60 illustrates dam inventory by year overlayed with socially vulnerable populations in San Antonio. In the event of a dam failure, socially vulnerable populations may be impacted to a greater extent due a lack transportation, disability, or insufficient financial resources to recover quickly.

Figure 60: Dam Inventory and Socially Vulnerable Populations in San Antonio



For specific vulnerability, please refer to the narratives below each high hazard dam in this section. Annualized loss-estimates for dam failure are not available; 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 the 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 to minimize dam failure.

Water systems face considerable risk, even without anticipated future climate changes. The Southern Great Plains region has tens of thousands of dams and levees; however, many are not subject to regular inspection and maintenance and the average age of these dams and levees exceeds 40 years. Extreme precipitation can put additional stress on Texas's aging water infrastructure. A total of 82 dams failed in Texas between 1982 and 2012, along with seepage observed in the Lewisville Dam in 2015. As climate conditions continue to change, rare events such as 1% annual chance of floods are likely to become more common. Future climate extremes can exacerbate flooding, along with the wear and tear on existing flood control infrastructure. This will necessitate revisions to design standards for flood infrastructure and require a reevaluation of floodplains.

ASSESSMENT OF IMPACTS

Any individual dam has a very specific area that will be impacted by a catastrophic failure. The 21 dams identified as high or significant hazard can directly threaten the lives of individuals living or working in the inundation zone below the dam. The impact from any catastrophic failure would be like that of a flash flood. Lives could be lost. There could be injuries from impacts with debris carried by the flood.

Response to a dam failure is a response to a hazardous situation. Swift-water rescue of individuals trapped by the water puts the immediate responders' own lives at risk. After the water has receded, those involved in the cleanup may be at risk from the debris left behind.

Continuity of operations for any jurisdiction outside the direct impact area could be very limited. Unlike most flood situations, a dam failure's impact will be limited to an area within a single watercourse. In addition, the failure, while sending a surge of water downstream, will not usually continue to direct water downstream over an extended period. Typically, there will be an initial surge of water, and then, as with most dam breach situations, the quantity of floodwaters will taper off relatively quickly.

Exceptions would include the partial failure of one of the large dams in the county or the failure of a major dam during a severe rain event causing major flooding. In either of these cases, there could be a flood hazard already in existence when the dam fails.

Having the damage located within a single watercourse, while limiting the area directly impacted, could still cause major disruption of operations and the delivery of services. The heavy surge 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 jurisdiction's ability to respond to many of the day-to-day needs.

No matter the size of the dam, the large quantity of water associated with the failure of a dam creates a scouring force in the area immediately below it. For small dams, this may cover only a few dozen to hundreds of yards not impacting much, if any, infrastructure. For large dams, like Olmos and Braunig, scouring could go for miles.

Depending on the quantity of water, the force caused by its surge could take out buildings, power lines (including the towers), and destroy roads. A large dam with a high head of water could effectively scour the terrain below it for miles, taking out all buildings and other infrastructure. This scouring force could also erode soil and any buried pipelines. Any dam that fails has a detrimental impact on the environment. This will vary depending on the size of the failure. Small dams will probably only impact a small portion of the environment downstream. In the other extreme, the scouring action of a large quantity of water will destroy all vegetation in its path. Like any flash flood, this will destroy any wildlife caught in the flow. Fish habitat could be destroyed as well. In some areas, it will take off most, if not all, topsoil, limiting the environment's ability to return to normal. It could take years for the natural restorative processes to develop a similar ecosystem.

A large dam that fails, depending on the quantity of water released, could impact far beyond what is normally expected from a flood on its watercourse. Part of this is due to the volume of water, which at its peak, may have a flow many times that of even a record flood. Added to this is the large quantity of material, both natural (e.g., logs and other vegetation) and human-related (e.g., fertilizer, sewage, livestock, vehicles, and other hazardous materials). This material, as it is deposited, may cause further pollution of not just the areas normally flooded, but also land that lies far above or away from the typical floodplain.

The San Antonio area is home to many cultural and historic resources. These resources, and the history they represent, are significant to the area, as they remind the community of its past and define its persona. In addition, the City's historic and cultural resources are a significant draw for tourists and visitors to the area and help generate revenue through jobs, taxes, and fees. This revenue, in turn, pays for services and programs, which benefit residents and the community.

Many of the City's historic homes and neighborhoods could be impacted by dam failure in the same ways as any other property or residence. In addition to the property damage, the flooding due to dam failure of historic neighborhoods, which often attract tourists and generate revenue, could have long-term economic impacts, both for the property owners and for the City, as tourists and visitors are unlikely to want to visit flood-damaged historic structures and neighborhoods.

The economic impact from the failure of many of the smaller, low hazard dams is minimal. The impact would be to the dam owner and potentially to a small local group, probably geographically located directly downstream from the dam. The impacted area would be small, and in most cases isolated, so that a failure of one of the smaller dams may go unnoticed by the residents outside the directly affected area.

As the size of the dam increases, and the proximity to the public and/or critical infrastructure increases, the probability of damage to the economy increases. Any of the 19 dams identified could have an impact on either the overall economy or on the financial condition of many of the businesses or homeowners located in the inundation zones from those dams.

A worst-case scenario would include a failure of Olmos Dam during peak storage. This scenario could not only kill many people but could irrevocably damage the infrastructure. Roads and bridges would be lost. This includes damage to US-281 and IH-35 highways. Businesses in the downtown area would be damaged or, in many cases, destroyed, and municipalities in the inundation zones would have a long-term process of rebuilding. All of this would not only impact those areas in the inundation zone, but any area relying on either the infrastructure or businesses located in that zone. For many of the small dams whose failure would have no impact on the general public, there would be little change in the public's confidence in local governments or any agency overseeing their safety or operation.

The failure of any dam causing considerable damage to the community will be under scrutiny by the press and the public. The organizations most in the line of fire will be those responsible for the dam and those responsible for overseeing its licensing and safety. When the dam owner is a public agency, the confidence in that agency will be adversely affected.

Dam safety inspections fall to the Dam Safety Program managed by the TCEQ.

The TCEQ currently focuses its inspection program of existing dams primarily on high and significant hazard dams as required by rule in 30 TAC §299.42(a)(2). According to the rule, high and significant hazard dams and large, low hazard dams are scheduled to be inspected every five years, while small and intermediate dams, and low hazard dams, are only to be inspected at the request of an owner; because of a complaint; at the request of someone other than the owner, following an emergency such as a flooding event; or for determining the hazard classification.

Section 13: Winter Storm

Hazard Description

A winter storm event is identified as a storm with extreme cold, freezing rain, snow, sleet, ice, and/or high winds. Winter storms that threaten the City of San Antonio usually begin as powerful cold fronts that push south from central Canada. The three core components necessary to create a winter storm are cold air, lift, and moisture.

Impact of Winter Storm Uri in San Antonio (WITF, 2021)

Winter storms can bring various types of precipitation to the San Antonio region. Most precipitation that forms in winter clouds starts out as snow because the top layer of the storm is usually at or below freezing temperatures.[114] Winter precipitation may result in one of the following:

1. **Blizzard**: Blizzards are dangerous winter storms that are a combination of falling snow and wind. While heavy snow accumulation and severe cold often accompany blizzards, they are not required. Sometimes, strong winds pick up snow that has already fallen, creating what is known as a "ground blizzard."
2. **Snow squalls**: Snow squalls are brief, intense snow showers accompanied by strong, gusty winds. Accumulation of snow may be significant.
3. **Sleet**: Sleet occurs when snowflakes only partially melt when they fall through a shallow layer of warm air. These slushy drops refreeze as they then fall through a deep layer of freezing air above the surface, and eventually reach the ground as frozen rain drops that bounce on impact. If enough sleet accumulates on the ground, it can make travel hazardous. Rain or drizzle is likely to refreeze upon impact, resulting in a coating of ice glaze on roads and all other exposed objects.
4. **Ice Storm**: A significant accumulation of freezing rain (at least 0.25") lasting several hours, or more is called an ice storm. They create hazardous driving and walking conditions. Tree branches and powerlines can easily snap under the weight of the ice.[115]

These types of winter storms are categorized by the public information distributed regarding the event and the relative danger associated with the event. Table 76 summarizes the types of

[114] NOAA National Severe Storms Laboratory "Severe Weather 101." https://www.nssl.noaa.gov/education/svrwx101/winter/.

[115] CDC. "Extreme Cold: A Prevention Guide to Promote Your Personal Health and Safety." https://www.cdc.gov/disasters/winter/pdf/extreme-cold-guide.pdf.

winter storm warnings, watches, and advisories that can be issued during a winter weather event.

Table 76: Types of Winter Storm Warnings, Watches, and Advisories[116]

TYPE	DESCRIPTION
Blizzard warning	Issued when winds of 35 MPH or greater and visibility is reduced to ¼ mile or less is occurring or expected to occur within the next 12 to 18 hours.
Ice storm warning	Issued when at least ¼ inch of ice is expected.
Wind chill advisory	Issued when seasonably cold wind chill values, but not extremely cold values are expected or occurring.
Wind chill warning	Issued when dangerously cold wind chill values are expected or occurring.
Wind chill watch	Issued when dangerously cold wind chill values are possible.
Winter storm warning	Issued when a significant combination of hazardous winter weather is occurring or imminent.
Winter storm watch	Issued when there is the potential for significant and hazardous winter weather within 48 hours.
Winter weather advisory	Issued when 2 to 4 inches of snow, alone or in combination with sleet and freezing rain, is expected to cause a significant inconvenience, but not serious enough to warrant a warning.

Winter weather can be dangerous in Texas in part because it is relatively rare in most areas of the State. The City of San Antonio is at risk of extremely cold temperatures and accumulation of ice and snow. Winter Storm events can cause major disruptions to transportation, commerce, and public safety. Extremely cold temperatures often accompany a winter storm and can result in significant direct impacts (e.g., icy roads, road closures, frozen pipes) and cascading impacts (e.g., power outages, pumping issues, increased utility prices, and challenges distributing food and water to the public) to the City.

In February 2021, millions of people in Texas were affected by extreme winter weather that came with the arrival of Winter Storm Uri. The winter storm brought several days of unusually low temperatures ranging within single digits, snowfall and ice, and rolling power outages across the State. This severe winter weather event left millions of people across Texas and thousands of people in San Antonio without power for several days in freezing temperatures. The City of San Antonio experienced significant impacts and unforeseen cascading impacts,

[116] City of San Antonio. "City of San Antonio Hazard Mitigation Action Plan: Update 2021." November 10, 2021. https://www.saoemprepare.com/Plans/HMAP.

including prolonged power and water outages, closures of roads and businesses, busted pipes, increased utility prices, and significant public health concerns.[117]

WINTER STORMS AND CLIMATE CHANGE

Although winters are becoming warmer and somewhat milder overall, extreme winter storms have been increasing. One of the factors feeding storms is a warmer atmosphere, which can hold more water vapor and therefore, more precipitation. When vapor forms on clouds, it releases heat into the air, which provides fuel for storms. Additionally, the increased tendency for the jet stream to rapidly change from north and south can create intense cold weather phenomena.

Location

Winter storm events are not confined to specific geographic boundaries. Therefore, all existing and future buildings, facilities, and populations in the City of San Antonio are considered to be exposed to a winter storm hazard and could potentially be impacted by an event.

Extent

The extent or magnitude of a severe winter storm is measured in intensity based on the temperature and level of accumulations, as shown in Table 77. Table 77 should be read in conjunction with the wind chill factor described in Figure 61 below to determine the intensity of a winter storm.

Table 77: Extent of Severe Winter Storms[118]

INTENSITY	TEMPERATURE RANGE	EXTENT DESCRIPTION
MILD	40°F – 50°F	Winds less than 10 mph and freezing rain or light snow falling for short durations with little or no accumulation.
MODERATE	30°F – 40°F	Winds 10 – 15 mph and sleet and/or snow up to 4 inches.
SIGNIFICANT	25°F – 30°F	Intense snow showers accompanied with strong gusty winds, between 15 and 20 mph with significant accumulation.

[117] City of San Antonio. "Community Emergency Preparedness Committee Report: A Response to the February 2021 Winter Storm." June 24, 2021.
[118] City of San Antonio. "City of San Antonio Hazard Mitigation Action Plan: Update 2021." November 10, 2021. https://www.saoemprepare.com/Plans/HMAP.

INTENSITY	TEMPERATURE RANGE	EXTENT DESCRIPTION
EXTREME	20°F – 25°F	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°F	Winds of 35 mph or more and snow and sleet greater than 4 inches.

The National Weather Service (NWS) Wind Chill Chart index provides a formula for calculating the dangers from wind and freezing temperatures. Wind chill is a measure of how cold the wind makes the air temperature feel to the human body. Since wind can dramatically accelerate heat loss from the body, a 30°F day with 25 mph winds can make it feel as if it is 16°F. The chart is not applicable when temperatures are over 50°F or winds are calm.

Figure 61: Wind Chill Chart[119]

Wind (mph) \ Temperature (°F)	Calm	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	19	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

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

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Based on historical data for the San Antonio area, the average event the City would likely experience is a mild to severe winter storm. These winter storm events typically have temperatures between 30°F and 50°F, winds ranging from 0 to 15 mph, and accumulate between 0.1 to 3.0 inches of ice and snow.

A growing body of research indicates that as average global temperatures rise due to climate change, and the Arctic continues to warm, the jet stream is both slowing down and becoming

[119] NWS. "Wind Chill Chart." https://www.weather.gov/safety/cold-wind-chill-chart.

increasingly wavy. In the winter months, this allows cold Artic air to spill much further south than usual.

Historical Occurrences

Table 78 through Table 81 shows historical occurrences for Bexar County from 1996 to 2021 provided by the NOAA National Centers for Environmental Information (NCEI) storm event database. There have been 12 recorded winter storm events in Bexar County. This table only includes winter storm events and does not include related weather events (e.g., cold/wind chill, cold/wind chill, or winter weather events).

Table 78: Historical Cold/Wind Chill Events, 1996 – 2021[120]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	11/23/07	1	0	$0	$0

Table 79: Historical Extreme Cold/Wind Chill Events, 1996 – 2021[121]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	2/14/21	1	0	$0	$0

Table 80: Historical Winter Storm Events, 1996 – 2021[122]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	2/1/1996	0	0	$0	$0
Bexar County	1/11/1997	0	0	$0	$0
Bexar County	12/23/1998	0	0	$0	$0
Bexar County	12/12/2000	0	0	$0	$0
Bexar County	11/28/2001	0	0	$0	$0
Bexar County	2/24/2003	0	0	$0	$0
Bexar County	1/16/2007	0	0	$0	$0
Bexar County	2/3/2011	0	0	$0	$0

[120] NCEI. *Storm Events Database*, 2022. https://www.ncdc.noaa.gov/stormevents/.
[121] Ibid.
[122] Ibid.

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	1/10/2015	0	0	$0	$0
Bexar County	1/16/2018	0	0	$0	$0
Bexar County	2/13/2021	0	0	$0	$0
Bexar County	2/16/21	0	0	$0	$0

Table 81: Historical Winter Weather Events, 1996 – 2021[123]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Bexar County	12/9/08	0	0	$0	$0
Bexar County	12/7/13	0	0	$0	$0
Bexar County	2/7/14	0	0	$0	$0
Bexar County	2/7/14	0	0	$0	$0
Bexar County	2/7/14	0	0	$0	$0
Bexar County	1/23/15	0	0	$0	$0
Bexar County	2/16/15	0	0	$0	$0
Bexar County	3/4/15	0	0	$0	$0
Bexar County	12/7/17	0	0	$0	$0
Bexar County	11/11/19	0	0	$0	$0
Bexar County	2/5/20	0	0	$0	$0
Bexar County	1/10/21	0	0	$0	$0

Based on the list of historical winter storm events for the City of San Antonio planning area, four winter storm events have occurred since the 2015 HMAP update. The following sections provide additional details regarding the most significant winter storms recorded in Bexar County between 1996 and 2021.[124]

[123] NCEI. *Storm Events Database*, 2022. https://www.ncdc.noaa.gov/stormevents/.

[124] City of San Antonio. "Community Emergency Preparedness Committee Report: A Response to the February 2021 Winter Storm." June 24, 2021.

SIGNIFICANT EVENTS

February 2021: Winter Storm Uri

A series of weather systems, known as Winter Storm Uri, brought several rounds of severe winter weather across Texas from February 11 through February 18, 2021. This storm produced record amounts of snow, periods of freezing rain, breezy winds, and frigid temperatures for the duration of the storm systems. The record winter storm conditions impacted all 254 counties in Texas, creating challenges and limitations in the response and recovery efforts. The Texas Department of State Health Services have confirmed 246 winter storm-related deaths across 77 Texas counties, 16 of those in Bexar County. Causes of death included hypothermia, deaths from falls, carbon monoxide, heating related fire, motor vehicle accidents, drowning, exacerbation of chronic illness, and frostbite.

> The unprecedented direct and cascading impacts from Winter Storm Uri on the city of San Antonio emphasize the need to invest in mitigation projects to support critical community lifelines and make the city more resilient.

The storm system led to a cascade of unanticipated impacts. The several days of unusually low temperatures combined with snowfall and ice depleted energy sources across the State. To conserve energy, the Electric Reliability Council of Texas (ERCOT), which manages the flow of electric power to more than 26 million Texas customers, initiated rolling power outages on Monday, February 15, 2021, throughout the duration of the storm. Other winter storm impacts included widespread power outages, water service interruptions, limited access to essential healthcare, business closures and supply chain disruptions, technological and communication disruptions, property loss, increased utility prices, dangerous roadway conditions, burst pipes, and failures of other essential infrastructure. These impacts left many residents without power, heat, or water for several days. More vulnerable populations, including individuals who are homebound, unhoused individuals, and individuals of lower socioeconomic status, were most impacted by the incident. The State is anticipated to accumulate billions of dollars in losses (insured and uninsured) from property damage due to the storm. The impacts were further felt given the ongoing impacts from the COVID-19 pandemic.[125]

January 2018: Sleet and Ice storm

A cold front brought a shallow layer of subfreezing air to South Central Texas on January 16, 2018. Isentropic lift of warm moist air over this shallow cold layer led to wintry precipitation. Most of the precipitation was freezing rain and sleet, but there was some snow toward the end of the event. There were reports of 1/8" of ice accumulation in Leon Valley, New Braunfels, and

[125] City of San Antonio. "Community Emergency Preparedness Committee Report: A Response to the February 2021 Winter Storm." June 24, 2021.

San Geronimo. Icy roads were a problem across the region, closing many roadways and causing numerous vehicle accidents.

February 2011: Ice Storm

An upper-level storm approached the area the evening of February 3, 2011. It produced a light freezing drizzle, which quickly formed a thin layer of ice on all exposed surfaces, making travel very dangerous. The precipitation later turned mostly to light snow along with a few reports of sleet. The greatest snow amounts were from 1 to 2 inches, mainly across portions of Travis and Williamson Counties, with generally less than one inch across the Hill Country, portions of San Antonio, and areas east of I-35. There were over 500 traffic accidents reported in San Antonio and Austin during the overnight hours. The icy roads forced all the major highways in San Antonio to close during the night. For a time, I-35 was closed from San Marcos through San Antonio into Atascosa County, a stretch of nearly 100 miles. Many other highways were closed across the area, including parts of I-10, US Hwy 90, US Hwy 77, and US Hwy 290. Most area schools were closed on February 4.

January 2007: Ice Storm

A combination of freezing rain and drizzle began falling over the County near 6:00 p.m. on January 15, 2007, and continued through noon the following day. Overpasses and elevated roads became iced-over and were closed on the evening of January 15. City and County offices and schools, which had been closed for the Martin Luther King Holiday, remained closed on January 16. Main offices and schools did not re-open until January 18. The ice caused power outages to more than 65,000 persons, along with widespread traffic accidents. The City of San Antonio reported over 500 accidents in one 12-hour period alone.[126]

December 1998: Freezing Rain

Temperatures in the 70°Fs on the afternoon of December 21 plunged into the 20°Fs through the evening as an arctic cold front crossed through South Central Texas on its way to the Gulf of Mexico. North winds gusting to 30 and 35 mph brought chill indices near the zero mark. Cold and cloudy weather persisted through December 22 and 23, with daytime temperatures holding in the 20°Fs over the Texas Hill Country and in the low 30°Fs to near 30°F for the remainder of South Central Texas. Spotty freezing rain and freezing drizzle on the morning of the 23rd began to cover roads and bridges, making driving very difficult. As ice continued to

[126] The Associated Press. "Ice storm spreads havoc across Texas." *Denver Post*, January 17, 2007. https://www.denverpost.com/2007/01/17/ice-storm-spreads-havoc-across-texas/#:~:text=January%2017%2C%202007%20at%203,to%20the%20Mexican%20border%20Wednesday.

accumulate, driving became very dangerous for the northern half of South Central Texas. Nearly 200 vehicle accidents were reported in the San Antonio area.

Probability of Future Events

According to historical records, the City of San Antonio experiences one winter storm event every one to two years. Hence, the probability of a winter storm event affecting the City's planning area is highly likely, with a winter storm likely to occur at least once per year.

Severe winter storms and unusual cold snaps are becoming more frequent as temperatures rise. Increasing temperatures due to climate change can lead to atmospheric patterns that result in easier winter storm development. Climate change makes storms worse and more unpredictable. Global warming and higher temperatures lead to increased evaporation. Eventually, this increased evaporation leads to increased precipitation. At certain times, when temperatures are cold enough, this precipitation is snowfall.

Vulnerability and Impact

Winter storm events can cause direct and cascading impacts on the San Antonio community. Cascading impacts are a chain of events caused by the direct impacts of the hazard. Many cascading impacts are unforeseen, while others can be anticipated based on previous hazard occurrences. Impacts from winter storms are further exacerbated by existing vulnerabilities present in the community and infrastructure, as well as the future impacts of climate change.

COMMUNITY

Winter storm conditions (e.g., extreme cold, freezing rain, snow, sleet, ice, and high wind) can have direct impacts on members of the community. Exposure to extreme cold can put the health and safety of individuals, animals, and communities at risk. All populations in the community are vulnerable to the impacts of a winter storm. However, certain populations are more likely to be impacted by and have a more difficult time recovering from a winter storm hazard event.

Certain community members particularly vulnerable to the impacts of winter storms include:

- Individuals experiencing homelessness
- Older adults
- Young children
- Individuals with preexisting medical conditions
- Individuals experiencing financial insecurity

Individuals experiencing homelessness are particularly vulnerable to the direct impacts of winter storms. As of the 2020 point-in-time count, 2,932 individuals are experiencing homelessness in San Antonio. Approximately half of the

individuals experiencing homelessness in San Antonio are unsheltered.[127] Unsheltered individuals are particularly vulnerable due to exposure to cold temperatures and increased risk of adverse health outcomes. While warming centers for individuals experiencing homelessness may be available during a winter weather event, individuals may be reluctant to seek shelter or leave their belongings.

Older adults, young children, and individuals with preexisting medical conditions are also more vulnerable to the impacts of winter storms. These individuals may have a harder time regulating body temperature and may have decreased circulation compared to healthy adults. This may increase the rate at which their health and safety becomes at risk. According to the US Census Bureau, 12% of the population in the City of San Antonio is over the age of 65, approximately 6.9% of the population is under the age of 5, and 11.3% of the population is under the age of 65 with a disability.[128] These populations, particularly older adults and individuals with preexisting medical conditions, are more likely to require life-supporting devices or require frequent medical care. Life supporting devices often require power, which may not be consistent during an emergency. Travel conditions may limit the ability of individuals to access needed medical appointments.

Lastly, individuals experiencing financial insecurity are especially vulnerable to the impacts of winter storms. An estimated 17.5% of the planning area population are below the poverty level.[129] Individuals experiencing financial insecurity often live in homes exposed to the elements, with less insulation and quality construction. They may also rely on landlords to make property enhancements rather than being able to make their own investments. Financial insecurity also limits the amount of personal preparedness measures that can be taken. In practice, this means fewer financial resources to purchase generators, heaters, or water.

TRANSPORTATION INFRASTRUCTURE

Winter storms have the capacity to directly impact roads, railroads, bridges, and other transportation infrastructure. Notably, the water in the cracks in the road freezes into ice, and this expansion and contraction creates cracks in the roadways. Depending on the extent of the winter storm event, infrastructure may be impacted for an extended period or may require time to repair. Additionally, winter storm conditions increase the roadway dangers for drivers. Ice and snow can cover roadways and make them slick. These impacted roads can make driving more dangerous and reduce visibility for roadway hazards.

---

[127] American Community Survey. "San Antonio City, Texas: ACS Demographic and Housing Estimates." 2020. https://data.census.gov/cedsci/table?q=san%20antonio%20texas&tid=ACSDP5Y2020.DP05.

[128] Ibid.

[129] Ibid.

Damaged transportation infrastructure can create cascading impacts on the response to and recovery from a winter storm event. The transport of emergency resources (e.g., medical supplies, water tankers, sand trucks) to the San Antonio area may be disrupted, as well as the continuity of government and community services, including public transportation routes and movement of emergency vehicles (e.g., ambulances, fire trucks).

ENERGY INFRASTRUCTURE

High winds, snow, and ice can break or down power lines, causing service disruptions. Electrical transmission can be impacted for an extended period depending on the extent of the storm and severity of the impact. Additionally, winter storm events can slow electricity generation in the State, leading to system-wide grid issues and communication disruptions. Cold temperatures can result in excessive strain on the power grid leading to system-wide grid failures. Due to a high energy demand, electric companies can impose rolling blackouts, which are generally planned periodic outages to alleviate stress on the power grid. Power outages can impact households, medical facilities, and other critical infrastructure. Water and/or power outages to households can leave residents without sufficient heat and/or access to electricity. This can result in community members seeking alternative lodging during treacherous weather conditions, putting the community in harm's way. Power outages can shut down heat at hospitals, potentially forcing facilities to turn patients away and take drastic steps to conserve resources.

Winter Storm Uri left millions of people from Texas and hundreds of thousands of people in San Antonio without power for several days in freezing temperatures. This storm exposed critical failures of the Texas electrical grid due to:

- Deregulation of the Texas electrical grid
- Manipulation of the cost of electric power and natural gas
- Functionality of power plants
- Unequal distribution of power
- Lack of public communication

While energy systems across the country are vulnerable to the cascading impacts of winter storms, Texas's electrical grid is particularly at risk. Texas's electricity is primarily supplied through an intra-state grid, which supports the energy needs of the majority of Texas.[130] In contrast, the energy needs of the rest of the continental United States is supplied by two inter-state grids and allows regional power to be supplied to states in need. This multi-state coalition of grids allows electricity resources to be shared across state lines during emergencies, whereas Texas primarily relies on power generated within the State. Texas is unable to borrow power from neighboring states, leaving Texas communities particularly vulnerable to power

[130] Texas Comptroller. "Texas' Electricity Resources: Where Power Comes From – And How it Gets to You." *Fiscal Notes*. https://comptroller.texas.gov/economy/fiscal-notes/2020/august/ercot.php.

outages during statewide emergencies where electricity demand is high across all communities, as seen during Winter Storm Uri.

The history of the development of the intra-state grid in Texas created unique rules for management and oversight of the Texas electrical grid. The grid is managed by the ERCOT and overseen by the Public Utility Commission of Texas.[131] Most electricity is generated through natural gas (47.4%), which is regulated by the Texas Railroad Commission.[132] As there are multiple State agencies and ERCOT responsible for these two interdependent industries, significant coordination in policymaking and oversight is required to maintain consistency in the management of the electrical grid. Any lack of coordination leaves the grid system more vulnerable to potential issues. Additionally, the Texas grid is subject to very limited federal oversight, compared to the other two energy grids in the contiguous United States. Regulation of the grid is an important step in ensuring the safety and wellbeing of the grid system, and this lack of oversight can cause issues in the continuity of electricity delivery to residents. The lack of regulation also resulted in a unique electrical system where 60% of customers choose from a pool of competitive generation companies.[133] This can dramatically increase the price of electricity during a winter storm event and result in limited resilience measures such as reserve capacity or interconnections to the grid supplying the rest of the country.

WATER INFRASTRUCTURE

Water infrastructure may be directly damaged during winter storms. During periods of extreme cold and freezing temperatures, water pipes can freeze and crack. Additionally, cascading impacts of winter storms may impact the water systems, including service disruptions and outages that require time to repair and last far past the extent of the storm. Limitations in water service delivery can again result in community members seeking alternative lodging during treacherous weather conditions, putting the community in harm's way. Additionally, water outages at critical facilities (e.g., hospitals) may impact how they deliver services.

ECONOMY

The City's economy is driven by historic and cultural resources that draw tourists and visitors to the area and generate revenue through taxes and fees. Based on the extent of a winter storm, San Antonio's local economy may be impacted. Increased consumption and limited production of resources may result in higher prices and limited availability for products. Ice

---

[131] Cai, Mandy; Erin Douglas; and Mitchell Ferman. "How Texas' power grid failed in 2021 – and who's responsible for preventing a repeat." *Texas Tribune*. https://www.texastribune.org/2022/02/15/texas-power-grid-winter-storm-2021/.

[132] Texas Comptroller. "Texas' Electricity Resources: Where Power Comes From – And How it Gets to You." *Fiscal Notes*. https://comptroller.texas.gov/economy/fiscal-notes/2020/august/ercot.php.

[133] Cai, Mandy; Erin Douglas; and Mitchell Ferman. "How Texas' power grid failed in 2021 – and who's responsible for preventing a repeat." *Texas Tribune*. https://www.texastribune.org/2022/02/15/texas-power-grid-winter-storm-2021/.

and snow on roadways may cause supply chain disruptions, further limiting access to resources, and may limit workers' ability to get to work, creating lost wages. Cleanup and repair costs may impact local government and the private sector. While cleanup and repair costs would likely be addressed with insurance coverage, available state and federal assistance, or operating reserves, the extent of damage can still result in significant costs.

NATURAL RESOURCES

Natural resources may be impacted by extended exposure to cold air from winter storms, including agricultural crops and plants and trees in local parks and on personal property. Fish and wildlife unaccustomed to living in colder temperatures could perish or access to food and water may be limited. Winter storm events could lead to tree, shrub, and plant damage or death.[134]

GOVERNMENT OPERATIONS

Buildings, such as facilities, government buildings, and cultural and historic resources, can incur roof or structural damage from downed trees, damage to paved areas, and broken pipes due to a winter storm event. This can result in issues related to continuity of government operations or tourism. While the City does have continuity of operations plans to support this type of response, there can be unforeseen impacts to operations.

As of June 1, 2022, the city has reported $4,988,347.08 in damage related to FEMA PA funding Category E – Buildings and Equipment Public Assistance from Winter Storm Uri.

An insufficient response to winter storm events can impact the public's confidence in its government and leaders. Perceived slow response to snow removal and winter storm-related power outages in other areas of the U.S. have become points of strident criticism in the impacted communities. In some cases, a lack of timely and realistic communication with the public was identified as a contributor to frustration and distrust that developed among the population. Perceptions of inequality in response or relief, particularly if those inequalities are based on socioeconomic status, ethnicity, age, gender, or position, can lead to increased dissatisfaction with government and leadership, and may result in a weakening of social order. If necessary, rationing of electricity needs to be conscientiously implemented to avoid the appearance of bias or impropriety.

[134] Center for Food Security & Public Health. "Winter Storms." *All Hazards: Resources to help rural communities prepare for disasters and other hazards*. https://www.prep4agthreats.org/Natural-Disasters/winter-storms.

Section 14: Lightening

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 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 FEMA, on average, 300 people are injured, and 80 people are killed in the United States each year by lightning. Direct lightning strikes also can 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 can contain and suppress the resultant fire.

LIGHTNING AND CLIMATE CHANGE

As temperature increases due to climate change, lightning will become more common. Lightning occurs more frequently when at higher temperatures due more convective instability, upward air motion, and moisture. More moisture suggests more vigorous thunderstorms, resulting in more lightning.

Location

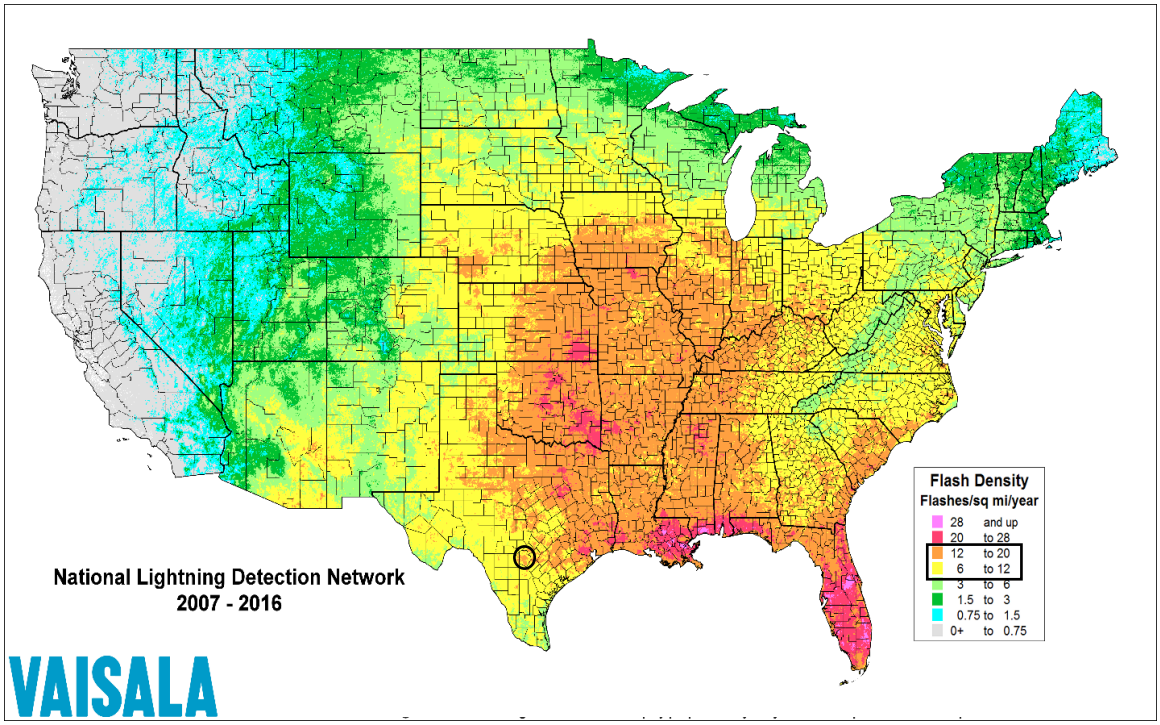
Lightning can strike in any geographic location and is considered a common occurrence in Texas. The City of San Antonio planning area is in a region of the country that is moderately susceptible to a lightning strike. Therefore, lightning could occur at any location within the entire planning area. It is assumed that the entire City of San Antonio 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 62) shows a range of six to 20 cloud-to-

ground lightning flashes per square mile per year for the entire City of San Antonio planning area. This rate equates to approximately 3,030 to 10,100 flashes per year for the planning area.

Figure 62. Lightning Flash Density, 2007-2016



The extent of 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 82).

Table 82. 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	16-25

LAL	CLOUD & STORM DEVELOPMENT	LIGHTNING STRIKES/15 MIN
	within the observation area. Moderate rain is common and lightning is frequent.	
5	Towering cumulus and thunderstorms are numerous. They cover more than three-tenths of the sky and occasionally obscure it. 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, to determine the extent of lightning strikes, the yearly average range of estimated number of lightning strikes within the planning area (3,030 to 10,100 flashes) and a cloud-to-ground flash density of six to twenty per square mile were divided by the number[135] of thunderstorm events that occur annually in the planning area. The City of San Antonio should expect an average range of two to seven 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 1 to 2 – the highest being a two on the LAL for the City of San Antonio planning area.

Lightning frequency is changing as climate is changing. Lightning strikes are predicted to increase about 12% for every 1°C of global warming. That suggests a 50 percent increase by the end of the century.

Historical Occurrences

Since January 1996, there have been three recorded lightning events for the City of San Antonio planning area. It is likely multiple lightning occurrences have gone unreported before and during the recording period. The NCEI is a national data source organized under the National Oceanic and Atmospheric Administration and considered a reliable resource for hazards. However, the flash density for the planning area along with input from local team members indicates regular lightning occurrences that have not been reported.

[135] 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.

Table 83. Historical Lightning Events, 1996- 2020

JURISDICTION	DATE	INJURIES	FATALITIES	PROPERTY DAMAGE	CROP DAMAGE
City of San Antonio	5/27/1999	1	1	$0	$0
City of San Antonio	5/12/2001	4	0	$0	$0
City of San Antonio	8/18/2012	0	0	$56,234	$0
TOTALS		**5**	**1**	**$56,234**	**$0**

Based on the list of historical lightning events for the City of San Antonio planning area (listed above), none of the reported events occurred since the previous HMAP update. However, the flash density for the planning area, along with input from local team members, indicates regular lightning occurrences that simply have not been reported.

SIGNIFICANT EVENTS

August 18, 2012 – City of San Antonio

A weak cold front moved through South Central Texas and produced widespread thunderstorms. Some of these storms produced damaging wind gusts and heavy rain that led to flash flooding. A thunderstorm produced a lightning strike that started a house fire in San Antonio.

PROBABILITY OF FUTURE EVENTS

Based on historical records and input from the planning team, the probability of occurrence for future lightning events in the City of San Antonio planning area is considered highly likely, or an event probable in the next year. The planning team stated that lightning occurs regularly in the area. According to NOAA, the City of San Antonio planning area is in an area of the country that experiences six to 20 lightning flashes per square mile per year (approximately 3,030 to 10,100 flashes per year). Given this estimated probability of events, 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 and facilities in the City of San Antonio planning area could potentially be impacted and remain vulnerable

to possible injury and property loss from lightning strikes. The City of San Antonio planning area has only three reported lightning events per the NCEI; however, the entire planning area is vulnerable and could be impacted by lightning.

The direct and indirect losses associated with these events include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources. The entire population of the City of San Antonio is considered exposed to the lightning hazard. 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. Individuals located outdoors are considered at risk and more vulnerable to a lightning strike compared to those 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 City of San Antonio planning area are considered exposed to the lightning hazard. Lightning can damage buildings, cause electrical, forest, and/or wildfires, and impair infrastructure such as power transmission lines and communication towers. Agricultural losses can be extensive due to lightning and resulting fires.

The following critical facilities would be vulnerable to lightning events in each participating jurisdiction:

Table 84. City of San Antonio Critical Facilities at Risk

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	102
Banking and Finance	382
Chemical and Hazardous Materials Industry	638
Defense Industrial Base	N/A
Energy	90
Emergency Services	197
Information Technology	N/A
Communications	101
Postal and Shipping	4
Healthcare and Public Health	1,047
Transportation	22
Water	275

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
National Monuments and Icons	8
Commercial Facilities	2,272
Government Facilities	527
Dams	34
Nuclear Reactors, Materials, and Waste	74
Manufacturing	1

The impact of lightning events experienced in the City of San Antonio planning area is considered "Limited," meaning shutdown of critical facilities and services for 24 hours or less and less than 10 percent of property destroyed or with major damage. However, historical events include five injuries and one fatality, indicating a "substantial" impact is possible. Overall, the average loss estimate of property and crops (in 2020 dollars) is $56,234, having an approximate annual loss estimate of $2,343.

Table 85. Potential Annualized Losses by Jurisdiction[136]

JURISDICTION	PROPERTY & CROP LOSS	ANNUAL LOSS ESTIMATE
City of San Antonio	$56,234	$2,343

ASSESSMENT OF IMPACTS

Lightning events can pose a significant risk to people and create dangerous and demanding situations for public health and safety officials. 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. Lightning strikes can be associated with structure fires and wildfires, creating additional risk to residents and first responders.

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 life safety, such as those on life support systems, if generators are not available. Also, 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.

Lack of electricity, or interruptions in the delivery of electricity, can pose risks to service delivery and operations for agencies and departments that are unprepared for electricity interruptions

[136] Damage values are in 2020 dollars.

and may not own emergency power generators. The San Antonio/Bexar County Emergency Operations Center (EOC) has full emergency generator backup; other City departments may not be as well-equipped as the EOC and may suffer more interruptions due to loss of power. If files (hard copy or electronic) are damaged, destroyed, or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. This interruption could have significant impacts throughout the City and could negatively impact its ability to respond to and recover from a lightning strike. Without a Continuity of Operations (COOP) Plan that takes these issues into account and considers how best to work around them, and without regular exercise of that COOP, departments may not be able to function and provide necessary services.

Private sector entities on which local government and its residents rely, such as utility providers, financial institutions, and medical care providers, should have specific plans that are routinely exercised. For example, if a loss of power occurs at medical centers, there could be dire consequences to patients and patient care if no emergency power is available. It is imperative that both public and private entities plan for these events and address how they will function and provide services until normal operating conditions can be resumed.

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 San Antonio area is home to many cultural and historic resources. These cultural and historic resources are largely immune to the effects of lightning. Historic and culturally significant structures could experience the same potential impacts as other property.

The City's historic and cultural resources are a significant draw for tourists and visitors to the area and generate revenue through taxes and fees. This revenue pays for services and programs that benefit residents and the community. Should an interruption in tourism occur because of a power outage due to lightning, it is likely to be short-lived and have a temporary impact on historic and cultural resources that depend on tourism for support.

The economic and financial impacts of power outages and fires on the City of San Antonio will depend 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 businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of a lightning event. Cleanup and repair costs would impact local government and the private sector. However, cleanup and repair costs would likely be addressed with insurance coverage, available state and federal assistance, operating reserves, or all of the above.

Section 15: Expansive Soils

Hazard Description

Expansive soils are soils and soft rocks with a relatively high percentage of clay minerals that are subject to changes in volume as they swell and shrink with changing moisture conditions. Drought conditions can cause soils to contract in response to a loss of soil moisture.

Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When these clays absorb water, they increase in volume and expand. Expansions in soil of ten percent or more are common in the City of San Antonio planning area. The change in soil volume and resulting expansion can exert enough force on a building or other structure to cause damage.

Expansive soils will also lose volume and shrink when they dry. A reduction in soil volume can affect the support to buildings or other structures and result in damaging soil subsidence. Fissures in the soil can also develop and facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures.

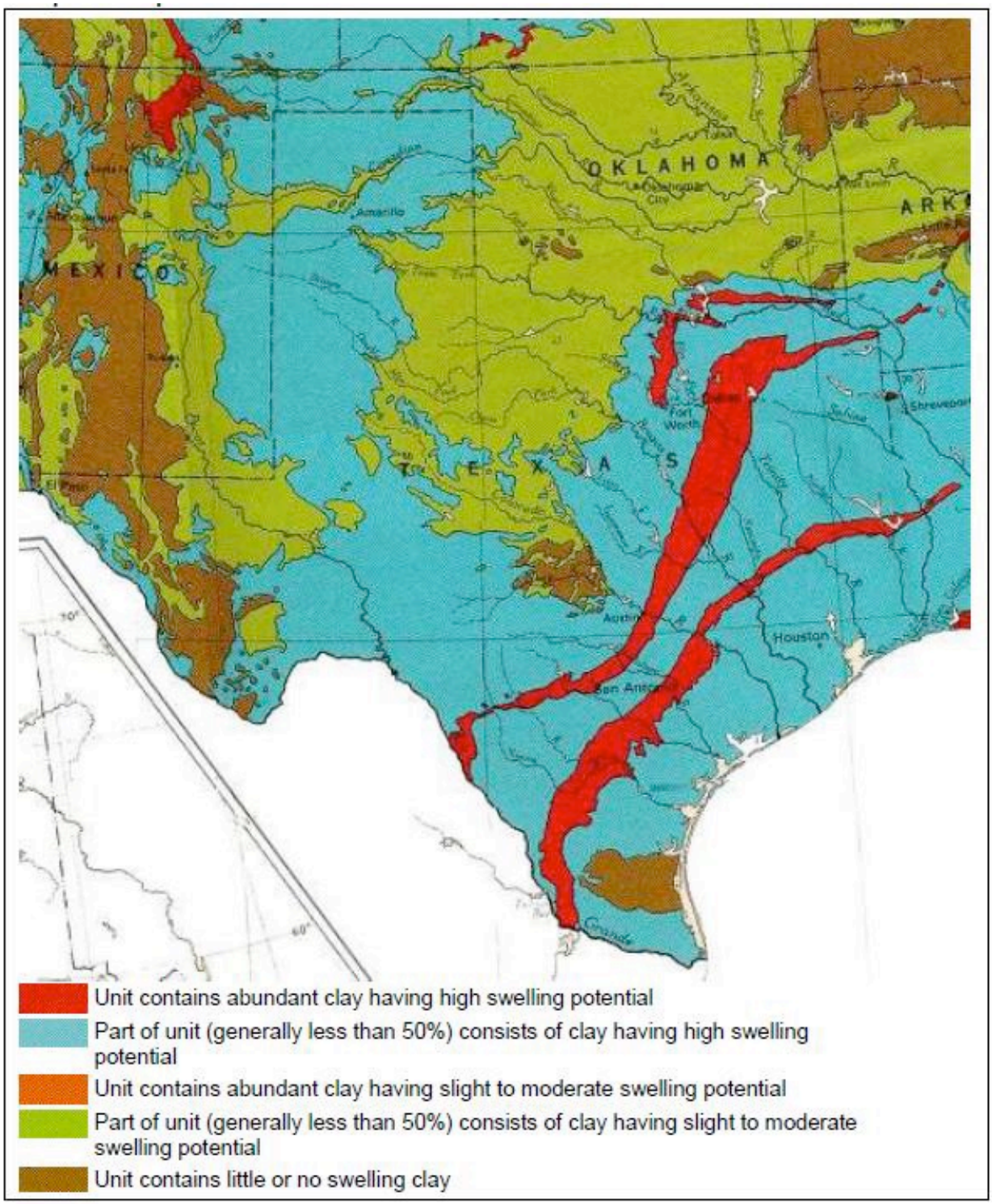
EXPANSIVE SOILS AND CLIMATE CHANGE

Increased heavy precipitation events are expected in Texas due to climate change. Additionally, temperatures are expected to increase throughout Texas. Expansive soils are therefore expected to go through the absorption/drying cycle more frequently due to climate change, causing increased property and infrastructure damage.

Location

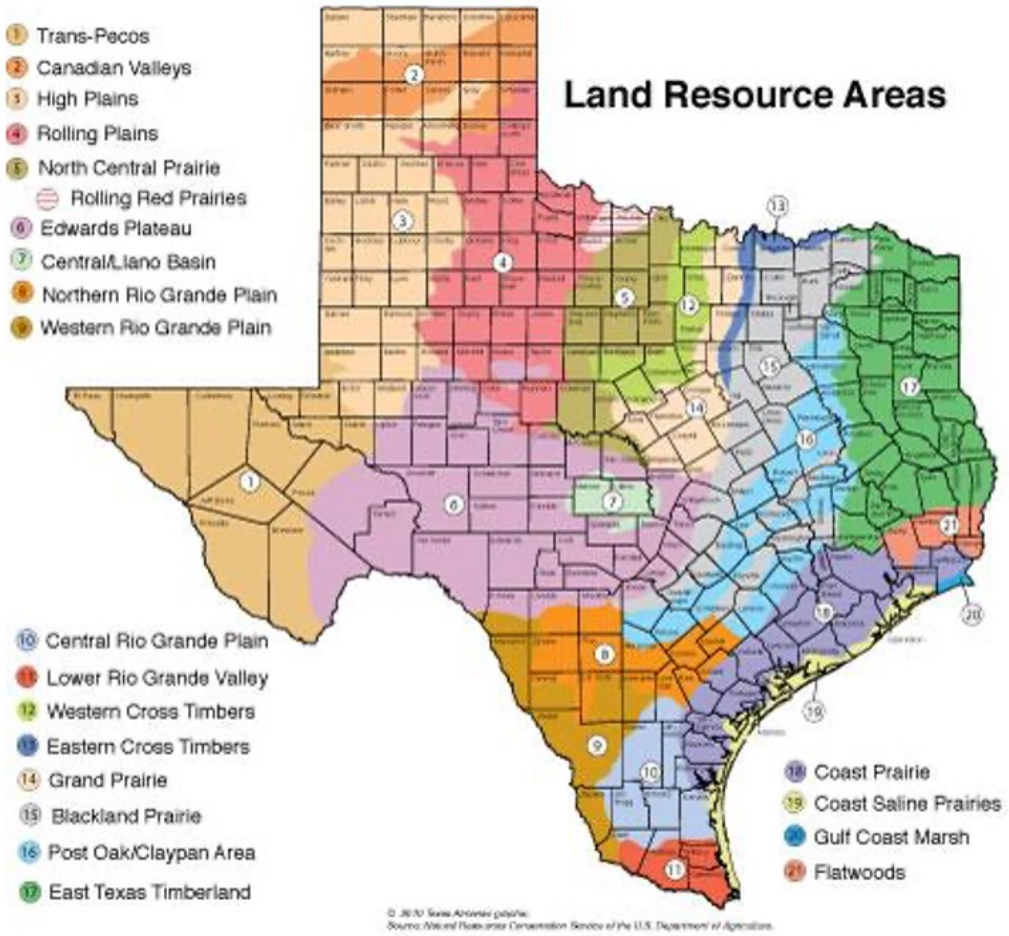
The City of San Antonio planning area may be affected by the band of expansive soils stretching from northeast Dallas, southwest through the City towards Laredo, and along an area known as the I-35 corridor. Figure 63 depicts expansive soils across the State of Texas and the City of San Antonio planning area is identified within the yellow circle. These areas receive the most moisture and are also vulnerable to droughts, which can cause the soils to expand and contract. Figure 64 depicts the types of land resources in the State of Texas due to their soil types.

Figure 63. Texas Geological Survey[137]



[137] Source: United States Geological Survey, http://www.usgs.gov

Figure 64. Texas Geological Survey



The City of San Antonio is located within the Edwards Plateau, Blackland Prairie, and Post Oak/Claypan areas identified within the black circle in Figure 64. The entire planning area is in a locale affected by expansive soils.

Edwards Plateau: The 22.7 million acres of the Edwards Plateau are in South Central Texas east of the Trans-Pecos and west of the Blackland Prairie. Uplands are nearly level to undulating, except near large stream valleys, where the landscape is hilly with deep canyons and steep slopes. There are many cedar brakes in this area and surface drainage is rapid.

Upland soils are mostly shallow, stony, or gravelly and consist of dark alkaline clays and clay loams underlain by limestone. Lighter-colored soils are on steep side slopes and deep, less-stony soils are in the valleys. Bottomland soils are mostly deep, dark gray or brown, with alkaline loams and clays.

Raising beef cattle is the main enterprise in this region, but it is also the center of Texas' and the nation's mohair and wool production. The area provides a major deer habitat, and hunting

leases produce income. Cropland is mostly in the valleys on the deeper soils and is used mainly for growing forage crops and hay. The major soil management concerns are brush control, large stones, low fertility, excess lime, and limited soil moisture.

Blackland Prairie: The Blackland Prairie consists of about 12.6 million acres of east-central Texas extending southwesterly from the Red River to Bexar County. There are smaller areas to the southeast. The landscape is undulating with few scattered wooded areas that are mostly in the bottomlands. Surface drainage is moderate to rapid.

Both upland and bottomland soils are deep, dark gray to black, and consist of alkaline clays. Some soils in the western part are shallow to moderately deep over chalk. Soils on the eastern edge are typically neutral to slightly acidic grayish clays and loams over mottled clay subsoils (sometimes called graylands). Blackland soils are known as "cracking clays" because of their high shrink-swell property and large, deep cracks that form in dry weather. The high shrink-swell property can cause serious damage to foundations, highways, and other structures, and is a safety hazard in pits and trenches.

Land use is almost equally cropland and grassland. Cotton, grain sorghums, corn, wheat, oats, and hay are grown in this area. Grassland is mostly improved pastures, with native range on the shallower and steeper soils. Water erosion, cotton root rot, soil tilth, and brush control are the major management problems.

Post Oak/Claypan Area: The Claypan Area consists of about 6.1 million acres in east-central Texas just east of the Blackland Prairie. The landscape is a gently undulating to rolling, moderately dissected woodland also known as the Post Oak Belt or Post Oak Savannah. Surface drainage is moderate.

Upland soils commonly have a thin, light-colored, acid sandy loam surface layer over dense, mottled red, yellow, and gray claypan subsoils. Some deep, sandy soils with less clayey subsoils exist. Bottomlands are deep, highly fertile reddish-brown to dark gray loamy to clayey soils.

Land use is mainly rangeland. Some areas are in improved pastures. Most cropland is in bottomlands that are protected from flooding. Major crops are cotton, grain sorghums, corn, hay, and forage crops, most of which are irrigated. Brush control on rangeland and irrigation water management on cropland are the major soil management problems. Water erosion is a serious problem on the highly erosive claypan soils, especially where they are overgrazed.

Extent

The extent to which soil expansion is present in an area can be determined using the predominant soil composition and associated permeability. The soil survey was developed by the USDA Soils Conservation Service and contains information that can be applied in

determining the suitability of soils in the planning area when selecting sites for roads, structures, and infrastructure. Figure 65 shows the predominant soil types throughout the State of Texas and the planning area.

Figure 65. USDA General Soil Map of Texas

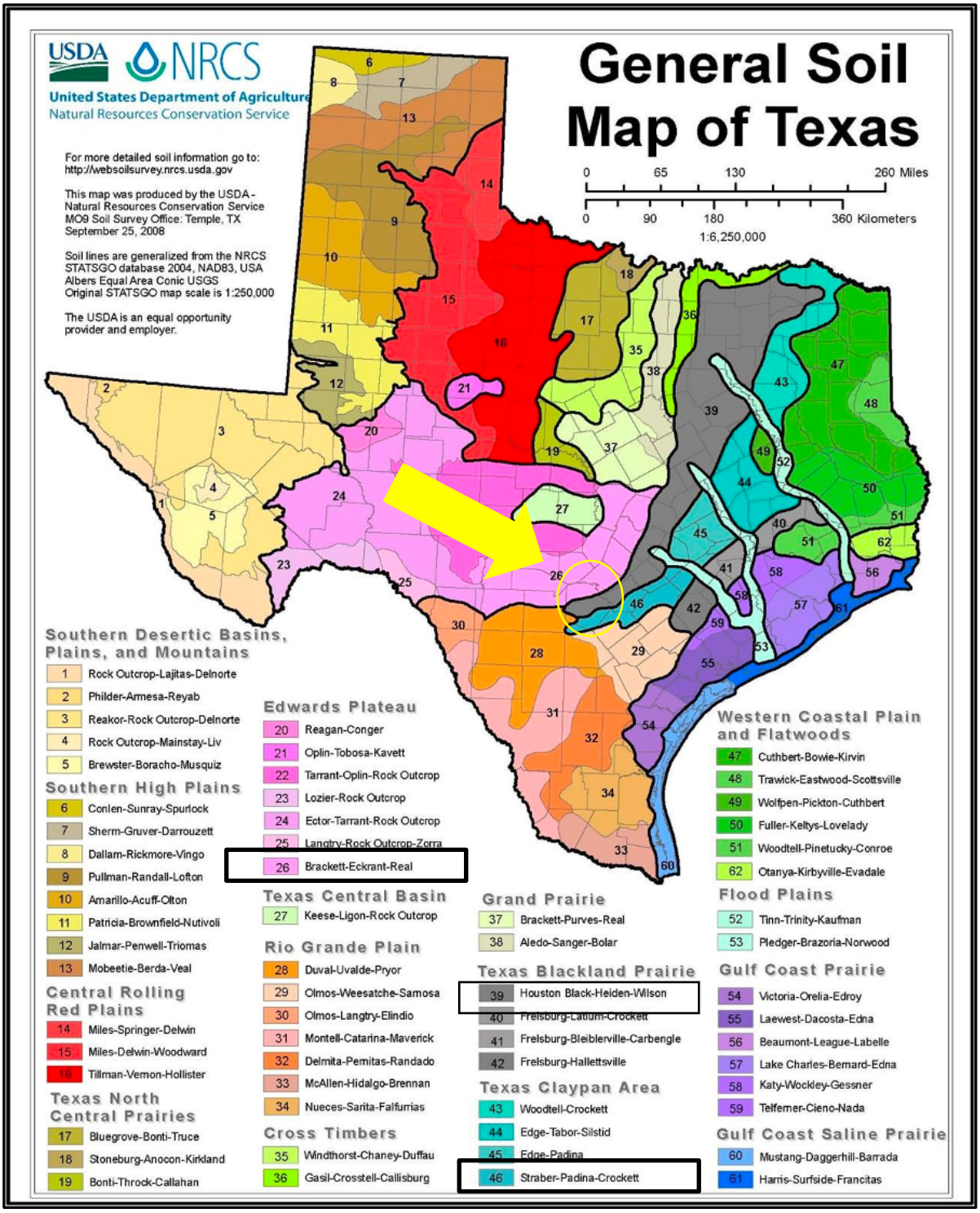


Table 86 includes the plasticity index value ranges and soil properties while Table 87 includes additional descriptions of the soil types predominant throughout the planning area with the assigned plasticity index per soil type by area as identified in Figure 65. The predominant soil types for each area can vary greatly from one plat to the next.

The Plasticity Index is provided for each type of soil within the planning area. The plasticity index ranges are provided on a countywide basis for each predominant soil type. The plasticity index for each soil type as well as the descriptions provided in the tables below represent a summary of the data provided in the USDA Soil Survey of Bexar County.

Table 86. Swelling Potential of Soils and Plasticity Index

POTENTIAL EXPANSION	EXPANSION INDEX
Low	0 – 15
Medium	10 – 35
High	20 – 55
Very High	35 and above

Table 87. Bexar County Soil Description by Area and Plasticity Index of Soils

AREA	SOILS	DESCRIPTION	PLASTICITY INDEX	POTENTIAL EXPANSION/EXTENT LEVEL
26	Brackett-Eckrant-Real	Brackett series soil consists of shallow to paralithic bedrock, well drained soils formed in residuum weathered from limestone of Cretaceous age, mainly from the Glen Rose formation. These nearly level to very steep soils are located on backslopes of ridges on dissected plateaus of the Edwards Plateau. This predominant soil type is typically suitable for rangeland. Eckrant series soil consists of well drained, moderately slowly permeable soils that are very shallow to shallow over indurated limestone bedrock. These nearly level to very steep soils formed in residuum derived from limestone and occur on summits, shoulders, and backslopes of ridges on dissected plateaus. This predominant soil type is typically suitable for rangeland and wildlife habitat. Real series soil consists of soils that are very shallow or shallow to paralithic limestone bedrock interbedded with marl and chalk. These well drained soils formed in residuum derived from limestone of Cretaceous age. These nearly level to steep soils are on summits, shoulders, and backslopes of ridges on dissected plateaus. This predominant soil type is typically suitable for rangeland.	9-26; 25-45; 8-15	Low, Medium, High, Very High

AREA	SOILS	DESCRIPTION	PLASTICITY INDEX	POTENTIAL EXPANSION/EXTENT LEVEL
39	Houston-Black-Heiden-Wilson	Houston Black series soil consists of very deep, moderately well drained, very slowly permeable soil. These nearly level to moderately sloping soils occur on interfluves and side slopes on upland. This predominant soil type is typically suitable for crops. Heiden series soil consists of deep and very deep to mudstone, well drained, very slowly permeable soils. These nearly level to moderately steep soils occur on foot slopes of base slopes, shoulders of interfluves, and backslopes of side slopes of ridges on dissected plains. This predominant soil type is typically suitable for livestock grazing and hay production. Wilson series soil consists of very deep, moderately well drained, very slowly permeable soils. These nearly level to gently sloping soils are on treads of Pleistocene stream terraces. This predominant soil type is typically suitable for crops.	11-20; 25-37; 24-40	Low, Medium, High, Very High

AREA	SOILS	DESCRIPTION	PLASTICITY INDEX	POTENTIAL EXPANSION/EXTENT LEVEL
46	Straber-Padina-Crockett	Straber series soil consists of very deep, moderately well drained, very slowly permeable soils that formed in calcareous loamy and clayey residuum derived from mudstone of the Willis Formation. These nearly level to moderately sloping soils are on broad ridges on inland dissected coastal plains. This predominant soil type is typically suitable for rangeland. Padina series soil consists of very deep, well drained, moderately permeable soils that formed in sandy residuum derived from sandstone. These nearly level to moderately steep sloping soils are on broad ridges on inland dissected coastal plains. This predominant soil type is typically suitable for grazing. Crockett series soil consists of soils that are deep to weathered shale of Cretaceous age. They are moderately well drained, and very slowly permeable. These soils are on broad ridges on the dissected plains. These nearly level to moderately sloping soils formed in alkaline residuum derived from interbedded shale and clay. This predominant soil type is typically suitable for various crops.	13-22; 25-45; 31-54	Low, Medium, High, Very High

High plasticity soils are prone to shrink and swell as soil moisture changes, which can degrade pavement, causing longitudinal cracking and edge drop-off. This effect can damage foundations of buildings and homes. The City of San Antonio planning area is subject to a range of plasticity Index levels including low, medium, high, and very high, as indicated by the soils in Figure 65, and Tables 15-1 and 15-2 above. Plasticity of soils is highly subject to location and soil moisture content in any given time frame and location. Due to the broad plasticity index range throughout the City of San Antonio planning area, the worst the entire planning area may anticipate is very high swelling potential.

Expansive soils are expected to go through the absorption/drying cycle more frequently due to the impacts of climate change.

Historical Occurrences

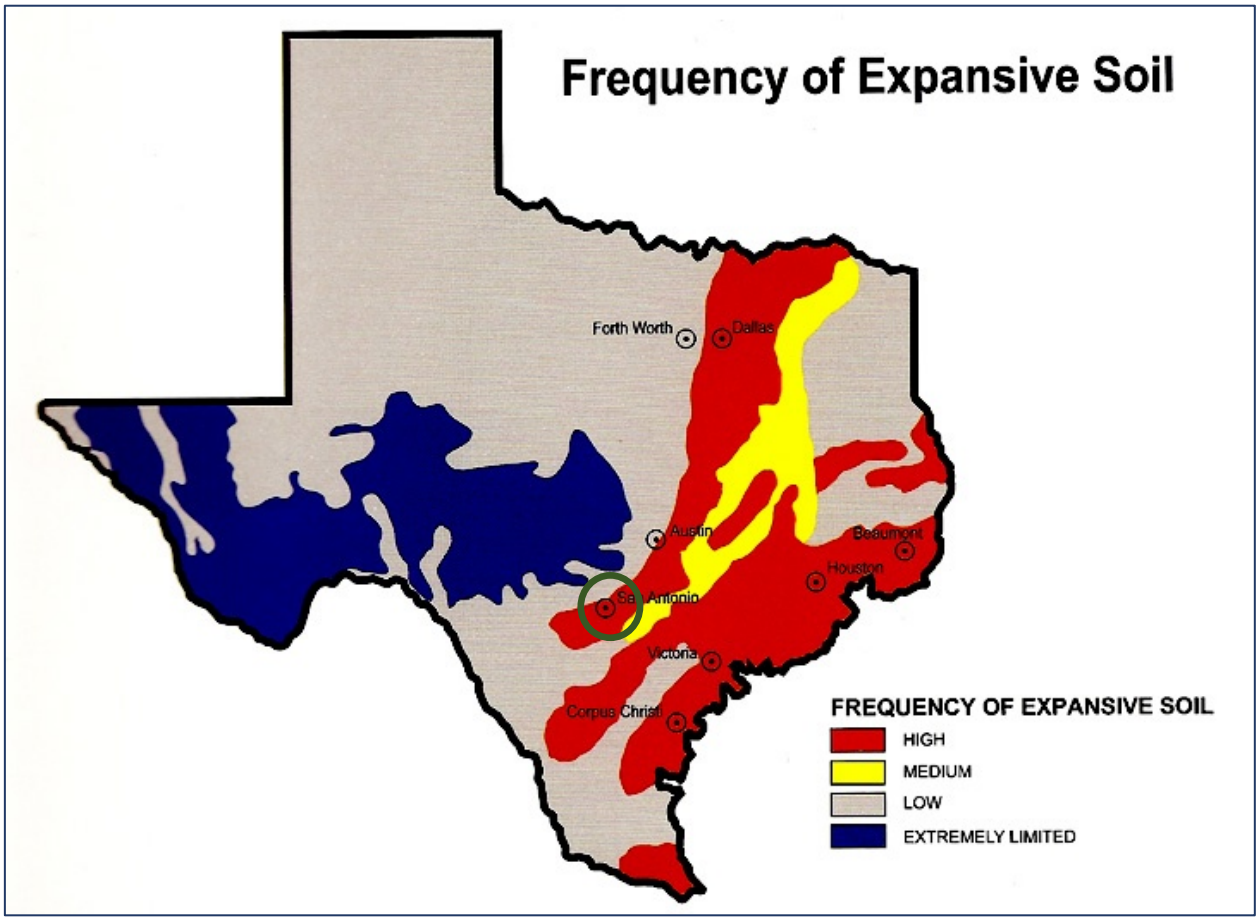
Expansive soils are a condition that is native to Texas soil characteristics and cannot be documented as a time-specific event, except when it leads to structural and infrastructure damage. Extreme conditions can damage roads, structures, and infrastructure, including projects still under construction. Damages from expansive soils are typically associated with droughts. There is currently no historical data available for expansive soil damages in the City of San Antonio. The limited data for historical expansive soil incidents is noted as a data deficiency for this planning cycle. An action has been created to enhance data collection for expansive soil incidents in future plan updates.

Probability of Future Events

Since no other records of specific incidences of loss associated with expansive soils were found, and no specific occurrences of expansive soils were identified within the planning area, the probability of future events cannot be determined at this time. However, according to public opinion, the probability of future events of loss due to expansive soils within the planning area is highly likely, especially when periods of drought increase throughout the planning area.

Figure 66 displays the frequency of expansive soil occurrences for the entire state. The City of San Antonio planning area is shown in the green circle and is subject to a "High" frequency of expansive soils. Section 5 of the plan provides in-depth analysis of drought in the planning area. Damages from expansive soils are typically associated with droughts. Historical drought records support a highly likely probability of future events. Assuming a correlation between drought and expansive soils, the planning area can anticipate a similar frequency for expansive soil events.

Figure 66. Frequency of Expansive Soil



Vulnerability and Impact

The effects of expansive soils are most prevalent when periods of moderate to high precipitation are followed by drought and then again by periods of rainfall. Other cases of damage result from increases in moisture volume from such sources as broken or leaking water and sewer lines. Dry clays are capable of absorbing water and will increase in volume in an amount proportional to the amount of water absorbed. Soils capable of changes in volume present a hazard to structures built over them and to the pipelines buried in them. Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling clays than multi-story buildings, which are usually heavy enough to counter swelling pressures. However, if constructed on wet clay, multi-story buildings may also be damaged by clay shrinkage when moisture levels are substantially reduced.

Cracked foundations and floors, jammed windows and doors, and ruptured pipelines are typical types of damage resulting from swelling soils. Damage to the upper floors of larger buildings can occur when motion in the structure is significant. All infrastructure within the planning area is susceptible to this phenomenon.

The following critical facilities would be vulnerable to expansive soil events in the planning area:

Table 88. City of San Antonio Critical Facilities at Risk

DHS INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	102
Banking and Finance	382
Chemical and Hazardous Materials Industry	638
Defense Industrial Base	N/A
Energy	90
Emergency Services	197
Information Technology	N/A
Communications	101
Postal and Shipping	4
Healthcare and Public Health	1,047
Transportation	22
Water	275
National Monuments and Icons	8
Commercial Facilities	2,272
Government Facilities	527
Dams	34
Nuclear Reactors, Materials, and Waste	74
Manufacturing	1

The impact of expansive soils ranges from cosmetic cracks in walls to substantial foundation and structural damage that can require building demolition. Infrastructure such as pipelines can be damaged, causing increased maintenance and repairs, replacement, or damage to the point of failure. Sewer and water lines are also affected by shrink and swell soils. The movement

of the soils can snap water and sewer lines, producing a minimum of temporary discomfort, and a maximum of a serious health and welfare risk.

Homeowners and public agencies that assume they cannot afford preventative measures such as more costly foundations and floor systems, often incur the largest percentage of damage and costly repairs from expanding soil. No figures are available for the total damage to homes in the planning area from expansive clays. However, several examples are known where the cost of repairs has exceeded the value of homes. Additionally, in some areas of San Antonio, streets and highways have required expensive reconstruction or maintenance due to damage from expansive clay.

For the City of San Antonio, the most extensive damage from expansive soils can occur to bridges, highways, streets, and parking lots. The greatest damage occurs when structures are constructed when clays are dry (such as during a drought) and then subsequent soaking rains swell the clay.

Section 16: Terrorism

Hazard Description

As defined in the Homeland Security Act of 2002, terrorism is activity that involves an act that is dangerous to human life or potentially destructive of critical infrastructure or key resources; is a violation of the criminal laws of the United States or of any state or other subdivision of the United States; and appears to be intended to intimidate or coerce a civilian population to influence the policy of a government by intimidation or coercion, or to affect the conduct of a government by mass destruction, assassination, or kidnapping.[138]

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States as domestic terrorism or international terrorism. Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. International terrorism involves groups or individuals whose terrorist activities are foreign-based and directed by countries or groups outside the United States or whose activities transcend their national boundaries.

A terrorist attack event can take several forms depending on the technological means available to the terrorist, nature of the issue motivating the attack, and points of weakness of the terrorist's target.

A terrorist using a chemical or biological weapon is of particular concern to officials. Special training and equipment are necessary to safely manage a Weapons of Mass Destruction (WMD) incident.

Biological agents are infectious microbes or toxins used to produce illness or death in people, animals, or plants. Biological agents can be dispersed as aerosols or airborne particles. Terrorists may use biological agents to contaminate food or water, which is difficult to detect.

Chemical agents can kill or incapacitate people, destroy livestock, or ravage crops. Some chemical agents are odorless and tasteless and are therefore difficult to detect. Chemical agents can have an immediate effect within a few seconds to a few minutes, or a delayed effect within several hours to several days.

[138] FEMA Glossary. https://training.fema.gov/programs/emischool/el361toolkit/glossary.htm#T

The U. S. Department of Defense estimates that 26 nations may possess chemical agents and weapons, and an additional 12 may be seeking to develop them. The Central Intelligence Agency reports that at least ten countries are believed to be in possession or conducting research on biological agents for weaponization.

Terrorist events involve the application of one or more modes of harmful force to the built environment. These modes include contamination, such as chemical, biological radiological, or nuclear hazards; energy, such as explosives, arson, and even electromagnetic waves; or denial of service, such as sabotage, infrastructure breakdown, and transportation service disruption.

Most recently, mass attacks pose a persistent and varied threat. Racially motivated attacks are currently the most violently active type of domestic terrorism within the United States and Texas. In 2018 and 2019, at least four major attacks occurred in the United States (including one in Texas) conducted by racially motivated actors, and at least four other incidents were thwarted. This activity outnumbered other types of domestic terrorism.[139]

In the last two decades, the international terrorism threat to the United States and Texas has increasingly shifted away from sophisticated, externally directed, or enabled foreign terrorist organization (FTO) plots and attacks toward self-initiated plots and mass attacks conducted by lone actor homegrown violent extremists (HVEs). HVEs represent the greatest international terrorism mass attack threat due primarily to their ability to remain undetected by law enforcement until operational, and their general preference to attack soft targets with simple, readily accessible weapons. Preferred weapons include small arms, edged weapons, vehicles, and rudimentary IEDs.[140] Law enforcement faces significant challenges in identifying and disrupting HVEs due, in part, to their limited connection with an FTO, ability to rapidly mobilize, and use of encrypted communications. The heavy use of social media by FTOs provides would-be HVEs with ample sources of readily accessible propaganda to inspire radicalization and operational planning.

TERRORISM AND CLIMATE CHANGE

Climate change has a multiplier effect and is an aggravating factor for instability, conflict, and climate change has a multiplier effect and is an aggravating factor for instability, conflict, and terrorism. Drought, flood, and other extreme weather conditions can put people in desperate situations, creating conditions in which terrorism can grow. Studies have shown that extreme

---

[139] Assessing the Threat of Mass Attacks in Texas: A State Intelligence Estimate. Texas Fusion Center and the Texas Department of Public Safety – Intelligence and Counterterrorism Division. January 2020.

[140] Department of Justice, 23 July 2019, Statement of Christopher Wray, Director, Federal Bureau of Investigation, Before the Committee on the Judiciary, United States Senate, at a Hearing Entitled "Oversight of the Federal Bureau of Investigation", https://www.judiciary.senate.gov/imo/media/doc/Wray%20Testimony1.pdf

weather often worsens social tensions, poverty, and hunger, which makes those populations vulnerable to recruitment by terrorist groups.

Location

There is no distinct geographic boundary to the threat of terrorism. An event is possible throughout the City of San Antonio planning area.

Terrorists most often search for highly visible targets that can be impacted while avoiding detection. However, the motivation behind a terrorist event can be varied, and the target's surrounding area is considered at risk.

Attacks can occur on soft targets, including schools, religious institutions, commercial facilities, and other locations where there are mass gatherings of people with little or no security. However, more secure structures, such as government, military, and law enforcement facilities, are also possible targets for future attacks.[141]

Extent

The Department of Homeland Security created the National Terrorism Advisory System, or NTAS, to replace the color-coded Homeland Security Advisory System (HSAS) in 2011. This new system will more effectively communicate information about terrorist threats by providing timely, detailed information to the public, government agencies, first responders, airports and other transportation hubs, and the private sector. It recognizes that Americans all share responsibility for the nation's security and should always be aware of the heightened risk of terrorist attack in the United States and what they should do.[142] The new system includes two types of advisories: bulletins and alerts.

Bulletins communicate current developments or general trends regarding threats of terrorism. NTAS bulletins permit the communication of critical terrorism information that, while not necessarily indicative of a specific threat against the United States, can reach homeland security partners or the public quickly, thereby allowing recipients to implement necessary protective measures.

When there is specific, credible information about a terrorist threat against the United States, DHS will share an NTAS Alert. The alert may include specific information about the nature of the threat, including the geographic region, mode of transportation, or critical infrastructure

[141] Intelligence and Counterterrorism Division, January 2020, Assessing the Threat of Mass Attacks in Texas: A State Intelligence Estimate. Texas Fusion Center and the Texas Department of Public Safety

[142] DHS website. https://www.dhs.gov/national-terrorism-advisory-system

potentially affected by the threat, as well as steps that individuals and communities can take to protect themselves and help prevent, mitigate, or respond to the threat.

The two forms of alerts are:

- Imminent Threat Alert: Warns of a credible, specific, and impending terrorist threat against the United States.
- Elevated Threat Alert: Warns of a credible terrorist threat against the United States.

The Red Cross also issues Advisory System Recommendations for individuals, families, neighborhoods, schools, and businesses for each alert level. These may be found at: www.redcross.org.

Historical Occurrences

Suspected terror plots have been thwarted in the City of San Antonio in past years. The Southwest Texas Fusion Center and Intelligence Office has reported 483 potential terrorist threats to state and federal agencies since 2006.[143]

There have been a variety of domestic terrorist attacks in the State of Texas in recent years. The following domestic terrorist attacks have been committed since 2012:

- July 7, 2016, an individual opened fire on a group of police officers in Dallas, Texas, killing five officers and wounding others, including two civilians.
- November 5, 2017, a lone-shooter attack was made on the First Baptist Church in Sutherland Springs, Texas, killing 26 people and wounding 21 others.
- May 18, 2018, an individual conducted a mass shooting at a school in Santa Fe, Texas. Ten people were killed, including eight students, and 13 others were wounded before the perpetrator surrendered to law enforcement on scene. Law enforcement found IEDs at the scene.
- August 3, 2019, an armed assailant opened fire in an El Paso, Texas Walmart, killing 22 people and injuring 26 others in a racially motivated attack.
- August 31, 2019, an individual killed seven people and injured 24 others in a mass shooting incident in Odessa, Texas.
- October 27, 2019, an assailant attacked an off-campus Texas A&M University-Commerce homecoming party at a commercial facility in Greenville, Texas, killing two people and injuring 12 others.
- December 29, 2019, a gunman opened fire with a shotgun during services at a church in White Settlement, Texas, killing two congregants and injuring at least two others.

[143] Source: San Antonio Office Emergency Management's Threat Hazard Identification and Risk Assessment, 2014

Probability of Future Events

The type, frequency, and location of many natural hazards are identifiable and somewhat predictable because natural hazards are governed by the laws of physics and nature. However, malevolence cannot be forecast with any accuracy. Therefore, there is potential for intentional terrorist acts to occur anywhere and at any time. According to the historical incident data, a terrorism incident for the City of San Antonio is unlikely, with an event occurring on average once every ten years.

Climate change is anticipated to increase political violence and instability around the world, potentially resulting in an increase in terrorism. Climate change will increase recruiting opportunities and expose weaknesses in state institutions that will make existing and future terrorist organizations more capable and/or more likely to emerge. A state institution's inadequate response to an extreme weather event can put communities in dire situations. Food and livelihood security have been central components of military recruitment for centuries. For this reason, food insecurity and reduced agricultural livelihoods can be a motivating factor for violent extremism.

Vulnerability and Impact

There is no defined geographic boundary for a terrorist event. All of the population, buildings, critical facilities, infrastructure and lifelines, and hazardous materials facilities are considered exposed to the hazards of terrorism and could potentially be affected.

There are no past local terrorist events. Therefore, all assets and facilities are potentially at risk to damages that may for the most part be secondary.

Terrorist events can have a "Major" severity of impact. They can cause injuries, illnesses, or both, and result in permanent disability, complete shutdown of City area facilities for at least two weeks, and cause more than 25 percent of affected properties to be destroyed or suffer major damage.

ASSESSMENT OF IMPACTS

Terrorism poses a potentially significant risk to public health and safety. Persons in the area at the time of a terrorist attack are at risk for injury or death from a variety of threats.

The chance for death, injury, and financial loss increases as population density increases. Therefore, locations in San Antonio planning area with high population density should be considered most at risk.

Response personnel face potential impacts similar to the general public. Response personnel can be at increased risk of physical injury because the nature of their responsibilities may bring them closer to the hazard and secondary incendiary devices are often directed at response personnel. Response personnel can be subjected to more long-term impacts resulting from prolonged exposure to chemicals or biological weapons.

Depending on the characteristics and location of the event, it is possible that operations and service delivery could be impacted by a terrorist attack. While the San Antonio Office of Emergency Management (SAOEM) has a protected facility from which to operate, the facility may not be accessible in the event of a terrorist attack near the facility. If the SAOEM office is inaccessible, staff members would be limited to performing work with the resources that are accessible to them from their remote location.

Other City departments may not be as protected as the SAOEM and may suffer more interruptions as a result of damages from a terrorist attack. If hard or electronic files are damaged, destroyed or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. This interruption could have significant impacts throughout the City and could negatively impact its ability to respond to and recover from the terrorist event. Without a Continuity of Operations (COOP) Plan that considers department-specific issues, or regular exercise of that COOP, critical departments may not be able to function and provide necessary services.

Damage from a terrorist event can impact utility infrastructure, either directly or indirectly. This could result in a temporary loss of function for businesses in the planning area that rely on utilities for operation, even if those businesses were not directly impacted by the terrorist event. Additionally, businesses can suffer interruption from closed or blocked roadways; for example, firefighters and law enforcement personnel may need to close a roadway during response and investigative operations. This could negatively impact other businesses in the area that were not otherwise damaged.

Most property, facilities, and infrastructure within the planning area are at risk from damage or destruction from a terrorism event, including residential and commercial structures and their supporting utilities, vehicles and transportation infrastructure, and community buildings, such as hospitals, police stations, and schools. Roadways in or near the terrorist event could be impacted because of damage or closure due to response or investigative operations.

When a terrorist attack occurs, there are many potential environmental impacts due to the varied ways an event can occur. The environmental impacts associated with terrorism include, but are not limited to:

- Air pollution;
- Soil contamination;
- Water pollution and hydrologic impacts; and
- Radiological contamination.

Examples of potential terrorist impacts on the environment include the following:

- During severe drought, a terrorist group conducts an arson campaign with multiple fire-bomb attacks that result in large-scale fires throughout the area. Fire-affected regions sustain losses to agriculture and forest areas.
- An intentional release of hazardous materials into soil, water, or the air that leads to environmental contamination and potential changes of the ecosystem, such as habitat loss.
- Failure of control systems of major utility companies due to cyberattack, leading to damages of critical infrastructure and consequent environmental impacts, such as uncontrolled release of chemicals into the environment, initiation of random fires, or radiological contamination.

The City of San Antonio planning area is home to many cultural and historic resources. Historic neighborhoods may be at risk from a terrorist event because they are of a construction type and material that is more vulnerable to fire and explosions. Historic homes are generally exempt from modern building code requirements, which may require fire suppression equipment in the structure, and are often constructed close together. The city/county's historic and cultural resources are a significant draw for tourists and visitors to the area and help to generate revenue through taxes and fees. This revenue in turn pays for services and programs, which benefit residents and the community.

The financial and economic impacts associated with a terrorist event may be significant. A major attack, where many structures are damaged or destroyed, can have serious economic and financial consequences for a community. These consequences will depend on what is damaged, the extent of the damage, and the services the damaged structures provided to the community.

The economic and financial impacts of a terrorist event on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by businesses and

citizens will also contribute to the overall economic and financial conditions in the aftermath of a terrorist event.

Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. A response demonstrating that the City, its leaders, and officials were prepared for the event, anticipated the magnitude, and understood what could happen, will boost the City's reputation and standing with residents. However, if the perception developed, correctly or incorrectly, that the response was slow, that needs or complaints of its residents were ignored, or that the leadership failed to anticipate the magnitude of the event, then public confidence can decline.

A terrorist attack that is responded to and handled with little damage to structures or infrastructure will enhance public perception. Visual images of the first responders can be a powerful tool to aid in the public trust and confidence regarding public safety.

Section 17: Hazardous Materials

Hazard Description

In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. This profile focuses on fixed sites. Weather conditions will directly affect how the hazard develops.

The Toxics Release Inventory (TRI) is a publicly available database from the federal Environmental Protection Agency (EPA) that contains information on toxic chemical releases and other waste management activities that are reported annually by certain covered industry groups' federal facilities. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. Each year, facilities that meet certain activity thresholds must report their releases and other waste management activities for listed toxic chemicals to the EPA and their state or tribal entity. A facility must report if it meets the following three criteria:

- The facility falls within one of the following industrial categories: manufacturing; metal mining; coal mining; electric generating facilities that combust coal and/or oil; chemical wholesale distributors; petroleum terminals and bulk storage facilities; Resource Conservation and Recovery Act (RCRA) Subtitle C Treatment, Storage and Disposal (TSD) facilities; and solvent recovery services.
- Have ten or more full-time employee equivalents.
- Manufactures or processes more than 25,000 pounds or otherwise uses more than 10,000 pounds of any listed chemical during the calendar year. Persistent, Bio-accumulative and Toxic (PBT) chemicals are subject to different thresholds of ten pounds, 100 pounds, or 0.1 grams, depending on the chemical.

Tier II data is a publicly available database from the Texas Department of State Health Services Tier II Chemical Reporting Program. Under EPCRA, all facilities that store significant quantities of hazardous chemicals must share this information with state and local emergency responders and planners. Facilities in Texas share this information by filing annual hazardous chemical inventories with the Texas Department of State Health Services (DSHS), Local Emergency Planning Committees (LEPCs), and local fire departments. The Texas Tier II Report contains facility identification information and detailed chemical data about hazardous chemicals stored at the facility.

A facility must report if it meets the following criteria:

- Any company using chemicals that could present a physical or health hazard must report them, according to Tier II requirements.
- If an industry has an Occupational Safety and Health Administration (OSHA) deemed hazardous chemical that exceeds the appropriate threshold at a certain point in time, then the chemical must be reported. These chemicals may be on the list of 356 Extremely Hazardous Substances (EHS) or could be one of the 650,000 reportable hazardous substances (not on the EHS list). This reporting format is for a "snapshot in time." EHS chemicals must be reported if the quantity is either greater than 500 pounds, or if the Threshold Planning Quantity (TPQ) amount is less than 500 pounds.

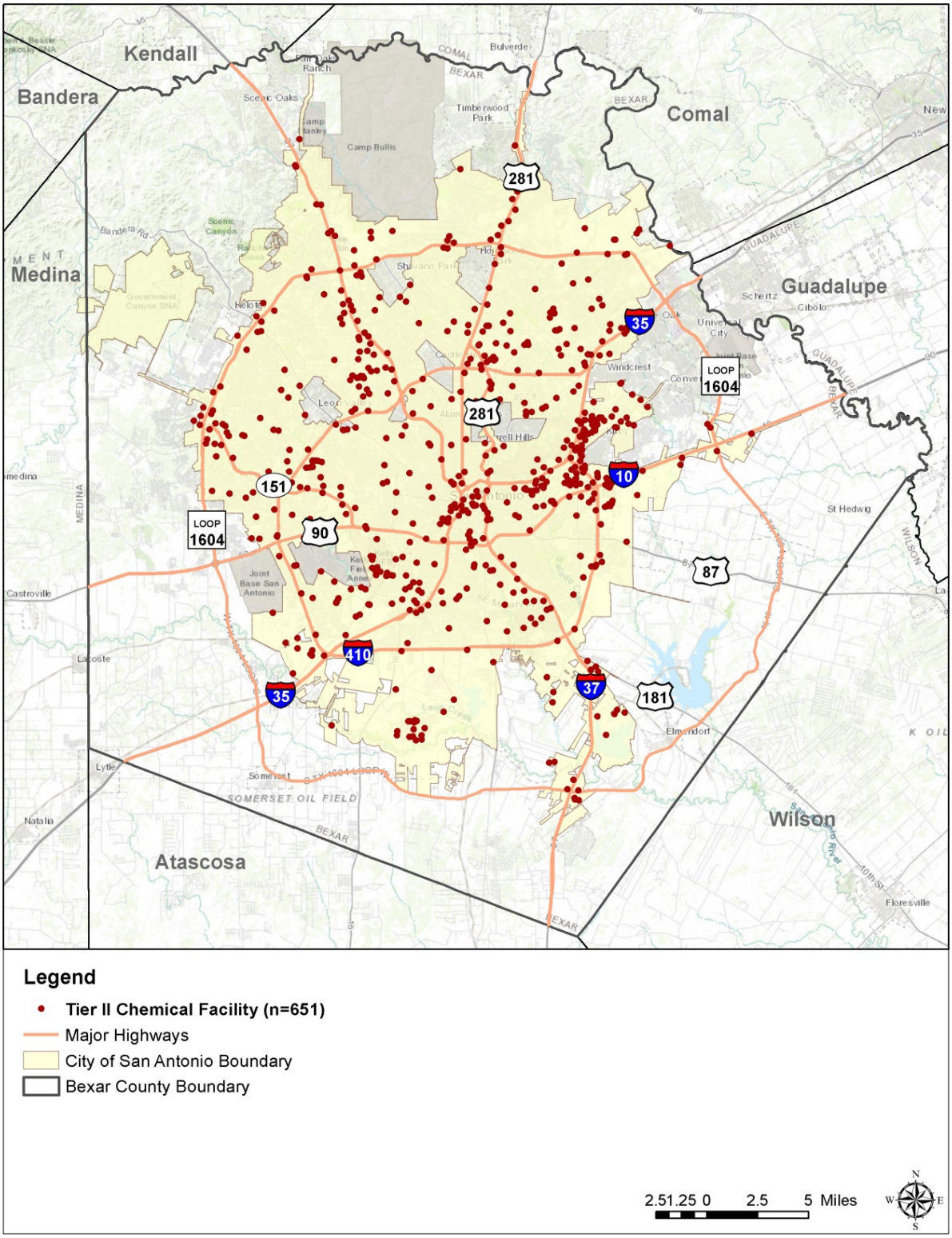
HAZARDOUS MATERIALS AND CLIMATE CHANGE

It is unknown how hazardous materials incidents will be impacted by climate change. As more specific climate data and projections become available, San Antonio's HMAP will address known climate impacts to fixed and mobile hazardous materials release incidents.

Location

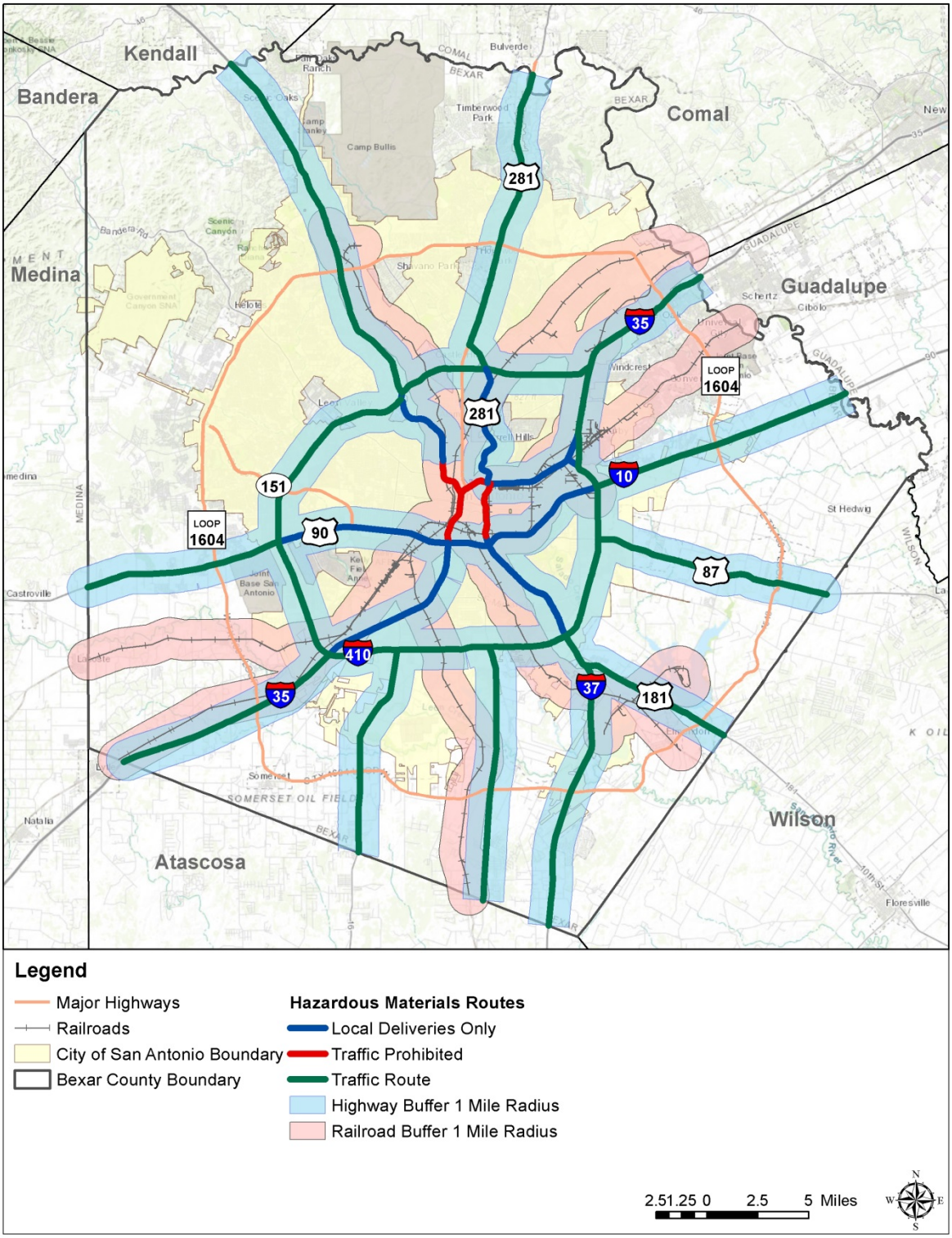
The locations of available TRI and Tier II toxic sites in the City of San Antonio planning area are shown below in Figure 67. Figure 68 shows the locations of hazardous materials transportation corridors.

Figure 67. Toxic Material Sites in the City of San Antonio[144]



[144] Source: Texas Department of State Health Services

Figure 68. Hazardous Materials Transportation Corridors in the City of San Antonio[145]



[145] Source: San Antonio Office of Emergency Management

Extent

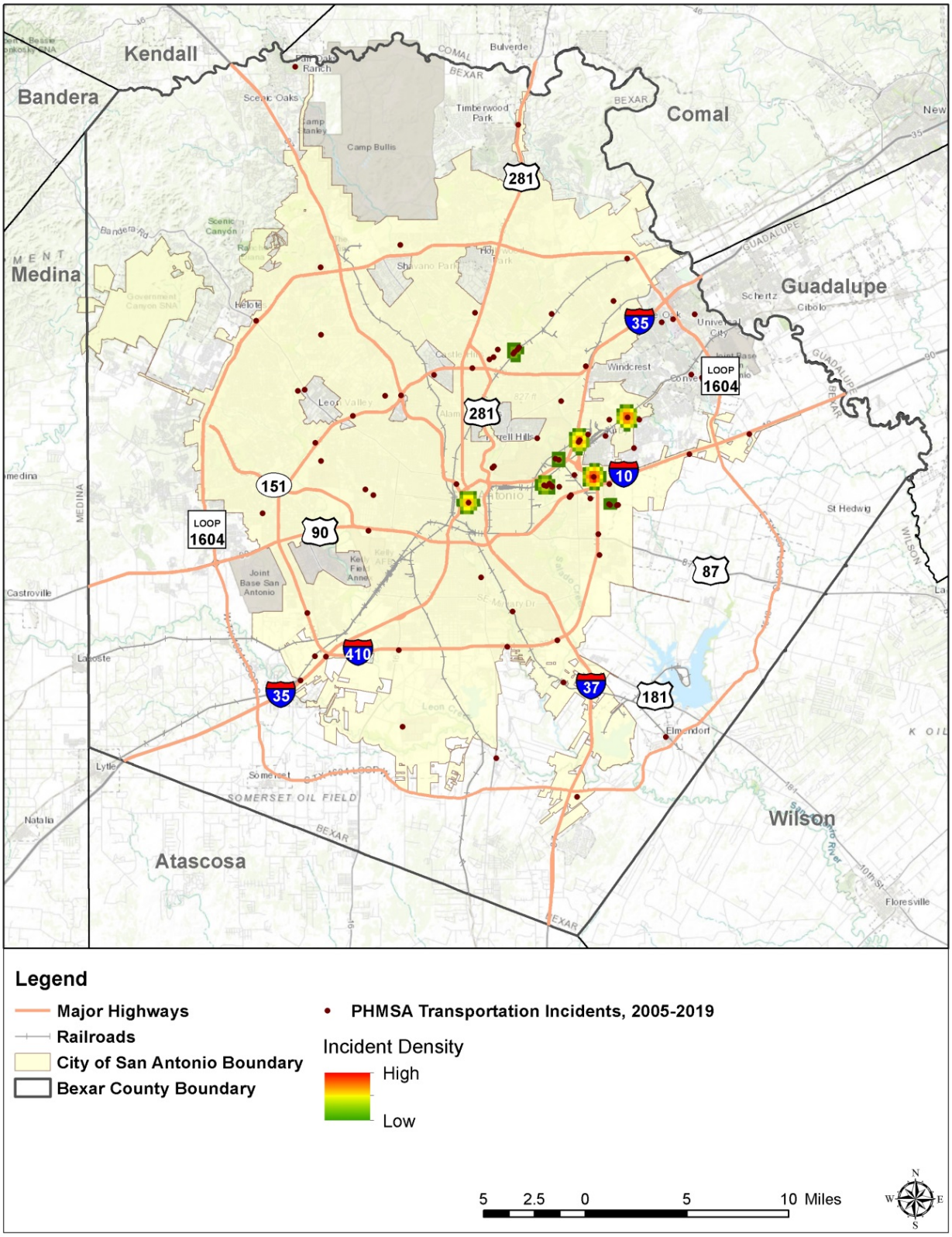
The micro-meteorological effects of buildings and terrain can alter travel and duration of agents from a hazardous materials incident. Shielding, in the form of sheltering-in-place, can protect people and property from the harmful effects of hazardous materials. Non-compliance with fire and building codes and failure to maintain existing fire and containment features can substantially increase the damage from a hazardous materials incident. The duration of a hazardous materials incident can range from hours to days. Warning time for hazardous materials incidents is minimal to none.

The San Antonio Fire Department Hazardous Materials response teams handle responses to hazardous materials transportation accidents and chemical spills in business and manufacturing facilities. The response teams are trained to take corrective actions to stop or mitigate the release of hazardous materials while safeguarding the welfare of residents, emergency response personnel, and the environment. The response teams are also trained to deliver basic fire suppression and emergency first aid service, as required. Team members participate in ongoing training for special situations, such as highway transportation emergencies, railroad tank car incidents, and chlorine emergencies.

Historical Occurrences

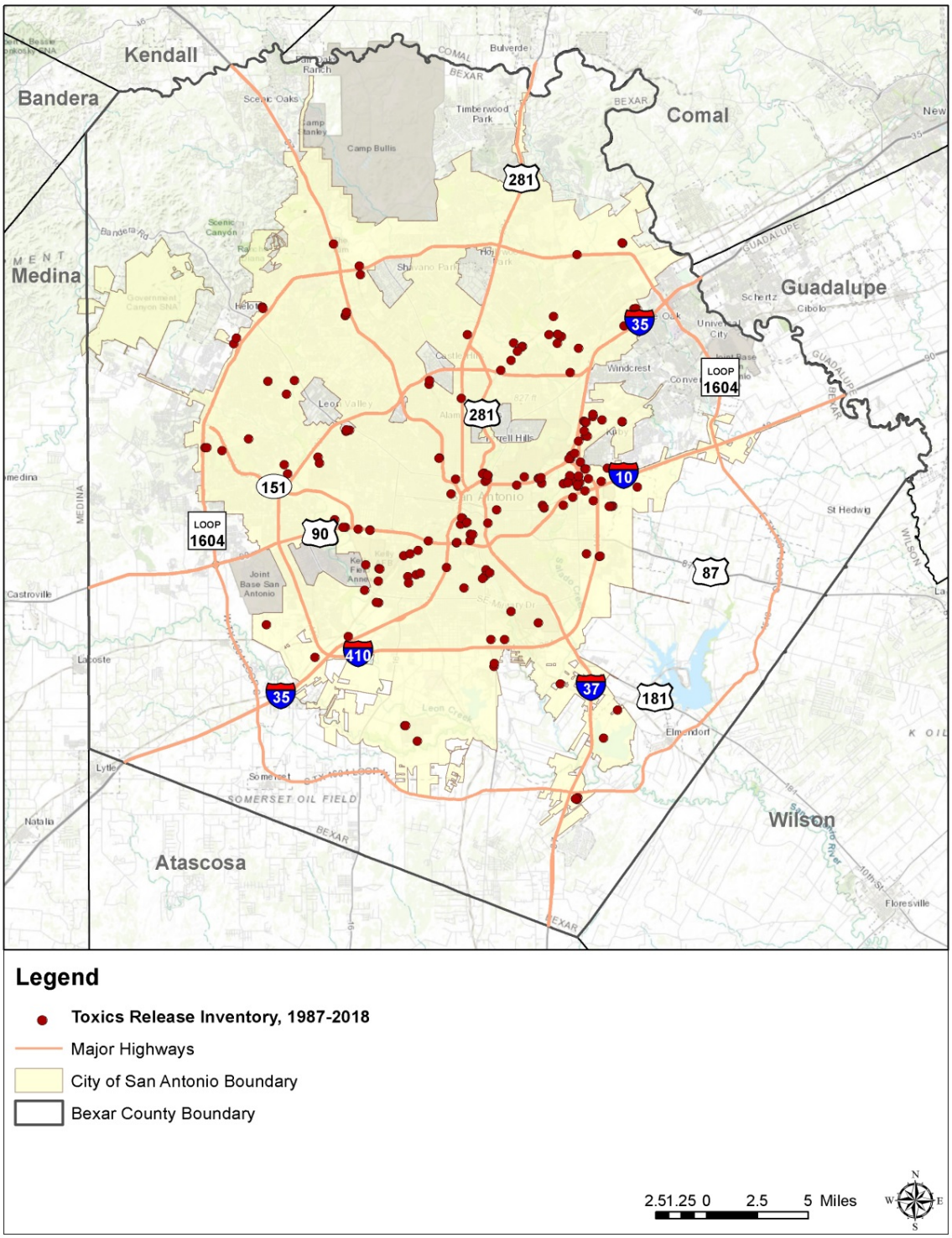
DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) has recorded a total of 820 hazardous materials transportation incidents in Bexar County; 797 (97%) of them were located in the City of San Antonio. The data collected is from 2005 to 2019 and identifies the hazardous materials transportation incidents as in-transit, in-transit storage, loading, and unloading of transport vehicles (highway, rail, and air modes of transportation). Figure 69 shows locations of the PHMSA transportation incidents in the study over the last 15 years.

Figure 69. PHMSA Transportation Incidents, 2005-2019



According to the EPA's TRI database, over the last 31 years, a total of 5,075 toxic chemical releases were recorded in Bexar County, of which 4,269 (84%) were located within the City of San Antonio. The data collected is from 1987 to 2018 and identifies fixed facilities that have reported toxic chemical releases in the County as shown in Figure 70.

Figure 70. Toxics Release Inventory, 1987 – 2018



Probability of Future Events

Based on the historic incident records, the frequency of occurrence is highly likely, and an event can be expected annually for the City of San Antonio.

Vulnerability and Impact

Based on the prevalence and geographic proximity of hazardous materials transportation routes and fixed locations, the majority of the City of San Antonio is vulnerable. The risk to the population depends on a variety of factors, including type and amount of chemical released, weather conditions, prevailing winds, time of day, and season.

The environment is often vulnerable in, and can be heavily damaged by, a hazardous materials incident.

Hazardous materials or toxic releases can have a "major" impact on the San Antonio planning area. Hazardous material incidents can cause injuries and/or illnesses that result in permanent disability, complete shutdown of facilities for at least two weeks, or both. Additionally, a hazardous materials incident can cause more than 25% of affected properties to be destroyed or suffer major damage.

ASSESSMENT OF IMPACTS

It is possible that a hazardous materials incident could involve several of fatalities. It is likely that inhaled hazardous gasses may result in respiratory problems, including burning sensations in the lungs, nose, and throat. Releases that involve solids or liquids can be absorbed through the skin and may cause burns on contact. In some instances, the threat to health and safety may not be evident for an extended period of time.

The particular transportation route and fixed site involved are significant factors in determining the risk to public health and safety and will determine the number of people in proximity to the hazard. Depending on the nature of the hazardous materials incident, the public could be required to either evacuate the area or shelter in place, which will interrupt normal routines. Below in Table 89 is a summary of the demographics according to their location within the City's transportation corridors.

Table 89. Demographics in Transportation Corridors[146]

Population	1,117,001
Households	398,279

146 Source: U.S. Census Bureau, Census 2010 Summary File 1, and Environmental Systems Research Institute's forecast for 2020

Housing Units	427,336
Businesses	40,997

Response personnel are also at risk from more concentrated or prolonged exposure to the agent involved in the hazardous materials incident. Through response efforts, response personnel can encounter hazardous materials before the nature of the hazard is determined. Response personnel also have a greater likelihood of being impacted by secondary explosions or leaks. Roadway damage resulting in unstable foundations or bridge and overpass instability may create an impact and more dangerous situations in which response personnel must work.

Generally, hazardous materials incidents will interrupt operations and services within a limited area. The incident may result in the closure of multiple facilities and transportation infrastructure until the area can be remediated and made safe and habitable.

The nature of an operational and service interruption will depend on the facilities in the impacted area. For example, if the incident results in the temporary closure and evacuation of a hospital, this will also impact all hospitals in the area because area hospitals may be expected to assume the patient load for the now-inaccessible facility. However, if the incident is near non-essential businesses, the operational or service interruption might not be as far-reaching. While the closure of businesses would result in negative impacts for those businesses, this scenario would not have the same community impacts as the first example.

Damage to roadways, railways, and physical infrastructure resulting from transportation of hazardous materials can impair normal operations and delivery of services.

Property, facilities, and infrastructure are all subject to significant impacts from hazardous materials. Hazardous materials incidents often involve fire or explosions that can impact property and facilities, including roadways and bridges.

Any infrastructure in the incident area could be impacted by a hazardous materials incident. Gas lines, water lines, sewer lines, and communication lines can be interrupted or destroyed, depending on the nature of the event. If the event is significant enough, utilities in the area may need to be temporarily suspended or disconnected, which would impact multiple facilities and properties as shown in Table 90.

Table 90. Critical Facilities located within a 1 Mile Buffer Radius of Major Highways & Railroads[147]

INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	63
Banking and Finance	256

147 Source: San Antonio Office of Emergency Management

INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Chemical and Hazardous Materials Industry	499
Defense Industrial Base	n/a
Energy	66
Emergency Services	141
Information Technology	n/a
Communications	86
Postal and Shipping	3
Healthcare and Public Health	623
Transportation	15
Water	200
National Monuments and Icons	8
Commercial Facilities	1,647
Government Facilities	353
Dams	19
Nuclear Reactors, Materials, and Waste	46
Manufacturing	0

Environmental risks from hazardous materials incidents can range from nonexistent to catastrophic, depending on the nature of the release. For example, the Macdona (Texas) train derailment in 2004 did not result in any long-term environmental impacts in San Antonio, though areas around San Antonio were subject to monitoring and testing for a period after the incident.[148] In a hazardous materials transportation incident, specialized containment, mitigation, and cleanup capabilities and procedures may be required to reduce environmental impacts.

By contrast, the 1986 Chernobyl nuclear reactor incident resulted in the permanent abandonment of several square miles, including an entire town. Impacts from the Chernobyl incident were felt on a global scale and impacted the environment thousands of miles away from the incident site. Residual impacts remain to this day and are not expected to diminish for decades.

[148] Source: Environmental Protection Agency's Emergency Response Review

Very little environmental testing or monitoring is completed after hazardous materials incidents, especially incidents in which there may be no impacts to monitor, because testing and monitoring can be expensive in terms of financial investments and staff resources. The inability to monitor and report on local environmental impacts is concerning to local hazardous materials officials.

Unless the incident causes physical damage to historical or cultural resources, the resources are unlikely to be impacted by a hazardous materials incident. Based on proximity, a resource could be impacted or have blocked access due to contamination concerns. Long-term lack of access, need for clean-up, or related negative publicity regarding the release could reduce ability of historic and cultural sites to attract tourists and generate income.

The risks to economic and financial sectors can be deeply felt and long-lasting. The depth and range of economic impacts will depend on the nature and severity of the incident. An incident that damages transportation infrastructure could have substantial financial ramifications and could result in a significant impact to the local or regional economy. Cleanup costs, loss of access to facilities, and lost business or customers are all possible impacts after a hazardous materials incident.

For minor hazardous materials incidents, there is generally no impact to public confidence because most people are either not impacted or unaware that the incident has even occurred. For larger incidents, the threat to public confidence is determined by how the public perceives the event is handled. Public perception will impact the public's behavior during the next incident.

Hazardous materials incidents often test the mechanisms and processes by which emergency management officials provide information, including evacuation orders, to the public. Misunderstood, confusing, and/or conflicting messages, or delivery mechanisms that are ineffective, could have negative impacts to public confidence in emergency management staff and leadership.

The perception of incorrect, slow, or ineffective handling of an incident, particularly if that incident requires an evacuation of the public, can result in a less cooperative or successful evacuation during the next incident because the public may have less confidence in emergency management leadership. The public may blame local, state, or federal governments for the event, if the cause of the event is viewed as a lack of responsible regulation or oversight, as occurred during the BP Deepwater Horizon oil spill incident in 2010. Without ongoing communication regarding hazardous materials risks and protective measures, the public may not perceive the government as aware and capable when an incident occurs.

Section 18: Pipeline Failure

Hazard Description

Energy pipeline breach or failure of an oil or natural gas pipeline is a serious hazard event. An estimated 2.4 million miles of pipelines in the United States carry hazardous materials. Natural gas pipelines transport natural gas and oil. Liquid petroleum pipelines transport crude oil and refined products from crude oils, such as gasoline, home heating oil, jet fuel, kerosene, liquefied propane, ethylene, butane, and petrochemical products. Oil pipelines can also transport liquefied gases, such as carbon dioxide.

Pipeline failure is a rare occurrence and has the potential to cause extensive property damage and loss of life. Pipelines have caused fires and explosions that killed more than 200 people and injured more than 1,000 people nationwide with 50 of the injuries in Texas in the last decade.

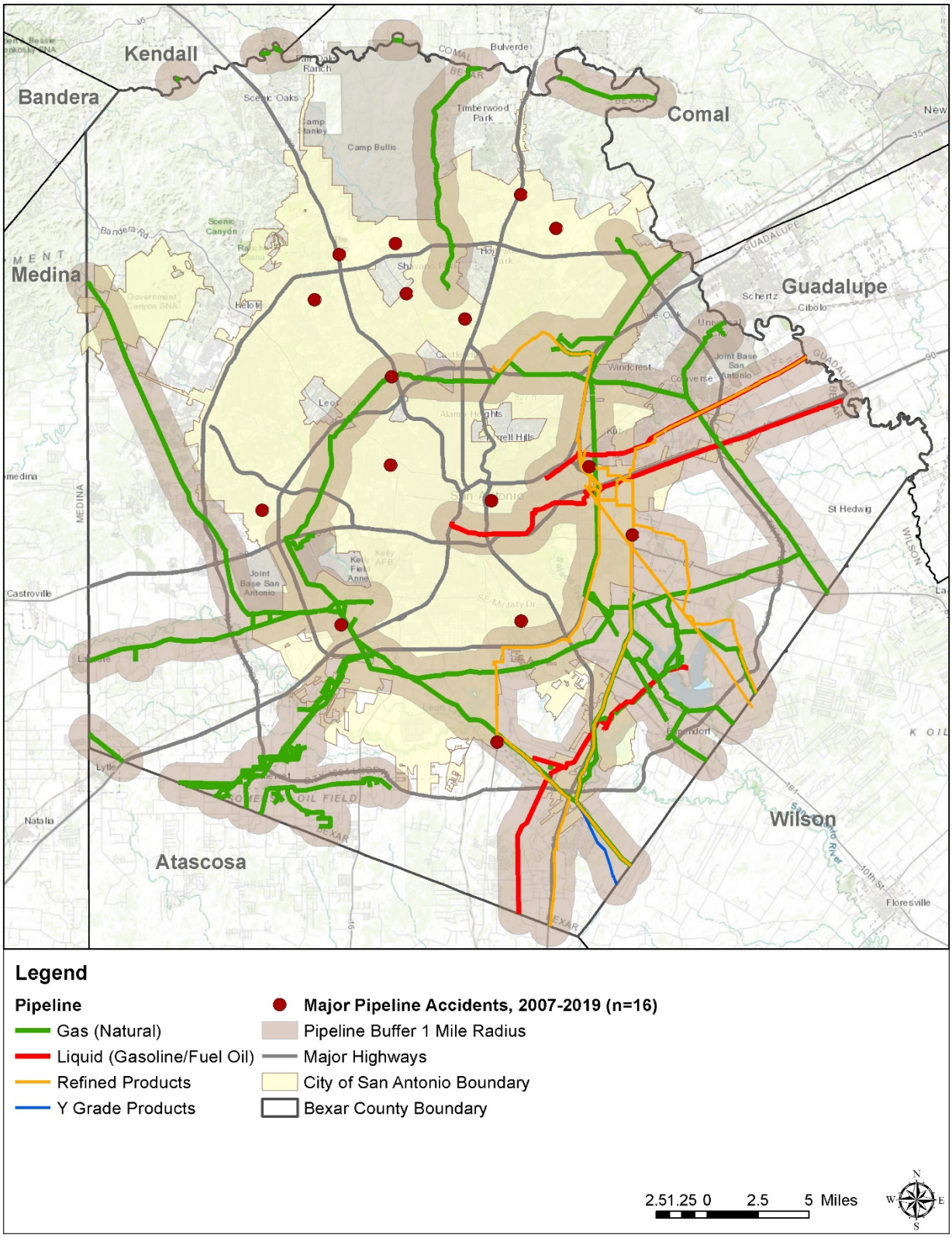
PIPELINE FAILURE AND CLIMATE CHANGE

Climate change creates an increased vulnerability for pipeline failure as irregular conditions increase and hazards become more frequent and severe. While these events are rare, pipelines impacted by weather events, such as heavy rains, can spill their contents, polluting the environment, impacting public health, and damaging ecosystems and property.

Location

Figure 71 shows the location of gas and oil energy pipelines and pipeline accidents in the City of San Antonio according to the Railroad Commission of Texas.

Figure 71. Pipeline Location and Pipeline Accidents, 2007 – 2019



Extent

The U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), acting through the Office of Pipeline Safety (OPS), administers the Department's national regulatory program to assure the safe transportation of natural gas, petroleum, and other hazardous materials by pipeline. The OPS develops regulations and other approaches to risk management to assure safety in design, construction, testing, operation, maintenance, and emergency response of pipeline facilities. Since 1986, the pipeline safety program has been funded by a user fee assessed on a per-mile basis for all pipeline operators that OPS regulates.

Climate change is anticipated to put an increased strain on Texas's aging infrastructure and lead to an increased risk of damage.

Historical Occurrences

Pipeline failure events can be caused by corrosion, equipment failure, damage from excavations, incorrect operation, and natural forces. Incidents are generally categorized by severity and type of affected pipeline system component.

The PHMSA defines significant events as those incidents reported by pipeline operators when any of the following occur:

1. Fatality or injury requiring in-patient hospitalization;
2. $50,000 or more in total costs, measured in 1984 dollars;
3. Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more; and
4. Liquid releases resulting in an unintentional fire or explosion.

The PHMSA defines a serious pipeline incident as an event involving a fatality or injury requiring in-patient hospitalization.

Table 91 summarizes 16 “Major” historical pipeline events for the City of San Antonio. A major pipeline event results from a cost or repair of $5,000 or greater and reported injuries or fatalities, or both.

Table 91. Historical Pipeline Accidents, 2007 – 2019[149]

INCIDENT DATE	OPERATOR	CITY	COST OR REPAIR	INJURED	FATALITIES	STAKEHOLDER
6/29/2009	CPS ENERGY	San Antonio	$0	1	0	Gas
4/17/2013	CALUMET SHREVEPORT FUELS LLC	San Antonio	$60,000	0	0	Liquid
12/23/2014	CPS ENERGY	San Antonio	$10,000	0	0	Gas
1/12/2015	CPS ENERGY	San Antonio	$22,350	0	0	Gas
6/26/2015	CPS ENERGY	San Antonio	$27,000	0	0	Gas
2/18/2016	GREY FOREST UTILITIES	San Antonio	$5,000	0	0	Gas
6/22/2016	CAPITAL EXCAVATION CO	San Antonio	$5,000	0	0	N/A
10/20/2016	CPS ENERGY	San Antonio	$5,500	0	0	Gas
12/7/2016	CPS ENERGY	San Antonio	$8,000	0	0	Gas
4/18/2018	NUSTAR LOGISTICS, L.P.	San Antonio	$10,045	0	0	Liquid
5/29/2018	GREY FOREST UTILITIES	San Antonio	$7,000	0	0	Gas
6/11/2018	NUSTAR LOGISTICS, L.P.	San Antonio	$25,000	0	0	Liquid
8/27/2018	N/A	San Antonio	$18,500	0	0	N/A

149 Source: Pipeline and Hazardous Materials Safety Administration and Railroad Commission of Texas

INCIDENT DATE	OPERATOR	CITY	COST OR REPAIR	INJURED	FATALITIES	STAKEHOLDER
3/28/2019	CPS ENERGY	San Antonio	$5,500	0	0	Gas
7/11/2019	CPS ENERGY	San Antonio	$23,000	0	0	Gas
9/26/2019	NUSTAR LOGISTICS, L.P.	San Antonio	$8,000	0	0	Liquid
Total			$239,895	1	0	

Probability of Future Events

According to the historical incident data, a pipeline incident for the City of San Antonio is likely, and a major event can occur on average once a year.

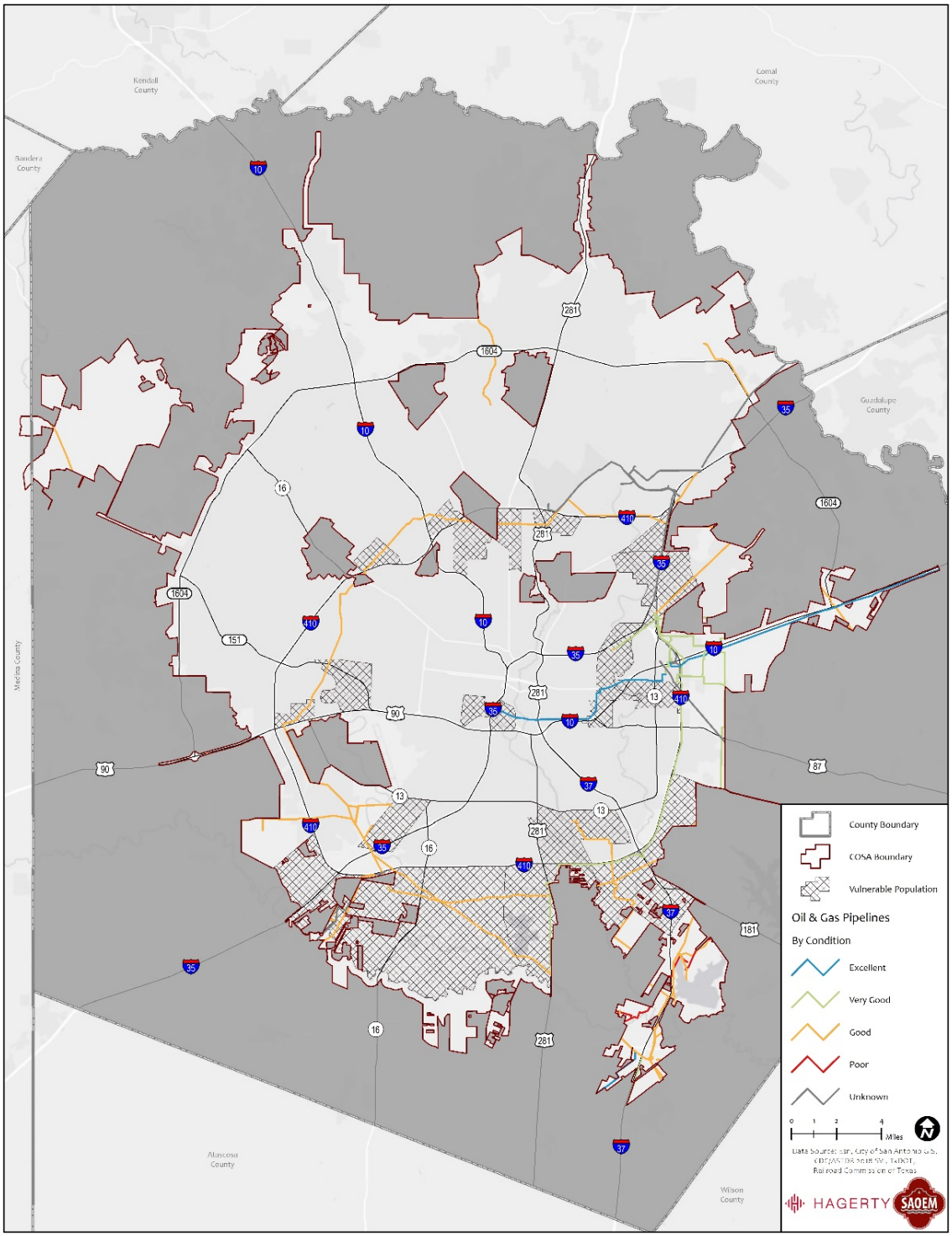
Due to climate change, aging pipelines that deliver oil and natural gas to power plants are at an increased risk of failure.

Vulnerability and Impact

The analysis for gas pipelines is for natural gas and the analysis for oil pipelines is for natural gas liquids. The immediate and primary area of impact for both types of pipeline events is a 500-meter buffer. The secondary area of impact for both types of pipeline events is a 2,500-meter buffer. Both types of impact can inflict substantial damage on the surrounding areas. Pipeline breaches have the potential to cause multiple deaths and complete shutdown of facilities for 30 days or more.

Pipeline failure can have a "major" impact on human health and area properties. Pipeline failure events can cause injuries, illnesses, and result in permanent disability. These events can also cause facilities in the City area to shut down for at least two weeks and cause more than twenty-five percent of affected properties to be destroyed or suffer major damage. Figure 72 illustrates oil and gas pipelines by condition (e.g., excellent, very good, good, poor) and socially vulnerable populations. In the event of a pipeline failure, socially vulnerable populations may be impacted to a greater extent due to mobility issues, lack of transportation, disability, or the financial resources to remove themselves from contaminated areas.

Figure 72: Oil and Gas Pipelines and Socially Vulnerable Populations in San Antonio



ASSESSMENT OF IMPACTS

The risk to public health and safety during a pipeline failure event depends on a number of factors, including the type and amount of chemical(s) involved, location, weather conditions,

time of day, and presence of an ignition source. The location of pipelines determines the potential number of people in proximity to the hazard and is a significant factor when determining the risk to public health and safety. It is possible that a release of materials from a pipeline failure could involve a number of fatalities. It is likely that inhaled hazardous gases may result in respiratory problems, including burning sensations in the lungs, nose, and throat. A release of solids or liquids can be absorbed through the skin and may cause burns on contact. In some instances, the threat to health and safety may not be evident for an extended period of time.

Depending on the nature and extent of a pipeline failure, the public could be required to either evacuate the area or shelter in place, which will interrupt normal routines. Table 92 summarizes demographics according to their location within a one-mile buffer radius of pipelines identified earlier in Figure 72.

Table 92. Demographics for One Mile Buffer Radius of the Pipelines[150]

Population	727,336
Households	253,080
Housing Units	270,210
Businesses	21,609

Response personnel are also at risk from more concentrated or prolonged exposure to the agent involved in the event. Through response efforts, response personnel may respond and encounter hazardous substances before the nature of the hazard is determined. Response personnel also have a greater likelihood of impacts from secondary explosions or leaks.

Generally, pipeline failure events will interrupt operations and services within a limited area. The nature of the interruption will depend on the facilities in the impacted area. For example, if the event results in the temporary closure or evacuation of a hospital, this will also impact all hospitals in the area because area hospitals may be expected to assume the patient load for the now-inaccessible facility. However, if the event is near non-essential businesses, the operational or service interruption might not be as far-reaching. While the closure of businesses would result in negative impacts for those businesses, this scenario would not have the same community impacts as the first example.

Damage to roadways, railways, and physical infrastructure resulting from a pipeline failure event can impair normal operations and delivery of services.

[150] Source: 2010 United States Census, Environmental Systems Research Institute's Community Analyst

During a pipeline failure event, the pressure in a pipeline can disrupt the soil above a break. Any facility or piece of infrastructure over or adjacent to a rupture could be damaged or destroyed. If gas ignites, it will set flammable objects near it on fire. Depending on environmental factors such as wind, proximity of vegetation or other fuels, and dryness of the environment, the fire could spread to other nearby structures, damaging or destroying them. Table 93 summarizes the City's critical facilities according to their location within a one-mile buffer radius of the pipelines.

Table 93. Facilities located within a 1 Mile Buffer Radius of the Pipelines[151]

INFRASTRUCTURE SECTOR	NUMBER OF FACILITIES
Agriculture and Food	29
Banking and Finance	126
Chemical and Hazardous Materials Industry	322
Defense Industrial Base	n/a
Energy	47
Emergency Services	60
Information Technology	n/a
Communications	52
Postal and Shipping	3
Healthcare and Public Health	327
Transportation	7
Water	93
National Monuments and Icons	3
Commercial Facilities	809
Government Facilities	182
Dams	15
Nuclear Reactors, Materials, and Waste	32
Manufacturing	0
TOTAL	**2,238**

Any infrastructure around the incident could be impacted by a pipeline failure event. Gas lines, water lines, sewer lines, and communication lines can be interrupted or destroyed, depending

[151] Source: San Antonio Office of Emergency Management

on the nature of the event. If the event is significant enough, utilities in the area may need to be temporarily suspended or disconnected, which would impact multiple facilities and properties.

Environmental risks from pipeline failure events can range from nonexistent to catastrophic, depending on the nature and extent of the release. Often minor environmental testing or monitoring is completed after a hazardous materials event, especially incidents in which there may be no impacts to monitor, because testing and monitoring can be expensive in terms of financial investments and staff resources. The inability to monitor and report on local environmental impacts is concerning to local hazardous materials officials.

A pipeline failure event can cause physical damage to historical or cultural resources in the San Antonio planning area if there is a presence of an ignition source during a pipeline failure event. Based on proximity, a resource could be impacted or have blocked access due to contamination concerns. Long-term lack of access, need for cleanup, or related negative publicity regarding the release could reduce the ability of historic and cultural sites to attract tourists and generate income.

The risks to local economic and financial sectors can be deeply felt and long-lasting. The depth and range of economic impacts will depend on the nature and severity of the event. Cleanup costs, loss of access to facilities, and lost business revenue are possible after a pipeline failure event.

For minor pipeline failure events, there is generally no impact to public confidence because most people are either not impacted or are unaware that the event has even occurred. For larger incidents, the threat to public confidence is determined by how the public perceives the event is handled. Public perception will impact the public's behavior during the next event.

Pipeline failure events often test the mechanisms and processes by which emergency management officials provide information, including evacuation orders, to the public. Misunderstood, confusing, and/or conflicting messages or delivery mechanisms that are ineffective could have devastating impacts to public confidence in emergency management staff and leadership.

The perception of incorrect, slow, or ineffective handling of an incident, particularly if that incident requires an evacuation of the public, can result in a less cooperative or successful evacuation during the next event because the public may have less confidence in emergency management leadership. The public may blame local, state, or federal governments for the event, if the cause of the event is viewed as a lack of responsible regulation or oversight, as occurred during the BP Deepwater Horizon oil spill incident in 2010. Without ongoing communication regarding pipeline and protective measures, the public may not perceive the government as aware and capable when an event occurs.

Section 19: Infectious Disease

Hazard Description

An infectious disease is as a clinically evident disease resulting from the presence of pathogenic microbial agents. According to FEMA, infectious diseases are a major threat around the world, killing millions globally each year. Transmission of an infectious disease may occur through one or more means, including physical contact with infected individuals. These infecting agents may also be transmitted through liquids, food, bodily fluids, contaminated objects, airborne inhalation or through vector-borne dissemination.

There are three classifications of disease impacts: endemic, epidemic, and pandemic. An endemic is always present at a low frequency, such as chicken pox in the United States. An epidemic is a sudden severe outbreak of disease, such as the bubonic plague during Medieval Times. A pandemic is an epidemic that becomes very widespread and affects a whole region, a continent, or the world; for example, the 1957 flu pandemic caused at least 70,000 deaths in the United States and one to two million deaths worldwide. In recent years, fears of pandemic have risen because the globalized economy and growing population fosters large scale international travel and trade. Growing populations increase the vulnerability of all areas to disease because a denser population increases the risk of exposure to, and subsequently the rapid spread of, an infectious disease.

The top 10 infectious diseases, according to the World Health Organization (WHO), based upon number of deaths, are presented in Table 94.

Table 94. Worldwide Mortality Due to Infectious Disease[152]

RANK	CAUSE OF DEATH	APPROXIMATE WORLDWIDE DEATHS IN 2018
1	Lower Respiratory Infections	4.4 million
2	Diarrheal diseases	3.1 million
3	Tuberculosis (TB)	3.1 million
4	Malaria	2.1 million
5	Hepatitis B	1.1 million
6	HIV/AIDS	1.0 million
7	Measles	1.0 million

[152] Source: World Health Organization

RANK	CAUSE OF DEATH	APPROXIMATE WORLDWIDE DEATHS IN 2018
8	Tetanus	160,000
9	Whooping Cough	355,000
10	Intestinal Worm Disease	135,000

While all these diseases are monitored by the City of San Antonio on a regular basis, the primary disease of concern at the time of this planning process was the Coronavirus disease (COVID-19) due to its rapid spread and impact on the global economy.

COVID-19 is an infectious disease caused by a recently discovered coronavirus. Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.

The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it is important to practice respiratory etiquette (for example, by coughing into a flexed elbow). Many months into the COVID-19 pandemic, the coronavirus is still spreading uncontrolled through the country and throughout the world. Public health authorities, including the U.S. Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO), recommend citizens remain six feet apart, wash hands frequently, disinfect frequently touched surfaces, and wear masks. There is a growing school of evidence that COVID-19 cases are transmitted through aerosols (sometimes referred to as airborne).

During the drafting of this plan, there were no specific vaccines or treatments for COVID-19 approved by the Food and Drug Administration (FDA). However, there were many ongoing clinical trials evaluating potential treatments. Similar to communities around the globe, the City of San Antonio was dramatically impacted by this virus with more than 100,000 confirmed cases and 2,000 related deaths as of January 6, 2021. The economic impact of the virus has been devastating for the planning area. Economic recovery is likely to take years. The COVID-19 infection was declared a pandemic by the World Health Organization on March 11, 2020.

The CDC contains the latest information and guidance on the COVID-19 pandemic and provides recommendations on protecting citizens and reducing the spread of the disease. The most current recommendations include:

Wash Your Hands Often

- Wash your hands often with soap and water for at least 20 seconds, especially after you have been in a public place, or after blowing your nose, coughing, or sneezing.
- It is especially important to wash:
  - Before eating or preparing food
  - Before touching your face
  - After using the restroom
  - After leaving a public place
  - After blowing your nose, coughing, or sneezing
  - After handling your mask
  - After changing a diaper
  - After caring for someone sick
  - After touching animals or pets
- If soap and water are not readily available, use a hand sanitizer that contains at least 60% alcohol. Cover all surfaces of your hands and rub them together until they feel dry.
- Avoid touching your eyes, nose, and mouth with unwashed hands.

Avoid Close Contact

- Inside your home: Avoid close contact with people who are sick.
- If possible, maintain 6 feet between the person who is sick and other household members.
- Outside your home: Put 6 feet of distance between yourself and people who don't live in your household.
- Remember that some people without symptoms may be able to spread virus.
- Stay at least 6 feet (about 2 arms' length) from other people.
- Keeping distance from others is especially important for people who are at higher risk of getting very sick.

Cover Your Mouth and Nose with a Mask When Around Others

- You could spread COVID-19 to others even if you do not feel sick.
- The mask is meant to protect other people in case you are infected.
- Everyone should wear a mask in public settings and when around people who don't live in your household, especially when other social distancing measures are difficult to maintain.
  - Masks should not be placed on young children under age 2, anyone who has trouble breathing, or is unconscious, incapacitated or otherwise unable to remove the mask without assistance.
- Do NOT use a mask meant for a healthcare worker. Currently, surgical masks and N95

respirators are critical supplies that should be reserved for healthcare workers and other first responders.

- Continue to keep about 6 feet between yourself and others. The mask is not a substitute for social distancing.

Cover Coughs and Sneezes

- Always cover your mouth and nose with a tissue when you cough or sneeze or use the inside of your elbow and do not spit.
- Throw used tissues in the trash.
- Immediately wash your hands with soap and water for at least 20 seconds. If soap and water are not readily available, clean your hands with a hand sanitizer that contains at least 60% alcohol.

Clean and Disinfect

- Clean AND disinfect frequently touched surfaces daily. This includes tables, doorknobs, light switches, countertops, handles, desks, phones, keyboards, toilets, faucets, and sinks.
- If surfaces are dirty, clean them. Use detergent or soap and water prior to disinfection.
- Then, use a household disinfectant. Most common EPA-registered household disinfectants will work.

Monitor Your Health Daily

- Be alert for symptoms. Watch for fever, cough, shortness of breath, or other symptoms of COVID-19.
  - Especially important if you are running essential errands, going into the office or workplace, and in settings where it may be difficult to keep a physical distance of 6 feet.
- Take your temperature if symptoms develop.
  - Don't take your temperature within 30 minutes of exercising or after taking medications that could lower your temperature, like acetaminophen.
- Follow CDC guidance if symptoms develop.

INFECTIOUS DISEASE AND CLIMATE CHANGE

Increasing global temperatures due to climate change is contributing to the spread of infectious diseases. Climate change can directly impact infectious disease emergence and re-emergence through effects on pathogen survival, vector survival and reproduction, and their animal reservoirs (i.e., hosts). Milder winters, warmer summers, and fewer days of frost make it easier for infectious diseases to expand to new geographic areas and infect more people. Additionally, climate change-related extreme weather events create circumstances where

infectious microorganisms flourish and novel infections emerge. Climate change has forced some animal species into new habitats as their natural habitat disappears, increasing opportunities for contact between humans and animals that can potentially spread zoonotic diseases (e.g., wildlife carrying the rabies virus, spread of deadly diseases, such as Ebola, Lassa, Rift Valley fever, and monkeypox).

Location

Pandemics are random and only a few happen every century. The impacts from an infectious disease event can affect all areas of the world; therefore, all areas are vulnerable, as evidenced by the current COVID-19 pandemic. Since air travel and worldwide shipping have increased, it has become increasingly difficult to contain localized outbreaks as infected or exposed people travel across the globe in a matter of hours. Third world countries have fewer resources to fight disease and may be more vulnerable than more industrialized nations. In the United States, the U.S. public health system works at the federal, state, and local levels to monitor diseases, plan and prepare for outbreaks, and prevent epidemics where possible.

There is no distinct geographic boundary to infectious disease; therefore, it can occur throughout the City of San Antonio planning area.

Extent

The severity of a pandemic virus can be evaluated from the perspective of the individual who has been infected; or from the population level, how many complications and deaths might be expected as a whole. The most common measure of severity for a pandemic virus event is the case-fatality rate (CFR) as depicted in Figure 72. The severity of the pandemic is measured in Category 1 through 5 based on the number of fatalities.

The magnitude of a pandemic event is identified in terms of warning levels based on population. Figure 74 illustrates the various warning levels for pandemic based on the transmission level. The current COVID-19 pandemic warning level is at Phase 6.

Figure 73. Case-Fatality Rate for Severity

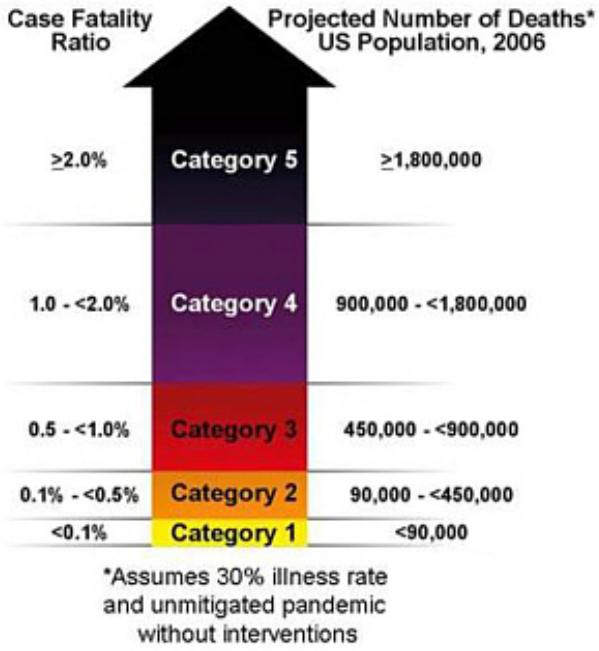


Figure 74. Risk levels for Pandemic (World Health Organization)

Interpandemic

Phase 1

Low risk of human case

Phase 2

Higher risk of human case

Pandemic Alert

Phase 3

No or very limited human-to-human transmission

Phase 4

Evidence of increased human-to-human transmission

Pandemic Alert Elevated

Phase 5

Evidence of significant human-to-human transmission

Pandemic

Phase 6

Efficient and sustained human-to-human transmission.

Historical Occurrences

The San Antonio Metropolitan Health District (Metro Health) has compiled a report on infectious disease from 2013-2018. The number of cases and rates are included in Table 95. Rates for each year were configured using the number of cases per 100,000 total population. Rates based on fewer than 20 cases are likely to be unstable and imprecise. On average, 1,115 cases of infectious disease are reported annually.

Table 95. Historical Infectious Disease for San Antonio and Bexar County, 2013 – 2018[153]

INFECTIOUS DISEASE	2013		2014		2015		2016		2017		2018	
	CASES	RATE	CASES	RATE	CASES	RATE	CASES	RATE	CASES	RATE	CASES	RATE
CAMPYLOBACTERIOSIS	248	13.6	195	10.5	272	14.4	494	25.6	579	29.6	612	30.8
CRYPTOSPORIDIOSIS	36	1.9	38	2.1	55	2.9	87	4.51	101	5.2	119	6.0
CYCLOSPORIASIS	<5	-	11	0.6	9	0.5	13	0.67	41	2.1	50	2.5
HEPATITIS A, ACUTE	9	.5	8	0.4	13	0.7	19	0.99	17	0.9	<5	-
MEASLES (RUBEOLA)	0	0	0	0	0	0	0	0	0	0	0	0
MUMPS	<5	-	<5	-	<5	-	<5	-	26	1.3	11	0.6
PERTUSSIS	114	6.2	83	4.4	64	3.4	54	2.8	66	3.4	70	3.5
SALMONELLOSIS	236	13.0	334	18.0	341	18.1	288	14.9	300	15.3	654	32.9
SHIGELLOSIS	78	4.3	242	13.0	877	46.6	290	15.0	159	801	192	9.7
TUBERCULOSIS	75	4.1	89	4.8	87	4.4	66	3.4	73	3.7	70	3.5
VARICELLA (CHICKEN POX)	88	4.8	83	4.4	106	5.6	79	401	87	4.4	60	3.0

[153] Source: San Antonio Metropolitan Health District

Occurrences of a biological event hazard are fairly common. Historically, there have been a number of E. coli and similar outbreaks traced to issues or deficiencies in the nation's food supply. In Texas, there have been several occurrences of biological hazards, as reported by the Centers for Disease Control and Prevention (CDC). In 2005, there were cases of dengue fever reported in South Texas, near the border with Mexico. In 2005, approximately 1,100 evacuees from hurricanes Katrina and Rita were infected with norovirus in the Houston area. During the winter of 2009 and early spring of 2010, 429 cases of mumps were reported in the greater Houston area.

In 2001, the CDC reported several cases of anthrax in both humans and cattle in South Texas and in the San Antonio and Bexar County area, including Bandera County, where one fatality occurred.

In the spring of 2012, Tuberculosis (TB) was detected at James Madison High School in San Antonio. Initially, two cases were confirmed, and a third case followed. By the time school released for the summer in June 2012, more than 400 students and almost 30 faculty members had been tested for TB and the majority of tests produced negative results.[154] Early detection of TB and quick action on the part of the Metro Health resulted in a contained event rather than an epidemic.

In March of 2009, a novel strain of Influenza A (H1N1 or "Swine Flu") virus was detected in Mexico and the United States. The virus has since spread worldwide. As of September 27, 2009, more than 340,000 cases of H1N1 were confirmed worldwide and approximately 4,100 deaths were reported.[155] The most commonly reported symptoms include cough, fever, sore throat, and gastrointestinal symptoms, such as vomiting and diarrhea. Most individuals infected with H1N1 did not require hospitalization and had symptoms that lasted four days.[156]

Since the early spring of 2020, more than 100,000 COVID-19 cases were reported for the planning area with 2,000 associated fatalities as of January 6, 2021. The disease has been associated with a long list of potential symptoms, the worst of which are significant respiratory issues that can lead to death. Most individuals infected with COVID-19 did not require hospitalization. While the length of symptoms is still being studied, most patients experience symptoms for a few days to one week but can be infectious for up to ten days, even after symptoms have subsided.[157]

---

[154] Source: San Antonio Metropolitan Health District

[155] World Health Organization

[156] Carrat, F. et al. Timelines of Infection and Disease in Human Influenza: A Review of Volunteer Challenge Studies. American Journal of Epidemiology, 2008, 167: 775–785.

[157] University of Maryland Medical System: https://www.umms.org/coronavirus/what-to-know/treat-covid-at-home

Probability of Future Events

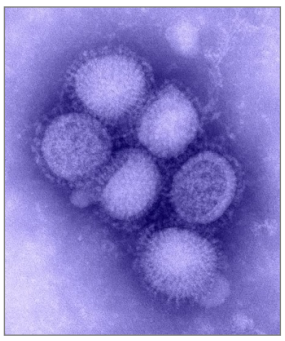
Epidemics and pandemics have occurred in human and animal populations for thousands of years. As humans began to gather and congregate in urban areas, the potential for pandemics and epidemics increased. As trade routes became established and contact with other cities became more frequent, the potential for transmission of illnesses increased. In modern society, the ease of global travel has created a situation where viruses and bacteria can spread quickly from one continent to another.

Historical evidence shows that the population of the City of San Antonio is vulnerable to disease outbreak, and the probability of future infectious disease or pandemic events is possible. Local public health officials maintain surveillance in hopes of identifying disease prominence and containing potential threats before they become epidemics. The primary concern is the reduction and treatment of COVID-19.

With the current COVID-19 pandemic, the probability of an infectious disease epidemic or pandemic in the City of San Antonio planning area is "occasional" and an event has the probability of occurring once every five years. At the time this plan was being developed, the City of San Antonio was still suffering the impacts of the 2020 World Pandemic of COVID-19.

There is an increased risk of introduction, and endemic transmission, of infectious diseases (both directly transmitted and vector-borne) from around the world due to climate change. Therefore, climate change is anticipated to increase the probability of infectious disease events.

Vulnerability and Impact



Estimated potential losses to the built environment are difficult to calculate because infectious disease causes little damage to the built environment and generally losses are experienced through public health response and medical costs, and lost wages of patients. Therefore, it is assumed that all buildings and facilities are exposed to disease but would experience negligible damage in the occurrence of an outbreak event. For example, upkeep and maintenance of buildings and facilities would fall behind due to the high absenteeism of employees or the closing of facilities.

Critical infrastructure services, such as emergency services, utility services, water services and telecommunications can be limited by an infectious disease event. With the COVID-19 pandemic, most of the people affected have mild illness and do not require hospitalization. People at the highest risk for developing complications from COVID-19 include adults 60 years

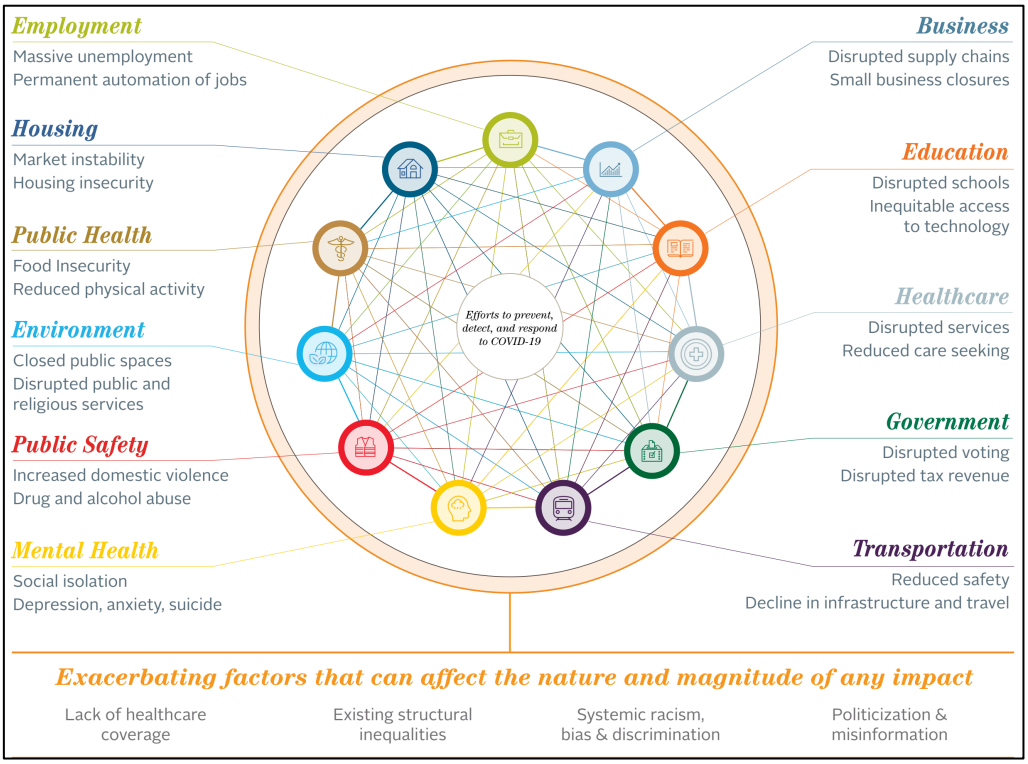
of age and older. In addition, people who have medical conditions, such as heart disease; chronic lung disease; blood, endocrine, kidney, liver, or metabolic disorders; obesity, or a weakened immune system can experience a worsening of existing conditions if they contract the COVID-19.

The current COVID-19 pandemic has demonstrated that the response costs to the public health sector for an outbreak, the economic impact, and the impact to health as a whole for the City of San Antonio planning area, is "Substantial." Multiple deaths can be expected, and the City of San Antonio area facilities could be shut down for at least four weeks. Property damage could result from high absenteeism of persons responsible for property management.

The City of San Antonio planning area executed a mandatory shutdown of non-essential businesses for eight weeks as a direct result of COVID-19. Re-opening of businesses and restaurants has been in limited measures to try and protect consumers while restarting the economy. Larger gatherings of people were limited to 50 and below and at times to 10 and below. The San Antonio Independent School District (ISD) closed all campuses and implemented remote learning in the spring of 2020 and for the first three weeks of the 2020-2021 school year. At the time of the drafting of this plan, in-person learning was ongoing with contract tracing for infected students.

The impacts of COVID-19, the mandatory shutdown, large gathering limits, ISD closures and pervasive unemployment have led to extensive secondary impacts. Figure 75 provides an overview of secondary impacts of COVID-19 in the United States.

Figure 75. Secondary Impacts of the COVID-19 Pandemic in the United States



ASSESSMENT OF IMPACTS

Pandemics impact larger than normal segments of the population and few sectors of the population are left untouched by infectious disease, as evidenced by the current pandemic. The physical problems associated with the infectious disease may be short term or may lead to long-term physical maladies.

The impact of an infectious disease event will be measured by the number of fatalities, how the community is affected, and to what extent. If many people get sick simultaneously, major social consequences will occur. Absenteeism in the workplace can have negative impacts on the overall functioning of society, particularly if it is prolonged.

The risks to public health and safety include first responders and others with increased exposure to the disease. Response personnel likely to experience the greatest impact would be those with medical responsibilities, such as fire fighters, ambulance workers, and clinic and hospital personnel. Response personnel could be in frequent contact with those who are either sick or infected and are prone to suffer proportionally higher impacts as a result.

Depending on the severity of the infectious disease event, there could be serious problems with continuity of operations and delivery of services. If City staff stay home due to illness, someone in their home is ill, or because they fear becoming ill, the ability of local government to maintain operations and deliver services could be seriously limited or compromised. A

pandemic illness that impacts City staff could have significant negative impacts, particularly for departments that do not have or exercise a Continuity of Operations (COOP) Plan. Without a COOP that considers department-specific issues, or regular exercise of that COOP, critical departments may not be able to function and provide necessary services.

A pandemic event may result in heightened stress for responders, health care providers, public health workers, individuals, and communities. A vital part of pandemic planning is the development of strategies and tactics to address these potential problems. Psychological health resources should be provided to ensure that special populations are identified prior to the event and that unique service and transportation needs are incorporated into the local pandemic influenza emergency management plan. Stress management support to those who are symptomatic, those who believe they are ill, and to staff who are dealing with the increased workloads and personal concerns will be required. The public will require information on how to recognize and cope with the short- and long-term risks of sustained stress during mass vaccinations, for those debilitated by an illness, and their caregivers.[158]

An infectious disease hazard affects living beings, therefore the vulnerability of property to an infectious disease event is minimal. Pandemics are unlikely to directly result in physical damage to the built environment. However, there is the possibility of indirect damage resulting from staff absenteeism and lack of routine operations and maintenance. For example, the City's flood control system, though largely operational through a telemetry system, requires some hands-on maintenance. Increased absenteeism of maintenance staff could result in reduced maintenance operations, which could negatively impact the operation of the system.

Human infectious diseases do not normally pose a risk to the natural environment. Infectious diseases tend to be specific to humans, and therefore pose little threat to the natural environment or non-mammalian species. However, certain exceptions exist, including the avian flu, which can affect both birds and humans. It is possible that other pathogens may affect more than one species, but those pathogens would likely be limited to specific species.

The historic and cultural resources of the area are generally immune to the effects of infectious disease events. However, historic and cultural resources attract significant numbers of tourists and visitors, increasing the potential for exposure and transmission of a variety of pathogens. The Alamo, Sea World, Six Flags, and Splashtown are all major tourist attractions. The Fiesta San Antonio cultural celebration, which lasts for 11 days and comprises more than 100 events, occurs in the early spring. These attractions and events draw large crowds. It would only take the presence of one infected person at a large event or attraction to cause the transmission of an infectious disease in the planning area and potentially damage the local tourism industry. A

[158] Source: San Antonio Metropolitan Health District

negative impact on local tourism could have serious economic ramifications for the community and for the businesses that operate or participate in these attractions and events.

Seasonal flu occurs annually and is estimated to cost the U.S. economy between $71 million and $167 million per year.[159] Severe pandemics have been predicted to cause more than $700 billion in economic losses, and to result in a 5.5% decrease in U.S. Gross Domestic Product (GDP).[160]

Major infectious disease events and pandemics can be expected to have larger and deeper impacts to the local and national economy. If the disease is slow progressing, particularly long-lasting, or has long-term residual effects, the impact to the economy could be extended.

If the normal movement of the epidemic within society needs to be curtailed, a process known as "social distancing," a greater impact to the local economy could occur. Social distancing can be accomplished by a several means; two ways of increasing social distance activity restrictions are to cancel events and close buildings or restrict access to certain sites or buildings. These measures are sometimes called "focused measures to increase social distance."

Depending on the situation, examples might include cancellation of public events, such as concerts, sports events, movies, plays; and closure of recreational facilities, such as community swimming pools, youth clubs, gymnasiums. While necessary to limit the spread of the pathogen, facility closures could have economic ramifications.[161]

Infectious disease events are complicated hazards. Accurate information and clear, concise explanation during an infectious disease event are critical when conveying messages to the public. When a communication to the public fails, it can result in a loss of credibility and public confidence in leadership.

Infectious disease events can undermine the public's confidence in its government and leaders. Public dissatisfaction with government response will typically increase as the number of cases rises and public fear increases. Perceptions of inequality in medical care, particularly if those inequalities are based on socioeconomic status, ethnicity, age, gender, or seniority, can lead to increased dissatisfaction with government and leadership, and may result in a weakening of social order or hostility towards those in leadership or medical roles. Required rationing of supplies or vaccinations should be conscientiously carried out to avoid the appearance of bias or impropriety. Decisions regarding vaccinations, guidance, and treatment should be explained clearly and consistently to the public. The Metro Health's Respiratory Viruses having Pandemic Potential Plan includes very specific guidance for communicating

[159] Source: World Health Organization

[160] Source: Federal Reserve Bank of St. Louis

[161] Source: GlobalSecurity.Org

with the public, acknowledging the importance of communication with the public and providing the clearest possible information during pandemics.

There could be significant public resistance to a decision to quarantine those who are ill or exposed, to restrict travel, or to implement social distancing. Any decision to restrict individual movement must be accompanied by a major public relations campaign to assure the public that these actions are necessary. If decisions are perceived by the public as necessary for their protection, the public is more likely to comply with official instruction.

Section 20: Cyberattack

Hazard Description

A cyberattack is any type of offensive maneuver employed by individuals or organizations that target computer information systems, infrastructures, computer networks, and personal computer devices by various means of malicious acts. The malicious act usually originates from an anonymous source that either steals, alters, or destroys a specified target by hacking into a susceptible system.

Cyberspace and its underlying infrastructure are vulnerable to a wide range of risk, including both physical and cyber threats and hazards. Sophisticated cyber actors and nation-states exploit vulnerabilities to steal information and money and can develop capabilities to disrupt, destroy, or threaten the delivery of essential services. Various crimes are perpetrated through cyberspace, including the production and distribution of child pornography and child exploitation conspiracies, banking and financial fraud, intellectual property violations, and other crimes, all of which have substantial human and economic consequences.

Cyberspace is particularly difficult to secure from cyberattack events, due to a number of factors, including the ability of malicious actors to operate from anywhere in the world, the links between cyberspace and physical systems, and the difficulty of reducing vulnerabilities and consequences in complex cyber networks. Of growing concern is the cyber threat to critical infrastructure, which is increasingly subject to sophisticated cyber intrusions that pose new risks. As information technology becomes increasingly integrated with physical infrastructure operations, there is increased risk for wide-scale or high-consequence events that could cause harm or disrupt services upon which our economy and the daily lives of millions of Americans depend. In light of the risk and potential consequences of cyber events, strengthening the security and resilience of cyberspace has become an important homeland security mission.[162]

The City of San Antonio has enjoyed continued growth over the past 35 years. As a university town, with an educated workforce, many technological companies have selected the City of San Antonio as their headquarters. To address the City's growth, the City of San Antonio has become a leader in its use of computers, networks, and the data stored on them. The city is home to our nation's second-largest concentration of cybersecurity experts—and growing.

[162] Source: Department of Homeland Security

Over 1,000 of those industry professionals are based in Port San Antonio's large campus—a proven strategic partner to the region's cyber community.[163] This section reviews the hazards to the cybersecurity assets for the City of San Antonio planning area.

HAZARDS

Denial of Service Attacks

A denial-of-service attack (DoS) is the attempt to make a computer or network resource unavailable to its intended users. A DoS attack may come from one or several computers, while a distributed denial-of-service attack (DDoS) will be launched from many, often thousands of computers. While a DoS attack may occur frequently and typically can be handled by the City's equipment, a DDoS attack can overload the City of San Antonio's network or computer resources resulting in extended downtime. Often these attacks rely on lower-level network vulnerabilities.

Data Loss / Leakage

Data loss can result from a variety of reasons, both intentional and unintentional. Data loss may result from a failure to properly backup or have disaster recovery equipment and processes; employees improperly handling sensitive data; and criminal activities such as espionage, theft, sabotage, and other malicious acts.

Infrastructure Loss / Failure

Loss of computer and network resources may result from a variety of natural and human-caused disasters including tornadoes, hurricanes, and explosions due to accident, power loss, terrorism, and fire.

Insider Threats

Insider threats are malicious threats to the planning area that comes from City of San Antonio employees, contractors, and volunteers who have access to the City's computers, networks, and data. An insider can initiate a DoS attack, leak or steal data, and sabotage the infrastructure and data.

Organized Cybercrime, State-Sponsored Hackers Espionage

Organized cybercrime, which may include state-sponsored cybercrime, are attacks on the City of San Antonio's computers, network, and data by criminal organizations. These criminals may

[163] Port Authority of San Antonio: https://www.portsanantonio.us/CyberWorksHere

be motivated by money or political reasons. Often these attacks are well planned out, difficult to identify due to their more limited scope, and can result in extensive damage.

Third Party Mismanagement

Reliance on third parties for cyber services implies acceptance of the risk that the third party may not properly protect the cyber resources from loss or unavailability. Hazards from the use of third parties include DoS, DDoS, data loss and leakage, infrastructure loss and failure, insider threats, and organized cybercrime.

Advance Persistent Threats

An advanced persistent threat (APT) is a stealthy and continuous attack on the City of San Antonio over a long period of time. The "advanced" process signifies sophisticated techniques using malware to exploit vulnerabilities in systems. The "persistent" process suggests that an external command and control system is continuously monitoring and extracting data from a specific target. The "threat" process indicates human involvement in orchestrating the attack.

Civil Disorder

Civil disorder may impact the cybersecurity of the planning area by directly or indirectly impacting the City of San Antonio's ability to support its computers, networks, and data. Civil disorder can result in the planning area not having resources due to direct impact to the computers and networks, and indirectly by limiting the resources necessary to run the computers and networks.

CYBERATTACK AND CLIMATE CHANGE

It is unknown how cyberattacks will be impacted by climate change. As more specific climate data and projections become available, the HMAP will address known climate impacts for all cyberattack hazards as appropriate.

Location

Cyberwar is deceptive, invisible to most, and fought out of sight. It takes place in cyberspace, a location that cannot be seen, touched, or felt. The physical instruments, such as computers, routers, and cables can be seen; however, these instruments interact in cyberspace, a virtual and unseen realm. Thus, the source of the hazard can extend from one part of the world to attacks on public or private sector entities in another part of the world, and the perpetrator can remain unknown in a legally provable sense. The entire City of San Antonio planning area can be affected by a cyberattack.

Extent

Currently an official index for measuring the extent of a cyberattack does not exist. The extent, nature, and timing of cyberattack events are impossible to predict. There may or may not be any warning. Some cyberattack events take a long time (weeks, months, or years) to be discovered and identified.[164] Therefore, the City of San Antonio planning area is vulnerable to all types of cyberattack, and can occur anywhere, at any time.

The extent of damages is based on historical incidents in the City of San Antonio planning area, which are classified as low, medium, and high; third party information regarding the impact; and if the City of San Antonio has experienced an occurrence of the incident.

Denial of service attacks: Low

A DoS and DDoS attack could result in an extended cyber-outage in the planning area. The outage, although impacting the daily business of the City of San Antonio would not have a substantial economic impact to the City.

Data loss/leakage: High

Data loss and leakage experienced by the City of San Antonio could result in costly remediation efforts to ensue. For example, if personally identifiable information (PII) is leaked, the City may be required to pay for credit protection services. Since the City of San Antonio manages a large quantity of sensitive information, the possibility of costly remediation efforts is high.

Infrastructure loss/failure: High

Loss of a cyber-processing facility could result in very high expenses to remediate, repair, and recover from the loss.

Insider threats: Medium

Insider threats can result in substantial impacts to the organization, depending on what data the insider has accessed. The City of San Antonio has remediated insider threats by using the industry standard separation of duties, and performing background checks of its employees, contractors, and volunteers.

Organized cybercrime, state-sponsored hackers espionage: High

The planning area is a target for organized criminals and state-sponsored hackers due to its political environment and the size of the organization. Due to the potential extent of attacks by organized criminals, the possibility and severity of resulting damages is great.

---

[164] Source: http://www.ready.gov/cyber-attack

Third party mismanagement: Low

Since each vendor is isolated to the service it performs, the damages from one third party's mismanagement is fairly low.

Advanced persistent threats: High

The impact of an APT to the planning area can be severe because a large number of systems can be affected and the remediation of such an attack could be expensive to recover from.

Civil disorder: High

The impacts of civil disorder on cybersecurity could be extensive due to the typical physical nature of the attacks.

Historical Occurrences

USA Today reported that the electric grid is attacked every four days, either physically or through cyber threats. San Antonio's Homeland Security official expressed that the number of attacks is accelerating and attacks are becoming more sophisticated. The Texas Governor announced that websites belonging to state agencies have seen an increase in attempted cyberattacks coming out of Iran (about 10,000 per minute) in the days since Iranian general Qassem Soleimani was killed in a U.S. drone strike.[165] While the attacks to gather data have not been successful, San Antonio's technology security team remains on high alert. The Electric Reliability Council of Texas (ERCOT) reportedly has a team of professionals and a series of procedures they utilized to protect the planning area systems from cyberattacks.

Even though cyberattack events are virtually impossible to predict, the City of San Antonio planning area has the potential for an occurrence at any time.

Probability of Future Events

The probability of occurrence based on historical incidents in the City of San Antonio are classified as low, medium, and high; as well as third party information regarding the likelihood of incidents if the City has not had an occurrence of the incident.

Denial-of-service attacks: Medium

The planning area has daily DOS attacks that are not severe enough to cause impact to the City of San Antonio's service levels. The City of San Antonio has had one DDoS attack over the last year that successfully impacted services.

---

[165] Statesman News Network, January 2020, Website: https://www.statesman.com/news/20200110/austin-on-guard-after-texas-hit-with-increased-cyberattacks-from-iran

Data loss/leakage: Medium

The planning area is subject to several compliance requirements that specifically address data loss and leakage. These compliance standards include but are not limited to:

- Payment Card Industry Security Standard (PCI/DSS)
- Health Insurance Portability and Accountability Act of 1996 (HIPAA)
- Criminal Justice Information Services Division (CJIS)

Historically, the City of San Antonio had one instance of data loss over the last year, which resulted in the City having to remediate the situation.

Infrastructure loss/failure: Low

The planning area has multiple data centers that are hardened in various ways to minimize the possibility of outage. Resilience and redundancy are continuously being reviewed and addressed to reduce the risk of loss or failure. Historically, the infrastructure has had few lengthy outages.

Insider threats: Low

The planning area requires anyone who has access to the City of San Antonio's enterprise network and resources to have gone through a background check, which is regularly reviewed. There has never been evidence of insider attacks.

Organized cybercrime, state-sponsored hackers espionage: Medium

Over the last five years, the City of San Antonio had several instances of organized attack via DDoS and malware by an organization. Because the City of San Antonio is a large public entity, it is more prone to these types of attacks.

Third party mismanagement: Low

The City of San Antonio utilizes third parties for its cyber activities, and vets all contracts prior to final agreement. As part of the contractual agreements, all data are required to be stored within the U.S. and segregated from other entities' data. There has not been an instance of Third-party mismanagement to date.

Advanced persistent threats: Medium

The City of San Antonio maintains systems that monitor symptoms of APT, and over the last year there has been one instance of an infection by malware, which had a command and control system.

Civil disorder: Low

The City of San Antonio has had instances of civil disorder in the past and is more subject to such events due to it being the capital of Texas. Although this is the case in general, the City has relatively low civil disorder.

Vulnerability and Impact

With the internet being largely open and unregulated, it leaves the planning area vulnerable to cyberattacks and threats. The attack can be on information systems resulting in a data breach, or the spread of a virus. With the growing dependence on digital interconnectivity, even a small incident may have widespread and damaging consequences.

Transportation, public safety, and utility services are all critical and highly dependent on information technology. The motive behind such disruptions can be driven by religious, political, or other objectives.

A cyberattack can last a few minutes to a couple of days, although large-scale events and their impacts can last much longer. Cyberattacks differ by motive, type, vector, and perpetrator profile.

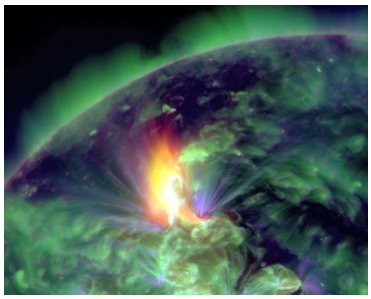
Cybersecurity involves protecting infrastructure by preventing, detecting, and responding to cyberattack incidents. Unlike physical threats that prompt immediate action, such as "stop, drop, and roll," in the event of a fire; cyber threats are often difficult to identify and comprehend. Among these dangers are viruses erasing entire systems, intruders breaking into systems and altering files, intruders using a computer or device to attack others, and intruders stealing confidential information. The spectrum of cyberattack risks is limitless. Threats of cyberattack can have wide-ranging effects on the individual, community, organizational, and national level. Risks from cyberattack include:

- Organized cybercrime, state-sponsored hackers, and cyber espionage, which can pose national security risks to our country.
- Transportation, power, and other services may be disrupted by large-scale cyber incidents, and the extent of the disruption is highly uncertain as it will be determined by many unknown factors, including the target and size of the incident.
- Vulnerability to data breach and loss increases if an organization's network is compromised, and therefore information about a company, its employees, and its customers can be at risk.
- Individually owned devices, such as computers, tablets, mobile phones, and gaming systems that connect to the Internet, are vulnerable to intrusion, and therefore personal information may be at risk without proper security.[166]

[166] Source: http://www.ready.gov/cyber-attack

Section 21: Technological Disruption

Hazard Description



Technological disruptions can be caused by solar flares, geomagnetic storms, and power disruptions. A solar flare is a sudden, rapid, and intense flash of brightness observed over the sun's surface that occurs when built-up magnetic energy from the solar atmosphere is suddenly released. Flares generally cannot pass through the Earth's magnetosphere and atmosphere; therefore, the City of San Antonio planning area is not vulnerable to powerful bursts of particles. However, solar flares can impact satellite and radio transmissions, cause flights to be re-routed due to changes in the Earth's magnetic field, and cause radio blackouts due to radiation. Geomagnetic storms are a major disturbance of Earth's magnetosphere that occur when there is a very efficient exchange of energy from solar wind into the space environment surrounding the Earth. Magnetic storms can affect the performance of equipment, upset radio communications, black out radars, and disrupt radio navigation systems.

TECHNOLOGICAL DISRUPTION AND CLIMATE CHANGE

It is unknown how technological disruptions will be impacted by climate change. As more specific climate data and projections become available, the HMAP will address known climate impacts for all causes of technical disruptions as appropriate.

Location

Space weather impacts various aspects of everyday life, including a variety of phenomena that occur due to the variability of the sun over periods ranging from hours to years. A technological disruption can happen anywhere and at any time within the entire world, including the City of San Antonio planning area.

Extent

The National Oceanic and Atmospheric Administration (NOAA) Space Weather Scales were introduced to publicly communicate the current and future space weather conditions and their possible effects on people and systems. Many of the Space Weather Prediction Center (SWPC) products describe the space environment, but few have described the effects that can be experienced as a result of environmental disturbances. The scales describe the environmental

disturbances for three event types, including geomagnetic storms, solar radiation storms, and radio blackouts. The scales have numbered levels, analogous to events that convey severity, including hurricanes, tornadoes, and earthquakes. The scales identify possible effects of an event, how frequently events occur, and the intensity of the physical causes.[167]

[167] Source: http://www.swpc.noaa.gov/noaa-scales-explanation

Table 96. Geomagnetic Storms

SCALE DESCRIPTION	EFFECT	PHYSICAL MEASURE	AVERAGE FREQUENCY (1 CYCLE = 11 YEARS)
G 5 Extreme	Power systems: Widespread voltage control problems and protective system problems can occur, and some grid systems may experience complete collapse or blackouts. Transformers may experience damage. Spacecraft operations: Problems with extensive surface charging, and orientation, uplink/downlink, and tracking satellites can occur. Other systems: Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)
G 4 Severe	Power systems: Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. Spacecraft operations: Problems with surface charging and tracking can occur, and corrections may be needed for orientation problems. Other systems: Induced pipeline currents can affect preventive measures, HF radio propagation is sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and Northern California (typically 45° geomagnetic lat.).	Kp = 8, including a 9	100 per cycle (60 days per cycle)

SCALE DESCRIPTION	EFFECT	PHYSICAL MEASURE	AVERAGE FREQUENCY (1 CYCLE = 11 YEARS)
G 3 Strong	Power systems: Voltage corrections can be required, and false alarms triggered on some protection devices. Spacecraft operations: Surface charging can occur on satellite components, drag can increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. Other systems: Intermittent satellite navigation and low-frequency radio navigation problems can occur, HF radio can be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G 2 Moderate	Power systems: High-latitude power systems can experience voltage alarms, and long-duration storms can cause transformer damage. Spacecraft operations: Corrective actions to orientation can be required by ground control, and possible changes in drag can affect orbit predictions. Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (360 days per cycle)
G 1 Minor	Power systems: Weak power grid fluctuations can occur. Spacecraft operations: Minor impact on satellite operations is possible. Other systems: Migratory animals are affected, and aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

Table 97. Solar Radiation Storms

SCALE DESCRIPTION	EFFECT	PHYSICAL MEASURE (FLUX LEVEL OF >= 10 MEV PARTICLES)	AVERAGE FREQUENCY (1 CYCLE = 11 YEARS)
S 5 Extreme	Biological: Unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity) occurs; and passengers and crew in high-flying aircraft at high latitudes can be exposed to radiation risk. Satellite operations: Satellites can be rendered useless, memory impacts can cause loss of control, serious noise in image data can occur, star-trackers may be unable to locate sources; and permanent damage to solar panels is possible. Other systems: Complete blackout of HF communications is possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S 4 Severe	Biological: Unavoidable radiation hazard to astronauts on EVA can occur; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. Satellite operations: Memory device problems and noise on imaging systems can occur; star-tracker problems can cause orientation problems, and solar panel efficiency can be degraded. Other systems: Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle

SCALE DESCRIPTION	EFFECT	PHYSICAL MEASURE (FLUX LEVEL OF >= 10 MEV PARTICLES)	AVERAGE FREQUENCY (1 CYCLE = 11 YEARS)
S 3 Strong	Biological: Radiation hazard avoidance is recommended for astronauts on EVA, and passengers and crew in high-flying aircraft at high latitudes can be exposed to radiation risk. Satellite operations: Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. Other systems: Degraded HF radio propagation through the polar regions and navigation position errors are likely.	10^3	10 per cycle
S 2 Moderate	Biological: Passengers and crew in high-flying aircraft at high latitudes can be exposed to elevated radiation risk. Satellite operations: Infrequent single-event upsets are possible. Other systems: Small effects on HF propagation through the polar regions can occur, and navigation at polar cap locations can possibly be affected.	10^2	25 per cycle
S 1 Minor	Biological: None. Satellite operations: None. Other systems: Minor impacts on HF radio in the polar regions.	10	50 per cycle

Table 98. Radio Blackouts

SCALE DESCRIPTION	EFFECT	PHYSICAL MEASURE	AVERAGE FREQUENCY (1 CYCLE = 11 YEARS)
R 5 Extreme	HF Radio: Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours can occur. This results in no HF radio contact with mariners and en route aviators in this sector. Navigation: Low-frequency navigation signals used by maritime and general aviation systems can experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours can occur on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	Less than 1 per cycle
R 4 Severe	HF Radio: HF radio communication blackout on most of the sunlit side of Earth can occur for one to two hours, and HF radio contact is lost during this time. Navigation: Outages of low-frequency navigation signals can cause increased error in positioning for one to two hours, and minor disruptions of satellite navigation are possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3 Strong	HF Radio: Wide area blackout of HF radio communication, and loss of radio contact for about an hour on sunlit side of Earth can occur. Navigation: Low-frequency navigation signals can be degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2 Moderate	HF Radio: Limited blackout of HF radio communication on the sunlit side of the Earth, and loss of radio contact for tens of minutes can occur. Navigation: Degradation of low-frequency navigation signals for tens of minutes can occur.	M5 (5×10^{-5})	350 per cycle (300 days per cycle)

SCALE DESCRIPTION	EFFECT	PHYSICAL MEASURE	AVERAGE FREQUENCY (1 CYCLE = 11 YEARS)
R 1 Minor	HF Radio: Weak or minor degradation of HF radio communication on the sunlit side of the Earth, and occasional loss of radio contact can occur. Navigation: Low-frequency navigation signals can be degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

The societal and economic impacts of a geomagnetic disturbance scenario have been mapped in Figure 76. Texas is at a zero percent for an at-risk transformer capacity. This does not mean that Texans are safe from power grid failure. In recent years, utilities have joined grids together to allow long-distance transmission of low-cost power to areas experiencing sudden demand. The interconnectedness of the power grid makes the system susceptible to wide-ranging "cascade failures." [168]

The U.S. electric grid has three main components, including generation (creation of electricity), transmission (long haul transport of electricity), and distribution (shorter distances connecting the electricity to the consumer and end user). The electric grid is complex with an increasing number of connection points. The U.S. has 80,000 miles of extra-high voltage (EHV) transmission lines comprising the backbone of the transmission grid that enables the long-haul transport of electricity. EHV transformers are considered critical equipment on the transmission grid and 90% of consumed power passes through a high voltage transformer at some point. If EHV transformers fail, especially in large numbers, the resulting damage could be extensive.

EHV transformers are huge, weighing hundreds of tons, making them difficult to transport, and in some cases rare and specialized rail cars must be used for transport. Many of the EHV transformers installed in the U.S. are approaching or exceeding the end of their design lifetimes (approx. 30-40 years), increasing their vulnerability to failure. Although the utility industry does maintain limited spares, it could be challenging to quickly replace several transformers at once.[169]

[168] Source: http://science.nasa.gov/science-news/science-at-nasa/2009/21jan_severespaceweather/

[169] Source: http://www.dhs.gov/science-and-technology/power-hungry-prototyping-replacement-ehv-transformers

Figure 76. At Risk Extra High Voltage (EHV) Transformer Capacity Map by State

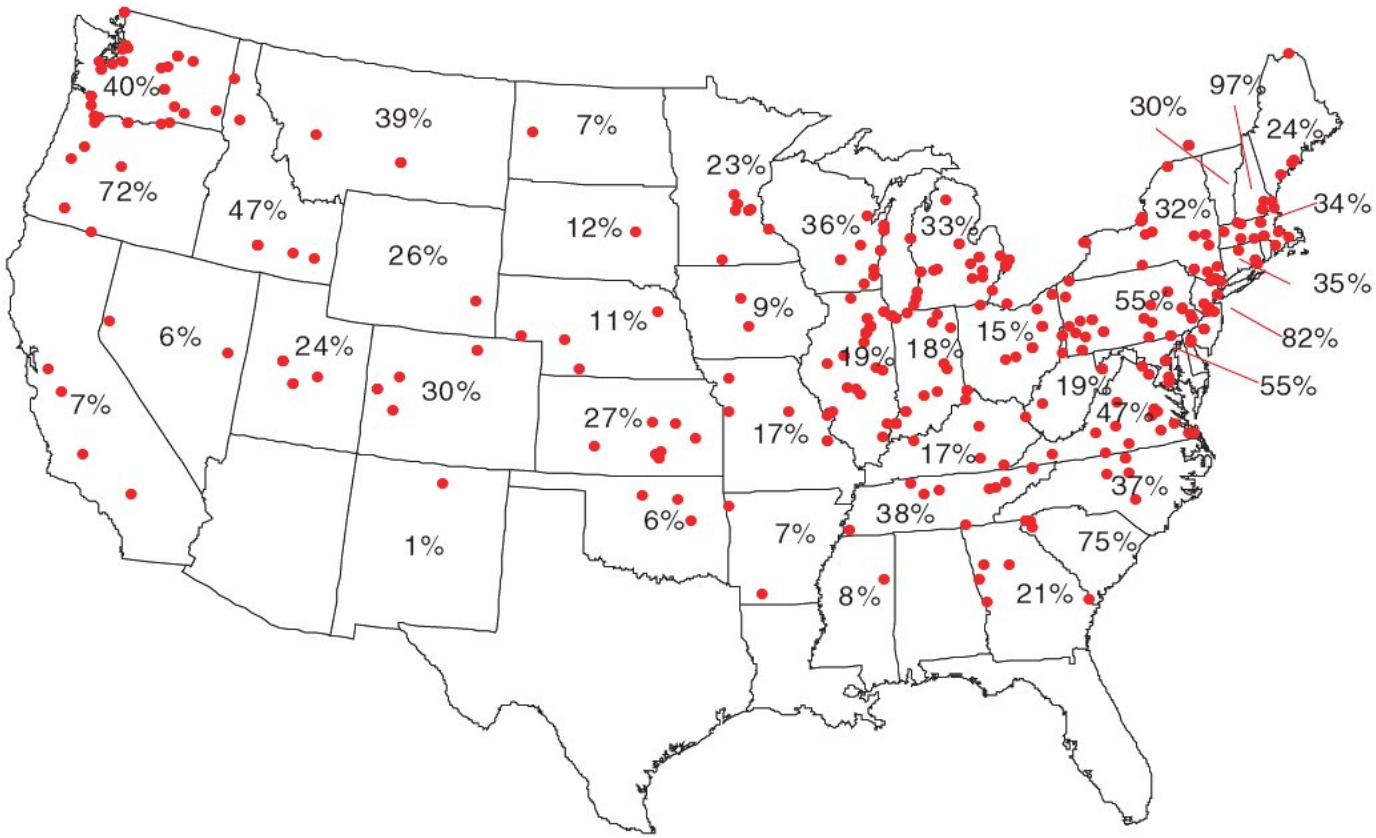


FIGURE 7.2 A map showing the at-risk EHV transformer capacity (estimated at ~365 large transformers) by state for a 4800 nT/min geomagnetic field disturbance at 50° geomagnetic latitude. Regions with high percentages of at-risk capacity could experience long-duration outages that could extend multiple years. SOURCE: J. Kappenman, Metatech Corp., "The Future: Solutions or Vulnerabilities?," presentation to the space weather workshop, May 23, 2008.

Historical Occurrences

SIGNIFICANT EVENTS

July 23, 2012

The solar storm of 2012 was an unusually large and strong coronal mass ejection (CME) event that occurred on July 23, 2012. It missed the Earth with a margin of approximately nine days, as the equator of the Sun rotates around its own axis with a period of about 25 days. The region that produced the outburst was thus not pointed directly towards the Earth at that time. The strength of the eruption was comparable to the 1859 Carrington event (see below) that caused damage to electrical equipment worldwide, which at that time consisted mostly of telegraph systems.

October-November 2003

The Halloween Solar Storms were a series of solar flares and coronal mass ejections that occurred from mid-October to early November 2003, peaking around October 28–29. Satellite-based systems and communications were affected, aircraft were advised to avoid high altitudes near the Polar Regions, and a one-hour-long power outage occurred in Sweden as a result of the solar activity. Auroras were observed at latitudes as far south as Texas and the Mediterranean countries of Europe.

The Solar and Heliospheric Observatory (SOHO) satellite failed temporarily, and the Advanced Composition Explorer was damaged by the solar activity. Numerous other spacecraft were damaged or experienced downtime. Some spacecrafts were intentionally put into safe mode to protect sensitive equipment. Astronauts aboard the International Space Station had to stay inside the more shielded parts of the Russian Orbital Segment to protect themselves against the increased radiation levels. Both the Ulysses spacecraft, which was near Jupiter at the time, and Cassini, approaching Saturn, were able to detect the emissions. In April 2004, Voyager 2 was also able to detect them as they reached the spacecraft.

These events occurred during solar cycle 23, approximately three years after its peak in 2000, which was marked by another occurrence of solar activity known as the Bastille Day Flare.

March 9-13, 1989

The March 1989 geomagnetic storm was a severe storm that caused the collapse of Hydro-Québec's electricity transmission system. It occurred during solar cycle 22.

The storm began on Earth with extremely intense auroras at the poles. The aurora could be seen as far south as Texas and Florida. As this occurred during the Cold War, an unknown

number of people worried that a nuclear first strike might be in progress. Others considered the intense auroras to be associated with the Space Shuttle mission STS-29, which had been launched on March 13, 1989, at 9:57:00 AM. The burst caused short-wave radio interference, including the disruption of radio signals from Radio Free Europe into Russia. It was initially believed that the signals had been jammed by the Soviet government.

Through the evening of March 13, a river of charged particles and electrons in the ionosphere flowed from west to east, inducing powerful electrical currents in the ground that surged into many natural nooks and crannies.

Some satellites in polar orbits lost control for several hours. Geostationary Operational Environmental Satellite (GOES) weather satellite communications were interrupted, causing weather images to be lost. National Aeronautics and Space Administration's (NASA) Tracking and Data Relay Satellite (TDRS)-1 communication satellite recorded over 250 anomalies caused by the increased particles flowing into its sensitive electronics. The Space Shuttle Discovery was having its own problems: a sensor on one of the tanks supplying hydrogen to a fuel cell was showing unusually high pressure readings on March 13, 1989. The problem went away after the solar storm subsided.

May 13 -15, 1921

The May 1921 geomagnetic storm was a significant event caused by the impact of an extraordinarily powerful coronal mass ejection on Earth's magnetosphere. It took place May 13 through May 15, 1921, and was part of solar cycle 15. This event occurred before extensive interconnectivity of electrical systems and the general electrical dependency across infrastructures in the developed world, so the effect was restricted to certain sectors. Resulting ground currents were up to an order of magnitude greater than those of the March 1989 geomagnetic storm that blacked out large parts of northeastern North America. At the time, scientists estimated the size of the sunspot—which began on May 10, 1921, and caused the storm—to be 94,000 by 21,000 miles (131,000 km by 33,800 km).

August 28-September 2, 1859

The 1859 Solar Flare is the largest magnetic explosion recorded and is referred to as the Carrington Event, named for British Astronomer Richard Carrington, who witnessed growing sunspots and documented a bright white flash that lasted about five minutes. The impacts on Earth were colorful and bright auroras seen as far south as Hawaii and Cuba. Telegraph operators experienced sparks from telegraph equipment that started fires. Scientists predict that such an event today would be devastating to the internet, communications, and power transformers; satellites; airplanes; or any GPS guided system. Solar activity is closely monitored as the sun storms have increased since 2011. Studies have shown that a solar storm of this

magnitude occurring today would likely cause widespread problems for modern civilization. The solar storm of 2012 was of similar magnitude, but it passed Earth's orbit without striking the planet.

Probability of Future Events

Technological Disruptions for the City of San Antonio are likely and are expected to continue in the near future. Solar storm activity is expected to increase and is being mapped by NASA's Solar Shield Project and NOAA's Space Weather Prediction Center to show strong currents and warn power companies to protect their systems. The entire City of San Antonio planning area could be affected if there is another major solar flare, depending on location of penetration within the Earth's atmosphere.

Vulnerability and Impact

Different types of space weather can affect different technologies at Earth. Solar flares can produce strong x-rays that degrade or block high-frequency radio waves used for radio communication during events known as Radio Blackout Storms. Solar Energetic Particles (energetic protons) can penetrate satellite electronics and cause electrical failure. These energetic particles also block radio communications at high latitudes during Solar Radiation Storms. Space weather has been recognized as causing problems with new technology since the invention of the telegraph in the 19th century.

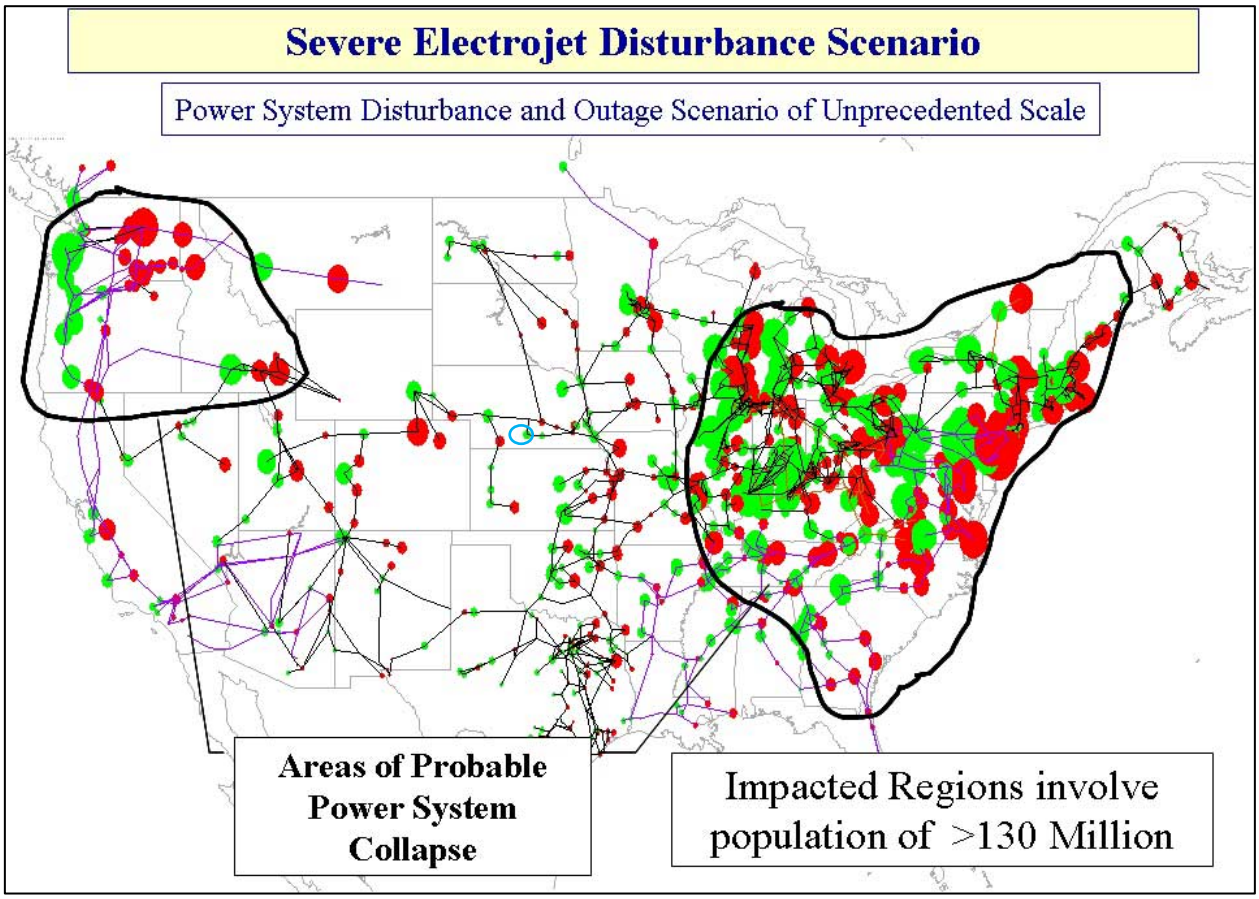
Besides emitting a continuous stream of plasma called the solar wind, the sun periodically releases billions of tons of matter called coronal mass ejections. These immense clouds of material, when directed toward Earth, can cause large magnetic storms in the magnetosphere and upper atmosphere. Such space weather can affect the performance and reliability of space-borne and ground-based technological systems. coronal mass ejections (CME) can cause geomagnetic storms on Earth and induce extra currents in the ground that can degrade power grid operations.

Geomagnetic storms can modify the signal from radio navigation systems (GPS and GNSS) causing degraded accuracy. Geomagnetic storms also produce the aurora. Space weather will impact people who depend on all these technologies.

A catastrophic failure of commercial and government infrastructure in space and on the ground can be mitigated through raising public awareness, improving vulnerable infrastructure, and developing advanced forecasting capabilities. Without preventive actions or plans, the trend of increased dependency on space-weather sensitive technology could make society more vulnerable to a technological disruption event in the future.

Figure 77 identifies a hypothetical scenario presented by a study on potential extreme space weather events that could result in a partial, widespread collapse of the U.S. electric power grid with enormous consequences for the affected population. As seen in Figure 77, the City of San Antonio planning area would be affected. Improvements in space weather forecasting, public awareness, and infrastructure preparedness can mitigate the potential effects of technological disruption.

Figure 77. Power System Disturbance Scenario[170]



[170] Source: NASA, San Antonio is indicated by the blue circle.

Section 22: Mitigation Goals

Mitigation Goals

Based on the results of the risk and capability assessments, the Planning Team was able to develop and prioritize the mitigation strategy. This involved utilizing the results of both assessments and reviewing the goals and objectives that were included in the previous previous HMAP update. At the Risk Assessment Workshop held September 9, 2020, and the Mitigation Workshop held October 1, 2020, Planning Team members refined the previous HMAP update's mitigation strategy from the previous HMAP update. The consensus among all members present was that the strategy developed for the previous HMAP update did not require changes, as it identified overall improvements to be sought in the HMAP. The following goals and objectives were identified by reviewing the information presented in the City of San Antonio and Bexar County Office of Emergency Management Hazard Identification, Risk Assessment (HIRA) and Consequence Analysis.

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 city 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 23: Previous Actions

Summary

Planning Team members were given copies of the previous mitigation actions submitted in the previous HMAP update at the mitigation workshop. The City of San Antonio 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. The actions from the previous HMAP updateare included in this section as they were written in 2015, except for the "2021 Analysis" section.

CITY OF SAN ANTONIO

		City of San Antonio (Past Action) – #1
	Proposed Action:	**Purchase radio communications equipment for the Fire Department.**
	BACKGROUND INFORMATION	
	Site and Location:	Locations in the City to be determined
	Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase operational preparedness for wildfire events.
	Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on New/Existing Buildings:	Reduce response time and loss of structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	Fire Department
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Firewise, Fire Protection Plan, Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #2	
Proposed Action:	**Implement program to remove dead and downed trees to decrease fire fuels, prevention of debris in case of hail or ice buildup during storms.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Natural landform protection and reduced risk of loss of property and life.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire, Winter Storm, Hail, Extreme Wind, Hurricane
Effect on New/Existing Buildings:	Reduce potential fire danger
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP, Texas Forest Service
Lead Agency/Department Responsible:	Parks & Recreation Department
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Fire Protection Plan, Firewise

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #3	
Proposed Action:	**Install hail guards for Heating, Ventilation, and Air-Conditioning (HVAC) systems on critical facilities to protect against severe hail in excess of ½ inch diameter.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Protect HVAC systems to increase efficiency of units by minimizing debris damage, reduce electrical costs, and prevent overheating of units.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hail
Effect on New/Existing Buildings:	Decrease damage to critical facilities
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$500,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	None

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #4	
Proposed Action:	**Conduct public education program and disseminate information to residents on how to mitigate their homes to extreme heat and protection associated with prolonged outdoor activities.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Provides education to the public on the dangers of extreme heat; reduces the risk to public health and welfare.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Heat
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$30,000
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	San Antonio Metropolitan Health District (Metro Health)
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #5	
Proposed Action:	**Insert information in residents' monthly utility bills for reducing water usage during drought conditions.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Conserve essential water supply.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought
Effect on New/Existing Buildings:	Educate residents on water conservation
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$30,000
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	San Antonio Water System (SAWS)
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Firewise Plan, Water/wastewater Utilities

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #6	
Proposed Action:	**Purchase generators for secondary emergency backup power. Generators will have enough power to enable full use of the primary pump stations that provide water to the City's critical facilities i.e., fire departments, fire hydrants, hospitals, medical offices, schools, universities, numerous high value commercial customers, large residential apartment complexes and homeowners.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Continue essential utility and electrical service to residents.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Tornado, Flood, Winter Storm, Hail, Extreme Wind, Terrorism, Dam Failure, Hurricane, Extreme Heat
Effect on New/Existing Buildings:	Continue to provide essential services
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$875,000 per unit (purchase generators over several years as federal funding is available)
Potential Funding Sources:	PDM & HMGP
Lead Agency/Department Responsible:	San Antonio Water System (SAWS)
Estimated Start Date:	2015-2020 based on funding
Incorporation into Existing Plans:	Water Contamination Emergency Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #7	
Proposed Action:	**Install quick connect systems on all critical facilities with emergency generators.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Continue essential service operations in the event of power failure.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Tornado, Flood, Hail, Winter Storm, Dam Failure, Extreme Wind, Terrorism, Hurricane, Extreme Heat
Effect on New/Existing Buildings:	Supply power to critical structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP, Grants
Lead Agency/Department Responsible:	Office of Emergency Management
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #8	
Proposed Action:	**Install shutters on glass windows and doors to protect critical facility buildings during severe weather events.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce damage to infrastructure during severe weather events, glass replacement costs, and injury to residents.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Wind, Tornado, Hail, Hurricane
Effect on New/Existing Buildings:	Protection of existing buildings
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$750,000
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #9	
Proposed Action:	**Adopt and enforce the current International Wildland-Urban Interface (WUI) Code.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to residents and first responders, minimizes financial loss to residents and infrastructure.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on New/Existing Buildings:	Reduce risk to structures from hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Minimal
Potential Funding Sources:	Local
Lead Agency/Department Responsible:	Development Services Department, Fire Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Fire Protection Plan, Emergency Operations/ Response Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #10	
Proposed Action:	**Develop and implement a Community Wildfire Protection Plan with local and state assistance.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to Citizens and First Responders; Allow for cooperative efforts from many entities; Minimize Cost of Recover.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System 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:	$250,000
Potential Funding Sources:	Texas Forest Service
Lead Agency/Department Responsible:	Fire Department, Office of Sustainability
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #11	
Proposed Action:	**Develop and implement a 'Dead and Down Fuels' Ordinance that requires residents and businesses to remove dead trees and brush from property.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk of hazards associated with dead trees and brush.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire, Extreme Wind, Hurricane
Effect on New/Existing Buildings:	Reduce risk to nearby structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000 annually
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Development Services Department, Fire Department
Estimated Start Date:	2015-2019
Incorporation into Existing Plans:	Fire Protection Plan, Firewise

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #12	
Proposed Action:	**Join the Firewise Program and educate residents on reducing fire fuels in corporation with the Texas A&M Forest Service, and local community organizations.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Wildfire Risk Reduction; Drought reduction (Firewise Landscaping); Flood (when done in green belts and waterways).
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on New/Existing Buildings:	Reduce threat to wildfire and drought conditions
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Texas Forest Service, local revenue
Lead Agency/Department Responsible:	Fire Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Fire Protection Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #13	
Proposed Action:	**Work with State and City departments to reduce fuel on public and private lands, easements, and right of ways.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risks to citizens and public land; minimize damage, speed recovery and safety of responders.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire, Hazardous Materials, Pipeline Failure
Effect on New/Existing Buildings:	Reduce fuel threat, fire, explosion to structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	Cooperating agencies
Estimated Start Date:	2015-2019
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #14	
Proposed Action:	**Implement prescribed fire program to reduce fire fuel on natural waterways, aquifers, parkland areas, and San Antonio Water source.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Wildfire risk reduction and protect area waterways and water sources from runoff and pollutants resulting from wildfire.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on New/Existing Buildings:	Educate and reduce risk and threat to structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Local revenue, HMGP, other funding source(s)
Lead Agency/Department Responsible:	Fire Department, Office of Sustainability
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #15	
Proposed Action:	**Expand brush pickup program, frequency and locations to reduce amount and length of time fire fuels are present on City and private property.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce fire risk, increase first responder and community safety. Better access for first responders.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Wind, Wildfire, Winter Storm, Hurricane
Effect on New/Existing Buildings:	Reduce possible fires that threaten structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000
Potential Funding Sources:	HMGP, local revenue
Lead Agency/Department Responsible:	Fire Department
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Firewise

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #16	
Proposed Action:	**Develop and implement agreements with railroads to develop a fuel reduction plan along the railways and right of ways.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduces risk to citizens, will keep railways open, reduces risk to first responders (access, being close to train); repair cost.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hazardous Materials
Effect on New/Existing Buildings:	Reduce exposure to structures/possible explosions
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	Railroad budget, local revenue
Lead Agency/Department Responsible:	Fire Department, Development Services Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #17	
Proposed Action:	**Identify shelters and safe refuge locations for public evacuation associated with disasters such as wildfire, hazardous materials, pipeline failure, terrorism, infectious disease.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Benefits citizens and first responders' safety.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hazardous Materials, Pipeline Failure, Wildfire, Terrorism, Infectious Disease, Dam Failure
Effect on New/Existing Buildings:	None
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	Local revenue, grants
Lead Agency/Department Responsible:	Office of Emergency Management, Fire Department, Police Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #18	
Proposed Action:	**Conduct public education and awareness through social media to advertise shelter locations in the event of disasters such as wildland fires, hazardous materials release, pipeline failure, infectious disease, terrorism, dam failure.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Benefits citizens and first responders' safety.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hazardous Materials, Pipeline Failure, Wildfire, Terrorism, Infectious Disease, Dam Failure
Effect on New/Existing Buildings:	None
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Office of Emergency Management, Fire Department, Police Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #19	
Proposed Action:	**Develop and implement an annual tree trimming program near public right-of-ways and utility lines to reduce falling limbs during severe weather events.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce cost of repairs; increase safety of citizens, utility workers.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Wind, Winter Storm, Flood, Tornado, Hail, Hurricane
Effect on New/Existing Buildings:	Reduce damage to nearby structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP, Local Utility Company, TCI
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Utility Services

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #20	
Proposed Action:	**Develop and implement annual program to identify and create fire breaks in public park areas and City-owned land to reduce fuels in the event of a fire.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce cost of repairs; life safety of citizens and first responders.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Effect on New/Existing Buildings:	Buffers around structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Texas Forest Service
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Firewise

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #21	
Proposed Action:	**Conduct assessment of eligible flood reduction activities in preparation for applying for Community Rating System (CRS) program.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce flood insurance premiums for residents; remove flood-prone properties, promote higher regulatory standards to reduce loss of life and property damage in flood events.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Minimize flooding of structures in City
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #22	
Proposed Action:	**Install automated systems at low-water crossings with high rate of vehicular access resulting in frequency of accidents and loss of life.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce potential loss of life from vehicular flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce loss of life during high water events
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Delete Action.

City of San Antonio (Past Action) – #23	
Proposed Action:	**Purchase open space in flood-prone areas to keep land free from construction in perpetuity.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce loss of life and property damage in flood-prone areas.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Natural Systems Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce loss of life during high water events
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Parks and Recreation Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #24	
Proposed Action:	**Install cooling stations at City-owned facilities to aid low income and elderly residents during extreme heat events.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce health risk, loss of life to a segment of population without air-conditioning.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Project

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Heat
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	San Antonio Metropolitan Health District (Metro Health)
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #25	
Proposed Action:	**As part of Community Rating System (CRS), conduct public education through social media, City's website, brochures, and flyers to promote reduced flood insurance premiums and other program benefits.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce loss of life and property damage in flood-prone areas through purchase of flood insurance and reduce cost of flooding post-disaster through higher regulatory standards.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System 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:	To be determined
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Parks and Recreation Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #26	
Proposed Action:	**Update city building codes and San Antonio Property Maintenance codes every three years as required by new state building code amendments.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to residents by implementing updated building and maintenance codes.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Extreme Wind, Tornado, Hurricane
Effect on New/Existing Buildings:	Strengthen existing and new building designs
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Development Services Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #27	
Proposed Action:	**Execute a Memorandum of Understanding between Solid Waste Management Department and Development Services Department to outline and coordinate efforts of debris removal on a quarterly basis.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to residents; reduce emergency response efforts during a severe weather event.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Extreme Wind, Tornado, Winter Storm, Dam Failure, Hurricane
Effect on New/Existing Buildings:	Reduce effects of debris on structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Development Services Department/Solid Waste Management Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #28	
Proposed Action:	**Upgrade drainage channels along the Union Pacific railroad tracks to reduce flooding to adjacent residential and commercial structures.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce intermediate flooding to residents living next to drainage channels. Reduce property damage, prevent soil erosion, reduces health risks to area.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flooding of adjacent structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$500,000
Potential Funding Sources:	HMGP, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department, Union Pacific
Estimated Start Date:	Upon Funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan, Drainage Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #29	
Proposed Action:	**Conduct a rooftop sight assessment plan of all flat roof buildings in the downtown business district to determine critical damage/necessary repairs to prevent roof collapse under current code.**
BACKGROUND INFORMATION	
Site and Location:	Downtown business district
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risks to businesses; reduce emergency response efforts during a severe weather event of damaged buildings or collapsing roofs.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Extreme Wind, Tornado, Winter Storm, Hail, Hurricane
Effect on New/Existing Buildings:	Retrofit and secure failing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$35,000
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Development Services Department: Building Inspections and Damage Assessment Team
Estimated Start Date:	2015
Incorporation into Existing Plans:	Building Code and Regulations

2021 ANALYSIS
Delete Action.

City of San Antonio (Past Action) – #30		
	Proposed Action:	**Adopt and implement smart growth initiatives that incorporate the adopted Hazard Mitigation Plan in long-term community development planning activities.**
	BACKGROUND INFORMATION	
	Site and Location:	Locations in City to be determined
	Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce future risk to residents and increase new and existing infrastructure resilience to severe weather events.

	Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans/Structure and Infrastructure Projects Emergency managers and planners will annually develop a method to coordinate revisions and updates of the natural hazard mitigation and the City's Comprehensive Plan "Comp plan 2040". The result of this coordination process is to select mitigation strategies to determine how they can best be integrated into comprehensive plan updates that development regulations or link with other public or private efforts, such as open space preservation or other capital improvement projects. The assurance of integration of the natural hazard mitigation plan into the comprehensive planning process can help make certain that the appropriate hazard assessment information is considered during future land use and development planning. The Office of Sustainability is proposing to lead an annual assessment and update of the Hazard Mitigation Plan and the Comp plan 2040. The deliverables within the annual assessment will include but are not limited to: 1) A climate and vulnerability assessment – climate change *sensitivity analysis* addressing stormwater management, and road operations and maintenance to identify current and projected weather conditions. 2) Policy recommendations to enable the identification of parcels or areas to be designated as high risk. 3) Identification of related capital improvements or land acquisition projects to strengthen at-risk public facilities, such as fire and police stations, and utility systems, or to resist floods and geological hazards or incorporate interconnection service networks, such as roads, pipelines, and cables, and to allow more than one route to any point so that they are less vulnerable to local failures. Source: http://www.fema.gov/media-library-data/1388432170894-6f744a8afa8929171dc62d96da067b9a/FEMA-X-IntegratingLocalMitigation.pdf

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Extreme Wind, Wildfire, Winter Storm, Hurricane
Effect on New/Existing Buildings:	Increase new and existing infrastructure resilience to severe weather events
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000 per year through December 2020
Potential Funding Sources:	Local revenue, HMGP, Regional and State Emergency Funding
Lead Agency/Department Responsible:	Office of Sustainability
Estimated Start Date:	December 2016 December 2017 December 2018 December 2019 December 2020
Incorporation into Existing Plans:	Comprehensive Plan 2040, Hazard Mitigation Plan, Infrastructure Management Plan, City of San Antonio Capital Improvements Program, Bond Program 2012-2017

2021 ANALYSIS
Competed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #31	
Proposed Action:	**Integrate fire services such as reporting suspicious activity and threat information into the Southwest Texas Fusion Center.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to citizens regarding suspicious activity reports, emerging threats and related information.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, DHS
Lead Agency/Department Responsible:	Fire Department, Southwest Texas Fusion Center
Estimated Start Date:	Upon Funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #32	
Proposed Action:	**Coordinate technology and communications equipment used by fire, police and first responders to be compatible and uniform.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to citizens regarding suspicious activity reports, emerging threats and related information.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, DHS
Lead Agency/Department Responsible:	Fire Department; Southwest Texas Fusion Center
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #33	
Proposed Action:	**Coordinate information/intelligence sharing and public safety information gleaned from first responders and departments upward through various government levels.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to citizens regarding suspicious activity reports, emerging threats and related information.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, DHS
Lead Agency/Department Responsible:	Fire Department; Southwest Texas Fusion Center
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #34	
Proposed Action:	**Form an all-man security team from fire and police trained in a uniform method to respond to terrorism acts and integrate into Fire Department Tech Services Division.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to citizens regarding suspicious activity reports, emerging threats and related information.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, DHS
Lead Agency/Department Responsible:	Fire Department; Southwest Texas Fusion Center
Estimated Start Date:	Upon Funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #35	
Proposed Action:	**Conduct public education via social media, utility flyers, and other outreach methods to increase awareness of hazardous materials release and pipeline failure.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to citizens regarding threat of pipeline failure and hazardous materials release and related events.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hazardous Materials, Pipeline Failure
Effect on New/Existing Buildings:	Reduce possible explosions
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, Fire Department
Lead Agency/Department Responsible:	Fire Department
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #36	
Proposed Action:	**Partner with pipeline companies, agencies and organizations to keep areas in the vicinity of oil and gas pipelines safe and secure, and report suspicious behavior or activity near pipelines.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to citizens regarding threat of pipeline failure and hazardous materials release and related events.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hazardous Materials, Pipeline Failure
Effect on New/Existing Buildings:	Reduce possible explosions
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, Fire Department
Lead Agency/Department Responsible:	Fire Department
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #37	
Proposed Action:	**Update City policy and plans for protecting City staff and residents from infectious disease.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risk to all residents from seasonal influenza, virus, and rabies.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Infectious Disease
Effect on New/Existing Buildings:	None
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	Public Health Emergency Preparedness Grant
Lead Agency/Department Responsible:	San Antonio Metropolitan Health District (Metro Health)
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #38	
Proposed Action:	**Implement and conduct electronic vaccine record system for first responders.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Secure first line defense to reduce risk to first responders in an effort to expedite response to seasonal influenza, virus, and rabies.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Infectious Disease
Effect on New/Existing Buildings:	None
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	Public Health Emergency Preparedness Grant
Lead Agency/Department Responsible:	San Antonio Metropolitan Health District (Metro Health)
Estimated Start Date:	Upon funding
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #39	
Proposed Action:	**Acquire properties in flood prone areas with priority given to repetitive flood loss structures.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Remove flood prone properties; promote higher regulatory standards to reduce loss of life and property damage in flood events.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Minimize flooding of structures in City
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #40	
Proposed Action:	**Remove existing Mulberry St bridge and construct a new bridge that will allow a 100-year ultimate flood to pass below the roadway.**
BACKGROUND INFORMATION	
Site and Location:	Mulberry St bridge
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding and potential loss of life at low water crossing.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Minimize flooding of structures in City
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,590,354.55
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #41	
Proposed Action:	**Replace existing culvert on with an upgraded multiple box culvert system (MBC) or bridge. Street reconstruction (including curbs and sidewalks as necessary) will be included. A concrete lined channel is also proposed.**
BACKGROUND INFORMATION	
Site and Location:	Sleepy Hollow St to Orsinger St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding and potential loss of life at low water crossing.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Minimize flooding of structures in City
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,450,346.56
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Storm Water Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #42	
Proposed Action:	**Improve drainage to watershed SA-4 by installing cross drains, replacing existing metal grate, and add box culverts and other miscellaneous storm drain improvements.**
BACKGROUND INFORMATION	
Site and Location:	Mahncke Park
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding and potential loss of life at low water crossing.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Minimize flooding of structures in City
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,374,500
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #43	
Proposed Action:	**Construct multiple culvert crossing, reconstruct existing concrete lined channel from W. Martin St to the confluence of Bandera Branch Tributary to Apache Creek and at each crossing; include curbs and sidewalks.**
BACKGROUND INFORMATION	
Site and Location:	From the Apache Creek confluence (at NW 26th St) to W. Martin St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Remove up to 25 homes from the FEMA SFHA
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,119,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #44	
Proposed Action:	**Construct concrete lined channel with 100 ft. bottom width with 5:1 side slopes and reconstruct the culvert system upstream headwall.**
BACKGROUND INFORMATION	
Site and Location:	Village Crest Dr to Rittiman Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Remove up to 13 homes from the FEMA SFHA
Priority (High, Moderate, Low):	High
Estimated Cost:	$6,023,330
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #45	
Proposed Action:	**Construct a 60 ft. lateral structure, installation of 2,700 LF of 10'x10' single box culvert (SBC), reconstruction of the existing earthen channel to a 60 ft. bottom-width trapezoidal channel with 3:1 side slopes, and replace the existing culvert system at Ira Lee Rd with a two-span bridge. The storm sewer system will be jacked/bored to prevent traffic disruption.**
BACKGROUND INFORMATION	
Site and Location:	Salado Creek confluence to Harry Wurzbach Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Removes all structures from the floodplain east of Harry Wurzbach Rd
Priority (High, Moderate, Low):	High
Estimated Cost:	$6,081,300
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #46	
Proposed Action:	**Construct an underground drainage system utilizing 66" reinforced concrete pipe (RCP).**
BACKGROUND INFORMATION	
Site and Location:	Moursund Blvd to Six Mile Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Alleviate home and street flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,710,090
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #47	
Proposed Action:	**Re-grading/channelization of the creek to improve flow characteristics. The project also includes the buy-out of several homes located in the floodplain.**
BACKGROUND INFORMATION	
Site and Location:	Bitters Rd to North Loop Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Alleviate home and street flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,700,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Completed. Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #48	
Proposed Action:	**Expand 116,370 sq. ft. bridge under SW. Loop 410 and approximately 2,930 LF channel modification downstream from SW. Loop 410. This project also includes property buyout for necessary easement.**
BACKGROUND INFORMATION	
Site and Location:	SW. Loop 410 (east of Somerset Rd) and approx. 3,000 ft. downstream
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Eliminate low water crossing at SW. Loop 410
Priority (High, Moderate, Low):	High
Estimated Cost:	$65,931,219
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #49	
Proposed Action:	**Construct underground drainage 72" reinforced concrete pipe (RCP) to alleviate street flooding. Repair street including curbs and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Fredericksburg Rd to Williamsburg Pl
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce potential flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,862,736.93
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #50	
Proposed Action:	**Replace the concrete lined open channel between McCullough Ave and the confluence of the box culverts located approximately 800 ft. east of McCullough Ave. Reconstruct McCullough Ave from Barbara Dr to Sharon Dr with an underground storm sewer system with curb inlets to eliminate the low water crossing at Barbara Dr and McCullough Ave.**
BACKGROUND INFORMATION	
Site and Location:	McCollough Ave – Barbara Dr to Sharon Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce potential flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,586,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #51	
Proposed Action:	**Improve drainage and reconstruct necessary streets with curbs, sidewalks, and driveway approaches: Phase I will only address a portion of the described project. Barbara Dr drainage #73 Phase IIA – Channel modifications and improvements.**
BACKGROUND INFORMATION	
Site and Location:	Pinewood Ln (El Montan Ave to Dellwood Dr), Dellwood Dr (Pinewood Ln to Oblate Dr), Waring Dr (Springwood Ln to Barbara Dr), Barbara Dr (Oblate Dr to Skipper Dr), McCullough Ave (W. Rector to Linda Dr)
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce potential flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$21,967,009
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #52	
Proposed Action:	**Construct bridge crossing with +/- 6,300 LF of total channel grading upstream and downstream and excavating to eliminate a low water crossing. Street reconstruction includes driveway approaches, curbs, and sidewalks as required. A total of three lots will be required to buyout for drainage proposes.**
BACKGROUND INFORMATION	
Site and Location:	Dreamland Dr from railroad to 550 ft. west of railroad crossing; 1,600 LF both and 4,700 LF south of Dreamland Dr low water crossing
Risk Reduction Benefit *(Current Cost/ Losses Avoided)*:	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,320,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #53	
Proposed Action:	**Construct underground drainage improvements to both low water crossings #26 and #27 with street reconstruction including curbs, sidewalks and culverts. The project will also consist of channel drainage improvements and 5-10'x5' multiple box culverts (MBCs) at each crossing to eliminate the low water crossings.**
BACKGROUND INFORMATION	
Site and Location:	Lockhill Rd and White Bonnet St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,410,518
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #54	
Proposed Action:	**Construct drainage improvements and buyout properties in the floodplain.**
BACKGROUND INFORMATION	
Site and Location:	Andover Dr to Salado Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,412,774
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #55	
Proposed Action:	**Construct drainage improvements to provide all weather access. Replace existing multiple box culvert (MBCs) system with bridge structure. Improvements will require associated street reconstruction to include curbs, sidewalks, and driveway approaches be incorporated into the project.**
BACKGROUND INFORMATION	
Site and Location:	Pinn Rd, 1,500 ft. south of W. Commerce St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,375,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #56	
Proposed Action:	**Upgrade existing concrete channel to reduce the 1% floodplain and erosion. The project will consist of proposing concrete channel and channel excavation. The project will also consist of installing 9-10'x10' multiple box culverts (MBCs) and street reconstruction that will include driveways, curbs, and sidewalks.**
BACKGROUND INFORMATION	
Site and Location:	Loop 410 to Olmos Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)*:	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,465,528
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #57	
Proposed Action:	**Installation of underground system consisting of box culverts, Capital Improvement Program (CIP) Bond Project Phase I.**
BACKGROUND INFORMATION	
Site and Location:	Oak Glen Dr & Haskins Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$8,050,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #58	
Proposed Action:	**Improve culvert crossing. Existing culvert causes storm water back up, which triggers flooding to local residents. Expand the existing channel, concrete line the channel, and replace the existing corrugated metal arch pipe with 5-12'X8' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Clyde Dent Dr to Leon Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,076,296
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #59	
Proposed Action:	**Construct a drainage system and reconstruct the street to alleviate localized ponding.**
BACKGROUND INFORMATION	
Site and Location:	Fratt Rd, from Rittiman Rd to Eisenhauer Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$6,587,700
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update. Update cost to $15,596,000.

City of San Antonio (Past Action) – #60	
Proposed Action:	**Construction of a drainage outfall to alleviate flooding problems in the area. The proposed system consists of 2-12'X8' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Outfall bounded by Frio City Rd and Hwy 90
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,798,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #61	
Proposed Action:	**Reconstruct underground drainage infrastructure and street reconstruction.**
BACKGROUND INFORMATION	
Site and Location:	Amity Rd from Roland Rd to Rigsby Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,660,075.50
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update. Update cost to $3,365,000.

City of San Antonio (Past Action) – #62	
Proposed Action:	**Reconstruct underground drainage 6'x4' single box culvert (SBC). Associated street reconstruction to include curbs, sidewalks, and driveway approaches will be incorporated into the project.**
BACKGROUND INFORMATION	
Site and Location:	Ray Ellison Blvd from SW. Loop 410 to Valley Hi Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,498,269
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #63	
Proposed Action:	**Install underground storm sewer system.**
BACKGROUND INFORMATION	
Site and Location:	Topperwein Rd from Nacogdoches Rd to Ridge Willow Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,336,800.84
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #64	
Proposed Action:	**Major structure upgrade replacement to provide access across Leon Creek, requires significant channel grading with necessary street reconstruction with curbs and sidewalks.**
BACKGROUND INFORMATION	
Site and Location:	W. Commerce St from Pinn Rd to SW. Military Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$14,020,627
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #65	
Proposed Action:	**Improve low water crossing to contain the 100-year ultimate flows. Includes channel improvements to Olmos Creek and necessary street reconstruction with curb and sidewalk.**
BACKGROUND INFORMATION	
Site and Location:	Vance Jackson Rd at Orsinger St low water crossing #36
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,524,121
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #66	
Proposed Action:	**Install underground drainage system utilizing 2-7'x3' multiple box culverts (MBCs) and an outfall to TxDOT channel. Necessary street reconstruction includes curbs, driveway approaches and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Marbach Rd from SW. Loop 410 to Horal Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,678,972.87
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #67	
Proposed Action:	**Channelize sections of the Salado Creek. These improvements would require the removal of an estimated 500 trees and the pruning of an estimated 250 trees. These improvements would provide the capacity of the 10-year flood event.**
BACKGROUND INFORMATION	
Site and Location:	Salado Creek from J Street Park to Rigsby Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,018,018.84
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #68	
Proposed Action:	**Install underground channel system consisting of 42" & 48" reinforced concrete pipe (RCP) and 2-8'x5' multiple box culverts (MBCs). The proposed channel will tie into an existing channel.**
BACKGROUND INFORMATION	
Site and Location:	Center Park Blvd from Remount Dr to Center Park Blvd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,243,565
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #69	
Proposed Action:	**Design and construct underground drainage system and earthen channel to divert drainage into the golf course and reconstruction to ensure proper drainage and include curbs and sidewalks.**
BACKGROUND INFORMATION	
Site and Location:	Pembroke Rd from Rochelle St to Abe Lincoln
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,543,466
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #70	
Proposed Action:	**Improve culvert crossings to provide an earthen channel that will convey the 1% annual chance future conditions floodplain.**
BACKGROUND INFORMATION	
Site and Location:	Mud Creek Tributary A drainage Improvements from Thousand Oaks Dr to Miss Ellie Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,016,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #71	
Proposed Action:	**Design and construct underground drainage and construct driveway culverts at all driveways to ensure proper drainage and include curbs and sidewalks.**
BACKGROUND INFORMATION	
Site and Location:	County View Ln from Rochelle St to Abe Lincoln
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,727,226.74
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #72	
Proposed Action:	**Channelize and improve the low water crossing #21 and #22 with 5'x7' multiple box culverts (MBCs). A bypass system that will capture and convey the flow downstream is consisting of 2-10'x6' multiple box culverts (MBCs) and 5'X6' single box culvert (SBC). Knoll Creek Improvements Phase 1.**
BACKGROUND INFORMATION	
Site and Location:	Low water crossing #21 and #22, - From Jung Rd to Stahl Rd on Salado Creek Tributary F.
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,984,339
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #73	
Proposed Action:	**Replace existing low water crossing with an upgraded culvert 2-10'x10' multiple box culverts (MBCs) or bridge to eliminate a low water crossing #71 with some channel modifications upstream and downstream of the crossing.**
BACKGROUND INFORMATION	
Site and Location:	Low water crossing #71 Danville and Overbrook
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #74	
Proposed Action:	**Improve drainage and drainage ditch.**
BACKGROUND INFORMATION	
Site and Location:	Multi-phase project Zarzamora #83 B,C,D Phase II from W. Hutchins Pl to SW. Loop 410
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,000,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #75	
Proposed Action:	**Upgrade the existing box culvert system and storm sewer system with associated street repair and rehabilitation that will include curbs and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Pinn Rd from Orr Dr to Westlawn Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,818,336.34
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #76	
Proposed Action:	**Upgrade and replace the existing channel with an underground drainage system. The proposed system would consist of approximately 3,300 LF of 4-8'x4' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Thames Dr between Blanco Rd and San Pedro Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,119,728.69
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #77	
Proposed Action:	**Install a reinforced-concrete open channel drainage system with associated at-grade drainage structures to alleviate localized street flooding.**
BACKGROUND INFORMATION	
Site and Location:	Normoyle Ditch
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$12,400,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #78	
Proposed Action:	**Construct underground drainage 7'x7' single box culvert (SBC) to alleviate street flooding.**
BACKGROUND INFORMATION	
Site and Location:	Freiling Dr from Wonder Pkwy to Vance Jackson Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,187,246
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #79	
Proposed Action:	**Construct earthen channel. Additionally, construction includes box culverts and a concrete channel.**
BACKGROUND INFORMATION	
Site and Location:	Shady Hollow Ln from northwest of Babcock Rd and NW. Loop 1604
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,181,560
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #80	
Proposed Action:	**Upgrade low water crossing #24 to 10-7'x4' multiple box culverts (MBCs), and upgrade low water crossing #24.1 to 11-10'x6' multiple box culverts (MBCs). The improvements will require an upgrade to the earthen channel to a concrete line channel with a varying bottom ranging from 60 ft. to 100 ft.**
BACKGROUND INFORMATION	
Site and Location:	Lookout Rd and Judson Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)*:	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,910,592
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update. Update cost to $3,868,327.

City of San Antonio (Past Action) – #81	
Proposed Action:	**Improve drainage system.**
BACKGROUND INFORMATION	
Site and Location:	Broadway St corridor - Phase V (Catalpa-Pershing drainage channel to Brackenridge Ave)
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,495,544
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #82	
Proposed Action:	**Install underground drainage system. The project will also reconstruct and modify/improve signalization as needed.**
BACKGROUND INFORMATION	
Site and Location:	Broadway Corridor Phase III- 1B; Burr Rd From Broadway St to N. New Braunfels Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,174,900
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #83	
Proposed Action:	**Construct a regional storm water facility.**
BACKGROUND INFORMATION	
Site and Location:	East of Huebner Rd and Apple Green Rd, south of Eckhert Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$9,599,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #84	
Proposed Action:	**Construct an underground drainage system to alleviate street flooding. Underground drainage system includes installing 6'x4' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Braubach St from Roosevelt Ave to Six Mile Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,115,764.24
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #85	
Proposed Action:	**Construct a parallel storm sewer system and at-grade drainage structures to alleviate flooding of homes and streets. The proposed system consists of 10'x7' single box culvert (SBC), 10' inlets, and 24" & 30" laterals.**
BACKGROUND INFORMATION	
Site and Location:	Overbrook outfall; Evelyn Dr from Seeling Blvd and St Cloud to Rosemont Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,154,961
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #86	
Proposed Action:	**Construct a storm sewer system. System will consist of inlets with reinforced concrete pipe (RCP).**
BACKGROUND INFORMATION	
Site and Location:	Castle Cross from Midcrown Dr to Rittiman Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,700,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #87	
Proposed Action:	**Install an underground system which will continue in a box culvert. This will eliminate low water crossing #95.**
BACKGROUND INFORMATION	
Site and Location:	Northwood-Devonshire area drainage; Chevy Chase Dr to Eisenhauer Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,058,929
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #88	
Proposed Action:	**Construct additional culvert from outfall. Reconstruct streets, curbs & sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Olympia area streets and drainage from Alhambra to San Angelo
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,373,609
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #89	
Proposed Action:	**Conduct major channel improvements as well as three bridge/culvert crossings. Street reconstruction will be required as well.**
BACKGROUND INFORMATION	
Site and Location:	Diversey drainage from IH 10 E. just inside Loop 1604
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$13,922,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #90	
Proposed Action:	**Install underground drainage system utilizing 3-9'x6' multiple box culverts (MBCs). Necessary street reconstruction includes sidewalks, curbs and driveway approaches.**
BACKGROUND INFORMATION	
Site and Location:	North San Antonio Hills subdivision; Misty Woods St & SH 151
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,567,272.42
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #91	
Proposed Action:	**Street and drainage reconstruction in order to alleviate runoff. The reconstruction of streets can include sidewalk, curbs, and approaches and inlets for the drainage improvements.**
BACKGROUND INFORMATION	
Site and Location:	Wilson from Woodlawn Ave to Waverly Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$8,199,874.7
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #92	
Proposed Action:	**Construct drainage improvements. Drainage system/outfall and street reconstruction including curbs and sidewalks as required. Sheet flowing runoff runs over streets and through lows in private properties causing flooding and ponding.**
BACKGROUND INFORMATION	
Site and Location:	Mabelle Dr; Goforth Dr and N. Weidner Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,255,867.14
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #93	
Proposed Action:	**Construct an underground drainage system within the right-of-way of Pickwell Dr to alleviate localized flooding at 115 Pickwell Dr. Reconstruction of Pickwell Dr, Gayle Ave, Banbridge Ave, Galway St, Tipperary Ave, Kilarney Dr, and Dublin Ave will be also be included along with curbs, sidewalks, and driveway approaches.**
BACKGROUND INFORMATION	
Site and Location:	Pickwell area drainage Improvement Phase C; Palfrey St to Dublin Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$8,847,337
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update. Update cost to $9,160,000.

City of San Antonio (Past Action) – #94	
Proposed Action:	**Construct an underground drainage system comprising 2-10'x4' multiple box culverts (MBCs) to alleviate street flooding. The project requires reconstruction of Elmira St and the intersections of Euclid Ave, McCullough Ave, Erie Ave, and Atlanta St and Wilmington Ave.**
BACKGROUND INFORMATION	
Site and Location:	Elmira St from McCullough Ave to San Antonio River
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,104,468.52
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #95	
Proposed Action:	**Construct an underground drainage structure 4'x5' multiple box culverts (MBCs) to alleviate street flooding. The improvements would require associated drainage structures (culverts) and street reconstruction to include curbs, sidewalks, and driveway approaches.**
BACKGROUND INFORMATION	
Site and Location:	Jackson Keller Rd from San Pedro Ave to McCullough Ave
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,036,610.20
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #96	
Proposed Action:	**Construct underground drainage system.**
BACKGROUND INFORMATION	
Site and Location:	Southwell Rd from Prue Rd to Huebner Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,080,032
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #97	
Proposed Action:	**Construct underground drainage 10'x7' single box culvert (SBC) to alleviate flooding of homes. This project requires the Woodlawn Lake outfall be upgraded first.**
BACKGROUND INFORMATION	
Site and Location:	Seeling Drainage Improvements; Placid Dr to Zachry Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$17,100,149
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #98	
Proposed Action:	**Install an underground drainage system along with street reconstruction curb, sidewalks, and driveway approaches.**
BACKGROUND INFORMATION	
Site and Location:	Five Palms Dr from Medina Base Rd to W. Military Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,935,700
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #99	
Proposed Action:	**Install an underground drainage system and street reconstruction. Also, an outfall to French Creek will be constructed.**
BACKGROUND INFORMATION	
Site and Location:	Heath Circle Dr from Coral Springs to Low Bid Ln
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$13,551,524.98
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #100	
Proposed Action:	**Install an underground drainage system along various streets. Along with associated at-grade drainage structures to alleviate localized street flooding with associated street repair and rehabilitation that will include curbs and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Wabash Storm Drainage; Fenfield Ave/W. Mayfield Blvd – Wabash St to New Laredo Hwy; Lovett Ave – Wabash St to New Laredo Hwy
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$13,685,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #101	
Proposed Action:	**Construct channel to contain storm water runoff within the Oakland Estates neighborhood, and utilized box culverts for street crossings. The project will help eliminate dangerous crossings.**
BACKGROUND INFORMATION	
Site and Location:	Southwell Rd From Verbena St to Encino Park Rd and Hollyhock Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,547,476
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #102	
Proposed Action:	**Install an underground drainage system 36" reinforced concrete pipe (RCP) to alleviate street flooding. Reconstruction of street including curbs, driveway approaches and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Cincinnati Ave from N. General McMullen Dr to Tulane Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,125,803.77
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #103	
Proposed Action:	**Alleviate localized flooding with proposed drainage to help convey flows underground.**
BACKGROUND INFORMATION	
Site and Location:	Roland Rd Drainage Phase I, II, and III; Rigsby Ave to Family Tree Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$20,127,403
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

		City of San Antonio (Past Action) – #104
	Proposed Action:	**Upgrade and improve low water crossing and associated street reconstruction. Street reconstruction to include sidewalks, curbs and driveway approaches.**
	BACKGROUND INFORMATION	
	Site and Location:	Old Fredericksburg Rd, north of N. Loop 1604 W., from N. Loop 1604 W. and IH 10
	Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
	Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,791,882
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #105	
Proposed Action:	**Construct an earthen channel. The improvements also include adding multiply box culverts under Sligo St, Esma St, and San Juan Rd and limited street reconstruction.**
BACKGROUND INFORMATION	
Site and Location:	Brookside Outfall; Brookside Subdivision. From Lebanon St to an unnamed tributary to the San Antonio River west of Southton Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,738,107
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #106	
Proposed Action:	**Improve drainage with 48" reinforced concrete pipe (RCP) & street reconstruction including curbs and sidewalks as required. Runoff sheet flow across streets into properties in whole neighborhood.**
BACKGROUND INFORMATION	
Site and Location:	Deerwood Dr from Rainbow Dr to Austin Hwy
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,003,464.05
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #107	
Proposed Action:	**Construct underground drainage system consisting of 24" to 60" reinforced concrete pipe (RCP), curb inlets, outfall structures, and boring beneath the railroad to the Airport Tributary.**
BACKGROUND INFORMATION	
Site and Location:	Empire St – Belfast Dr to Everest St; Ridgecrest Dr & W. Lawndale Dr – Everest St to Broadway St; Belfast Dr, Colton Dr, & Conway Dr – Empire St to Everest St; Mavis St – Belfast Dr to Conway Dr; Everest St – W. Lawndale Dr to Conway Dr; Janda Susan Rd & Lookover St - dead-end to Ridgecrest Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$9,385,100
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #108	
Proposed Action:	**Improve channel for +/- 2,200 LF and +/- 3,000 LF of storm drain box culverts. The project limits will consist from an adjacent drainage channel to Hwy 90 to General Hudnell Dr, where runoff will be conveyed buy an additional 12'x8' box culvert +/- 3,000 LF will connect to an existing storm system.**
BACKGROUND INFORMATION	
Site and Location:	Hwy 90 to General Hudnell Dr to Frio City Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,500,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #109	
Proposed Action:	**Expand 1,050 LF of existing channel and adding 1,655 LF of multiple box culverts (MBCs) to alleviate localized flooding. This project is created for drainage because the existing conveyance system does not have capacity.**
BACKGROUND INFORMATION	
Site and Location:	Channel runs north of Juniper St & underground system running down Gallant St to Sligo St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,219,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #110	
Proposed Action:	**Install an underground drainage system utilizing 8'x5' single box culvert (SBC) to alleviate flooding of homes. Necessary street reconstruction includes curbs, driveway approaches, and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	W. Hildebrand Ave to W. Kings Hwy
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$23,878,250.92
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #111	
Proposed Action:	**Upgrade channel for floodplain reclamation and flow improvement in the area.**
BACKGROUND INFORMATION	
Site and Location:	Pershing Creek from Salado Creek to Fort Sam Houston
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,912,301
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #112	
Proposed Action:	**Install a large underground system that will capture the majority of the storm water before it gets to the grate inlet. The proposed system will tie into an existing TxDOT system, and increase the capacity of the existing system. The system ranges from 30" reinforced concrete pipe (RCP) to 4-7'x3' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Busby System Phase 2: Nacogdoches Rd to Lawndale Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,313,725
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update. Update cost to $3,674,000.

City of San Antonio (Past Action) – #113	
Proposed Action:	**Improve the drainage infrastructure to include installing 2-7'x3' multiple box culverts (MBCs). Necessary street reconstruction will include driveway approaches, curbs, and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Churchill Estates; Chloe Dr/Churchill Ave/Mimmie St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,710,090
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #114	
Proposed Action:	**Install a large underground system that will capture the majority of the storm water before it gets to the grate inlet. The proposed system will tie into an existing TxDOT system, and increase the capacity of the existing system. The system ranges from 30" reinforced concrete pipe (RCP) to 4-7'x3' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Busby System Phase 1: Nacogdoches Rd to Lawndale Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,861,419
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #115	
Proposed Action:	**Install a large underground system that will capture the majority of the storm water before it gets to the grate inlet. The proposed system will tie into an existing TxDOT system, and increase the capacity of the existing system. The system ranges from 30" reinforced concrete pipe (RCP) to 4-7'x3' multiple box culverts (MBCs).**
BACKGROUND INFORMATION	
Site and Location:	Busby System Phase 3: Nacogdoches Rd to Lawndale Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,118,162
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update. Update cost to $3,025,000.

City of San Antonio (Past Action) – #116	
Proposed Action:	**Improve underground drainage 2-7'x3' multiple box culverts (MBCs) to one of three outfalls to the Hills & Dales neighborhood. Associated street reconstruction to include curbs, sidewalks, and driveway approaches be incorporated into the project.**
BACKGROUND INFORMATION	
Site and Location:	Shady Hollow Ln; Hills & Dales
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,111,316
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #117	
Proposed Action:	**Reconstruct and upgrade of underground drainage, curbs, and sidewalks. May require at least a 7'x6' single box culvert (SBC) outfall existing channel and laterals on these streets to alleviate street flooding.**
BACKGROUND INFORMATION	
Site and Location:	Vestal Pl/Hutchins Pl/Langford Pl/Amber St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,512,617.57
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #118	
Proposed Action:	**Construct a trapezoidal channel that connects to a storm water system. The trapezoidal channel will consist of a top width of 13 ft., bottom width of 4 ft. and side slopes of 3:1. The system will consist of eight 10ft curb inlets. The system will tie into an existing system.**
BACKGROUND INFORMATION	
Site and Location:	Stringfellow St to Menlo Blvd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,805,945.96
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #119	
Proposed Action:	**Construct channel to accept the flows from two culvert systems 1-48" and 2-36" corrugated metal pipes (CMP). The channel will be grass lined with exception of the upstream 100 ft. and downstream 100 ft., where it will be concrete riprap for erosion protection. Wing walls and energy dissipaters will also be required.**
BACKGROUND INFORMATION	
Site and Location:	Rockwell Outfall to Six Mile Creek; Railroad tract/Baetz Blvd to Six Mile Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)*:	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,035,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #120	
Proposed Action:	**Construct an underground drainage system utilizing 9'x2' single box culvert (SBC) and street reconstruction to alleviate street flooding. Necessary street reconstruction includes driveway approaches, curbs, and sidewalks as required.**
BACKGROUND INFORMATION	
Site and Location:	Donore Pl and Tupelo Ln
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,075,856.69
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #121	
Proposed Action:	**Construct an underground drainage system and an 8'x6' multiple box culverts (MBCs) to alleviate street flooding.**
BACKGROUND INFORMATION	
Site and Location:	Wilma Jean Dr and Rockwell Blvd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,034,964
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #122	
Proposed Action:	**Construct and improve drainage ditch. Proposed improvements will rebuild S. Zarzamora St to a 5-lane section, 62 ft. travel lanes and two 5 ft. bike lanes for total 72 ft. pavement.**
BACKGROUND INFORMATION	
Site and Location:	S. Zarzamora St from W. Hutchins Pl to W. Villaret Blvd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$17,038,223.29
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #123	
Proposed Action:	**Upgrade channel at San Antonio River Spill at Broadway St. The upgraded channel will consist of removal and reconstruction of the current channel.**
BACKGROUND INFORMATION	
Site and Location:	San Antonio River near Broadway St and Carnahan St to Funston Pl
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$8,000,000
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #124	
Proposed Action:	**Install an underground drainage to improve local drainage. Street reconstruction includes driveway approaches, sidewalks and curbs.**
BACKGROUND INFORMATION	
Site and Location:	New Laredo Hwy between Pitluk Ave to Leon Creek
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,835,760.82
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #125	
Proposed Action:	**Drainage improvements of existing box culvert system on Westwood Village Creek, low water crossing #112.**
BACKGROUND INFORMATION	
Site and Location:	Near intersection of Westbriar and W. Military Dr
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,476,946
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #126	
Proposed Action:	**Construct a 7'x5' single box culvert (SBC) to alleviate street flooding.**
BACKGROUND INFORMATION	
Site and Location:	S. General McMullen Dr from Hwy 90 to Roselawn Rd
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,022,187.34
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #127	
Proposed Action:	**Upgrade underground drainage 2-7'x3' multiple box culverts (MBCs). Associated street reconstruction to include curbs, sidewalks, and driveway approaches are incorporated into the project.**
BACKGROUND INFORMATION	
Site and Location:	Shady Hollow Ln near northwest corner of Babcock Rd and N. Loop1604 W.
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,410,759
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #128	
Proposed Action:	**Construct underground drainage 9'x6' single box culvert (SBC) to alleviate flooding of yards and streets. Associated street reconstruction to include curbs, sidewalks, and driveway.**
BACKGROUND INFORMATION	
Site and Location:	S. San Ignacio Ave from W. Commerce St to Dartmouth St
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce flood waters from backing up into area
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,127,937.86
Potential Funding Sources:	HMGP, TWDB, local revenue
Lead Agency/Department Responsible:	Transportation & Capital Improvements (TCI) Department
Estimated Start Date:	2015
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System (CRS)

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

City of San Antonio (Past Action) – #129	
Proposed Action:	**Advertise availability of cooling stations at City-owned facilities through City's website and other social media to aid low income and elderly residents during extreme heat events.**
BACKGROUND INFORMATION	
Site and Location:	Locations in City to be determined
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce health risk, loss of life to a segment of population without air-conditioning.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Heat
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	San Antonio Metropolitan Health District
Estimated Start Date:	2015
Incorporation into Existing Plans:	Emergency Operations/Response Plan

2021 ANALYSIS
Completed.

City of San Antonio (Past Action) – #130	
Proposed Action:	**Notify property owners of results of rooftop sight assessment plan of all flat roof buildings in the downtown business district to make necessary repairs to prevent roof collapse under current code.**
BACKGROUND INFORMATION	
Site and Location:	Downtown business district
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Reduce risks to businesses, reduce emergency response efforts during a severe weather event of damaged buildings or collapsing roofs.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood, Extreme Wind, Tornado, Winter Storm, Hail, Hurricane
Effect on New/Existing Buildings:	Retrofit and secure failing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$35,000
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	Development Services Department: Building Inspections and Damage Assessment Team
Estimated Start Date:	2015
Incorporation into Existing Plans:	Building Code and Regulations

2021 ANALYSIS
Delete Action.

City of San Antonio (Past Action) – #131	
Proposed Action:	**Develop and implement an ordinance to restrict the use of public water resources for non-essential usage, such as landscaping, washing cars, filling swimming pools, etc. during drought conditions.**
BACKGROUND INFORMATION	
Site and Location:	Throughout City
Risk Reduction Benefit *(Current Cost/ Losses Avoided)***:**	Conserve essential water supply.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure projects, Natural System Protection, or Education and Awareness)*	Local Plans and Regulations

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought
Effect on New/Existing Buildings:	Water conservation measures during drought emergencies
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$30,000
Potential Funding Sources:	Local revenue
Lead Agency/Department Responsible:	San Antonio Water System (SAWS)
Estimated Start Date:	2015-2016
Incorporation into Existing Plans:	Firewise Plan, Water/wastewater Utilities

2021 ANALYSIS
Defer Action – Action will be included in the 2021 Plan Update.

Section 24: 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 HMAP. 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 part of the economic evaluation of the STAPLEE analysis, jurisdictions 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. As a result of this exercise, priority was assigned to each mitigation action by marking them as High (H), Moderate (M), or Low (L). An action ranked as "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, of two different types.

Table 99. City of San Antonio Mitigation Action Matrix

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.					
CITY OF SAN ANTONIO: MITIGATION ACTION MATRIX					
HAZARDS	**TYPES OF ACTION:**				
	LOCAL PLANS / REGULATIONS	**STRUCTURE / INFRASTRUCTURE**	**NATURAL SYSTEMS PROTECTION**	**EDUCATION & AWARENESS**	**PREPAREDNESS / RESPONSE / OTHER**
Drought	1	3		3	
Extreme Heat	1	6		3	
Flood	6	94	1	4	
Wildfire	6	5	4	5	
Tornado	2	5		2	
Extreme Wind[171]	5	7	1	2	
Hail		7	1	2	
Dam Failure	2	4		3	
Winter Storm	3	6	1	2	
Lightning		5		2	
Expansive Soils		1		2	
Terrorism	4	2		3	
Hazardous Materials	2		1	4	
Pipeline Failure	1		1	4	
Infectious Disease	1			2	
Cyber Attack				1	
Technological Disruption				1	

[171] Extreme Wind includes Thunderstorm Wind, Hurricane Wind, and Straight-Line Wind.

CITY OF SAN ANTONIO

	City of San Antonio – Action #1
Proposed Action:	Purchase radio communications equipment for the Fire Department.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio Fire Department
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase operational preparedness for wildfire events.
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):	High
Estimated Cost:	$500,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Firewise; Fire Protection Plan; Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #2	
Proposed Action:	Implement a program to remove dead and downed trees to decrease fire fuels and to prevent debris in case of hail or ice buildup during storms.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Protect natural landforms; Reduce risk of loss of property and life
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; Winter Storm; Hail; Extreme Wind
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Local funds; State and federal grants; Texas Forest Service
Lead Agency/Department Responsible:	Parks & Recreation Department
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Fire Protection Plan; Firewise

COMMENTS
A street tree inventory ranges from $3.50-$5.00 a tree. A tree storm report $4,000-$5,000 and with analysis $6,000-$7,500. A tree canopy study with ecosystem service benefits $50,000-$60,000.

City of San Antonio – Action #3	
Proposed Action:	Install hail guards for heating, ventilation, and air conditioning (HVAC) systems on critical facilities to protect against severe hail more than a half inch diameter.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio critical facilities
Risk Reduction* Benefit** *(Current Cost/Losses Avoided):**	Protect HVAC systems to increase efficiency of units by minimizing debris damage; Reduce electrical costs; Prevent overheating of units.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hail
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$500,000
Potential Funding Sources:	Local Funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	None

COMMENTS

City of San Antonio – Action #4	
Proposed Action:	Insert information in residents' monthly utility bills for reducing water usage during drought conditions.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided):*	Conserve essential water supply.
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):	Moderate
Estimated Cost:	$30,000
Potential Funding Sources:	Local funds
Lead Agency/Department Responsible:	San Antonio Water System
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Firewise Plan, Water/wastewater utilities

COMMENTS

City of San Antonio – Action #5	
Proposed Action:	Purchase generators for secondary emergency backup power. Generators will have enough power to enable full use of the primary pump stations that provide water to the City's critical facilities (e.g., fire departments, fire hydrants, hospitals, medical offices, schools, universities, numerous high value commercial customers, large residential apartment complexes and homeowners).
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio primary pump stations
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Continue essential utility and electrical service to residents.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Tornado; Flood; Winter Storm; Hail; Extreme Wind; Terrorism; Dam Failure; Extreme Heat; Wildfire; Lightning
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$875,000 per unit (generators will be purchased over several years as federal funding is available)
Potential Funding Sources:	Local funds; State and federal Grants
Lead Agency/Department Responsible:	San Antonio Water System
Implementation Schedule:	Within 12-36 months of plan adoption
Incorporation into Existing Plans:	Water Contamination Emergency Response Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Helps to ensure critical facilities will continue to provide services during a power outage caused by unforeseen events.

City of San Antonio – Action #6	
Proposed Action:	Install quick connect systems on all critical facilities with emergency generators.
BACKGROUND INFORMATION	
Jurisdiction/Location:	The City of San Antonio's critical facilities
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Continue essential service operations in the event of power failure.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Tornado; Flood; Winter Storm; Hail; Extreme Wind; Terrorism; Dam Failure; Extreme Heat; Wildfire; Lightning
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Enables safe and fast connection to electrical system.

City of San Antonio – Action #7	
Proposed Action:	Install shutters on glass windows and doors to protect critical facilities during severe weather events.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio critical facilities
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Reduce damage to infrastructure during severe weather events; Reduce glass replacement costs; Reduce injury to residents.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Wind; Tornado; Hail
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$750,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects infrastructure, reduces cost of operation, and prevents injury to residents.

City of San Antonio – Action #8	
Proposed Action:	Adopt and enforce the current International Wildland-Urban Interface Code.
BACKGROUND INFORMATION	
Jurisdiction/Location:	The City of San Antonio's wildland-urban interface
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Reduce risk to residents and first responders; Minimizes financial loss to residents and infrastructure.
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 and existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	Minimal
Potential Funding Sources:	Local Funds
Lead Agency/Department Responsible:	Development Services Department; Fire Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Fire Protection Plan; Emergency Operations/ Response Plan

COMMENTS

City of San Antonio – Action #9	
Proposed Action:	Develop and implement a community wildfire protection plan with local and state assistance.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided):*	Reduce risk to citizens and first responders; Allow for cooperative efforts from many entities; Minimize cost of recovery.
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:	$250,000
Potential Funding Sources:	Local funds; Texas Forest Service
Lead Agency/Department Responsible:	Fire Department, Office of Sustainability
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS
Provides an opportunity for various agencies to work together; Minimizes multiple risks; Provides an opportunity to incorporate other projects (e.g., Firewise, waterway fuel reduction, etc.).

City of San Antonio – Action #10	
Proposed Action:	Develop and implement a "dead and down fuels" ordinance that requires residents and businesses to remove dead trees and brush from property.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Reduce risk of hazards associated with dead trees and brush.
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; Extreme Wind
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000 annually
Potential Funding Sources:	Local Funds
Lead Agency/Department Responsible:	Development Services Department; Fire Department
Implementation Schedule:	Within 12-48 months of plan adoption
Incorporation into Existing Plans:	Fire Protection Plan; Firewise

COMMENTS
Recognizes that if property is over five acres any "dead and down fuels" within 30 feet of a property line must be removed.

City of San Antonio – Action #11	
Proposed Action:	Join the Firewise program and educate residents on reducing fire fuels in corporation with the Texas A&M Forest Service and local community organizations.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce wildfire risk; Reduce the impact of drought through Firewise Landscaping; Reduces the impact of flooding when done in green belts and waterways.
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):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Local funds; Texas Forest Service
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Fire Protection Plan

COMMENTS
Engages local horticulture clubs, landscaper organizations, etc.

City of San Antonio – Action #12	
Proposed Action:	Work with state and city departments to reduce fire fuel on public and private lands, easements, and rights-of-way.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risks to citizens and public land; Minimize damage; Increases recovery speed and safety of responders.
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; Hazardous Materials; Pipeline Failure
Effect on New/Existing Buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Cooperating agencies
Implementation Schedule:	Within 12-48 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #13	
Proposed Action:	Implement prescribed fire program to reduce fire fuel on natural waterways, aquifers, parkland areas, and San Antonio water sources.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce wildfire risk; Protect area waterways and water sources from runoff and pollutants resulting from wildfire.
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):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Local funds; State and federal grants; Other funding sources
Lead Agency/Department Responsible:	Fire Department, Office of Sustainability
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS
Benefits everyone; Acts as the most logical and cost of effective action for the overall benefit gained; Provides citizens time to get used to and see the benefits of fire.

City of San Antonio – Action #14	
Proposed Action:	Expand the brush pickup program, including the frequency and locations, to reduce the amount and length of time that fire fuels are present on city and private property.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce fire risk; Increase first responder and community safety; Provide better access for first responders.
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:	Extreme Wind; Wildfire; Winter Storm
Effect on New/Existing Buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Firewise

COMMENTS

City of San Antonio – Action #15	
Proposed Action:	Develop and implement agreements with railroads to develop a fuel reduction plan along the railways and rights-of-way.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio railways and rights-of-ways
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens; Increase likelihood railways will be open; Reduces risk to first responders (due to increased access and proximity to trains); Decreases repair cost.
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:	Hazardous Materials
Effect on New/Existing Buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Railroad budget; Local funds
Lead Agency/Department Responsible:	Fire Department; Development Services Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS
Assists in HazMat incident response if rights-of-ways are clean and easier to access. Many brush and grass fires are caused by rail cars.

City of San Antonio – Action #16	
Proposed Action:	Identify shelters and safe refuge locations for public evacuation associated with disasters such as wildfire, hazardous materials, pipeline failure, terrorism, and infectious disease.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio – locations to be determined
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Benefits citizens; Enhances first responder safety.
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:	Hazardous Materials; Pipeline Failure; Wildfire; Terrorism; Infectious Disease; Dam Failure
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Office of Emergency Management; Fire Department; Police Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #17	
Proposed Action:	Conduct public education and awareness through social media to advertise shelter locations in the event of disasters such as wildland fires, hazardous materials release, pipeline failure, infectious disease, terrorism, and dam failure.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Benefits citizens; Enhances first responder safety.
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:	Hazardous Materials; Pipeline Failure; Wildfire; Terrorism; Infectious Disease; Dam Failure
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	Local Funds
Lead Agency/Department Responsible:	Office of Emergency Management; Fire Department; Police Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #18	
Proposed Action:	Develop and implement an annual program to identify and create fire breaks in public parks and other city-owned land to reduce fuels in the event of a fire.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio public parks and other city-owned land
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce cost of repairs; Increases safety of citizens and first responders.
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
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Local funds; Texas Forest Service
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Firewise

COMMENTS

City of San Antonio – Action #19	
Proposed Action:	Conduct assessment of eligible flood reduction activities in preparation for applying for the Community Rating System program.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Reduce flood insurance premiums for residents; Remove flood-prone properties; Promote higher regulatory standards to reduce loss of life and property damage in flood events.
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
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$100,000
Potential Funding Sources:	Local funds; State and federal grants; Texas Water Development Board
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces cost of living for residents and increases public safety.

City of San Antonio – Action #20	
Proposed Action:	Purchase open space in flood-prone areas to keep land free from construction in perpetuity.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce loss of life and property damage in flood-prone 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:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000,000
Potential Funding Sources:	Local Funds; State and federal grants; Texas Water Development Board
Lead Agency/Department Responsible:	Parks and Recreation Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Allocates areas for flood mitigation.

City of San Antonio – Action #21	
Proposed Action:	As part of Community Rating System, conduct public education through social media, the city's website, brochures, and flyers to promote reduced flood insurance premiums and other program benefits.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Reduce loss of life and property damage in flood-prone areas through purchase of flood insurance; Reduce cost of flooding post-disaster through higher regulatory standards.
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:	$50,000
Potential Funding Sources:	Local Funds
Lead Agency/Department Responsible:	Parks and Recreation Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces cost of living for residents and increases public safety.

City of San Antonio – Action #22	
Proposed Action:	Update city building codes and San Antonio property maintenance codes every three years as required by new state building code amendments.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to residents by implementing updated building and maintenance codes.
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; Extreme Wind; Tornado
Effect on New/Existing Buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$100,000
Potential Funding Sources:	Local funds
Lead Agency/Department Responsible:	Development Services Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Keeps communities up to date.

City of San Antonio – Action #23	
Proposed Action:	Execute a memorandum of understanding between the Solid Waste Management Department and Development Services Department to outline and coordinate efforts of debris removal on a quarterly basis.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio Solid Waste Management Department and Development Services Department
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to residents; Reduce emergency response efforts during a severe weather event.
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; Extreme Wind; Tornado; Winter Storm; Dam Failure
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	Local Funds
Lead Agency/Department Responsible:	Development Services Department/Solid Waste Management Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Keeps both departments in sync to make response efforts more efficient.

City of San Antonio – Action #24	
Proposed Action:	Upgrade drainage channels along the Union Pacific railroad tracks to reduce flooding to adjacent residential and commercial structures.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio – Union Pacific railroad tracks
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce intermediate flooding to residents living next to drainage channels; Reduce property damage; Prevent soil erosion; Reduce community health risk.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$500,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department , Union Pacific
Implementation Schedule:	Within 24 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan, Drainage Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects communities and reduces overall cost for community.

City of San Antonio – Action #25	
Proposed Action:	Adopt and implement smart growth initiatives that incorporate the adopted hazard mitigation action plan in long-term community development planning activities.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce future risk to residents and increase new and existing infrastructure resilience to severe weather events.
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 Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood; Extreme Wind; Wildfire; Winter Storm
Effect on New/Existing Buildings:	Reduce risk to new and existing infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000 per year
Potential Funding Sources:	Local funds; State and federal grants; Regional and state emergency funding
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Each December following plan adoption
Incorporation into Existing Plans:	Comprehensive Plan 2040; Hazard Mitigation Action Plan; Infrastructure Management Plan; City of San Antonio Capital Improvements Program, Bond Program 2012-2017

COMMENTS
Emergency managers and planners will annually develop a method to coordinate revisions and updates of the hazard mitigation action plan and the city's comprehensive plan. The result of this coordination process will be to select mitigation strategies to integrate into the updates of the comprehensive plan that relate to development regulations or link with other public or private efforts, such as open space preservation or capital improvement projects. Integration of the hazard mitigation action plan into the comprehensive planning process can help ensure that the

appropriate hazard assessment information is considered during future land use and development planning.[1]

The Office of Sustainability will lead an annual assessment and update of the hazard mitigation action plan and the comprehensive plan. The deliverables within the annual assessment will include:

1. Climate and vulnerability assessment, including a climate change sensitivity analysis to identify current and projected weather conditions to address stormwater management and road operations and maintenance.
2. Policy recommendations to enable the identification of parcels or areas to be designated as high risk in the city.
3. Identification of related capital improvement or land acquisition projects to strengthen at-risk public facilities (e.g., fire and police stations) and utility systems to resist floods and geological hazards or incorporate system interconnections (e.g., roads, pipelines, and cables) so that they are less vulnerable to local failures.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Prepares communities for severe events.

[1] Source: http://www.fema.gov/media-library-data/1388432170894-6f744a8afa8929171dc62d96da067b9a/FEMA-X-IntegratingLocalMitigation.pdf

City of San Antonio – Action #26	
Proposed Action:	Integrate fire services, such as reporting suspicious activity and threat information, into the Southwest Texas Fusion Center.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens regarding suspicious activity reports, emerging threats, and related information.
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:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department, Southwest Texas Fusion Center
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #27	
Proposed Action:	Coordinate technological and communications equipment used by fire, police, and first responders to be compatible and uniform.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio fire, police, and first responders
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens regarding suspicious activity reports, emerging threats, and related information.
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:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department; Southwest Texas Fusion Center
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #28	
Proposed Action:	Coordinate information and intelligence sharing and public safety information gleaned from first responders and departments up through various government levels.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens regarding suspicious activity reports, emerging threats, and related information.
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:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department; Southwest Texas Fusion Center
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #29	
Proposed Action:	Form an all-man security team, from fire and police, trained in a uniform method to respond to terrorism acts. Integrate the team into Fire Department Tech Services Division.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio fire and police
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens regarding suspicious activity reports, emerging threats, and related information.
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:	Terrorism
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$25,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department; Southwest Texas Fusion Center
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #30	
Proposed Action:	Conduct public education via social media, utility flyers, and other outreach methods to increase awareness of hazardous materials release and pipeline failure.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens regarding threat of pipeline failure and hazardous materials release and related events.
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:	Hazardous Materials; Pipeline Failure
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	Local funds, State and federal grants
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #31	
Proposed Action:	Partner with pipeline companies, agencies and other organizations to keep areas in the vicinity of oil and gas pipelines safe and secure and report suspicious behavior or activity near pipelines.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce risk to citizens regarding threat of pipeline failure and hazardous materials release and related events.
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:	Hazardous Materials; Pipeline Failure
Effect on New/Existing Buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Emergency Operations/Response Plan

COMMENTS

City of San Antonio – Action #32	
Proposed Action:	Acquire properties in flood prone areas with priority being given to repetitive flood loss structures.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Remove flood prone properties; Promote higher regulatory standards to reduce loss of life and property damage in flood events.
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
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Allocates areas for flood mitigation and increases public safety.

City of San Antonio – Action #33	
Proposed Action:	Remove existing Mulberry Street bridge and construct a new bridge that will allow a 1% annual chance flood to pass below the roadway.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Mulberry Street bridge
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding and potential loss of life at low water crossing.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,590,354.55
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Increases public safety and protects infrastructure.

City of San Antonio – Action #34	
Proposed Action:	Replace existing culvert on Sleepy Hollow Street to Orsinger Street with an upgraded multiple box culvert system or a bridge. Street reconstruction (including curbs and sidewalks as necessary) will be included. A concrete lined channel is also proposed as part of this project.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Sleepy Hollow Street to Orsinger Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase flow and contain flood waters to reduce flooding and potential loss of life at low water crossing.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,450,346.56
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Storm Water Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding.

City of San Antonio – Action #35	
Proposed Action:	Improve drainage to watershed SA-4 by installing cross drains, replacing existing metal grate, and adding box culverts and other miscellaneous storm drain improvements.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Mahncke Park
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase flow and contain flood waters to reduce flooding and potential loss of life at low water crossing.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$7,374,500
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding, protects properties, and increases public safety.

City of San Antonio – Action #36	
Proposed Action:	Construct multiple culvert crossings, reconstruct existing concrete lined channel from W Martin Street to the confluence of the Bandera Branch Tributary to Apache Creek. At each crossing include curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	From the Apache Creek confluence (at NW 26th Street) to W Martin Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$1,119,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Removes up to 25 homes from the Federal Emergency Management Agency Special Flood Hazard Area.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding, protects properties, and increases public safety.

City of San Antonio – Action #37	
Proposed Action:	Construct concrete lined channel with 100-foot bottom width and five to one side slopes. Reconstruct the upstream culvert system headwall.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Village Crest Drive to Rittiman Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$6,023,330
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Removes up to 13 homes from the Federal Emergency Management Agency Special Flood Hazard Area.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Provides an adequate place for water flow to go through.

City of San Antonio – Action #38	
Proposed Action:	Construct a 60-foot lateral structure. Includes installation of 2,700 linear feet of 10-foot by 10-foot box culvert, reconstruction of the existing earthen channel to a 60-foot bottom-width trapezoidal channel with three to one side slopes and replace the existing culvert system at Ira Lee Road with a two-span bridge. The storm sewer system will be jacked / bored to prevent traffic disruption.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Salado Creek confluence to Harry Wurzbach Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$6,081,300
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Removes all structures from the floodplain east of Harry Wurzbach Road.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding and provides a more adequate place for water flow to go through.

City of San Antonio – Action #39	
Proposed Action:	Construct an underground drainage system utilizing 66-inch reinforced concrete pipe.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Moursund Boulevard to Six Mile Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$5,710,090
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding and provides a more adequate place for water flow to go through.

City of San Antonio – Action #40	
Proposed Action:	Re-grading / channelization of the creek to improve flow characteristics. The project will also include the buyout of several homes located in the floodplain.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Bitters Road to North Loop Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,700,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves an already existing channel of water flow which reduces costs and allocates areas for flood mitigation.

City of San Antonio – Action #41	
Proposed Action:	Expand the 116,370 square foot bridge under SW Loop 410 and the approximately 2,930 linear foot channel modification downstream from SW Loop 410. This project will also include property buyout for necessary easement.
BACKGROUND INFORMATION	
Jurisdiction/Location:	SW Loop 410 (east of Somerset Road) and approximately 3,000 feet downstream
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$65,931,219
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding; Provides a more adequate place for water flow to go through and allocates areas for flood mitigation.

City of San Antonio – Action #42	
Proposed Action:	Construct underground drainage with 72-inch reinforced concrete pipe to alleviate street flooding. Repair street including curbs and sidewalks as required.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Fredericksburg Road to Williamsburg Place
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,862,736.93
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding and repairs for damaged infrastructure.

City of San Antonio – Action #43	
Proposed Action:	Improve drainage and reconstruct necessary streets with curbs, sidewalks, and driveway approaches. Phase I will only address a portion of the described project. Barbara Drive drainage #73 Phase IIA will include channel modifications and improvements.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Pinewood Lane (El Montan Avenue to Dellwood Drive); Dellwood Drive (Pinewood Lane to Oblate Drive); Waring Drive (Springwood Lane to Barbara Drive); Barbara Drive (Oblate Drive to Skipper Drive); McCullough Avenue (W. Rector to Linda Drive)
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$21,967,009
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding and improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #44	
Proposed Action:	Construct a bridge crossing with approximately 6,300 linear feet of total channel grading upstream and downstream. Excavate to eliminate a low water crossing. Street reconstruction to include driveway approaches, curbs and sidewalks as required. A total of three lots will be required to buyout for drainage proposes.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Dreamland Drive from railroad to 550 feet west of railroad crossing; 1,600 linear feet north and 4,700 linear feet south of Dreamland Drive low water crossing
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$11,320,000
Potential Funding Sources:	Local Funds, State and Federal Grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance, Flood Management Plan, Stormwater Management Plan, Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding and improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #45	
Proposed Action:	Construct underground drainage improvements to both low water crossings #26 and #27. Street reconstruction to include curbs, sidewalks, and culverts. The project will also consist of channel drainage improvements and five, 10-foot by five-foot multiple box culverts at each crossing to eliminate the low water crossings.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Lockhill Road and White Bonnet Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action (*Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

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:	$3,410,518
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves drainage system and infrastructure by protecting properties and the public; Reduces overall cost over time.

City of San Antonio – Action #46	
Proposed Action:	Construct drainage improvements and buyout properties in the floodplain.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Andover Drive to Salado Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,412,774
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages stormwater and allocates areas for flood mitigation.

City of San Antonio – Action #47	
Proposed Action:	Construct drainage improvements to provide all weather access. Replace existing multiple box culvert system with a bridge structure. Improvements will require associated street reconstruction to include curbs, sidewalks, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Pinn Road, 1,500 feet south of W Commerce Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,375,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system. Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #48	
Proposed Action:	Upgrade existing concrete channel to reduce the 1% annual chance floodplain and erosion. The project will consist of installing a concrete channel and channel excavation. The project will also consist of installing nine, 10-foot by 10-foot multiple box culverts and street reconstruction that will include driveways, curbs, and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Loop 410 to Olmos Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,465,528
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves already existing channel which will reduce ongoing costs and flooding. Protects surrounding infrastructure.

City of San Antonio – Action #49	
Proposed Action:	Installation of underground system consisting of box culverts; Capital Improvement Program Bond Project Phase I.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Oak Glen Drive and Haskins Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$8,050,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #50	
Proposed Action:	Improve culvert crossing. Existing culvert causes storm water back up, which triggers flooding to residents. This project will include expanding the existing channel, lining the channel with concrete, and replacing the existing corrugated metal arch pipe with five, 12-foot by 8-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Clyde Dent Drive to Leon Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,076,296
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #51	
Proposed Action:	Construct a drainage system and reconstruct the street to alleviate localized ponding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Fratt Road – from Rittiman Road to Eisenhauer Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$15,596,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and protects properties from damage.

City of San Antonio – Action #52	
Proposed Action:	Construct a drainage outfall to alleviate flooding problems in the area. The proposed system consists of two, 12-foot by 8-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Outfall bounded by Frio City Road and Highway 90
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,798,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and protects properties from damage.

City of San Antonio – Action #53	
Proposed Action:	Reconstruct underground drainage infrastructure and streets.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Amity Road, from Roland Road to Rigsby Avenue
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,365,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages stormwater to reduce flooding; Repairs damaged infrastructure.

City of San Antonio – Action #54	
Proposed Action:	Reconstruct the underground drainage six-foot by four-foot single box culvert. Associated street reconstruction to include curbs, sidewalks, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Ray Ellison Boulevard from SW Loop 410 to Valley Hi Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,498,269
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages stormwater to reduce flooding and repairs damaged infrastructure.

City of San Antonio – Action #55	
Proposed Action:	Install underground storm sewer system.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Topperwein Road from Nacogdoches Road to Ridge Willow Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,336,800.84
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding and provides additional flow space.

City of San Antonio – Action #56	
Proposed Action:	Major structural upgrade to provide access across Leon Creek. This will require significant channel grading and street reconstruction including curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	W Commerce Street from Pinn Road to SW Military Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$14,020,627
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Repairs damaged infrastructure; Provides additional flow space.

City of San Antonio – Action #57	
Proposed Action:	Improve low water crossing to contain the 1% annual chance flood. This project will include channel improvements to Olmos Creek and necessary street reconstruction including curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Vance Jackson Road at Orsinger Street low water crossing #36
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,524,121
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Repairs damaged infrastructure; Provides additional flow space.

City of San Antonio – Action #58	
Proposed Action:	Install underground drainage system utilizing two, seven-foot by three-foot multiple box culverts and an outfall to the Texas Department of Transportation channel. Necessary street reconstruction will include curbs, driveway approaches, and sidewalks as required.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Marbach Road from SW Loop 410 to Horal Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,678,972.87
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Repairs damaged infrastructure; Provides additional flow space.

City of San Antonio – Action #59	
Proposed Action:	Install underground channel system consisting of 42-inch and 48-inch reinforced concrete pipe and two, eight-foot by five-foot multiple box culverts. The proposed channel will tie into an existing channel.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Center Park Boulevard from Remount Drive to Center Park Boulevard
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,243,565
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Repairs damaged infrastructure; Provides additional flow space.

City of San Antonio – Action #60	
Proposed Action:	Design and construct an underground drainage system and an earthen channel to divert drainage into the golf course. Necessary street reconstruction will ensure proper drainage and include curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Pembroke Road from Rochelle Street to Abe Lincoln
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,543,466
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Repairs damaged infrastructure; Provides additional flow space.

City of San Antonio – Action #61	
Proposed Action:	Improve culvert crossings to provide an earthen channel that will convey the 1% annual chance floodplain for future conditions.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Mud Creek Tributary A drainage improvements from Thousand Oaks Drive to Miss Ellie Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,016,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
The proposed channel was designed in the Army Corps of Engineers Hydrologic Engineering Center River Analysis System using the channel modification tool. The project will take multiple houses out of the 1% annual chance flood hazard area.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #62	
Proposed Action:	Design and construct underground drainage and driveway culverts at all driveways to ensure proper drainage. Necessary street reconstruction will include curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	County View Lane from Rochelle Street to Abe Lincoln
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,727,226.74
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Improves infrastructure; Provides additional flow space.

City of San Antonio – Action #63	
Proposed Action:	Channelize and improve low water crossings #21 and #22 with five-foot by seven-foot multiple box culverts. This will include a bypass system that will capture and convey the flow downstream, consisting of two, ten-foot by six-foot multiple box culverts and a five-foot by six-foot single box culvert. Knoll Creek Improvements Phase 1.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Low water crossing #21 and #22 – From Jung Road to Stahl Road on Salado Creek Tributary F
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,984,339
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Improves infrastructure; Provides additional flow space.

City of San Antonio – Action #64	
Proposed Action:	Replace existing low water crossing #71 with an upgraded culvert with two, ten-foot by ten-foot multiple box culverts or bridge. There will also be some channel modifications upstream and downstream of the crossing.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Low water crossing #71 Danville and Overbrook
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk of existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Improves infrastructure; Provides additional flow space.

City of San Antonio – Action #65	
Proposed Action:	Improve drainage and drainage ditch.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Multi-phase project "Zarzamora #83" B, C, D Phase II from W Hutchins Place to SW Loop 410
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Outlines the remaining phases of a multi-phase project "Zarzamora #83" from W Hutchins Place to SW Loop 410. Includes completing street reconstruction with underground drainage and upgrading of existing earthen channel to alleviate street flooding. The total cost of the project is $20,000,000 with a $4,000,000 city match.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #66	
Proposed Action:	Upgrade the existing box culvert system and storm sewer system with required street repair and rehabilitation including curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Pinn Road from Orr Drive to Westlawn Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,818,336.34
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Improves infrastructure; Provides additional flow space.

City of San Antonio – Action #67	
Proposed Action:	Upgrade and replace the existing channel with an underground drainage system. The proposed system would consist of approximately 3,300 linear feet of four, eight-foot by four-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Thames Drive between Blanco Road and San Pedro Avenue
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$11,119,728.69
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
This project is expected to remove up to 15 homes from the floodplain. The capacity of the system must be verified prior to construction of the project. Bexar County has conducted multiple feasibility studies for that system (from El Montan Avenue to the Olmos Basin Golf Course).

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #68	
Proposed Action:	Install a reinforced-concrete open channel drainage system with associated at-grade drainage structures to alleviate localized street flooding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Normoyle Ditch
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water-flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$12,400,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #69	
Proposed Action:	Construct underground drainage seven-foot by seven-foot single box culvert to alleviate street flooding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Freiling Drive from Wonder Parkway to Vance Jackson Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,187,246
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #70	
Proposed Action:	Construct earthen channel. Additionally, construction includes box culverts and a concrete channel.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Shady Hollow Lane from northwest of Babcock Road and NW. Loop 1604
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,181,560
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #71	
Proposed Action:	Upgrade low water crossing #24 to ten, seven-foot by four-foot multiple box culverts and upgrade low water crossing #24.1 to eleven, ten-foot by six-foot multiple box culverts. The improvements will require an upgrade to the earthen channel to a concrete line channel with a varying bottom ranging from 60 feet to 100 feet.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Lookout Road and Judson Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,868,327
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #72	
Proposed Action:	Improve drainage system.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Broadway Street corridor – Phase V (Catalpa-Pershing drainage channel to Brackenridge Avenue)
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,495,544
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding, protects properties, and costs less over time through efficient drainage.

City of San Antonio – Action #73	
Proposed Action:	Install underground drainage system. The project will also reconstruct, modify, and improve signalization as needed.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Broadway Corridor Phase III – 1B; Burr Road from Broadway Street to N. New Braunfels Avenue
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,174,900
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #74	
Proposed Action:	Construct a regional stormwater facility.
BACKGROUND INFORMATION	
Jurisdiction/Location:	East of Huebner Road and Apple Green Road, south of Eckhert Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$9,599,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding; Protects properties; Increases public safety.

City of San Antonio – Action #75	
Proposed Action:	Construct an underground drainage system to alleviate street flooding. Underground drainage system will include installing six-foot by four-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Braubach Street from Roosevelt Avenue to Six Mile Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$7,115,764.24
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #76	
Proposed Action:	Construct a parallel storm sewer system and at-grade drainage structures to alleviate flooding of homes and streets. The proposed system consists of a 10-foot by seven-foot single box culvert, 10-foot inlet, and 24-inch and 30-inch laterals.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Overbrook outfall; Evelyn Drive from Seeling Boulevard and St Cloud to Rosemont Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$7,154,961
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
The project includes reconstruction of all associated streets, curbs, sidewalks, and driveway approaches. This project requires that the Seeling Channel and Woodlawn Lake outfall be upgraded first.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #77	
Proposed Action:	Construct a storm sewer system. System will consist of inlets with reinforced concrete pipe .
BACKGROUND INFORMATION	
Jurisdiction/Location:	Castle Cross from Midcrown Drive to Rittiman Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

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:	$2,700,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Street reconstruction including curbs and sidewalks. Concrete Riprap with rock riprap embedded will be required.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #78	
Proposed Action:	Install an underground system which will continue in a box culvert. This will eliminate low water crossing #95.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Northwood-Devonshire area drainage; Chevy Chase Drive to Eisenhauer Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$7,058,929
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Manages storm water to reduce flooding; Provides additional flow space.

City of San Antonio – Action #79	
Proposed Action:	Construct additional culvert from outfall. Reconstruct streets, curbs and sidewalks as required.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Olympia area streets and drainage from Alhambra to San Angelo
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$4,373,609
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #80	
Proposed Action:	Conduct major channel improvements as well as three bridge/culvert crossings. Street reconstruction will be required as well.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Diversey drainage from IH 10 E just inside Loop 1604
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$13,922,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Additional right-of-way of 11,800 square feet will be needed.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #81	
Proposed Action:	Install underground drainage system utilizing three, nine-foot by six-foot multiple box culverts. Necessary street reconstruction includes sidewalks, curbs, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	North San Antonio Hills subdivision; Misty Woods Street and SH 151
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,567,272.42
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #82	
Proposed Action:	Street and drainage reconstruction to alleviate runoff. The reconstruction of streets may include sidewalk, curbs, driveway approaches, and inlets for the drainage improvements.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Wilson Boulevard from Woodlawn Avenue to Waverly Avenue
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

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:	$8,199,874.7
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #83	
Proposed Action:	Construct drainage improvements. Drainage system/outfall and street reconstruction including curbs and sidewalks as required. Sheet flow runoff runs over streets and through low areas on private properties causing flooding and ponding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Mabelle Drive; Goforth Drive and N Weidner Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$5,255,867.14
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #84	
Proposed Action:	Construct an underground drainage system within the right-of-way of Pickwell Drive to alleviate localized flooding at 115 Pickwell Drive. Reconstruction of Pickwell Drive, Gayle Avenue, Banbridge Avenue, Galway Street, Tipperary Avenue, Kilarney Drive, and Dublin Avenue will be included along with curbs, sidewalks, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Pickwell area drainage Improvement Phase C; Palfrey Street to Dublin Avenue
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$9,160,000
Potential Funding Sources:	Local funds, State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

\

City of San Antonio – Action #85	
Proposed Action:	Construct an underground drainage system comprising two, 10-foot by 4-foot multiple box culverts to alleviate street flooding. The project requires reconstruction of Elmira Street and the intersections of Euclid Avenue, McCullough Avenue, Erie Avenue, and Atlanta Street and Wilmington Avenue.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Elmira Street from McCullough Avenue to San Antonio River
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	High
Estimated Cost:	$7,104,468.52
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE

Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #86	
Proposed Action:	Construct an underground drainage structure with four-foot by five-foot multiple box culverts to alleviate street flooding. The improvements would require associated drainage structures (culverts) and street reconstruction to include curbs, sidewalks, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Jackson Keller Road from San Pedro Avenue to McCullough Avenue
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$10,036,610.20
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #87	
Proposed Action:	Construct underground drainage system.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Southwell Road from Prue Road to Huebner Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,080,032
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #88	
Proposed Action:	Construct underground drainage with a 10-foot by 7-foot single box culvert to alleviate flooding of homes. This project requires the Woodlawn Lake outfall be upgraded first.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Seeling Drainage Improvements; Placid Drive to Zachry Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$17,100,149
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and property damages to homes; Protects the health and safety of the community.

City of San Antonio – Action #89	
Proposed Action:	Install an underground drainage system along with street reconstruction of curbs, sidewalks, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Five Palms Drive from Medina Base Road to W Military Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$5,935,700
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding; Reduces demand on the drainage system; Increases water flow to quickly remove water from neighborhoods; Improves infrastructure to protect the safety and welfare of the public.

City of San Antonio – Action #90	
Proposed Action:	Install an underground drainage system and complete street reconstruction. An outfall to French Creek will be constructed.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Heath Circle Drive from Coral Springs to Low Bid Lane
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$13,551,524.98
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves the drainage capabilities to reduce flooding, improve flow, and protect the health and safety of the community.

City of San Antonio – Action #91	
Proposed Action:	Install an underground drainage system along various streets. Complete associated at-grade drainage structures to alleviate localized street flooding with associated street repair and rehabilitation that will include curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Wabash Storm Drainage; Fenfield Avenue/W Mayfield Boulevard from Wabash Street to New Laredo Highway; Lovett Avenue from Wabash Street to New Laredo Highway
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$13,685,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system. Improves infrastructure for the safety of drivers and to reduce repair costs.

City of San Antonio – Action #92	
Proposed Action:	Construct a channel to contain storm water runoff within the Oakland Estates neighborhood and utilize box culverts for street crossings. The project will help eliminate dangerous water crossings.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Southwell Road from Verbena Street to Encino Park Road and Hollyhock Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$5,547,476
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and increases flow to prevent dangerous flooding on roads; Improves driver safety and repair costs of roads.

City of San Antonio – Action #93	
Proposed Action:	Install an underground drainage system with 36-inch reinforced concrete pipe to alleviate street flooding. Reconstruction of streets including curbs, driveway approaches, and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Cincinnati Avenue from N General McMullen Drive to Tulane Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,125,803.77
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding and demand on drainage system; Improves infrastructure for the safety and welfare of the public.

City of San Antonio – Action #94	
Proposed Action:	Alleviate localized flooding with proposed drainage to help convey flows underground.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Roland Road Drainage Phase I, II, and III; Rigsby Avenue to Family Tree Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$20,127,403
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Removes floodwaters from the surface to improve the overall health and safety of the community.

City of San Antonio – Action #95	
Proposed Action:	Upgrade and improve low water crossing and associated street reconstruction. Street reconstruction to include sidewalks, curbs, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Old Fredericksburg Road, north of N Loop 1604 W, from N Loop 1604 . and IH 10
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$7,791,882
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces impacts of flooding on infrastructure and personal property; Provides improved safety and overall reduced costs for the community.

City of San Antonio – Action #96	
Proposed Action:	Construct an earthen channel. The improvements also include adding multiple box culverts under Sligo Street, Esma Street, and San Juan Road and limited street reconstruction.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Brookside Outfall; Brookside Subdivision from Lebanon Street to an unnamed tributary to the San Antonio River west of Southton Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,738,107
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects infrastructure, properties, and the health and safety of the whole community.

City of San Antonio – Action #97	
Proposed Action:	Improve drainage for runoff sheet flow across the whole neighborhood with 48-inch reinforced concrete pipe. Complete street reconstruction including curbs and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Deerwood Drive from Rainbow Drive to Austin Highway
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flood
Effect on New/Existing Buildings:	Reduce risk to existing structure and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$3,003,464.05
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves the overall health and safety of the community.

City of San Antonio – Action #98	
Proposed Action:	Construct underground drainage system consisting of 24-inch to 60-inch reinforced concrete pipe, curb inlets, outfall structures, and boring beneath the railroad to the Airport Tributary.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Empire Street from Belfast Drive to Everest Street; Ridgecrest Drive and W Lawndale Drive from Everest Street to Broadway Street; Belfast Drive, Colton Drive, and Conway Drive from Empire Street to Everest Street; Mavis Street from Belfast Drive to Conway Drive; Everest Street from W Lawndale Drive to Conway Drive; Janda Susan Road and Lookover Street from dead-end to Ridgecrest Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$9,385,100
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves the health and safety of the surrounding communities.

City of San Antonio – Action #99	
Proposed Action:	Improve channel for approximately 2,200 linear feet and 3,000 linear feet of storm drain box culverts. The project limits will consist of an adjacent drainage channel to Highway 90 to General Hudnell Drive, where runoff will be conveyed by an additional 12-foot by 8-foot box culvert and approximately 3,000 linear feet will connect to an existing storm system.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Highway 90 to General Hudnell Drive to Rio City Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$11,500,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Increases water flow and capacity to reduce flooding, keep drivers safe, and the overall health and safety of the community.

City of San Antonio – Action #100	
Proposed Action:	Expand 1,050 linear feet of existing channel and adding 1,655 linear feet of multiple box culverts to alleviate localized flooding to expand the existing conveyance system does not have capacity.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Channel runs north of Juniper Street and underground system running down Gallant Street to Sligo Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$5,219,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Increases water flow and drainage to allow floodwater to recede quickly; Ensures the health and safety of the community.

City of San Antonio – Action #101	
Proposed Action:	Install an underground drainage system utilizing a eight-foot by five-foot single box culvert to alleviate flooding of homes. Complete necessary street reconstruction including curbs, driveway approaches, and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	W Hildebrand Avenue to W Kings Highway
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

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:	$23,878,250.92
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects the health and private property of the community.

City of San Antonio – Action #102	
Proposed Action:	Upgrade channel for floodplain reclamation and flow improvement in the area.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Pershing Creek from Salado Creek to Fort Sam Houston
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,912,301
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects the safety and health of the community.

City of San Antonio – Action #103	
Proposed Action:	Install a large underground system that will capture most of the storm water before it gets to the grate inlet. The proposed system will tie into an existing Texas Department of Transportation system and increase the capacity of the existing system. The system ranges from 3-inch reinforced concrete pipe to four, seven-foot by three-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Busby System; Phase 2: Nacogdoches Road to Lawndale Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,674,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Localized flooding occurs near the intersection of N New Braunfels Avenue and NE Loop 410 Access Road. A single grate inlet near this intersection is supposed to capture over 650 cubic feet per second but does not effectively collect storm water. This causes the storm water to back up into private property.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding quickly and efficiently; Improves the health and safety of the community; Reduces damages to cars and private property.

City of San Antonio – Action #104	
Proposed Action:	Improve the drainage infrastructure to include installing two, seven-foot by three-foot multiple box culverts. Necessary street reconstruction will include driveway approaches, curbs, and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Churchill Estates including Chloe Drive, Churchill Avenue, and Mimmie Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$5,710,090
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding; Protects the health of the community as well as private property.

City of San Antonio – Action #105	
Proposed Action:	Install a large underground system that will capture most of the storm water before it gets into the grate inlet. The proposed system will tie into an existing Texas Department of Transportation system and increase the capacity of the existing system. The system ranges from 30-inch reinforced concrete pipe to four, seven-foot by three-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Busby System Phase 1: Nacogdoches Road to Lawndale Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,861,419
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Localized flooding occurs near the intersection of N New Braunfels Avenue and NE Loop 410 Access Road. A single grate inlet near this intersection is supposed to capture over 650 cubic feet per second but does not effectively collect storm water. This causes the storm water to back up onto private property.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding quickly and efficiently; Improves the health and safety of the community; Reduces damages to cars and private property.

City of San Antonio – Action #106	
Proposed Action:	Install a large underground system that will capture most of the storm water before it gets into the grate inlet. The proposed system will tie into an existing Texas Department of Transportation system and increase the capacity of the existing system. The system ranges from 30-inch reinforced concrete pipe to four, seven-foot by three-foot multiple box culverts.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Busby System Phase 3: Nacogdoches Road to Lawndale Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,025,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
Localized flooding occurs near the intersection of N New Braunfels Avenue and NE Loop 410 Access Road. A single grate inlet near this intersection is supposed to capture over 650 cubic feet per second but does not effectively collect storm water. This causes the storm water to back up onto private property.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding quickly and efficiently; Improves the health and safety of the community; Reduces damages to cars and private property.

City of San Antonio – Action #107	
Proposed Action:	Improve underground drainage two, seven-foot by three-foot multiple box culverts to one of three outfalls to the Hills and Dales neighborhood. Associated street reconstruction will include curbs, sidewalks, and driveway will be included in the project.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Shady Hollow Lane; Hills and Dales
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$4,111,316
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects cars, property, houses, drivers, and the health of the whole community by reducing flooding in the Hills and Dales neighborhood.

City of San Antonio – Action #108	
Proposed Action:	Reconstruct and upgrade underground drainage, curbs, and sidewalks. This may require at least a seven-foot by six-foot single box culvert outfall existing channel and laterals on these streets to alleviate street flooding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Vestal Place; Hutchins Place; Langford Place; Amber Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)*:	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)*:	Structure and Infrastructure Projects

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:	$4,512,617.57
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves safety drivers and the community by reducing flooding and reduces road repair costs.

City of San Antonio – Action #109	
Proposed Action:	Construct a trapezoidal channel that connects to a storm water system. The trapezoidal channel will consist of a top width of 13 feet, bottom width of four feet and side slopes with a three to one ratio. The system will consist of eight 10-foot curb inlets. The system will tie into an existing system.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Stringfellow Street to Menlo Boulevard
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,805,945.96
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects community health and property by reducing flooding and increasing water flow.

City of San Antonio – Action #110	
Proposed Action:	Construct channel to accept the flows from two culvert systems one 48-inch and two 36-inch corrugated metal pipes. The channel will be grass lined with exception of upstream 100 feet and downstream 100 feet, where it will be concrete riprap for erosion protection. Wing walls and energy dissipaters will also be required.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Rockwell Outfall to Six Mile Creek; Railroad tract and Baetz Boulevard to Six Mile Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,035,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Increases flow of water while reducing erosion; Provides for safety of community by reducing flooding.

City of San Antonio – Action #111	
Proposed Action:	Construct an underground drainage system utilizing nine-foot by two-foot single box culvert and street reconstruction to alleviate street flooding. Necessary street reconstruction includes driveway approaches, curbs, and sidewalks.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Donore Place and Tupelo Lane
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

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:	$2,075,856.69
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects drivers, cars, and properties, as well as community health and safety.

City of San Antonio – Action #112	
Proposed Action:	Construct an underground drainage system and an eight-foot by six-foot multiple box culverts to alleviate street flooding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Wilma Jean Drive and Rockwell Boulevard
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,034,964
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves safety for drivers; Reduces flooding and repair costs; Allocates water flow to a more appropriate location.

City of San Antonio – Action #113	
Proposed Action:	Construct and improve drainage ditch. Proposed improvements will rebuild S Zarzamora Street to a five-lane section, 62 feet of travel lanes, and two five-foot bike lanes for total 72 feet of pavement.
BACKGROUND INFORMATION	
Jurisdiction/Location:	S Zarzamora Street from W Hutchins Place to W Villaret Boulevard
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$17,038,223.29
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS
This is a multi-phased project for “Zarzamora #83” with 9,276 feet per street.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Improves roadway; Reduces risk of flooding; Provides additional flow space.

City of San Antonio – Action #114	
Proposed Action:	Upgrade channel at San Antonio River Spill at Broadway Street. The upgraded channel will consist of removal and reconstruction of the current channel.
BACKGROUND INFORMATION	
Jurisdiction/Location:	San Antonio River near Broadway Street and Carnahan Street to Funston Place
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$8,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding; Provides additional flow space.

City of San Antonio – Action #115	
Proposed Action:	Install underground drainage to improve local drainage. Street reconstruction will include driveway approaches, sidewalks, and curbs.
BACKGROUND INFORMATION	
Jurisdiction/Location:	New Laredo Highway between Pitluk Avenue to Leon Creek
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$10,835,760.82
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects drivers, cars, and property from flooding; Allows for increased flow and water storage.

City of San Antonio – Action #116	
Proposed Action:	Implement drainage improvements of existing box culvert system on Westwood Village Creek at low water crossing #112.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Near the intersection of Westbriar and W Military Drive
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

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:	$4,476,946
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding; Allows for quicker transportation of water; Improves safety and health of community; Reduces infrastructure costs associated with repairs.

City of San Antonio – Action #117	
Proposed Action:	Construct a seven-foot by five-foot single box culvert to alleviate street flooding.
BACKGROUND INFORMATION	
Jurisdiction/Location:	S General McMullen Drive from Highway 90 to Roselawn Road
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$2,022,187.34
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces flooding; Allows for proper allocation of water flows; Improves the safety and health of the community.

City of San Antonio – Action #118	
Proposed Action:	Upgrade underground drainage two, seven-foot by three-foot multiple box culverts. Associated street reconstruction will include curbs, sidewalks, and driveway approaches.
BACKGROUND INFORMATION	
Jurisdiction/Location:	Shady Hollow Lane near northwest corner of Babcock Road and N Loop 1604 W
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,410,759
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Reduces risk of flooding; Provides an adequate place for water flow to go through.

City of San Antonio – Action #119	
Proposed Action:	Construct underground drainage a nine-foot by six-foot single box culvert to alleviate flooding of yards and streets. Associated street reconstruction will include curbs, sidewalks, and driveways.
BACKGROUND INFORMATION	
Jurisdiction/Location:	S San Ignacio Avenue from W Commerce Street to Dartmouth Street
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Increase water flow and contain flood waters to reduce flooding.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)**:***	Structure and Infrastructure Projects

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:	$3,127,937.86
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Public Works Department
Implementation Schedule:	Within 12 months of plan adoption
Incorporation into Existing Plans:	Flood Ordinance; Flood Management Plan; Stormwater Management Plan; Community Rating System

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Mitigates flooding; Protects properties and structures.

City of San Antonio – Action #120	
Proposed Action:	Develop and implement an ordinance to restrict the use of public water resources for non-essential consumption (e.g., landscaping, washing cars, filling pools, etc.) during drought conditions.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Conserve essential water supply.
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:	Drought
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$30,000
Potential Funding Sources:	Local funds
Lead Agency/Department Responsible:	San Antonio Water System
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Firewise Plan; Water/Wastewater Utilities

COMMENTS

City of San Antonio – Action #121	
Proposed Action:	Develop and implement a green and blue infrastructure plan that will assess opportunities for creating connected networks to manage water and regulate air temperature through ecosystem-based adaptation measures. For example, an opportunity assessed may include connecting and/or enhancing existing park and open space networks and adjacent areas to provide cooling corridors and stormwater management.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce flood damage in high-risk areas; Reduce heat related injuries/illness
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, Extreme Heat
Effect on New/Existing Buildings:	Reduce risk to existing structures and infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$300,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Office of Sustainability; Parks & Recreation; Public Works
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	San Antonio Climate Ready (Adaptation #31: Create an Integrated Green and Blue Infrastructure Plan)

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects existing structures and communities using environmentally conscious solutions.

City of San Antonio – Action #122	
Proposed Action:	Conduct aerial documentation of all mobile home parks in flood prone areas to ensure they are not improperly expanding within a floodplain.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce future damage in high-risk areas.
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 new structures and infrastructure
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$13,000
Potential Funding Sources:	Local funds (i.e., staff time); State and federal grants
Lead Agency/Department Responsible:	Development Services
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	N/A

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects property; Prevents encroachment onto floodplains.

City of San Antonio – Action #123	
Proposed Action:	Develop a city-wide network of resilience hubs with a priority focus on San Antonio's must vulnerable residents and neighborhoods. These locations will provide community members access to resources and services on an ongoing basis, as well as during extended periods of power outages due to natural or man-made hazard events. Sites will be selected based upon equity indicators, social vulnerability, and CPS Energy's grid benefits. Resilience hubs are community-serving facilities augmented to support residents, coordinate communication, distribute resources, and reduce carbon pollution while enhancing quality of life. This action will include: • Identification of locations through a community-led planning process, particularly frontline and vulnerable communities; • Incorporation of on-site renewable energy generation and battery storage; • Incorporation of electric vehicle charging infrastructure; • Incorporation of nature-based solutions (e.g., green infrastructure and urban agriculture); • Incorporation City of San Antonio emergency response critical facilities; • Provision of on-site or nearby resources and services identified by community members (e.g., ATM and banking, groceries, food production and distribution, emergency services, communications, technology charging, temporary housing, and childcare); • Considerations for situating resilience hubs (e.g., benefiting CPS Energy's grid resilience).
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio – Specific locations to be determined based on analysis of vulnerability, need, service area, and grid compatibility. There is the potential for multiple sites per district.

Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Mitigates health and economic impacts during emergency.
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; Expansive Soils; Flood; Hail; Extreme Wind; Lightning; Tornado; Wildfire; Winter Storm
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$250,000 planning (Additional $250,000 per hub)
Potential Funding Sources:	Local funds; State and federal grants (e.g., the Federal Emergency Management Agency's Building Resilient Infrastructure and Communities Program)
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Within 12-36 months of plan adoption
Incorporation into Existing Plans:	See below

COMMENTS

Incorporation into existing plans will include:

- SA Tomorrow Sustainability Plan (2016) – which discussing exploring distributed renewable energy generation and battery storage opportunities at critical municipal facilities.
- SA Climate Ready (2019) – Mitigation #20: Urban Heat Island, which includes analyzing and quantifying the urban heat island in the city and developing an implementable and impactful urban heat island mitigation and adaptation plan with a focus on vulnerable populations and ecosystems.
- SA Climate Ready (2019) - Adaptation #22: Assess Emergency Shelter Policies, which includes evaluating shelter policies and resources considering future climate impacts. Considerations will include provision of indoor shelter during periods of elevated nighttime temperatures (>80°F), expansion cooling center open times (e.g., to weekends and warm nights), consideration of additional locations; and consideration of potential impacts from extreme precipitation. This action also will assess opportunities to integrate back-up renewable and battery technology and identify priority locations to pilot resilience hubs.

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Promotes disaster contingency planning and facility safety among institutions that provide essential services such as food, clothing, shelter, and healthcare to vulnerable populations.

City of San Antonio – Action #124	
Proposed Action:	Develop an urban heat island plan that identifies policies, programs, building codes, and site requirements to mitigate the impact of extreme heat (which is increasing because of climate change). Focus will be based on the identification of areas of vulnerability to extreme heat and vulnerable populations. This plan will identify mitigation strategies to mitigate extreme heat impacts (e.g., priority areas for tree planting, cool/green roofs, cool pavement, green walls, architectural canopies, etc.). The planning process will include community engagement to assist with plan development.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduction of heat-related illnesses.
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:	Extreme Heat
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	High
Estimated Cost:	$200,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Office of Sustainability
Implementation Schedule:	Within 12-36 months of plan adoption
Incorporation into Existing Plans:	San Antonio Climate Ready

COMMENTS
SA Climate Ready (2019) Mitigation #20: Urban Heat Island, which includes analyzing and quantifying the urban heat island in the city and developing an implementable and impactful urban heat island mitigation and adaptation plan with a focus on vulnerable populations and ecosystems.

City of San Antonio – Action #125	
Proposed Action:	Brooks City Base (Emergency Operations Center / Public Safety Answering Point) microgrid
BACKGROUND INFORMATION	
Jurisdiction/Location:	San Antonio/Bexar County Emergency Operations Center and the Public Safety Answering Point (8130 Challenger Dr, San Antonio, TX 78235 and 8130 Inner Circle Dr San Antonio, TX 78235)
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Lessen impacts from system outages; Improve resiliency and business continuity.
Type of Action *(Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)***:**	Structure and Infrastructure Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Extreme Heat; Flood; Hail; Lightning; Extreme Wind; Winter Storm
Effect on New/Existing Buildings:	Reduce impacts on existing infrastructure
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	San Antonio Office of Emergency Management
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	Continuity of Operations

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects critical city facilities and services; Promotes reliability of lifeline systems to minimize impacts from hazards, maintain operations, and expedite recovery in an emergency.

City of San Antonio – Action #126	
Proposed Action:	Implement education and awareness program utilizing media, social media, bulletins, flyers, etc. to educate citizens of hazards that can threaten the area and mitigation measures to reduce injuries, fatalities, and property damage.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Promote hazard awareness and protect citizens from potential injuries and damage.
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; Expansive Soils; Extreme Heat; Flood; Hail; Lightning; Extreme Wind; Tornado, Wildfire, Winter Storm, Terrorism, Hazardous Materials, Pipeline Failure, Infectious Disease, Cyber Attack, Technological Disruption
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000
Potential Funding Sources:	Local Funds, State and Federal Grants
Lead Agency/Department Responsible:	San Antonio Office of Emergency Management
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	N/A

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Educates and alerts the community about flooding hazards and tips to stay safe; Helps protect community safety, health, and property.

City of San Antonio – Action #127	
Proposed Action:	Acquire and install generators with hard wired quick connections at critical facilities.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio critical facilities
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Provide power for critical facilities during power outages; Ensure continuity of critical 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; Extreme Heat; Flood; Hail; Lightning; Extreme Wind; Tornado; Wildfire; Winter Storm
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$3,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	San Antonio Public Works
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Emergency Management Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects critical city facilities and services; Promotes reliability of lifeline systems to minimize impacts from hazards, maintain operations, and expedite recovery in an emergency.

City of San Antonio – Action #128	
Proposed Action:	Upgrade critical facilities to include drought mitigation measures (e.g., drought tolerant landscaping and installation of a sprinkler system with regular watering schedule).
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio critical facilities
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce damage at critical 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:	Drought
Effect on New/Existing Buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$1,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	San Antonio Public Works
Implementation Schedule:	Within 12-24 months of plan adoption
Incorporation into Existing Plans:	N/A

COMMENTS

City of San Antonio – Action #129	
Proposed Action:	Harden and/or retrofit critical facilities to hazard-resistant levels.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio critical facilities
Risk Reduction Benefit *(Current Cost/Losses Avoided)***:**	Reduce damage at critical facilities; Ensure continuity of critical services during and after event; Reduce risk of injury to emergency and critical personnel.
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; Drought; Extreme Heat; Flood; Hail; Lightning; Extreme Wind; Tornado; Wildfire; Winter Storm
Effect on New/Existing Buildings:	Reduce risk to existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	San Antonio Public Works
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Emergency Management Plan; Capital Improvement Plan

COMMENTS

EXPLANATION TO WHY MITIGATION ACTION IS APPROPRIATE
Protects critical city facilities and services; Promotes reliability of lifeline systems to minimize impacts from hazards, maintain operations, and expedite recovery in an emergency.

City of San Antonio – Action #130	
Proposed Action:	Upgrade critical facilities to include drought mitigation measures and expansive soils protection (e.g., greywater reuse systems, drought tolerant landscaping, installation of sprinkler systems with regular watering schedules, and installation of French drains where there are high plasticity soils).
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio critical facilities
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Reduce damage at critical 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:	Drought, Expansive Soils
Effect on New/Existing Buildings:	Reduce risk to new and existing structures
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$250,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	San Antonio Public Works
Implementation Schedule:	Within 24-36 months of plan adoption
Incorporation into Existing Plans:	Capital Improvement Plan

COMMENTS

City of San Antonio – Action #131	
Proposed Action:	Develop and implement a system for tracking expansive soil incidents and associated damage.
BACKGROUND INFORMATION	
Jurisdiction/Location:	City of San Antonio
Risk Reduction Benefit *(Current Cost/Losses Avoided)**:***	Enhance risk assessment; Identify mitigation actions to mitigate expansive soils.
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:	Expansive Soils
Effect on New/Existing Buildings:	N/A
Priority (High, Moderate, Low):	Low
Estimated Cost:	$10,000
Potential Funding Sources:	Local funds; State and federal grants
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	Within 36-48 months of plan adoption
Incorporation into Existing Plans:	Capital Improvement Plan

COMMENTS

Section 25: Plan Maintenance

Plan Maintenance Procedures

The following is an explanation of how the City of San Antonio will implement the HMAP and continue to evaluate and enhance the plan over time. To ensure the HMAP remains current and relevant, the following Plan Maintenance procedures will be addressed:

- Incorporation
- Monitoring and Evaluation
- Updating
- Continued Public Involvement

Incorporation

The City of San Antonio will be responsible for further development and implementation of mitigation actions. Each action has been assigned to a specific department within the City. The following describes the process by which the City of San Antonio will incorporate elements of the mitigation plan into other planning mechanisms.

PROCESS OF INCORPORATION

Once the HMAP is adopted, the City of San Antonio will implement actions based on priority and the availability of funding. The City currently implements policies and programs to reduce loss of life and property damage from hazards. The mitigation actions developed for this HMAP enhance this ongoing effort and will be implemented through other program mechanisms where possible.

The potential funding sources listed for each identified mitigation action may be used when Planning Team members begin to seek funds to implement actions. An implementation time period, or a specific implementation date, has been assigned to each mitigation action as an incentive for completing each task and gauging whether actions are implemented in a timely manner.

The City of San Antonio will integrate 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 HMAP will further maximize funding and provide possible cost-sharing of key projects, thereby reducing loss of lives and property, and mitigating hazards affecting the area.

Upon formal adoption of the HMAP, all team members will work to integrate the hazard mitigation strategies into other planning mechanisms for the City. The Planning Team will review plans and policies on an annual basis and analyze the need for amendments in light of the approved HMAP. The Planning Team will ensure that future planning of capital improvement, disaster recovery, historic preservation, flood response plans, and other planning mechanisms will be consistent with the goals of the HMAP. Within one year of formal adoption of the HMAP, existing planning mechanisms will be reviewed.

The full Planning Team (Section 2) will meet in person bi-annually, and more often if warranted, to ensure mitigation actions prioritized as high to moderate are tracked and monitored based on federal disaster declarations, Building Resilient Infrastructure and Communities (BRIC) funding cycles, and other non-federal funding sources. For Hazard Mitigation Grant Programs (HMGP), grant applications will be developed for submittal to TDEM and FEMA accordingly.

Existing plans for the City will be reviewed by the Planning Team to optimize the incorporation of mitigation policies and actions. Table 100 indicates titles of persons for incorporating actions, method of incorporation, and approving authority. Table 101 identifies key planning mechanisms available and process of incorporation into current mitigation and planning efforts.

The HMAP will be discussed at annual budget meetings to consider proposed funding sources for mitigation actions.

Table 100. Approving Authority, Team Members Responsible for Coordinating Incorporation of Planning Mechanisms into the Plan, Methods of Incorporation

POINTS OF CONTACT	METHOD OF INCORPORATING MITIGATION ACTIONS INTO LOCAL PLANNING MECHANISMS
Mayor (approving authority for the Plan), Office of Emergency Management Staff	Annual budget review, Flood Damage Ordinance, Community Rating System, Emergency Operations Plan, Building Codes, Disaster Response and Recovery Plan, Master Drainage Plan, Storm Water Management Plan, National Flood Insurance Program (NFIP), Long-term Comprehensive Development Plan, Local Emergency Planning Committee, Fire Plan, Transportation and CIP Plan.

Table 101. Process of Incorporation by Planning Mechanism

PLANNING MECHANISM	INCORPORATION OF PLAN
Grant Applications	The Planning Team members will consult the Plan whenever grant funding is sought for mitigation projects. If a project is not in the HMAP, an amendment may be necessary to include the action in the HMAP.
Annual Budget Review	Various departments and key personnel that participated in the planning process will review the HMAP and mitigation actions therein when conducting their annual budget review. Allowances will be made in accordance with grant applications sought or mitigation actions that will be undertaken according to the implementation schedule of the specific action.
Regulatory Plans	Currently, the City of San Antonio has regulatory plans in place, such as Emergency Management Plans, Continuity of Operations, Disaster Recovery Plans, Economic Development and Evacuation Plans. The HMAP will be consulted when city departments review or revise their current regulatory planning mechanisms, or in the development of regulatory plans that are not currently in place.
Capital Improvement Plans	The City of San Antonio has a Capital Improvement Plan (CIP) in place. Prior to any revisions to the CIP, city departments will review the risk assessment and mitigation strategy sections of the HMAP, as limiting public spending in hazardous zones is one of the most effective long-term mitigation actions available to local governments.
Comprehensive Plans	The City of San Antonio has a Long-Term Comprehensive Development Plan in place. Since comprehensive plans involve developing a unified vision for a community, the mitigation vision and goals of the HMAP will be reviewed in the development or revision of a Comprehensive Plan.
Floodplain Management and Fire Protection Plans	Floodplain Management Plans include preventative and corrective actions to address the flood hazard. Therefore, the actions for flooding, and information found in Section 7 of this plan discussing the people and property at risk to flood, will be reviewed and revised when the City of San Antonio updates its management plans or develops new plans.

Monitoring and Evaluation

Periodic revisions of the HMAP are required to ensure that goals, objectives, and mitigation actions are kept current. Revisions may be required to ensure the HMAP is in compliance with federal and state statutes and regulations. This section outlines the procedures for completing plan revisions, updates, and review. Table 102 indicates the department and title responsible for plan monitoring, updating and review of the HMAP. Monitoring, evaluating, and updating the plan include the planning process, hazard risk assessment, and the mitigation strategies and actions as they are written in the plan. In the paragraphs below, when the plan is mentioned, it is to include the hazard risk assessment and mitigation actions.

Table 102. Team Members Responsible for Plan Monitoring, Evaluating, Updating and Review of the Plan

DEPARTMENT	TITLE
Office of Emergency Management	Emergency Management Coordinator
Office of Emergency Management	Assistant Emergency Management Coordinator (1)
Office of Emergency Management	Assistant Emergency Management Coordinator (2)
Office of Emergency Management	Special Projects Manager
Office of Emergency Management	Senior Management Analyst (1)
Office of Emergency Management	Senior Management Analyst (2)
Office of Emergency Management	Department Fiscal Administrator

MONITORING

Designated Planning Team members are responsible for monitoring, updating, and reviewing the HMAP, as shown in Table 102. Individuals holding the title listed in Table 102 will be responsible for monitoring the HMAP on an annual basis. Plan monitoring includes reviewing the HMAP and incorporating other existing planning mechanisms that relate or support goals and objectives of the HMAP; monitoring the incorporation of the plan into future updates of other existing planning mechanisms as appropriate; monitoring team members to maintain updated contact information and ensure availability throughout the planning cycle; reviewing mitigation actions submitted and coordinating with various City departments to determine if mitigation actions need to be re-evaluated and updated; evaluating the hazards that pose a risk to the planning area and updating the risk assessment when warranted; evaluating and updating the HMAP as necessary; and monitoring plan maintenance to ensure that the process described is being followed, on an annual basis, throughout the planning process. The Planning Team will develop a brief report that identifies policies and actions in the plan that have been successfully implemented and any changes in the implementation process needed

for continued success. Team meetings for monitoring the HMAP will include a sign-in sheet to record attendance and a written summary of meeting notes will report the particulars involved in developing an action into a project. In addition to the annual monitoring, the HMAP will be similarly reviewed immediately after extreme weather events, including but not limited to state and federally declared disasters.

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 HMAP, identify any needed changes, and assess the effectiveness of the plan in achieving its stated purpose and goals. The Team Lead, along with key team members (Table 102) will evaluate the team participants in the last planning cycle to determine if additional participants can contribute further areas of expertise during the current planning cycle and future updates. The team will evaluate the number of mitigation actions implemented along with the loss-reduction associated with each action. Actions that have not been implemented will be evaluated to determine if any social, political, or financial barriers are impeding implementation and if any changes are necessary to improve the viability of an action. The team will evaluate changes in land development and/or programs that affect mitigation priorities in their respective areas of authority. This annual evaluation process will include an annual meeting with a sign-in sheet to record attendance and a brief report that identifies any changes that may be necessary. In addition, the HMAP will be similarly evaluated immediately after extreme weather events, including but not limited to state and federally declared disasters.

Updating

PLAN AMENDMENTS

At any time, minor technical changes may be made to update the HMAP. Material changes to mitigation actions or major changes in the overall direction of the HMAP, or the policies contained within it, must be subject to formal adoption by the City.

The City will review proposed amendments and vote to accept, reject, or amend the proposed change. Upon ratification, the amendment will be transmitted to the Texas Division of

Emergency Management (TDEM) for review and forwarding to FEMA for final approval of amendment.

In determining whether to recommend approval or denial of a plan amendment request, the City will consider the following factors:

- Errors or omissions made in the identification of issues or needs during the preparation of the HMAP;
- New issues or needs that were not adequately addressed in the HMAP; and
- Changes in information, data, or assumptions upon which the HMAP was based.

FIVE YEAR REVIEW

The Planning Team will thoroughly review the HMAP by 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 HMAP 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 HMAP review process provides the City 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) meet to review the HMAP 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 5-year plan update deadline is recommended, considering the timelines for grant and planning cycles can be more than 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 HMAP 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 HMAP and will continue to be essential for plan updates. Changes or suggestions to improve or update the HMAP will provide opportunities for additional public input.

The public can review the HMAP on the City of San Antonio's website (http://saoemprepare.com/), where officials and the public are invited to provide ongoing feedback. The City of San Antonio will also provide an opportunity for feedback during the annual Citizens Preparedness Workshop. Additionally, copies of the HMAP will be kept in the offices of the City.

The Planning Team may also designate voluntary citizens from the City, or willing stakeholder members that were involved in the HMAP'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 HMAP.

Media, including local newspaper and radio stations, will be used to notify the public of any maintenance or periodic review activities during the implementation, monitoring, and evaluation phases. Additionally, local news media will be contacted to cover information regarding plan updates, status of grant applications, and project implementation. Local and social media outlets, such as Facebook and Twitter, will keep the public and stakeholders apprised of potential opportunities to fund and implement mitigation projects identified in the HMAP. Social media outlets have been successful for communicating in the past and will continue to be utilized to not only inform the public of progress, but to create public awareness of activities and the need for public involvement going forward.

Appendix A: Planning Team

Planning Team Members

The HMAP was organized using a direct representative model. Table 103reflects the Planning Team, consisting of City departments and area organizations that participated throughout the planning process and provided HMAP input. The Planning Team members from the City of San Antonio Office of Emergency Management were assigned to coordinate planning efforts, and request input and participation in the planning process. The public were also invited to participate via e-mail and throughout the planning process. Public outreach efforts and meeting documentation is provided in Appendix E.

Table 103. Planning Team

DEPARTMENT	TITLE
Alamo Area Council of Governments (AACOG)	Homeland Security Planner
Alamo Federal Executive Board (AFEB)	Director
American Red Cross	Disaster Program Manager
Bexar County Office of Emergency Management	Emergency Management Coordinator
Bexar County Office of Emergency Management	Deputy Chief
CPS Energy	Director, Emergency Operations
Department of Homeland Security (DHS)	Protective Security Advisor
Department of State Health Services (DSHS)	Preparedness Manager
disABILITYsa	Director
Education Service Center, Region 20	Deputy Director, Admin and Instructional Services
Education Service Center, Region 20	School Safety Consultant
Haven for Hope	Director of Life Safety
H-E-B	Director of Emergency Preparedness
Joint Base San Antonio (JBSA)	Chief of Emergency Management
Lighthouse for the Blind	CEO
Local Emergency Planning Committee (LEPC)	Chair

DEPARTMENT	TITLE
National Weather Service (NWS)	Warning Coordination Meteorologist
Port San Antonio	Airport Operations Director
San Antonio 311	Director
San Antonio Airport	Airport Emergency Manager
San Antonio Animal Care Services	Assistant Director
San Antonio Building and Equipment Services Department	Assistant Director
San Antonio Department of Human Services	Senior Management Coordinator for Homeless Veterans
San Antonio Department of Planning	Assistant Director
San Antonio Development Services	Code Enforcement Manager
San Antonio Development Services	Director
San Antonio Development Services	Deputy Director
San Antonio Economic Development Department	Director
San Antonio Fire Department (SAFD) Fire Prevention	Battalion Chief
San Antonio Fire Department (SAFD) Hazmat	Battalion Chief
San Antonio Fire Department (SAFD) Hazmat	Battalion Chief
San Antonio Fire Department (SAFD) Hazmat	Battalion Chief
San Antonio Fire Department (SAFD) Public Information	Public Information Officer
San Antonio Fire Department (SAFD) Planning	Battalion Chief
San Antonio Fire Department (SAFD) Wildland Fire	Captain
San Antonio Food Bank	Chief Operating Officer
San Antonio Government and Public Affairs	Assistant Director
San Antonio Housing Authority (SAHA)	Risk Manager

DEPARTMENT	TITLE
San Antonio Information Technology Services Department (ITSD)	Chief Information Security Officer
San Antonio Metropolitan Health District (Metro Health)	Emergency Preparedness Coordinator
San Antonio Office of Diversity, Equity, and Inclusion	Director
San Antonio Office of Emergency Management	Emergency Management Coordinator
San Antonio Office of Emergency Management	Special Projects Manager
San Antonio Office of Emergency Management	Assistant Emergency Management Coordinator
San Antonio Office of Emergency Management	Assistant Emergency Management Coordinator
San Antonio Office of Emergency Management	Senior Management Analyst
San Antonio Office of Emergency Management	Senior Management Analyst
San Antonio Office of Emergency Management	Senior Management Analyst, Vulnerable Populations
San Antonio Office of Emergency Management	Management Analyst, Public Outreach Coordinator
San Antonio Office of Innovation	Director
San Antonio Office of Sustainability	Chief Sustainability Officer
San Antonio Office of Sustainability	Deputy Chief Sustainability Officer
San Antonio Police Department (SAPD)	Police Captain
San Antonio Public Works	Capital Programs Manager
San Antonio Public Works Storm Water	Assistant Director
San Antonio Public Works Transportation	Special Projects Manager
San Antonio River Authority (SARA)	Watershed Engineer
San Antonio Solid Waste Management	Director
San Antonio Water System (SAWS)	Emergency Manager
Southwest Texas Fusion Center	Deputy Director
Southwest Texas Regional Advisory Council (STRAC)	Division Director

DEPARTMENT	TITLE
Texas A&M Forest Service	Assistant Chief Regional Fire Coordinator
Texas Division of Emergency Management (TDEM)	District Coordinator
The University of Texas at San Antonio (UTSA)	Business Continuity and EM Coordinator
The University of Texas Health Science Center (UTHSC) at San Antonio	Medical Director
United Services Automobile Association (USAA)	Senior Business Continuity Advisor
United Way	211 Contact Center Manager and Disaster Response Coordinator
University Health System (UHS)	Director, Disaster Management
Valero	Director of Health, Safety, and Emergency Preparedness
VIA Metropolitan Transit	VP of Safety, Training, and System Security

Appendix B: Public Survey Results

Overview

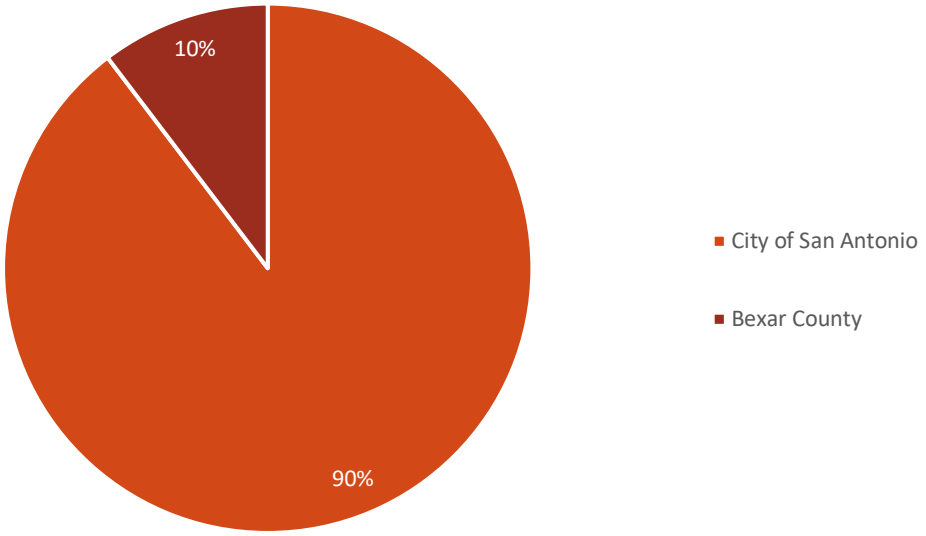
The City of San Antonio prepared a public survey that requested public opinion on a wide range of questions relating to natural hazards. The survey was made available in both English and Spanish on the City of San Antonio's website, Facebook, Twitter, and Nextdoor. This survey link was also distributed at public meetings and stakeholder events throughout the planning process.

A total of 174 surveys were collected, the results of which are analyzed in Appendix B. The purpose of the survey was twofold: (1) to solicit public input during the planning process, and (2) to help the City 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.

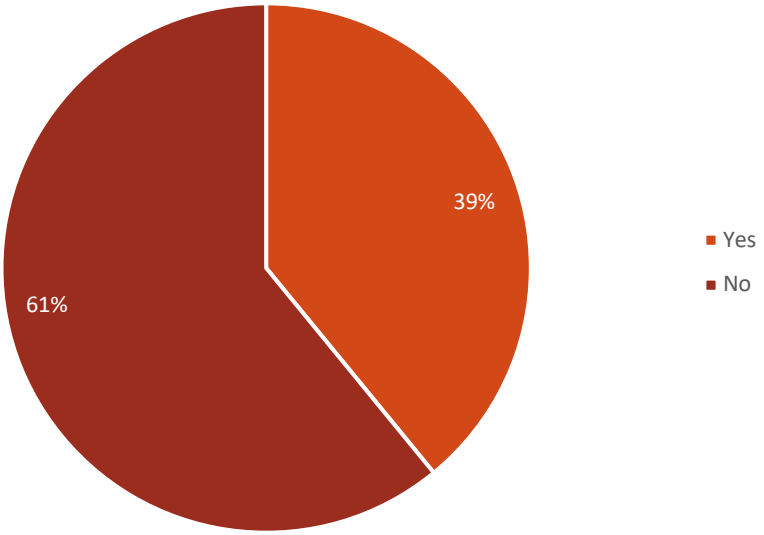
Public Survey Results

1. Please state the jurisdiction (city or community) where you reside.[172]

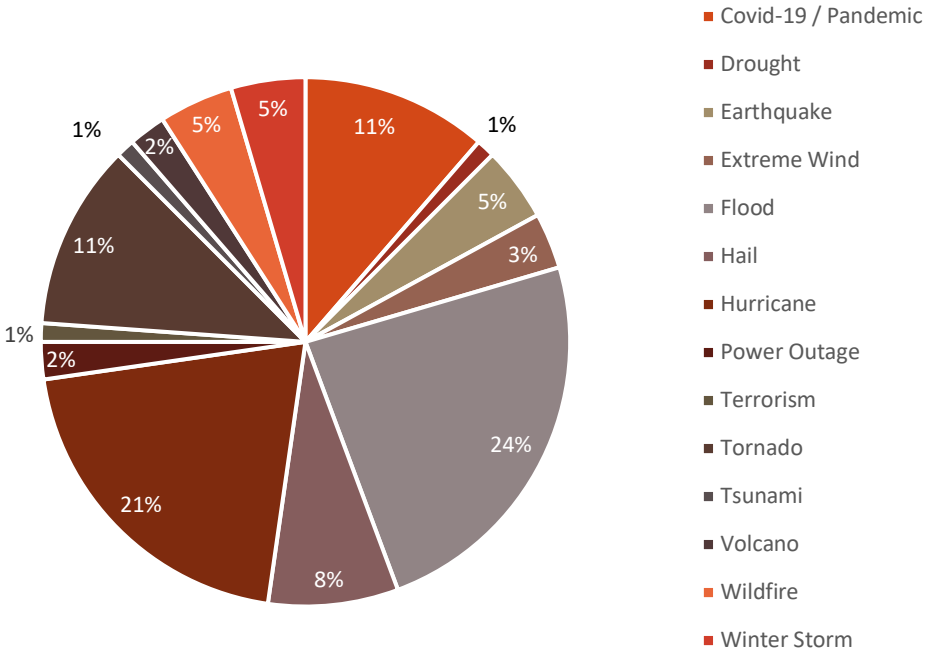


[172] There were several responses indicating residence in cities outside of the City of San Antonio but still within Bexar County. As the respondents may work within the City of San Antonio, their responses to the survey were included.

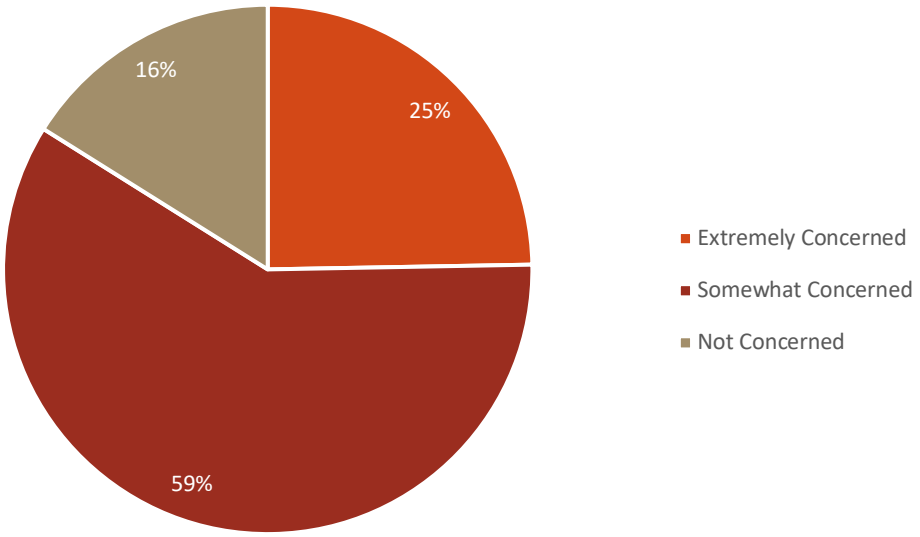
2. Have you ever experienced or been impacted by a disaster?



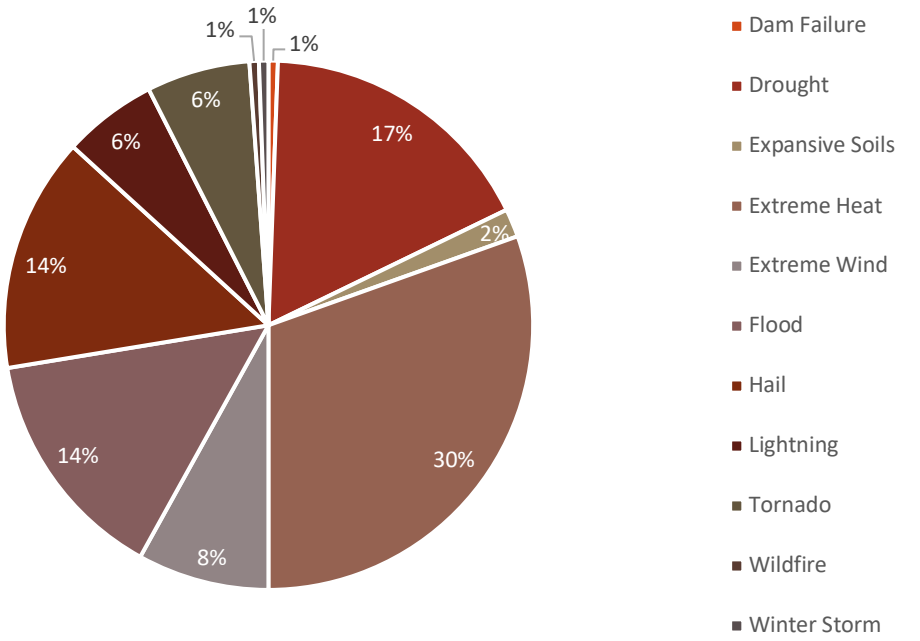
3. If you answered "YES" to Question #2, please explain.



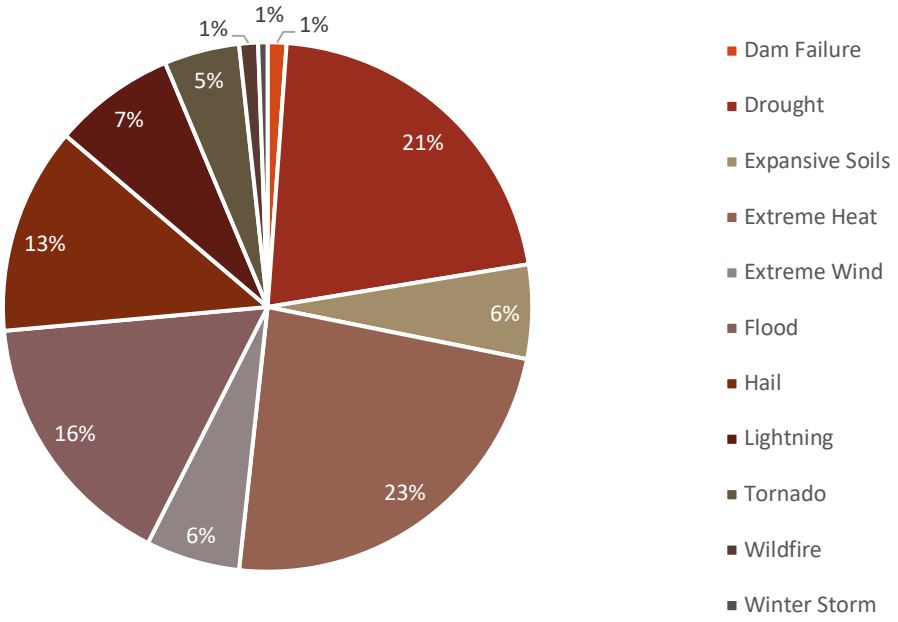
4. How concerned are you about the possibility of your community being impacted by a disaster?



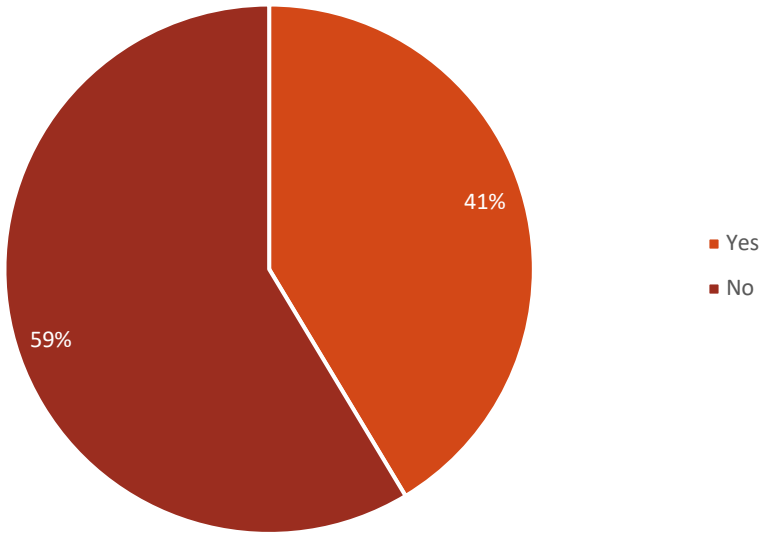
5. Please select the one hazard you think is the highest threat to your neighborhood:



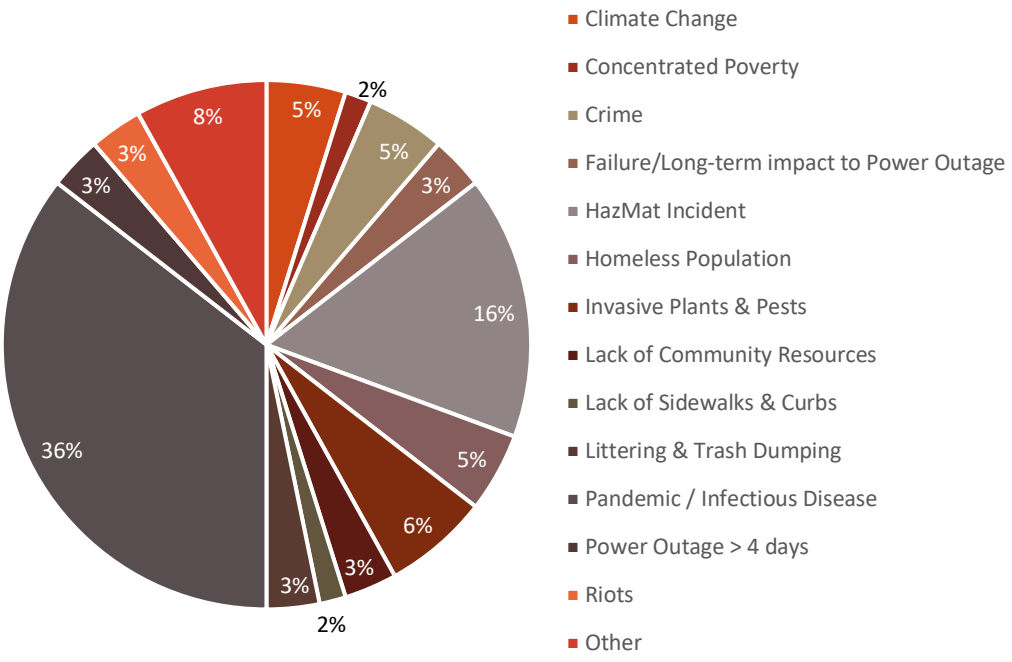
6. Please select the one hazard you think is the second highest threat to your neighborhood:



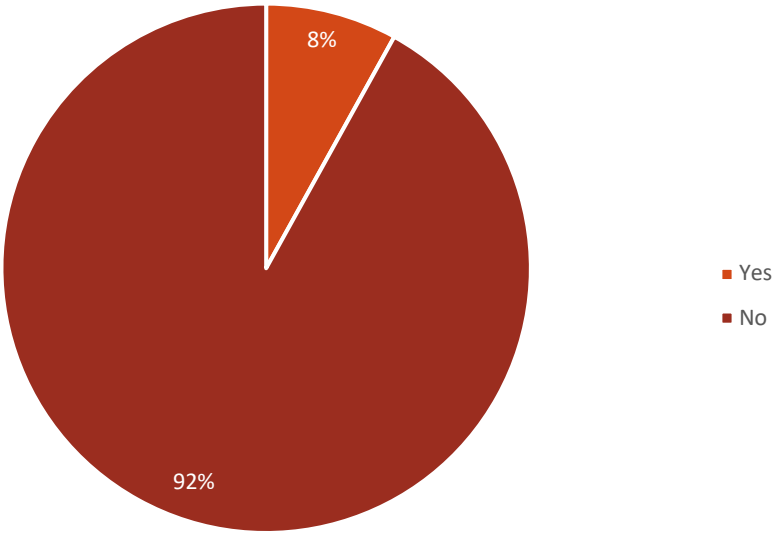
7. Are there hazards not listed above that you think is a wide-scale threat to your neighborhood?



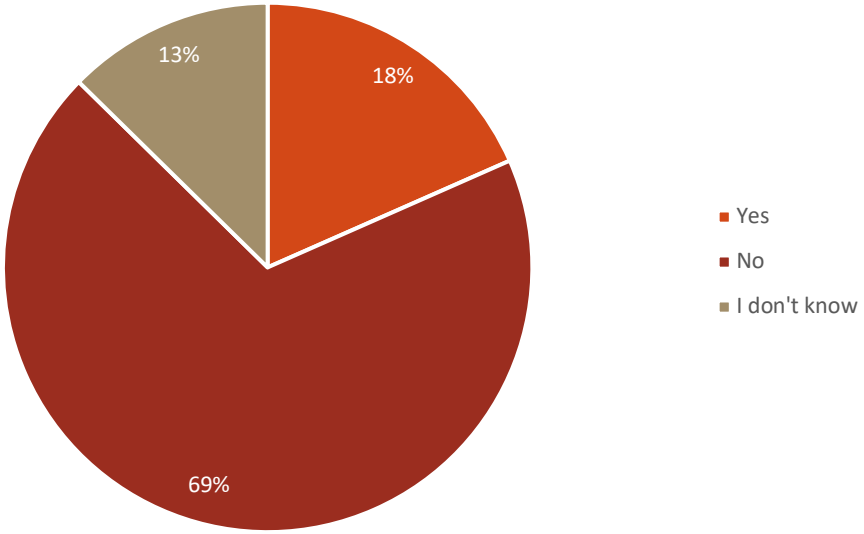
8. If you answered "YES" to Question #7, please explain.



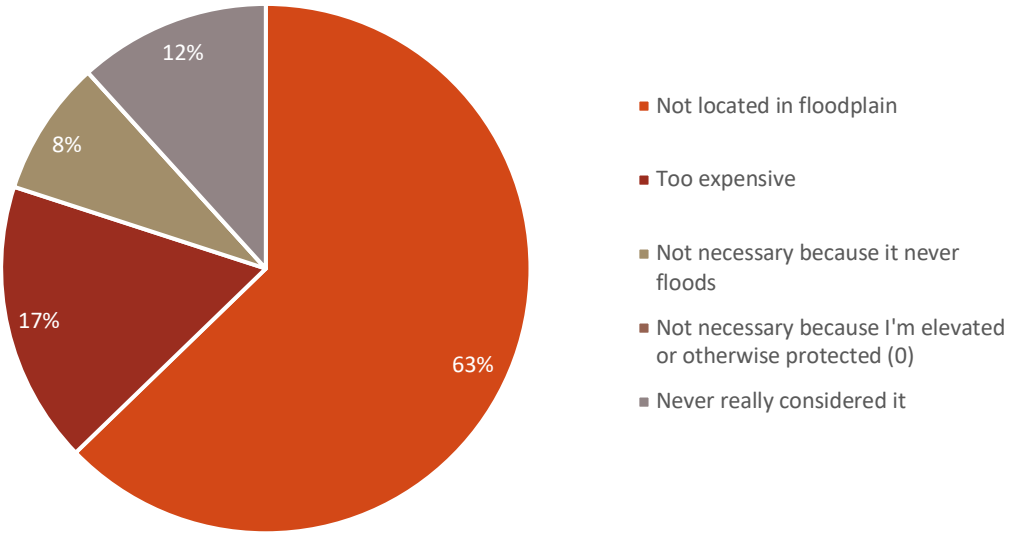
9. Is your home located in a floodplain?



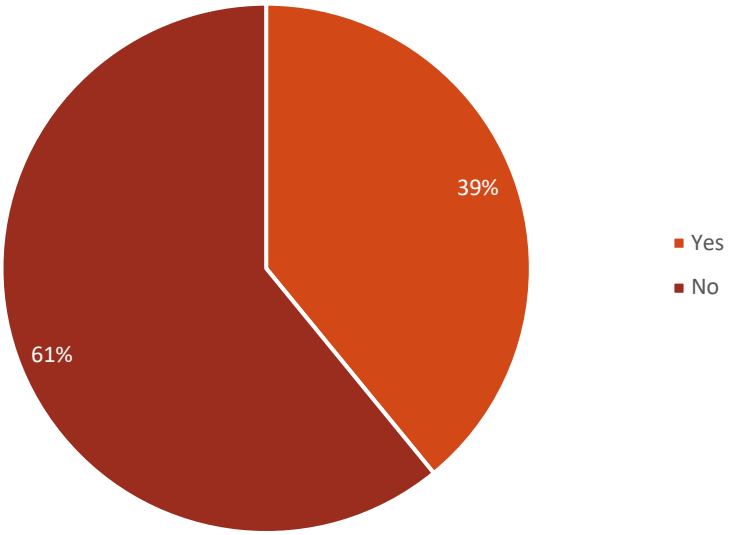
10. Do you have flood insurance?



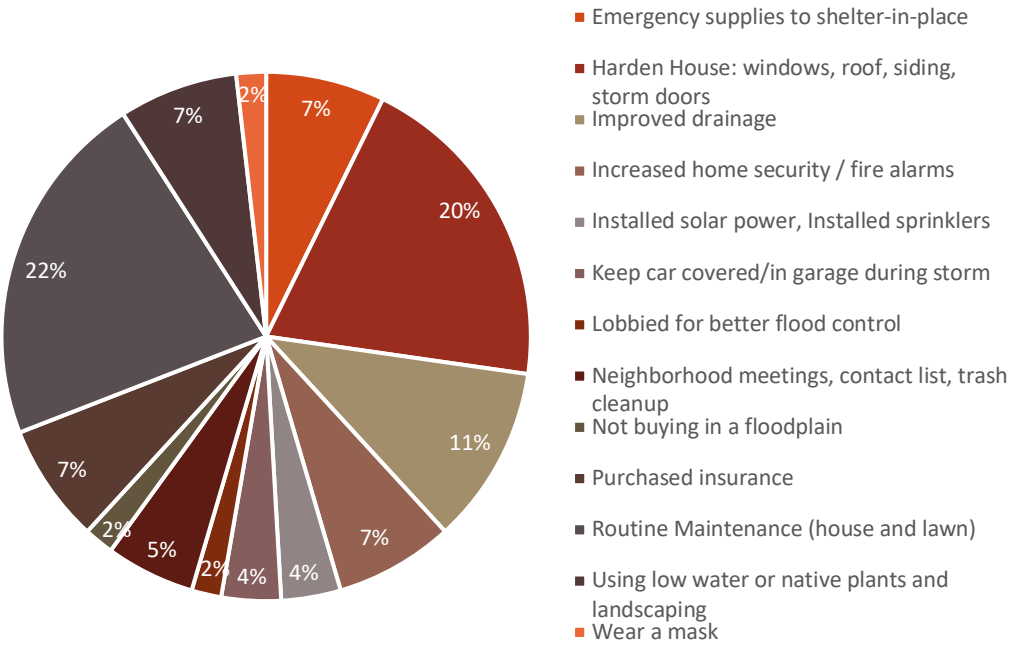
11. If you do not have flood insurance, why not?



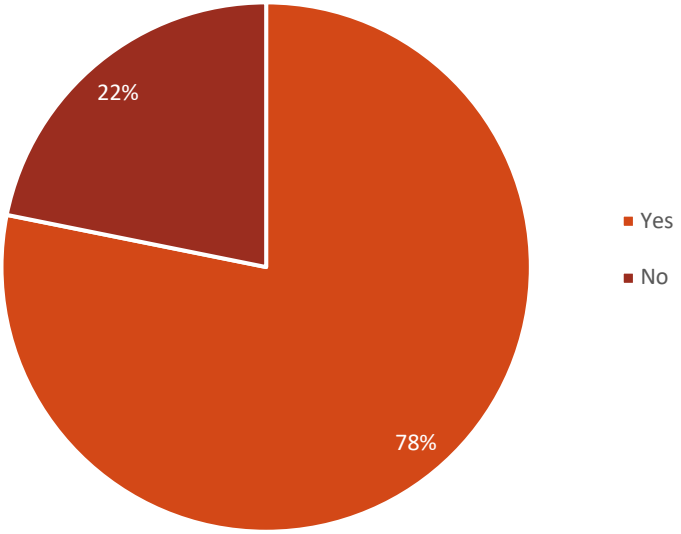
11. Have you taken any actions to make your home or neighborhood more resistant to hazards?



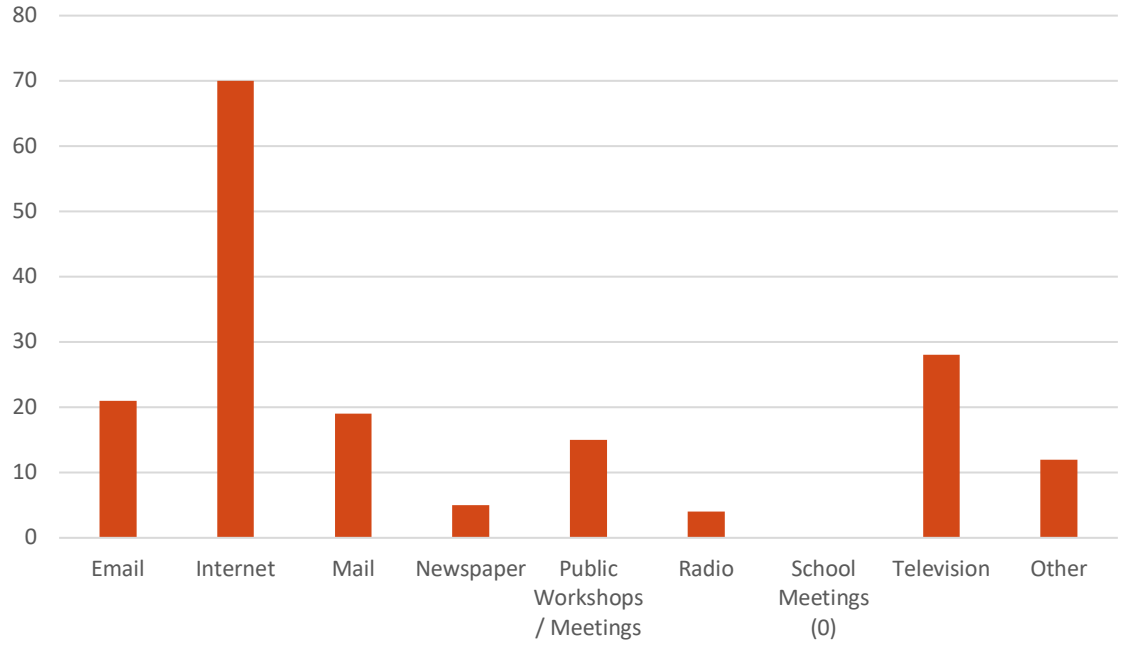
12. If you answered "YES" to Question #12, please explain.



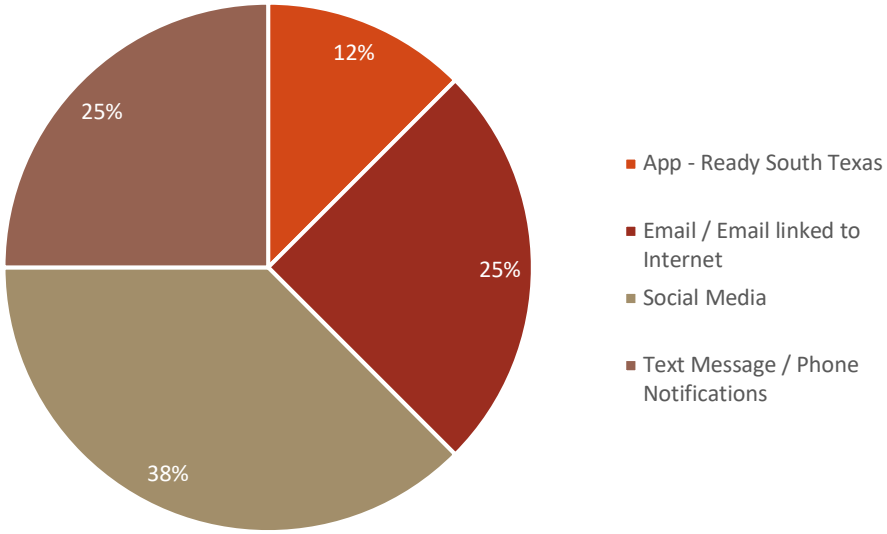
13. Are you interested in making your home or neighborhood more resistant to hazards?



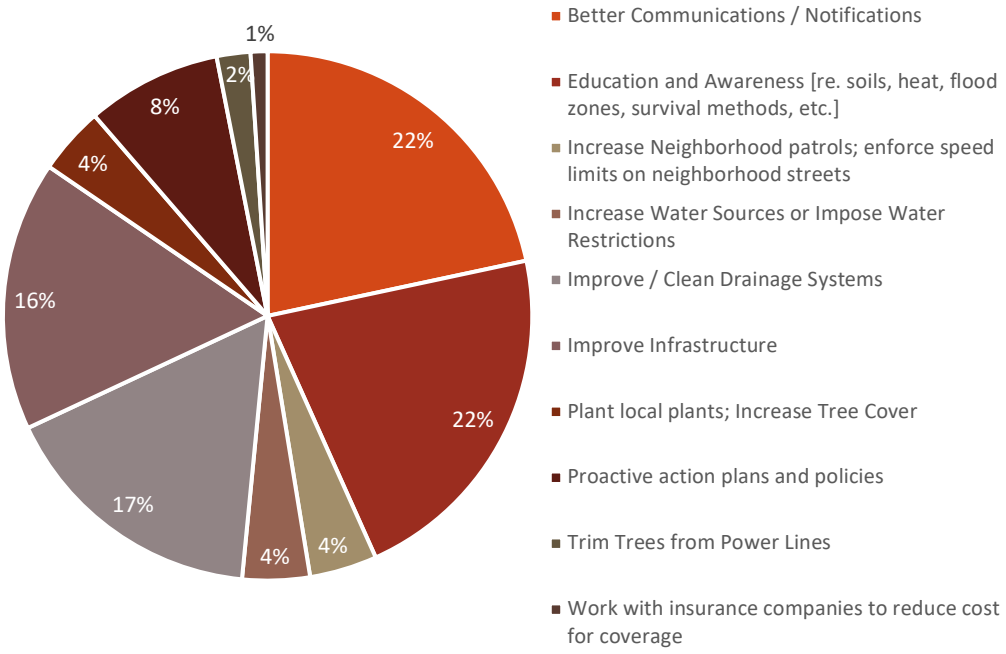
14. What is the most effective way for you to receive information about how to make your home and neighborhood more resistant to hazards?



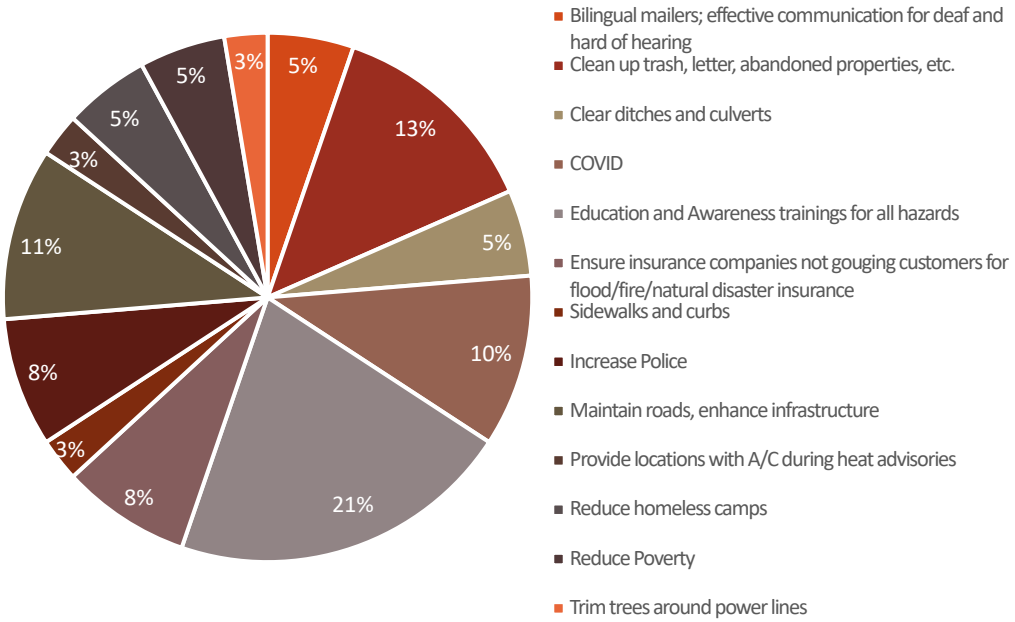
15. If you answered "Other" to Question #15, please explain.



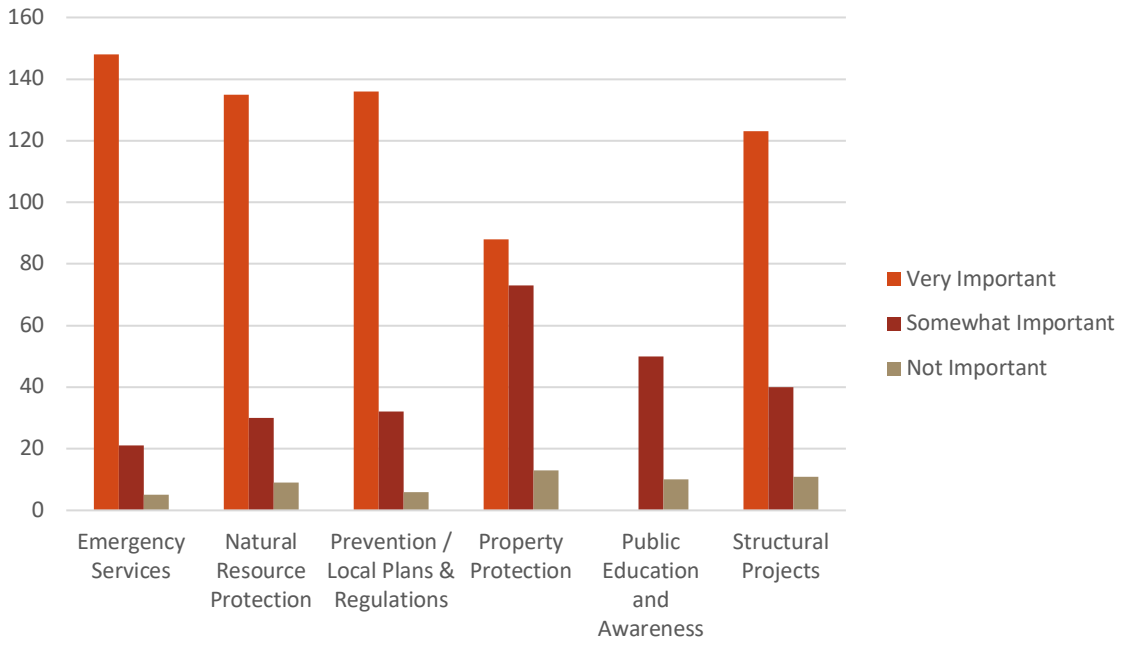
16. In your opinion, what are some steps your local government could take to reduce or eliminate the risk of future hazard damages in your neighborhood?



17. 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?



18. A number of community-wide activities can reduce the 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.



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.

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.

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.

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.

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.

Appendix C: Critical Failures

Overview

This Appendix is For Official Use Only (FOUO) and may be exempt from public release under the Freedom of Information Act (FOIA). Table C-1 reflects critical facilities by "type" in the City of San Antonio. Figure 78 through Figure 93 locates all critical facilities that were included in the risk assessment. Facilities mapped were provided by the City of San Antonio Planning Team members.

The City of San Antonio owns numerous critical facilities and has authority to mitigate risk to natural hazards affecting these facilities. The City of San Antonio critical facilities include emergency response facilities such as fire and police stations, hospitals, schools, and other structures as indicated below.

Critical Facilities

Table 104. Critical Facilities by Type in the City of San Antonio

DHS INFRASTRUCTURE SECTOR	NUMBER OF CRITICAL FACILITIES	
	CITY OF SAN ANTONIO	BEXAR COUNTY, TOTAL
Agriculture and Food	102	118
Banking and Finance	382	432
Chemical and Hazardous Materials Industry	638	813
Energy	90	127
Emergency Services	197	311
Communications	101	206
Postal and Shipping	4	4
Healthcare and Public Health	1,047	1,227
Transportation	22	35
Water	275	393
National Monuments and Icons	8	8
Commercial Facilities	2,272	2,707
Government Facilities	527	675

DHS INFRASTRUCTURE SECTOR	NUMBER OF CRITICAL FACILITIES	
	CITY OF SAN ANTONIO	BEXAR COUNTY, TOTAL
Dams	34	78
Nuclear Reactors, Materials, and Waste	74	83
Manufacturing	1	1
TOTAL	**5,774**	**7,218**

Figure 78. Agriculture and Food

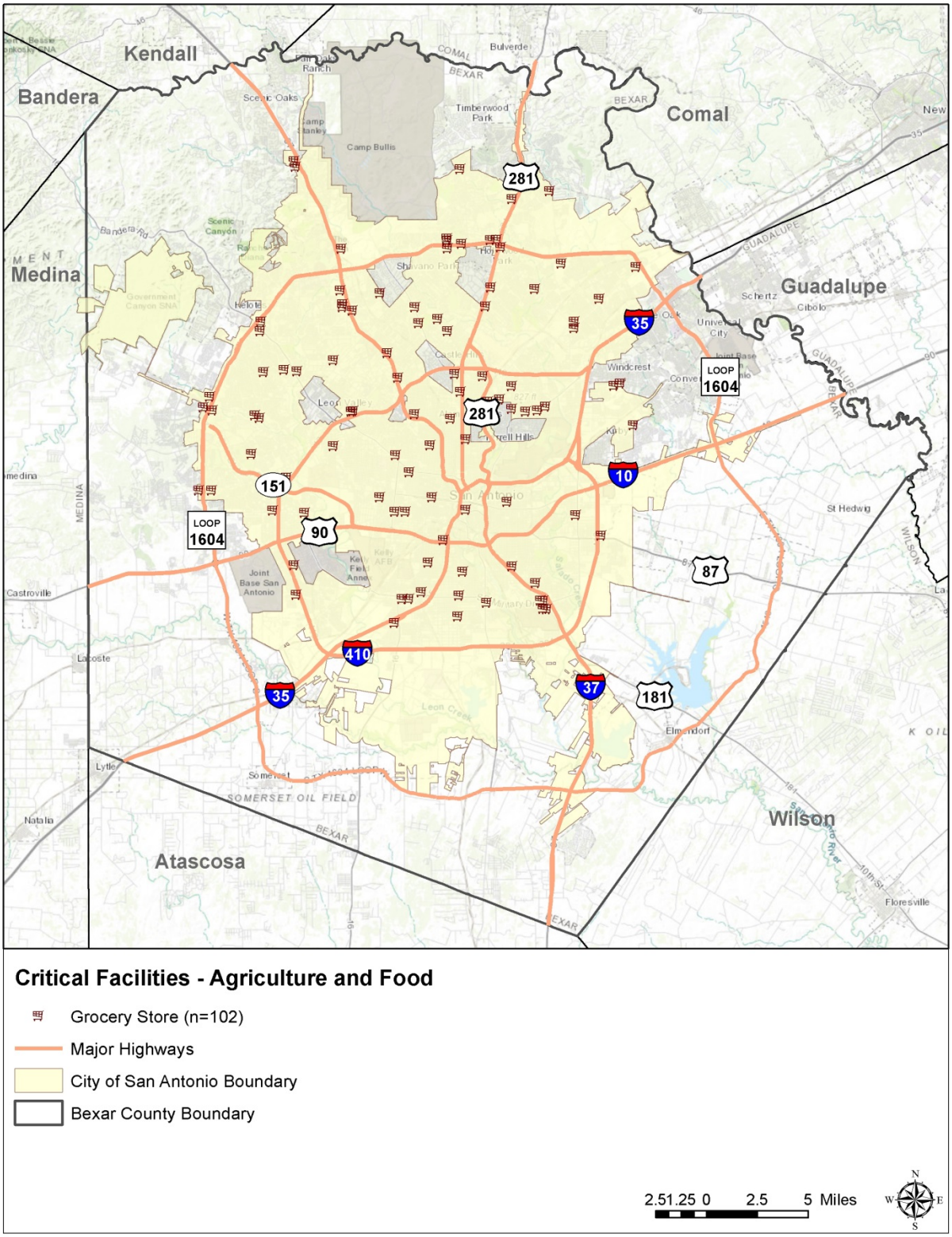


Figure 79. Banking and Finance

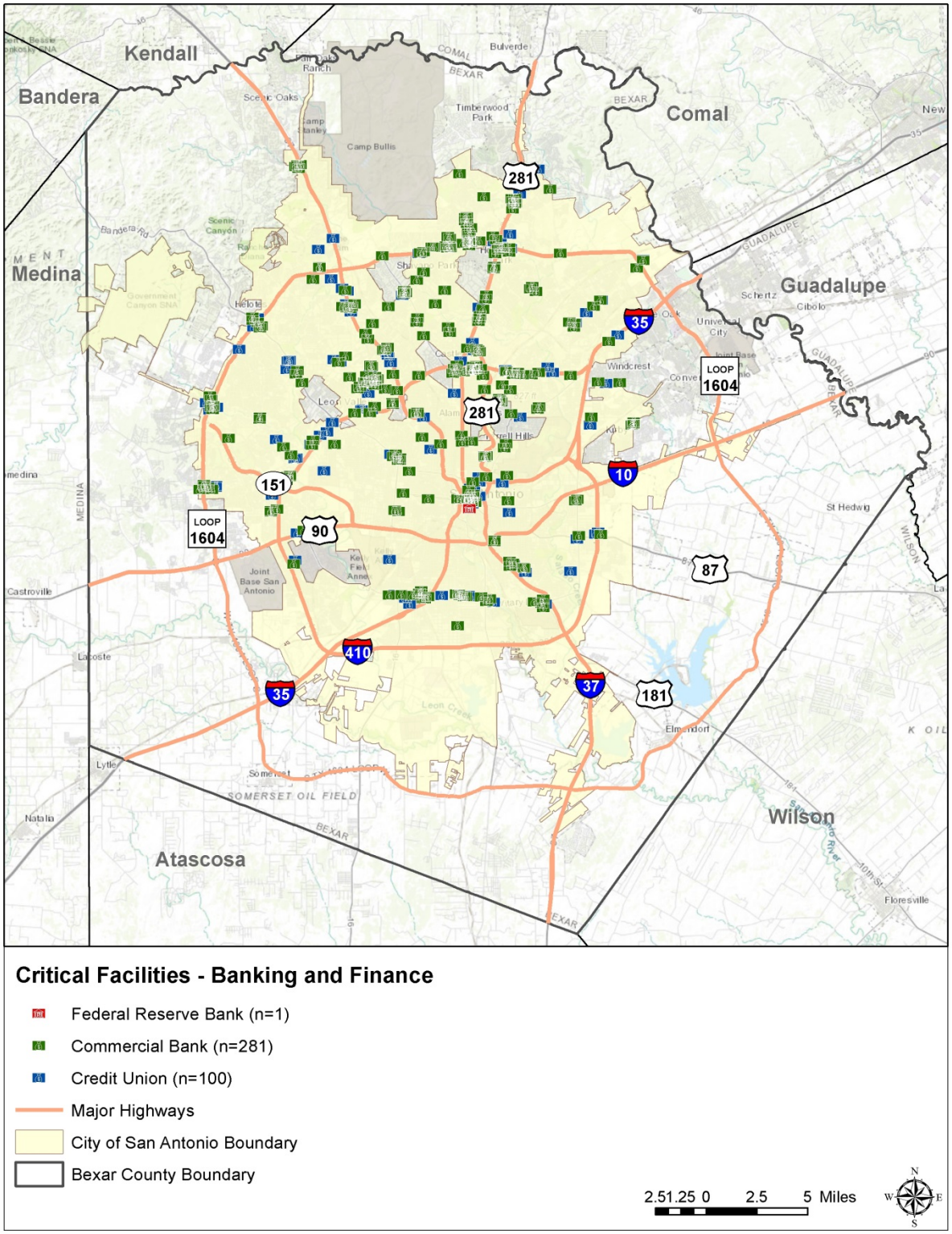


Figure 80. Chemical and Hazardous Materials Industry

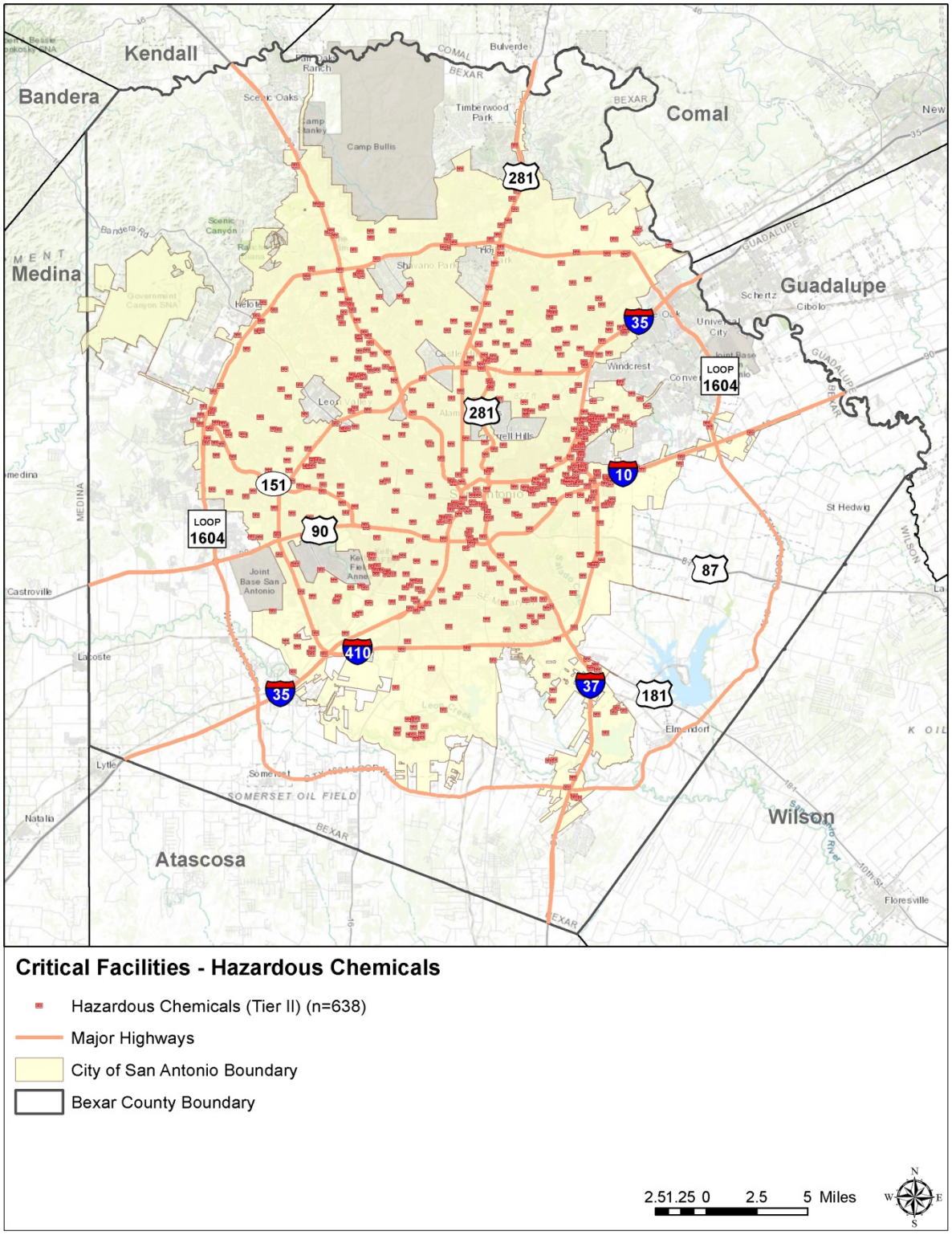


Figure 81. Energy

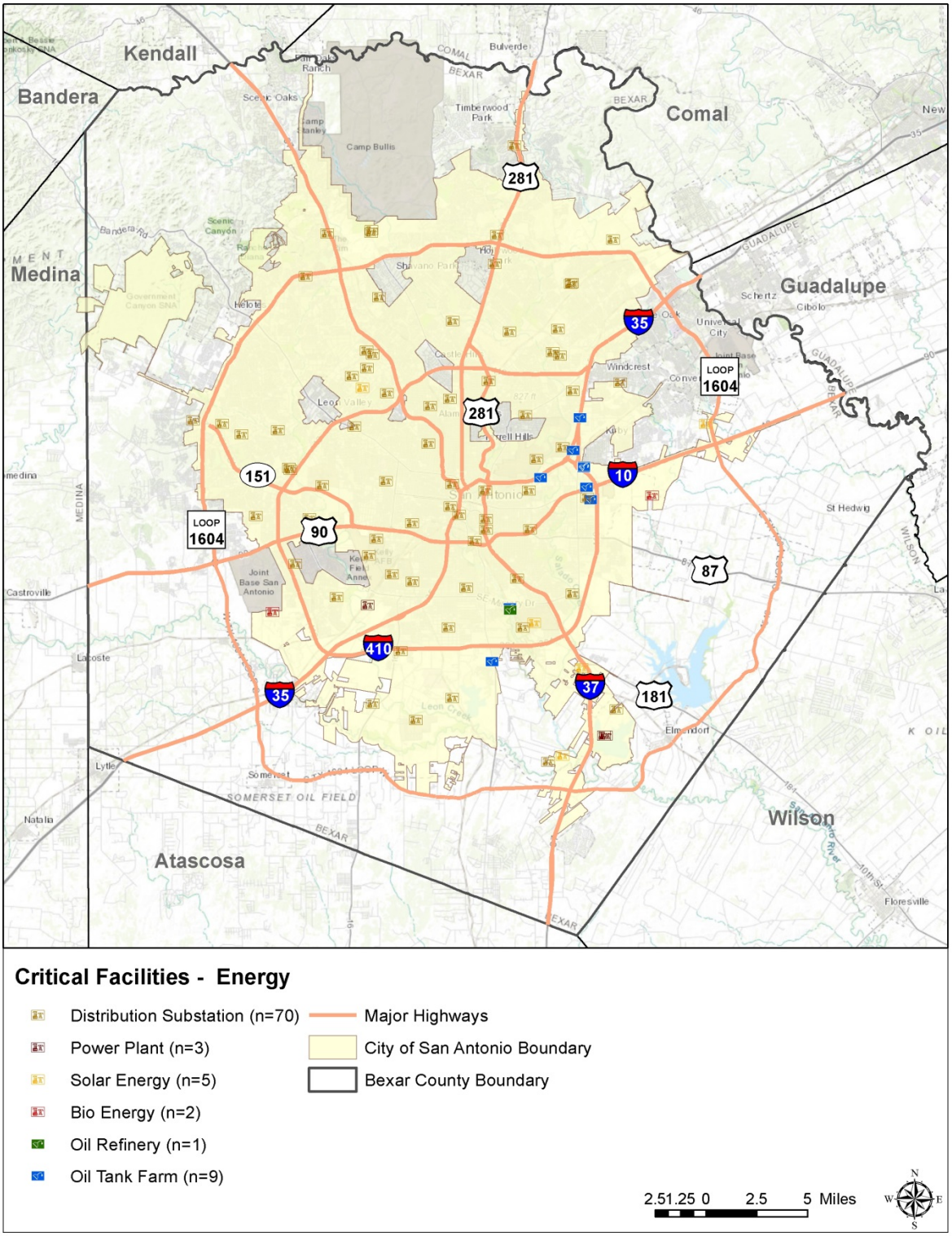


Figure 82. Emergency Services

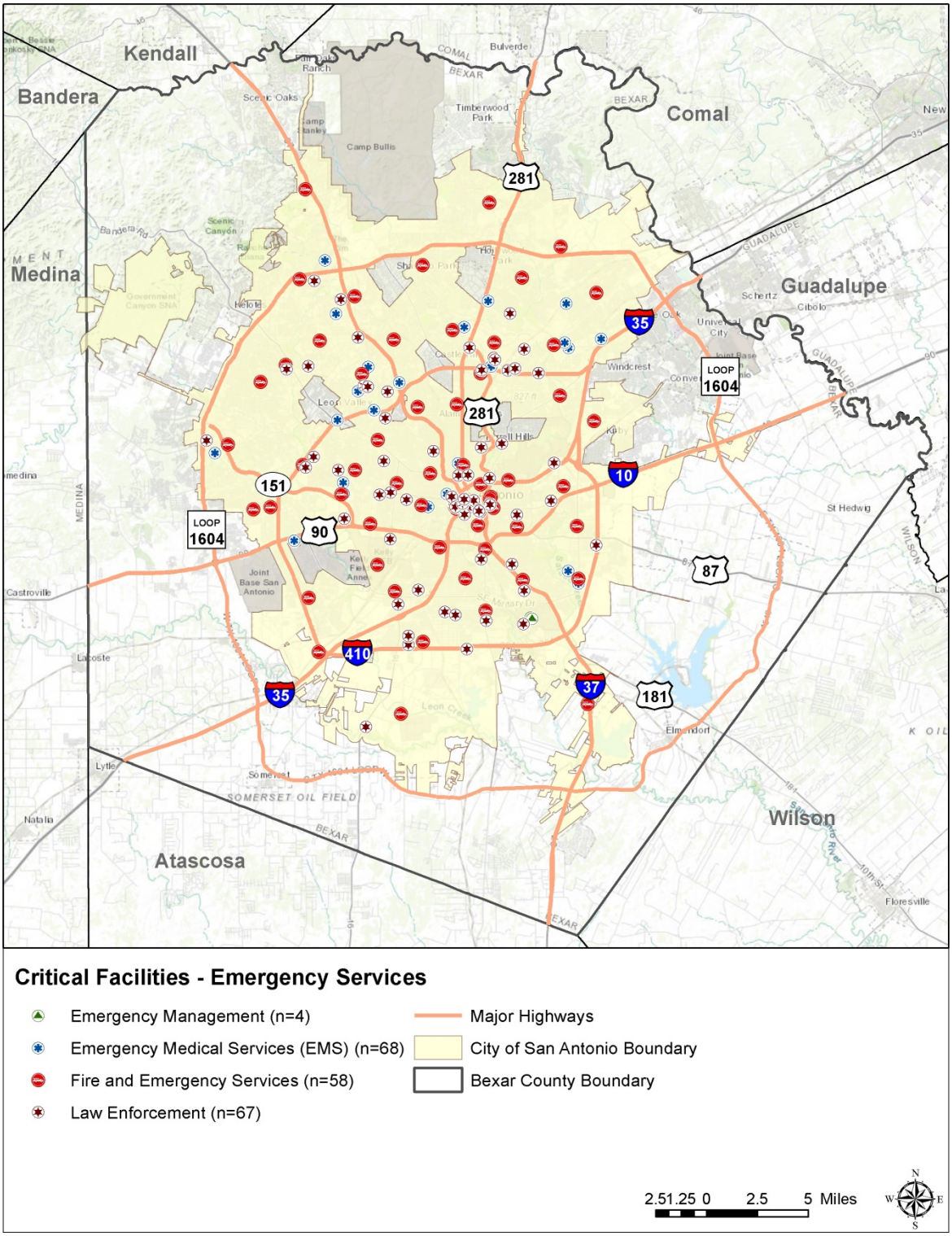


Figure 83. Communications

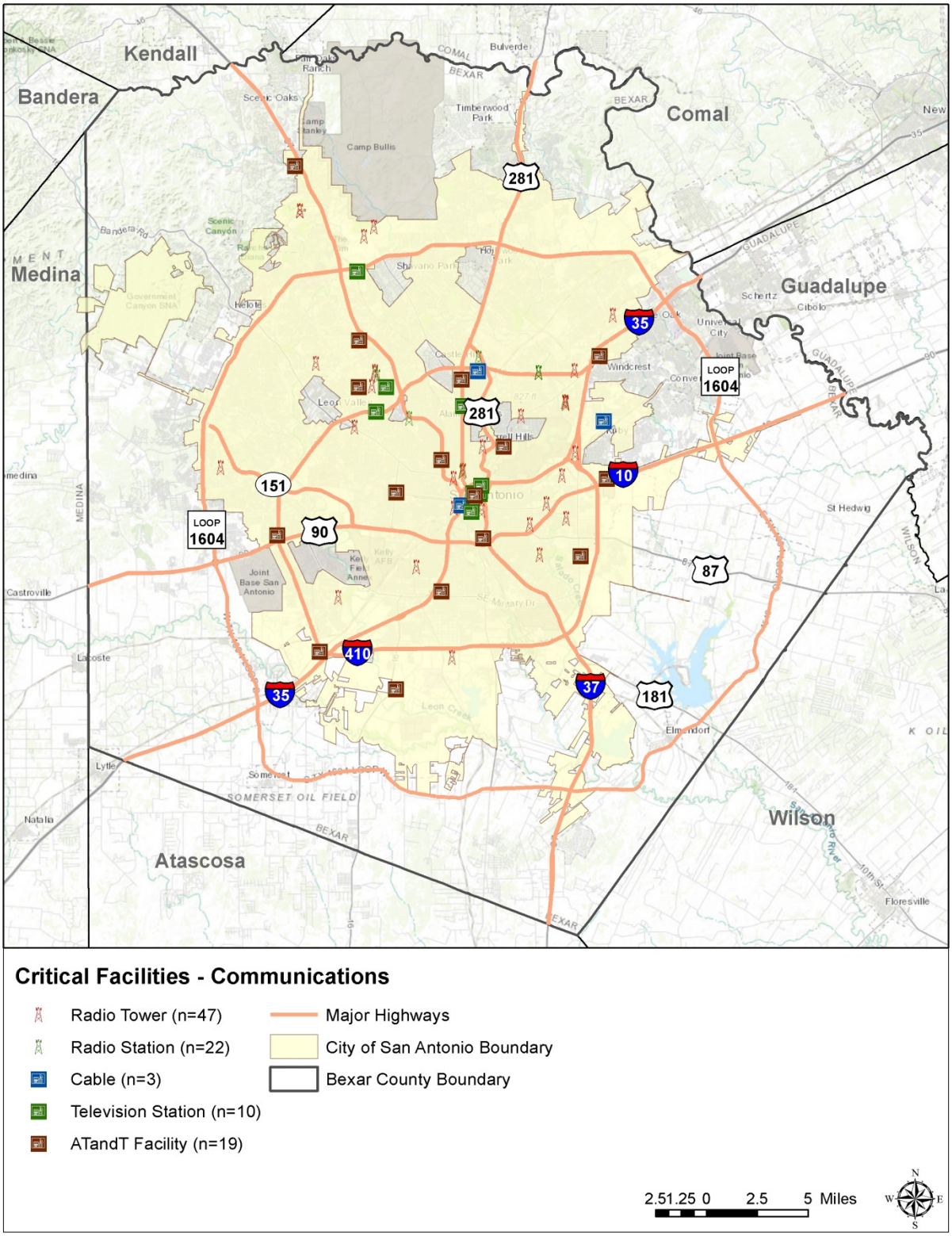


Figure 84. Postal and Shipping

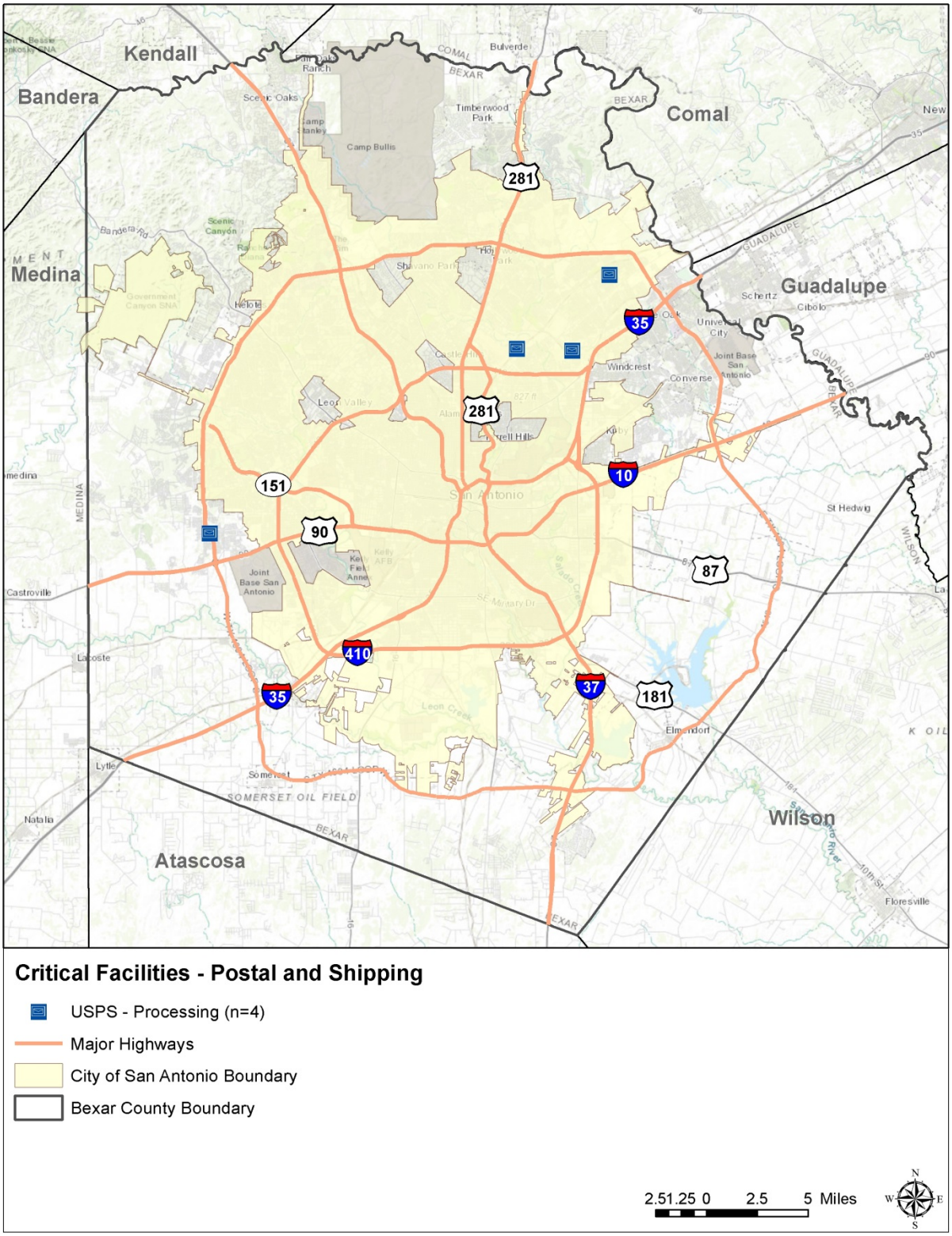


Figure 85. Healthcare & Public Health

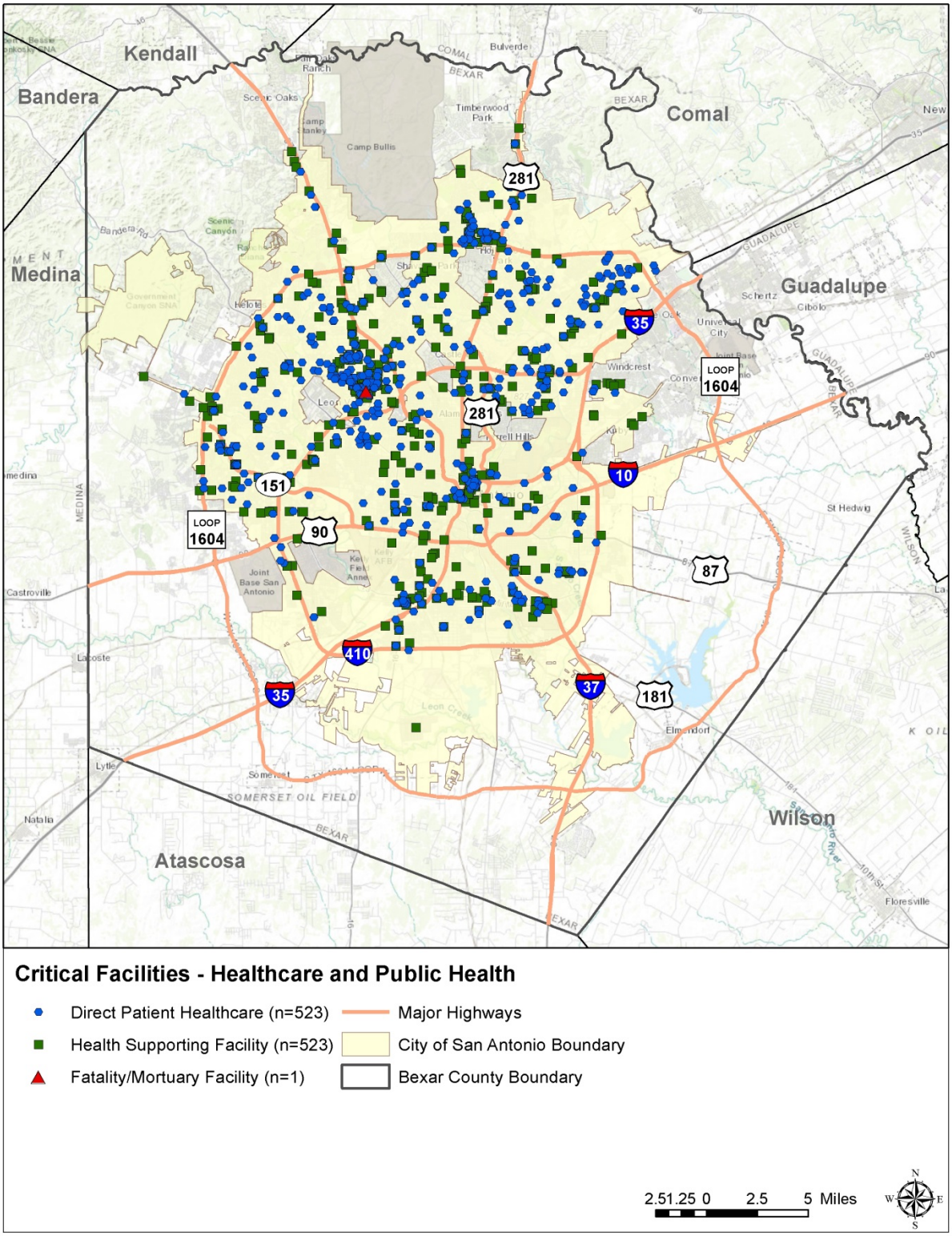


Figure 86. Transportation

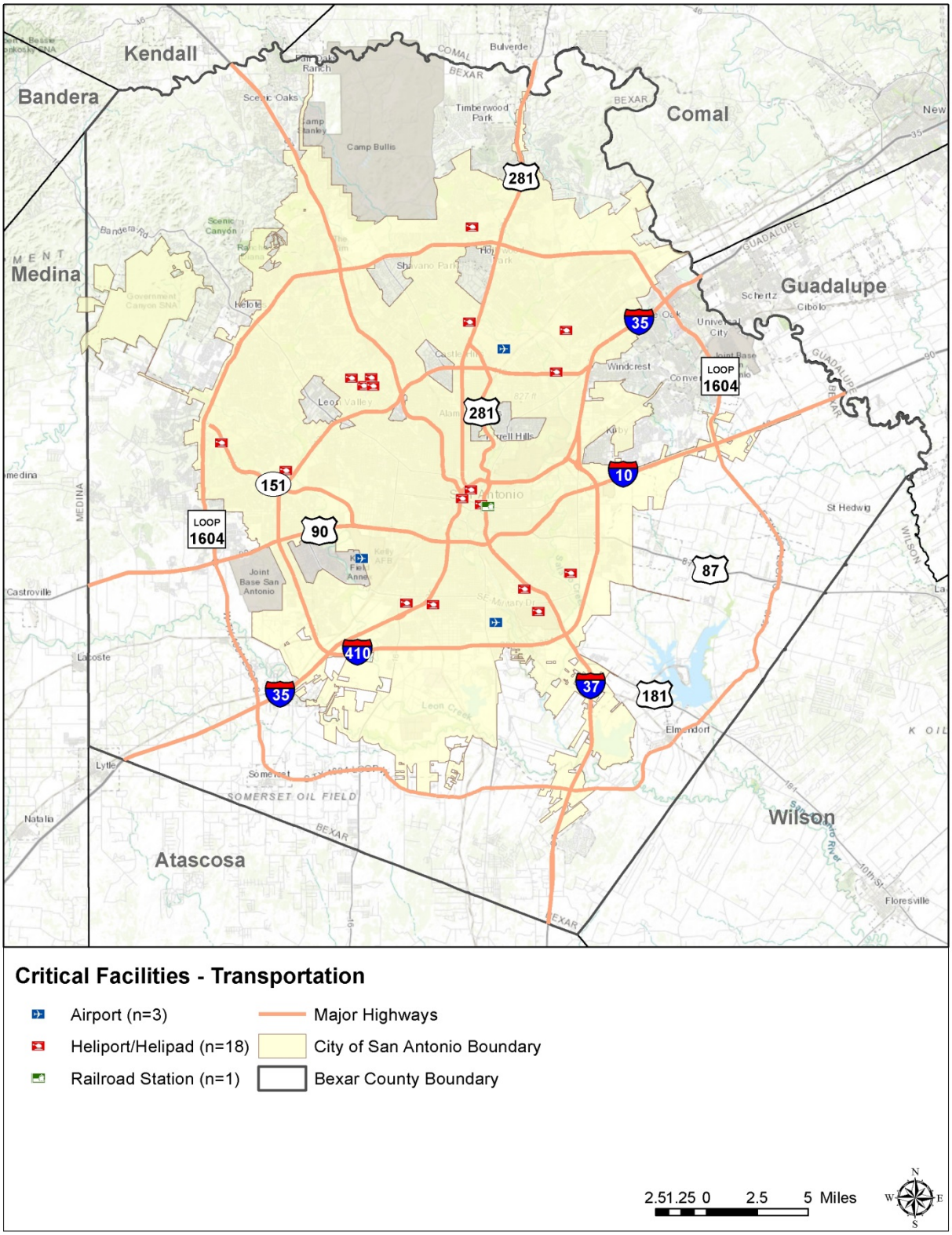


Figure 87. Water

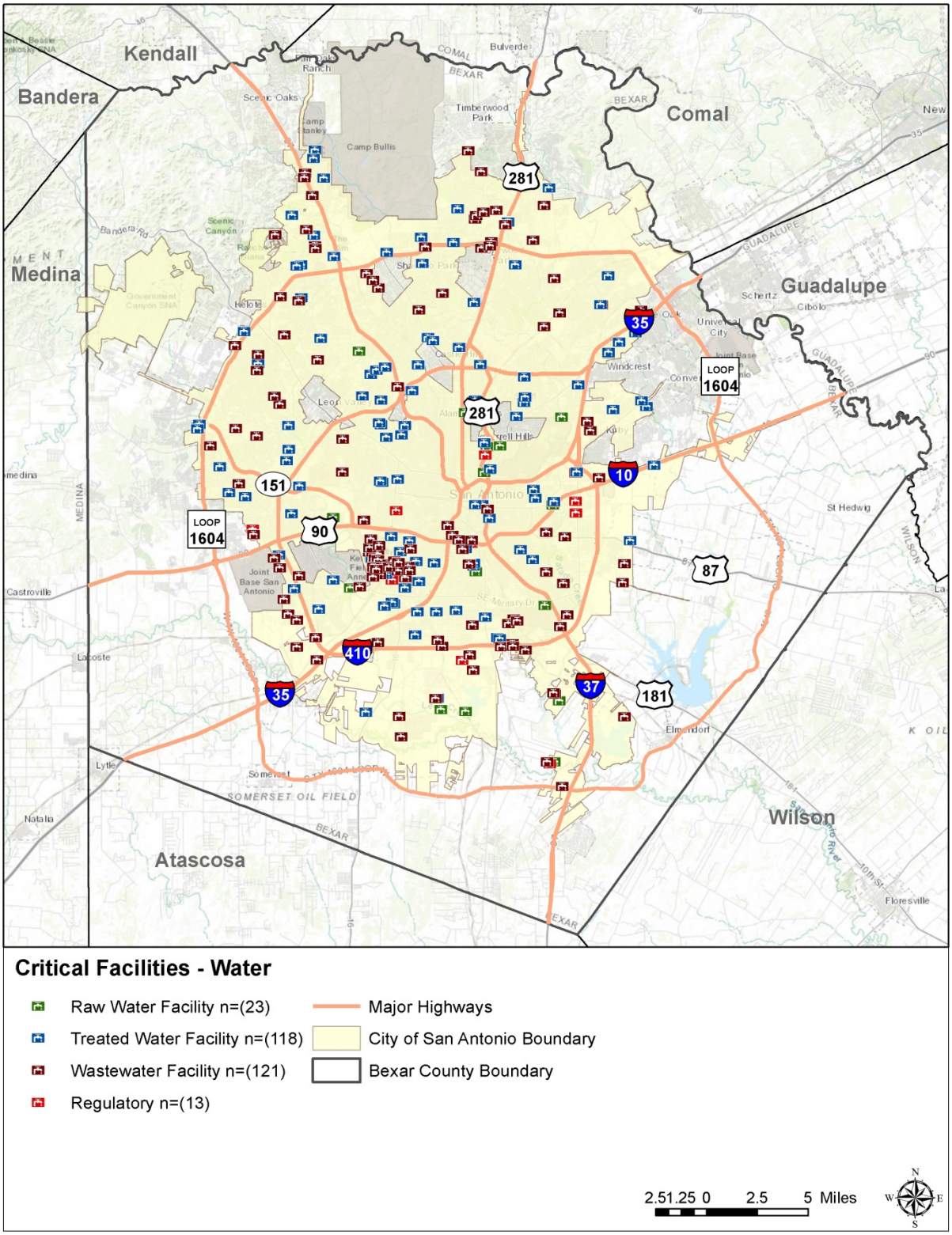


Figure 88. National Monuments and Icons

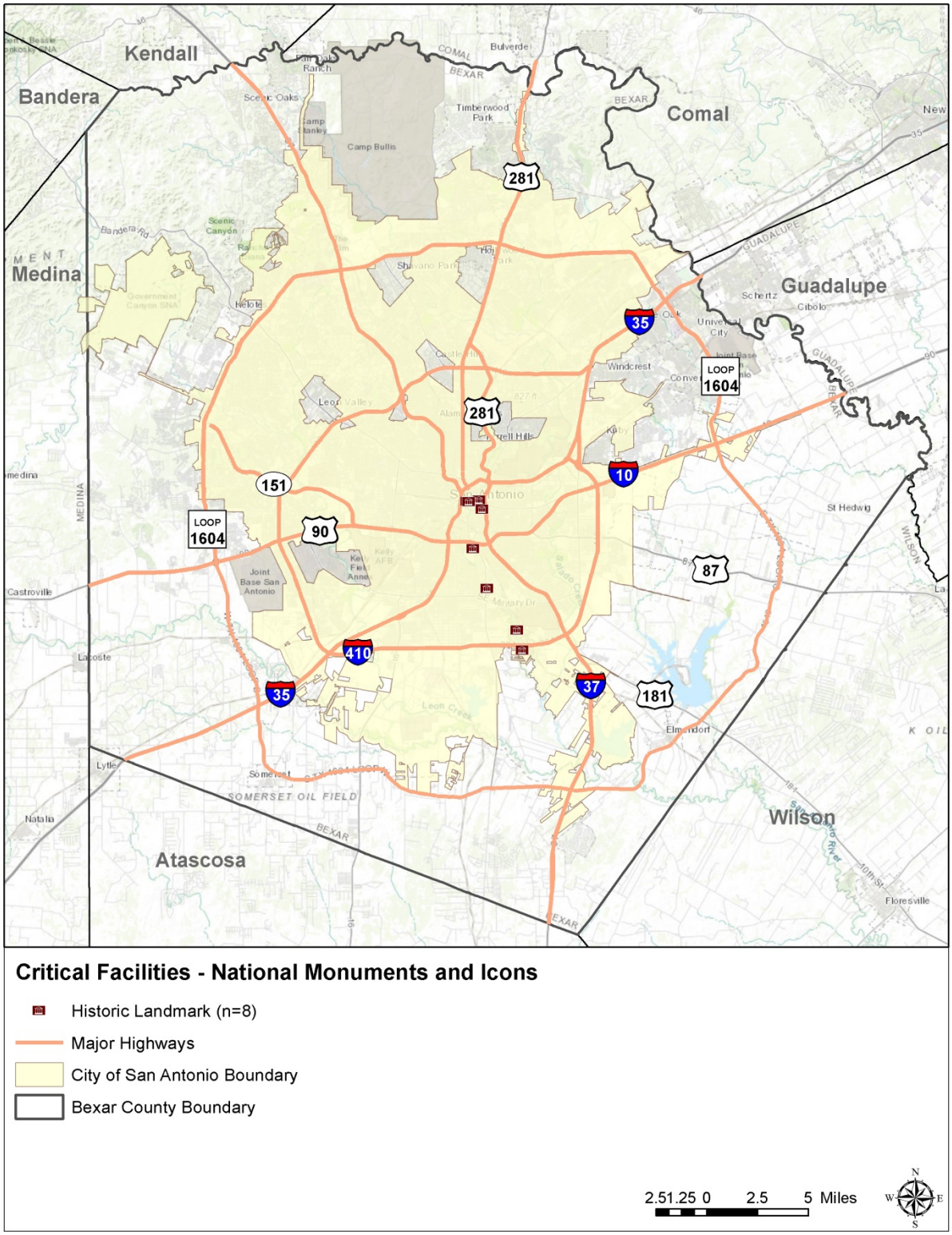


Figure 89. Commercial Facilities

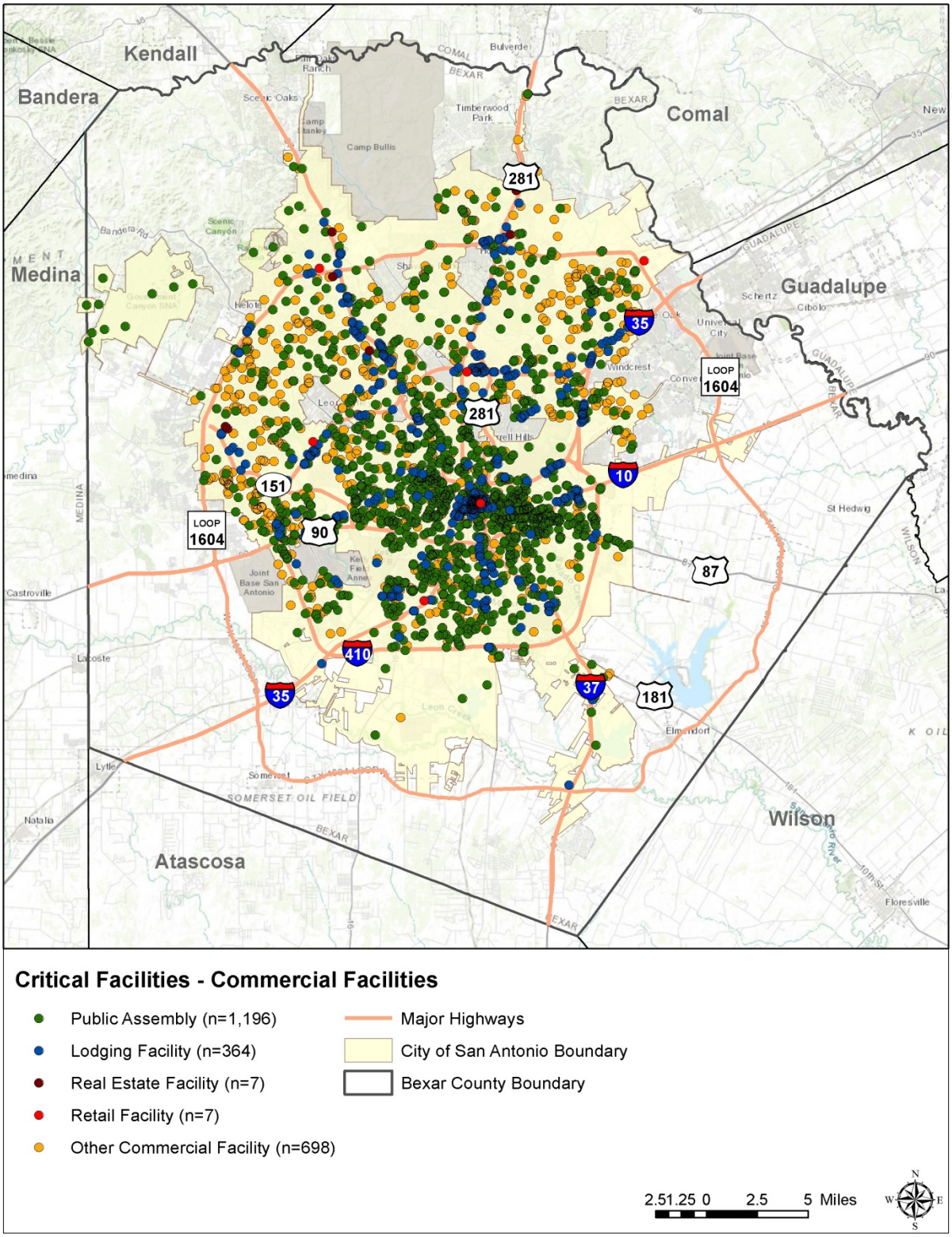


Figure 90. Government Facilities

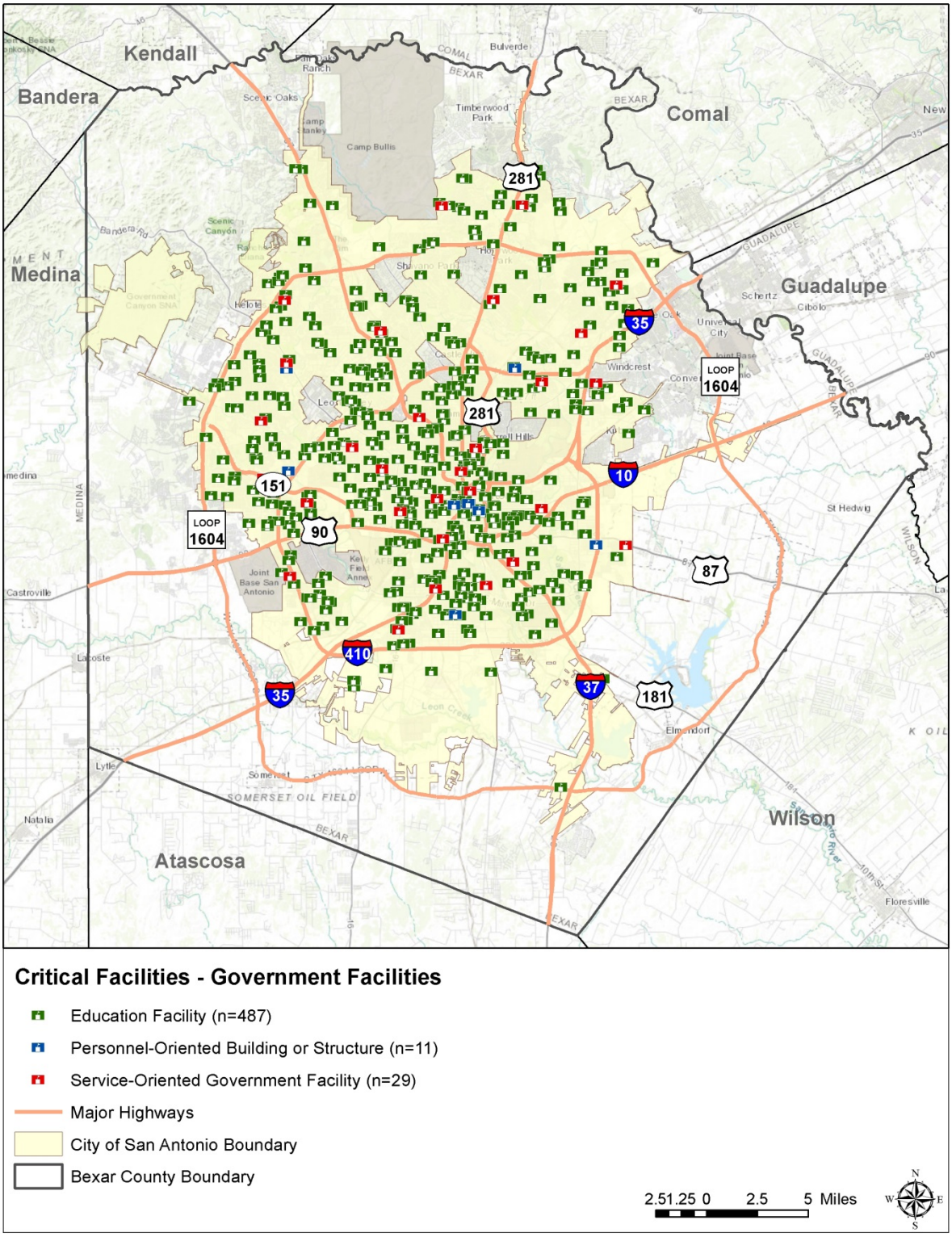


Figure 91. Dams

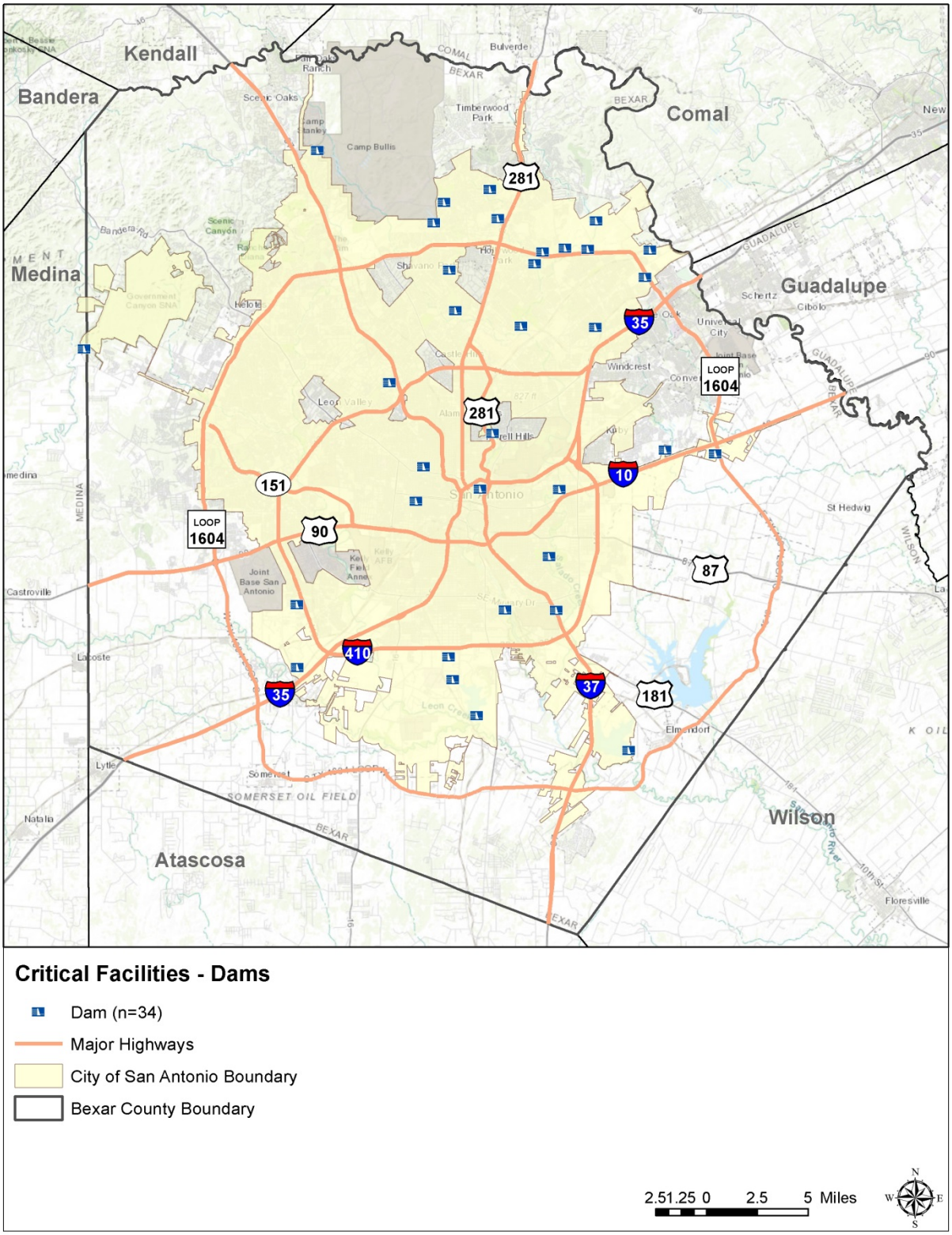


Figure 92. Nuclear Reactors, Materials, and Waste

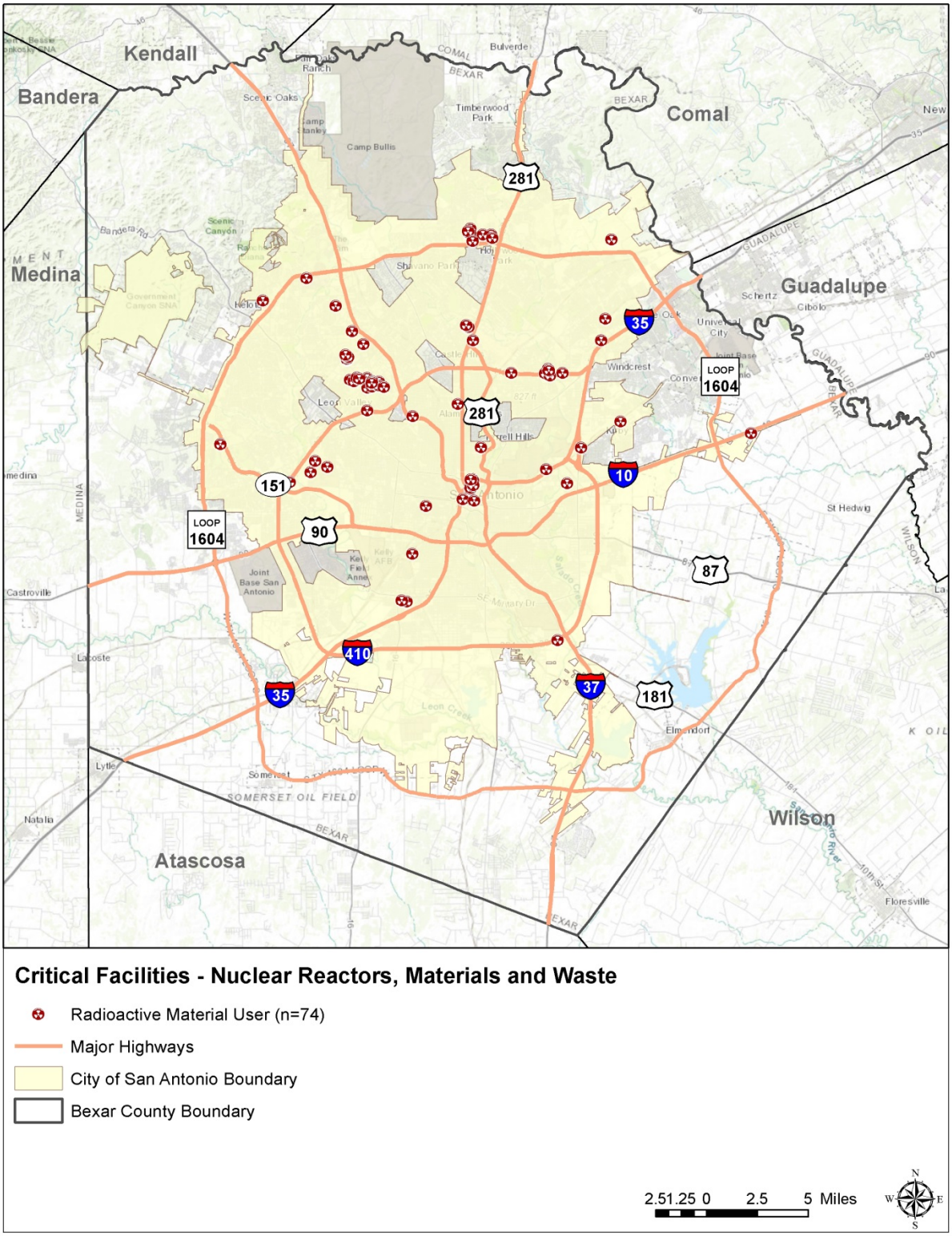
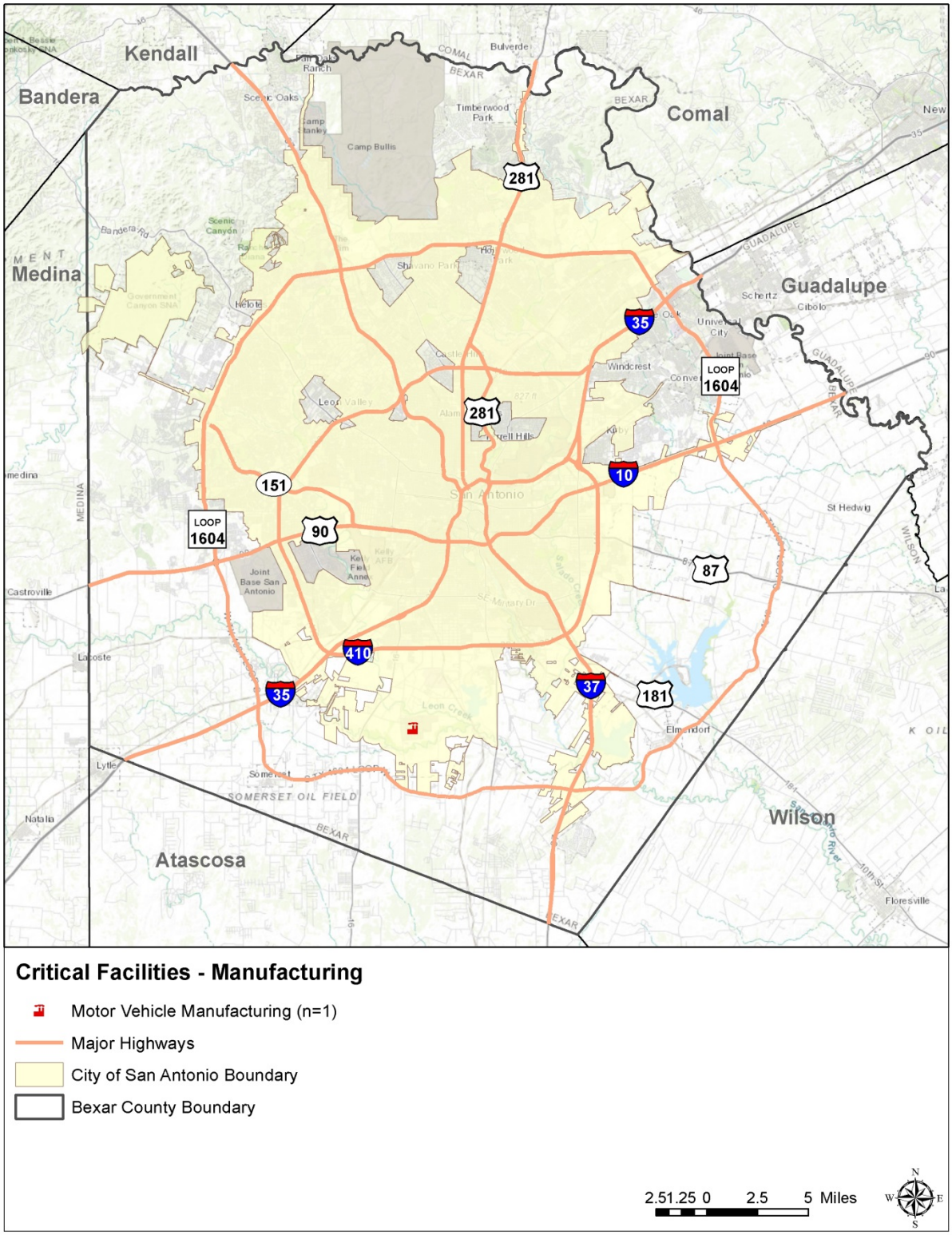


Figure 93. Manufacturing



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 105 below reflects all dams that are located in the City of San Antonio. This list includes High, Significant, and Low Hazard Dams. Section 12 of the HMAP does not profile dams that were deemed to pose no past, current, or future risk to the planning area as no loss of life or impact to critical facilities or infrastructure is expected in the event of a breach. The asterisk denotes those that were profiled in the hazard assessment.

Table 105. List of Dam Locations and Storage Capacities

NAME	LATITUDE	LONGITUDE	HEIGHT (FEET)	STORAGE (ACRE FEET)
Ballasetal Lake Dam	29.31343	-98.5110	14	450
Brooklyn Avenue Lock and Dam*	29.43326	-98.4856	14	28
Canvasback Lake Dam	29.29718	-98.5076	19	730
Circle Dot Dam*	29.6040	-98.3448	14	157
Crea Brothers Lake Dam	29.58453	-98.3491	18	80
Denman Park Dam*	29.51026	-98.5584	20	19
El Dorado Lake Dam	29.5490	-98.3899	5	78
Elmendorf Lake Dam*	29.42503	-98.5371	10	105
Hidden Springs Dam	29.6764	-98.6160	25	46
Lions Park Lake Dam	29.3849	-98.4284	32	145
Martinez Creek WS SCS Site 2 Dam*	29.46099	-98.3332	28	1,085
Martinez Creek WS SCS Site 3 Dam*	29.4581	-98.2926	31	1,622
Mission Trails RV Park Detention Dam	29.3465	-98.4229	14	28

NAME	LATITUDE	LONGITUDE	HEIGHT (FEET)	STORAGE (ACRE FEET)
Mitchell Lake Dam	29.27152	-98.4883	10	5,000
New Espada Lake Dam	29.34696	-98.4647	12	120
Olmos Dam*	29.47349	-98.4741	58	21,970
Or Mitchell Lake 1 Dam	29.30644	-98.6338	32	520
Red Berry Estates Dam	29.4329	-98.4198	0	0
Salado Creek WS NRCS Site 15R Dam*	29.55025	-98.4507	49	8,741
Salado Creek WS SCS Site 4 Dam*	29.62448	-98.5216	58	3,957
Salado Creek WS SCS Site 5 Dam*	29.63897	-98.513	56	5,807
Salado Creek WS SCS Site 6 Dam*	29.59041	-98.5091	62	2,830
Salado Creek WS SCS Site 7 Dam*	29.56139	-98.5039	47	6,864
Salado Creek WS SCS Site 8 Dam*	29.64805	-98.4755	62	7,100
Salado Creek WS SCS Site 9 Dam*	29.62718	-98.4691	50	2,612
Salado Creek WS SCS Site 10 Dam*	29.59486	-98.4392	66	4,063
Salado Creek WS SCS Site 11 Dam*	29.60307	-98.4327	64	6,318
Salado Creek WS SCS Site 12 Dam*	29.62528	-98.3886	61	7,837
Salado Creek WS SCS Site 13A Dam*	29.60489	-98.3956	42	3,053
Salado Creek WS SCS Site 13B Dam*	29.60579	-98.4143	46	1,898
San Geronimo Creek Recharge Dam	29.5348	-98.8073	22	307

NAME	LATITUDE	LONGITUDE	HEIGHT (FEET)	STORAGE (ACRE FEET)
Solana Ridge Detention Pond Dam	29.3514	-98.6341	0	0
Victor Braunig Dam*	29.24609	-98.3645	76	32,324
Woodlawn Lake Dam*	29.44952	-98.5307	20	460

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).

The City of San Antonio held a series of Planning Team workshops: a Kickoff Workshop webinar on July 13, 2020, a Risk Assessment Workshop webinar on September 9, 2020, and a Mitigation Strategy Workshop webinar on October 1, 2020. At each of these workshops members of the Planning Team were informed of the planning process, expressed opinions, and volunteered information. The sign-in sheets for each workshop and public meeting are included below. For more details on the workshops and planning process, see Section 2.

Figure 94. City of San Antonio Kickoff Workshop, July 13, 2020

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Kickoff Workshop
Adobe Connect Webinar
July 13, 2020

Name/Title	Department	Title	Email	Phone
Chris Stokes	City of San Antonio	Special Projects Manager	chris.stokes@sanantonio.gov	210-487-9516
Tracy Beach	American Red Cross serving Greater San Antonio	Disaster Program Manager	tracy.beach@redcross.org	210-834-2280
Shawna Arroyo	San Antonio River Authority	User Services Officer	sarroyo@sara-tx.org	210-302-3261
Douglas Melnick	City of San Antonio	Chief Sustainability Officer	douglas.melnick@sanantonio.gov	210-207-1720
Luu Do	South Texas	Protective Security Advisor	luu.do@cisa.dhs.gov	210-243-3696
Jacqueline Silva	San Antonio Water System	Emergency Manager	jacqueline.silva@saws.org	210-901-2429
Wayne Tschirhart	San Antonio River Authority	Senior Technical Engineer	wtschirhart@sara-tx.org	210-302-3678
James Glass	SWTFC SAPD	Deputy Director	james.glass@sanantonio.gov	210-207-8246
Larry Cole	San Antonio River Authority	IC	lcole@sara-tx.org	210-302-3698

1

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Kickoff Workshop
Adobe Connect Webinar
July 13, 2020

Name/Title	Department	Title	Email	Phone
Terry Donovan	USAA	Business Continuation Advisor Lead	Terry.Donovan@Usaa.com	210-913-2508
Michael Shannon	City of San Antonio	Development Services Director	michael.shannon@sanantonio.gov	210-207-5006
Patrick Zepeda	City of San Antonio	Chief	Patrick.zepeda@sanantonio.gov	210-237-8543
Melissa Gutierrez	CPS Energy	Senior Manager	meagutierrez@cpsenergy.com	210-353-4572
Robert Reyna	City of San Antonio Public Works – Storm Water	Capital Programs Manager	Roberto.Reyna@sanantonio.gov	210-416-8615
Brian Stanush	San Antonio Fire Department	Wildland Program Director	brian.stanush@sanantonio.gov	210-218-2970
Paul Yura	AACOG and South Central Texas	WCM National Weather Service	paul.yura@noaa.gov	830-221-8565
Cory Garcia	UTSA	Business Continuity and EM Coordinator	cory.garcia@utsa.edu	214-418-1410
Olga Guajardo	City of San Antonio	Senior Management Analyst	olga.guajardo@sanantonio.gov	210-206-8566

2

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Kickoff Workshop
Adobe Connect Webinar
July 13, 2020

Name/Title	Department	Title	Email	Phone
Sandra Cogburn	San Antonio Water/ Wastewater Utility	Executive Management Analyst	sandra.cogburn@saws.org	210-233-3775
Amin Tohmaz	City of San Antonio	Deputy Director	amin.tohmaz@sanantonio.gov	210-207-0114
Joe Fernandez	San Antonio River Authority	Project Management Associate	jjosef@sara-tx.org	210-302-3675
Jenny Ramirez	City of San Antonio	Code Enforcement Manager	jenny.ramirez@sanantonio.gov	210-207-7084
Chris Monestier	San Antonio Fire Department	Deputy Fire Chief	christopher.monestier@sanantonio.gov	210-207-4299
James Mendoza	City of San Antonio	Assistant EMC	james.mendoza@sanantonio.gov	210-249-1416
Javier Vasquez	City of San Antonio – EDD	Assistant to the Director	Javier.Vasquez@sanantonio.gov	210-508-9490
Jacob Powell	City of San Antonio	Floodplain Administrator	jacob.powell@sanantonio.gov	210-207-0176
Tyler Engler	Delivery Associates	Delivery Leader	tyler.engler@deliveryassociates.com	781-507-4357
Timothy Pierson	DDC18	Regional Fire Coordinator	tpierson@tfs.tamu.edu	830-998-6958

3

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Kickoff Workshop
Adobe Connect Webinar
July 13, 2020

Name/Title	Department	Title	Email	Phone
Margarita Hernandez	City of San Antonio	Special Projects Manager	margarita.hernandez@sanantonio.gov	210-207-8045
Amanda Ireta-Goode	City of San Antonio – Office of Equity	Sr Administrative Assistant	amanda.ireta-goode@sanantonio.gov	210-207-8911
Ruth Lewis	Ham Radio	ARES District 12 EC	KE5MHJ@144200.net	210-548-0758
Chris Benavides	San Antonio / Bexar County	Captain	chris.benavides@sanantonio.gov	210-206-8554
Shirley 'Lea' Urshan	Bexar & Surrounding 11 Counties	211 Disaster Response Coordinator	surshan@unitedwaysatx.org	210-725-2874
Erika Borrego	San Antonio Food Bank	Chief Operating Officer	eborrego@safoodbank.org	210-857-3949
Alejandra Lopez	City of San Antonio	Director – Economic Development	alex.lopez@sanantonio.gov	210-535-0397
Ashley Carter	City of San Antonio, OEM	Senior Project Management Specialist	ashley.carter@sanantonio.gov	210-371-5807
Rhonda Murphy	H2O Partners	Mitigation Planner	rmurphy@h2opartnersusa.com	214-707-0056
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

4

Figure 95. City of San Antonio Risk Assessment Workshop, September 9, 2020

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Risk Assessment Workshop
Adobe Connect Webinar
September 9, 2020

Name/Title	Department	Title	Email	Phone
Chris Stokes	City of San Antonio	Special Projects Manager	chris.stokes@sanantonio.gov	210-487-9516
Chris Benavides	City of San Antonio Police Department	Captain	chris.benavides@sanantonio.gov	210-206-8554
Tracy Beach	American Red Cross serving Greater San Antonio	Disaster Program Manager	tracy.beach@redcross.org	210-834-2280
Shawna Arroyo	San Antonio River Authority	IT Manager	sarroyo@sara-tx.org	210-302-3261
Ruth Lewis	Ham Radio	ARES DEC 12	KE5MHJ@144200.net	210-548-0758
Luu Do	CISA/DHS	Protective Security Advisor	luu.do@cisa.dhs.gov	210-300-8207
Jeffrey Moore	City of San Antonio	Senior Management Analyst	jeffrey.moore@sanantonio.gov	210-249-1416
Terry Donovan	USAA	Business Continuation Advisor Lead	Terry.Donovan@Usaa.com	210-913-2508

1

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Risk Assessment Workshop
Adobe Connect Webinar
September 9, 2020

Jacqueline Silva	San Antonio Water System	Emergency Manager	jacqueline.silva@saws.org	210-901-2429
Timothy Pierson	DDC 18A/18B	Regional Fire Coordinator	tpierson@tfs.tamu.edu	830-998-6958
Lorenzo Sanchez	UTSA	Director of Risk & Emergency Management	lorenzo.sanchez@utsa.edu	210-458-6756
Cory Garcia	UTSA	EM Coordinator	cory.garcia@utsa.edu	214-418-1410
Sammy Sikes	DSHS Region 8	Preparedness Manager	Sammy.Sikes@dshs.texas.gov	210-949-2040
Michael Mullins	City of San Antonio	Division Chief of Planning – SAFD	michael.mullins@sanantonio.gov	210-207-4928
Roberto Reyna	City of San Antonio	Capital Programs Manager	Roberto.Reyna@sanantonio.gov	210-207-1427
Rudy Nino	City of San Antonio	Assistant Director	rminojr@att.net	210-207-8389
Sarah Flores	City of San Antonio Fire Department	Special Projects Manager	sarah.flores@sanantonio.gov	210-207-0060
Olga Guajardo	City of San Antonio	Senior Management Analyst	olga.guajardo@sanantonio.gov	210-218-7158
Patrick Zepeda	City of San Antonio	Emergency Manager	Patrick/zepeda@sanantonio.gov	210-846-6446

2

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Risk Assessment Workshop
Adobe Connect Webinar
September 9, 2020

Javier Vasquez	City of San Antonio – EDD	Assistant to the Director	Javier.Vasquez@sanantonio.gov	210-508-9490
Nefi Garza	City of San Antonio	Assistant Director	Nefi.garza@sanantonio.gov	210-207-8024
Jenny Ramirez	City of San Antonio	DSD Manager	jenny.ramirez@sanantonio.gov	210-207-4084
Doug Melnick	City of San Antonio	Chief Sustainability Officer	douglas.melnick@sanantonio.gov	210-885-8310
Joe Fernandez	San Antonio River Authority	Project Management Associate	josef@sariverauthority.org	210-302-3675
Amanda Ireta-Goode	City of San Antonio – Office of Equity	Senior Administrative Assistant	amanda.ireta-goode@sanantonio.gov	210-207-8911
James Mendoza	City of San Antonio	Assistant EMC	james.mendoza@sanantonio.gov	210-249-1416
Sabrina Santiago	City of San Antonio – Public Works	Special Projects Manager	sabrina.santiago@sanantonio.gov	210-207-0182
Melissa Gutierrez	CPS Energy	Senior Manager	meagutierrez@cpsenergy.com	210-353-4572
Christopher Monestier	City of San Antonio	Deputy Fire Chief	christopher.monestier@sanantonio.gov	210-207-4299
Michael Clanton	City of San Antonio	Airport Emergency Manager	michael.clanton@sanantonio.gov	210-207-1638

3

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Risk Assessment Workshop
Adobe Connect Webinar
September 9, 2020

Amin Tohmaz	City of San Antonio	Deputy Director	amin.tohmaz@sanantonio.gov	210-207-0114
Nefi Garza	City of San Antonio	Assistant Director	nefi.garza@gmail.com	210-207-8024
James Glass	City of San Antonio – SWTFC	Deputy Director	james.glass@sanantonio.gov	210-207-8246
Shirley 'Lea' Urshan	United Way – San Antonio	211 Disaster Coordinator	surshan@unitedwaysatx.org	210-352-7148
Margarita Hernandez	City of San Antonio	Special Projects Manager	margarita.hernandez@sanantonio.gov	210-207-8045
Jennifer Superales	Region 6	Regional Planner	Jennifer.Superales@cisa.dhs.gov	202-503-5689
Rhonda Murphy	H2O Partners	Mitigation Planner	rmurphy@h2opartnersusa.com	214-707-0056
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

4

Figure 96. City of San Antonio Mitigation Strategy Workshop, October 1, 2020

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Mitigation Strategy Workshop
Adobe Connect Webinar
October 1, 2020

Name/Title	Department	Title	Email	Phone
Amanda Ireta-Goode	City of San Antonio – Office of Equity	Senior Administrative Assistant	amanda.ireta-goode@sanantonio.gov	210-207-8911
Amin Tohmaz	City of San Antonio	Deputy Director	amin.tohmaz@sanantonio.gov	210-207-0114
Chris Benavides	City of San Antonio Police Department	Captain	chris.benavides@sanantonio.gov	210-207-1329
Chris Stokes	City of San Antonio	Special Projects Manager	chris.stokes@sanantonio.gov	210-487-9516
Christopher Monestier	City of San Antonio	Deputy Fire Chief	christopher.monestier@sanantonio.gov	210-207-4299
Doug Melnick	City of San Antonio	Chief Sustainability Officer	douglas.melnick@sanantonio.gov	210-885-8310
Eric Olson	Power Generation Projects	Project Manager	erolson@cpsenergy.com	210-213-4098
Jacqueline Silva	San Antonio Water System	Emergency Manager	jacqueline.silva@saws.org	210-901-2429
James Glass	City of San Antonio – SWTFC	Deputy Director	james.glass@sanantonio.gov	210-207-8246

1

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Mitigation Strategy Workshop
Adobe Connect Webinar
October 1, 2020

Name/Title	Department	Title	Email	Phone
Javier Vasquez	City of San Antonio – EDD	Assistant to the Director	Javier.Vasquez@sanantonio.gov	210-207-6002
Jennifer Superales	Region 6	Regional Planner	Jennifer.Superales@cisa.dhs.gov	202-503-5689
Joe Fernandez	San Antonio River Authority	Project Management Associate	josef@sara-tx.org	210-302-3675
Larry Cole	San Antonio River Authority	IC	lcole@sara-tx.org	210-302-3698
Luu Do	CISA/DHS	Protective Security Advisor	luu.do@cisa.dhs.gov	210-243-3696
Margarita Hernandez	City of San Antonio	Special Projects Manager	margarita.hernandez@sanantonio.gov	210-207-8045
Michael Mullins	City of San Antonio	Division Chief of Planning – SAFD	michael.mullins@sanantonio.gov	210-207-4928
Monty McCann	Haven for Hope Homeless Shelter	Director of Life Safety	monty.mccann@havenforhope.org	210-220-2507
Olga Guajardo	City of San Antonio	Senior Management Analyst	olga.guajardo@sanantonio.gov	210-206-8566
Roberto Reyna	City of San Antonio	Capital Programs Manager	Roberto.Reyna@sanantonio.gov	210-207-1427

2

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Mitigation Strategy Workshop
Adobe Connect Webinar
October 1, 2020

Name/Title	Department	Title	Email	Phone
Roger Pollok	City of San Antonio	Emergency Preparedness Coordinator	roger.pollok@sanantonio.gov	210-219-7396
Sabrina Santiago	City of San Antonio – Public Works	Capital Programs Manager (interim)	sabrina.santiago@sanantonio.gov	210-207-0182
Wayne Tschirhart	San Antonio River Authority	Senior Technical Engineer	wtschirhart@sariverauthority.org	210-302-3678
Cory Garcia	UTSA	BCEM Coordinator	cory.garcia@utsa.edu	214-418-1410
Paul Yura	National Weather Service	Warning Coordination Meteorologist	paul.yura@noaa.gov	830-221-8565
Ruth Lewis	Ham Radio	ARES DEC 12	KE5MHJ@144200.net	210-548-0758
Rhonda Murphy	H2O Partners	Mitigation Planner	rmurphy@h2opartnersusa.com	214-707-0056
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

3

Public Meeting Documentation

As discussed in Section 2, public meetings were held throughout the planning process. Documentation in the form of sign-in sheets for each of the meetings follows.

Figure 97. City of San Antonio Public Meeting, September 10, 2020

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Public Meeting
Adobe Connect Webinar
September 10, 2020

Name/Title	Department	Title	Email	Phone
Blanche Dudoit	JBSA (Texas Air National Guard)	Technical Sergeant	blanche.dudoit@yahoo.com	808-554-1075
Chris Stokes	City of San Antonio	Special Projects Manager	chris.stokes@sanantonio.gov	210-487-9516
David Dominguez	City of San Antonio	Citizen	ezs841@my.utsa.edu	682-704-0626
Jana Wentzel	City of San Antonio	Citizen	gjd138@my.utsa.edu	402-525-9760
Gabriel Lugo	City of San Antonio	Citizen	gabe2134@gmail.com	210-718-4149
Meghan Cazares	City of San Antonio	Citizen	Meg.Cazares@gmail.com	210-954-7843
Rhonda Murphy	H2O Partners	Mitigation Planner	rmurphy@h2opartnersusa.com	214-707-0056
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

1

Figure 98. City of San Antonio Public Meeting, September 17, 2020

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Public Meeting
Adobe Connect Webinar
September 17, 2020

Name/Title	Department	Title	Email	Phone
Patrick Zepeda	City of San Antonio	Emergency Manager	Patrick.zepeda@sanantonio.gov	210-846-6446
Chris Stokes	City of San Antonio	Special Projects Manager	chris.stokes@sanantonio.gov	210-487-9516
Rhonda Murphy	H2O Partners	Mitigation Planner	rmurphy@h2opartnersusa.com	214-707-0056
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

1

Figure 99. City of San Antonio Public Meeting, September 24, 2020

CITY OF SAN ANTONIO HAZARD MITIGATION PLAN
Public Meeting
GoToWebinar
September 24, 2020

Name/Title	Department	Title	Email	Phone
Ashely Carter	City of San Antonio	Senior Project Management Specialist	Ashley.Carter@sanantonio.gov	210-206-8551
Blanche DuDoit	City of San Antonio	Citizen		
Francisco San Miguel	City of San Antonio	Citizen		
Sacramento Moncada	City of San Antonio	Citizen		
Jaci Finch	City of San Antonio	Citizen		
Ryan Reische	City of San Antonio	Citizen		
Rhonda Murphy	H2O Partners	Mitigation Planner	rmurphy@h2opartnersusa.com	214-707-0056
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

1

Public Notices

Public notices to announce the City of San Antonio's participation in the Plan Update development process were posted on various websites and Facebook, as shown in Figure 100 - Figure 109. Additionally, the City invited the public to participate in the survey.

Figure 100. Public Notice, City of San Antonio website, Public Meetings

Figure 101. Public Notice, City of San Antonio website, Public Survey

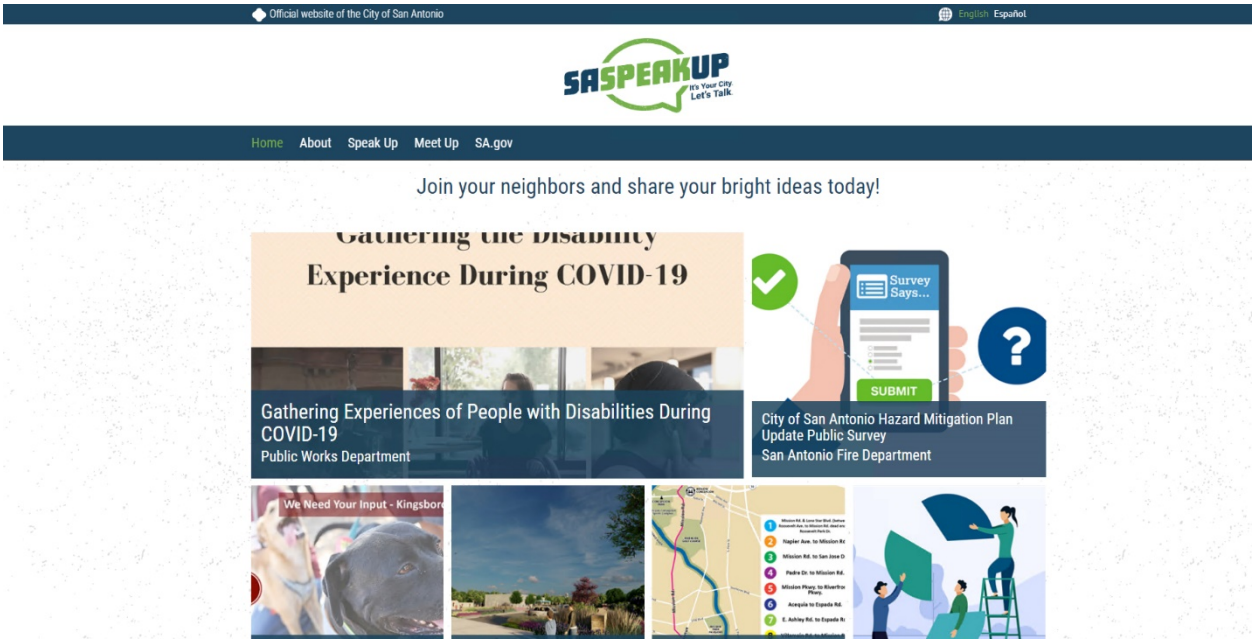


Figure 102. Public Notice, City of San Antonio website, Public Survey

Figure 103. Public Notice, City of San Antonio Facebook, Public Meetings and Public Survey

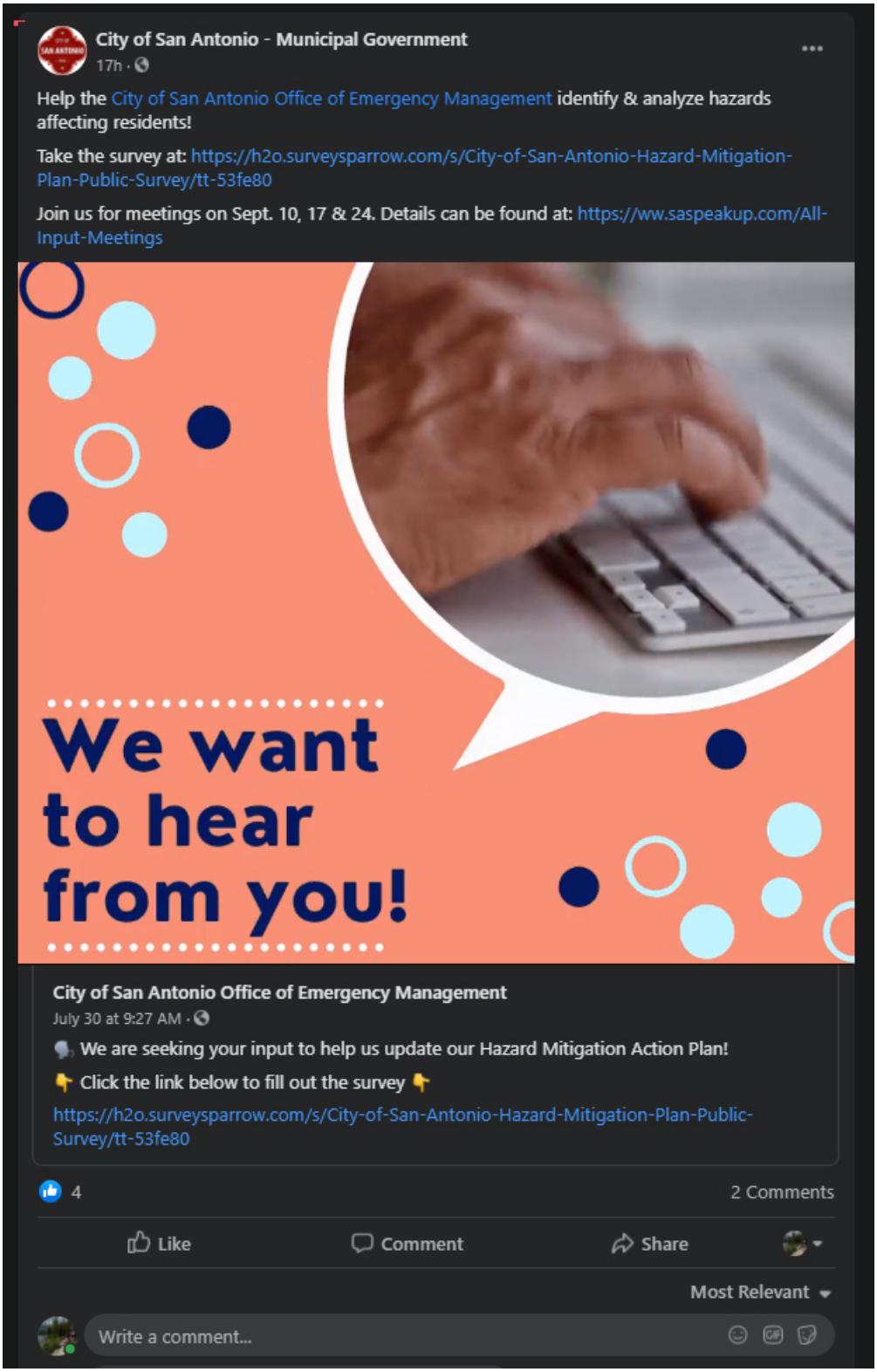


Figure 104. Public Notice, City of San Antonio Twitter, Public Survey and Public Meetings

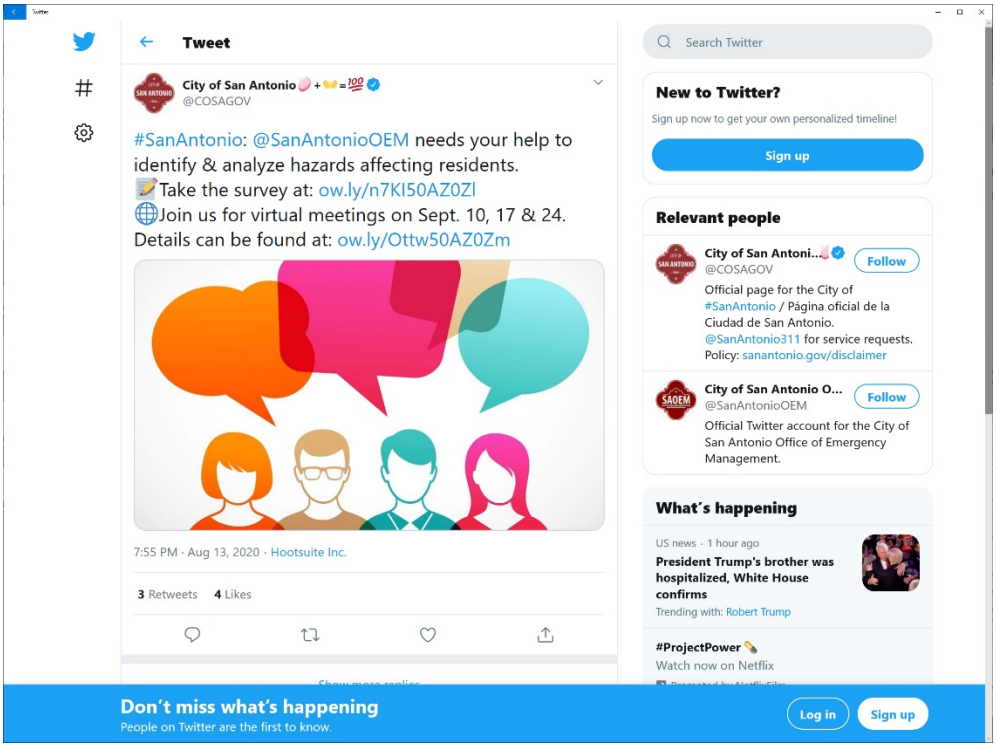


Figure 105. Public Notice, City of San Antonio Nextdoor, Public Meetings and Public Survey

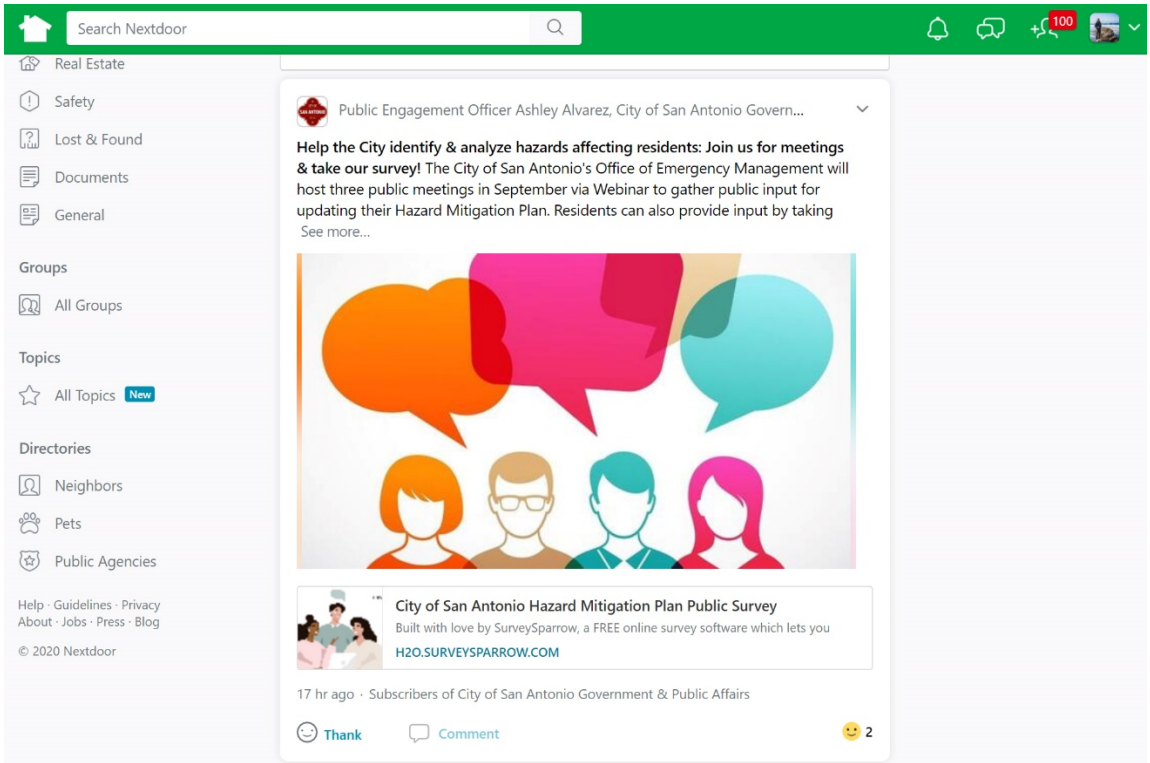


Figure 106. Public Notice, City of San Antonio Office of Emergency Management Facebook, Public Survey

City of San Antonio Office of Emergency Management

Posted by Ashley Carter

Jul 30 ·

🗣️ We are seeking your input to help us update our Hazard Mitigation Action Plan!

👇 Click the link below to fill out the survey 👇

https://h2o.surveysparrow.com/s/City-of-San-Antonio-Hazard-Mitigation-Plan-Public-Survey/tt-53fe80

2 1 Comment 2 Shares 621 Views

Figure 107. Public Notice, City of San Antonio Office of Emergency Management Facebook, Public Survey and Public Meetings

City of San Antonio Office of Emergency Management

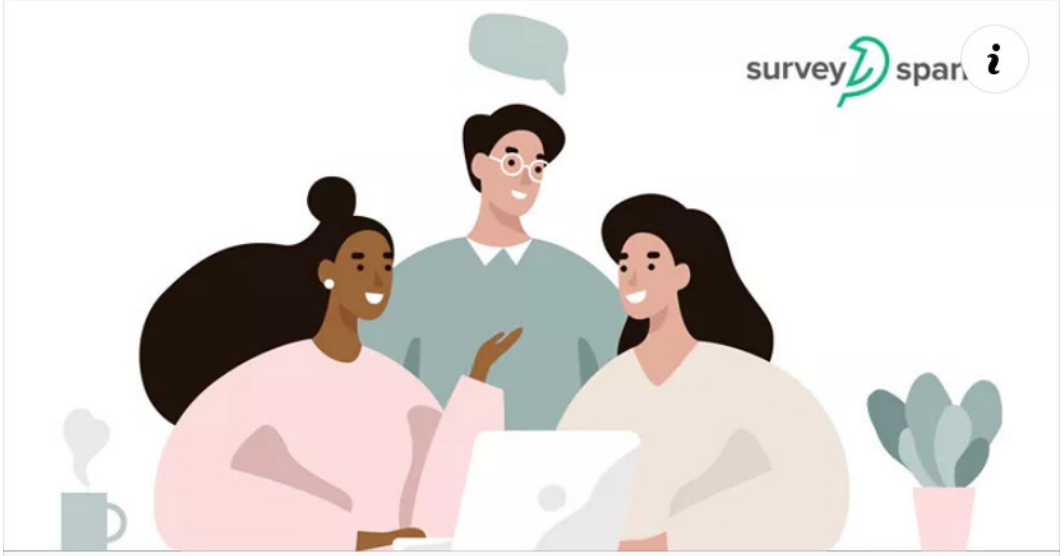
Posted by Ashley Carter

Aug 14 ·

🗣️ We need your help to identify and analyze hazards affecting our community!

📝 Participate in the planning process by clicking the image below and taking a survey

💻 Join us for three virtual meetings on September 10, 17 and 24 were you can provide input and help our team identify and understand potential hazards in our area. Details can be found at saspeakup.com/all-input-meetings



H2O.SURVEYSPARROW.COM

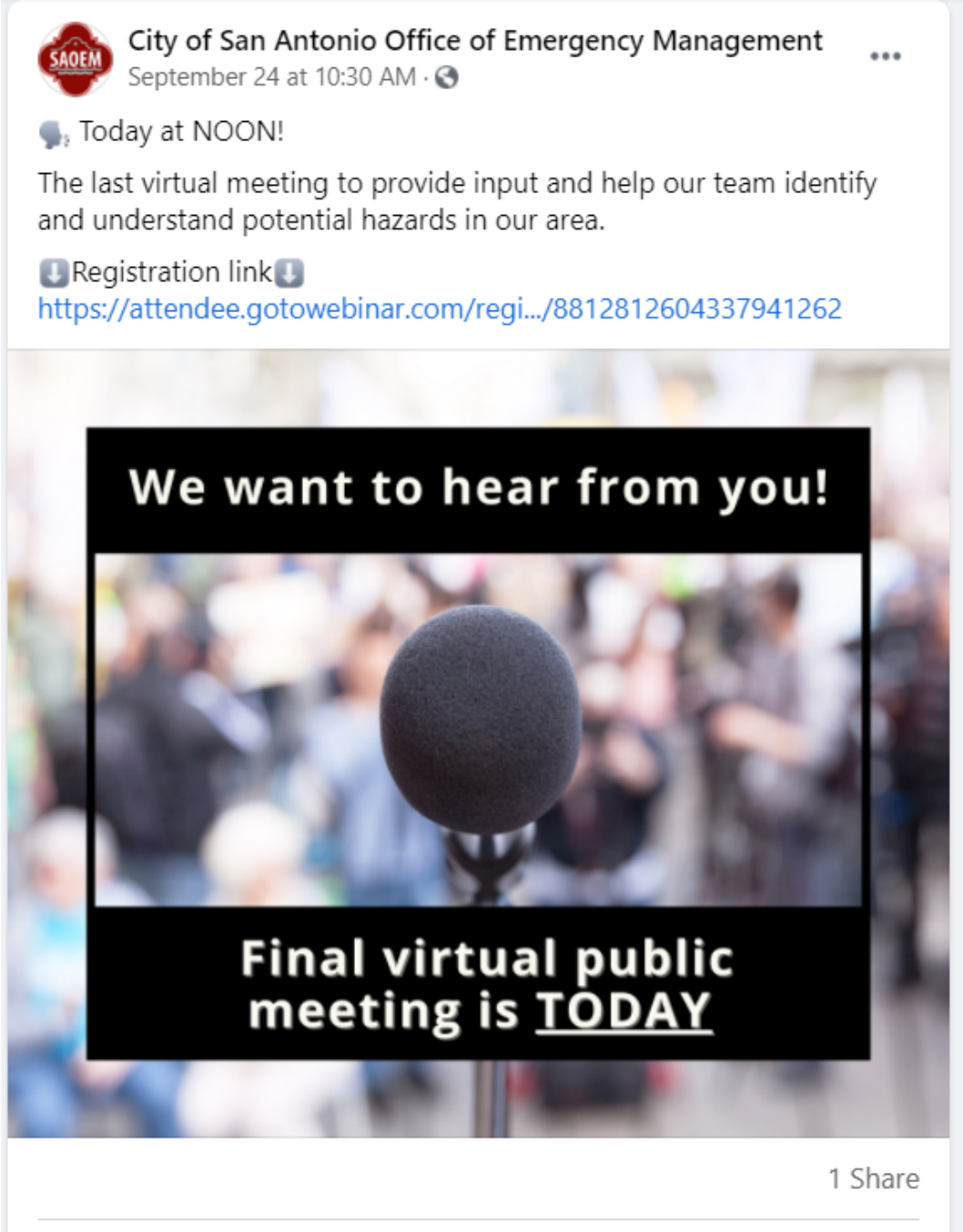
City of San Antonio Hazard Mitigation Plan Public Survey

Built with love by SurveySparrow, a FREE online survey sof...

4 2 Comments 1 Share

Figure 108. Public Notice, City of San Antonio Office of Emergency Management Twitter, Public Survey and Public Meetings

Figure 109. Public Notice, City of San Antonio Office of Emergency Management Facebook, Public Meeting



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, plans, and regulations for the City of San Antonio.

A Capability Assessment is an integral component of the HMAP development process. The Capability Assessment serves to evaluate a community's existing planning and regulatory capabilities to support implementation of the HMAP's Mitigation Strategy Objectives.

Each community 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 that currently reduce disaster losses or could be used to reduce losses in the future, and capabilities that inadvertently increase risks in the community.

The City of San Antonio continuously assesses the impacts of current policies, ordinances, and plans for community safety from hazard risk due to growth. The City conducts its assessment through respective planning mechanisms, such as a Capital Improvements Program, Comprehensive Long-Term Development Plan, and Flood Protection Plan, and other planning strategies. The Capability Assessment was completed considering safe growth initiative to various sectors of the City, including transportation, environmental management, and land use requirements.

Political capability is measured by the degree to which local political leadership is willing to enact policies and programs that further reduce hazard vulnerabilities in a community, even if met with opposition. The City of San Antonio has effectively initiated the following additional measures to reduce risk in the community:

- Amended Texas Local Government Code Section 54.012 and 54.017 in 2013. By initiating this measure, the city will see a decrease in capital improvement projects needed to mitigate illegal fill violations.
- The San Antonio River Authority is developing Risk Maps. Together with the city's development of a HMAP, this initiative will further identify projects that are eligible for FEMA grant funding.
- The city currently participates in the National Flood Insurance Program (NFIP) and is working towards completing eligibility as a Community Rating System (CRS) community.
- Previous mitigation activities include digital FEMA FIRMs, and FEMA buyouts in 1998 and 2002 for over 300 properties.

In summary, the City of San Antonio, through development of a hazard mitigation plan, and other mitigation strategies outlined above to reduce risk to the community, is demonstrating their ability to implement and support mitigation strategy objectives identified in the HMAP.

The City of San Antonio's annual budget will include timelines for implementing actions based on funding capabilities, potential funding sources, and available HMA and other grant funding to turn an action into a project to achieve future mitigation. San Antonio has grant personnel that will develop grant applications through various funding mechanisms, including HMA grants, Texas Forest Service, Homeland Security, and other funding sources, depending on the type of mitigation action. The capability assessment below outlines other programs by which to expand funding capabilities and utilize available resources to achieve mitigation.

City of San Antonio Capability Assessment

COMMUNITY CAPABILITY CHECKLIST		
PLANNING / REGULATORY TOOL	**IN PLACE**	**UNDER DEVELOPMENT**
Capital Improvements Plan	X	
Community Wildfire Protection Plan	X	
Comprehensive / Master Plan / Land Use Plan	X	
Continuity of Operations Plan	X	
Emergency Operations Plan	X	
Evacuation Plan	X	
Flood Protection Plan	X	
Hazard Mitigation Plan	X	X
Stormwater Management Plan / Ordinance	X	
POLICIES / ORDINANCES	**IN PLACE**	**UNDER DEVELOPMENT**
Building Code	X	
Fire Code	X	
Floodplain Ordinance	X	
Stormwater Ordinance	X	
Subdivision Regulations	X	
Wildfire Ordinance		X
Zoning Ordinance / Land Use Restrictions	X	

PROGRAMS / STUDIES	IN PLACE	UNDER DEVELOPMENT
Floodplain Maps / Flood Insurance Studies	X	
Hydrologic / Hydraulic Studies	X	
Mutual Aid Agreement	X	
National Flood Insurance Program (NFIP)	X	
NFIP Community Rating System (CRS Program)		X
Property Acquisition Program		X
Public Education / Awareness Programs	X	
Storm Drainage Systems Maintenance	X	
Stream Maintenance Program	X	
Warning Systems/Services (reverse 911, outdoor warning signals)	X	
STAFF / PERSONNEL RESOURCES	**YES**	**NO**
Building Code Official	X	
Emergency Manager	X	
Engineers	X	
Environmental Conservation Specialist	X	
Floodplain Manager	X	
Geographic Information Systems (GIS) Coordinator	X	
Planners	X	
Public Information Official	X	
Resource development staff or grant writers	X	

Expanding and Improving Capabilities

The purpose of the Capability Assessment is to assist the City of San Antonio in identifying gaps in planning, staff, and resourcing and examine the potential to expand and improve capabilities. Options for improving capabilities include the following:

- Engaging Planning Team members with the authority to monitor the HMAP 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) via preparingtexas.org.
- Reviewing current floodplain ordinances for opportunities to increase resiliency such as modifying permitting or building codes.
- Identifying partnerships where communities may form inter-local agreements or Memorandums of Understanding to provide assistance and bolster existing resources and solicit assistance from national sources such as FloodSmart (floodsmart.gov) and state sources such as the Texas Association of Counties.