Appendix A – Hydrology, Hydraulics, and Climate

Mitchell Lake
San Antonio, Texas
General Investigations Feasibility Study
Integrated Draft Feasibility Report and Environmental Impact Assessment

May 2021

US Army Corps of Engineers®
Fort Worth District

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1 Background

The non-Federal sponsor, the San Antonio Water Systems (SAWS) requested the U.S. Army Corps of Engineers (USACE) evaluate Mitchell Lake to assess the feasibility of restoring the degraded habitat in Mitchell Lake and the surrounding habitats. Mitchell Lake is owned and managed by SAWS. The purpose of the study is to identify and implement aquatic ecosystem restoration measures to restore the structure and/or function of the historical wetland ecosystem within the study area that has been impaired through the operation as a sewage treatment facility.

1.1 Watershed Study Area

1.1.1 General description. Mitchell Lake is located in the Medina River watershed, which is a major tributary of the San Antonio River Basin. The Mitchell Lake drainage area (above Mitchell Lake Dam) is 9.76 square miles. The topography in the watershed around Mitchell Lake is generally flat with slopes less than 1 percent but with more relief on the north side of the watershed with slopes between 1 percent and 4 percent. The majority of the watershed is open space with a mix of grass and small trees. The primary developments in the area are the City of San Antonio Police Academy, Mission Del Lago, and the Texas A&M University San Antonio campus. There are also low-density residential and commercial developments along Pleasanton Road between Loop 410 and the dam. A series of small lakes exist between Loop 410 and the dam - these small lakes include Canvasback, Little Canvasback, Timber, and Teacup Lakes. In addition, Bird Pond and several smaller ponds are located along the tributaries north of the lake. Figure A-1 shows the general soils classification of the Mitchell Lake area. The predominant soil type within the study area is Houston Black Clay (HsB) which covers about 740 acres or 12.7% of the study area marked in the soil survey map. Houston Black Clay is a Group D soil that has high runoff potential and low infiltration rates when thoroughly wetted. Refer to the Geotechnical Appendix for additional soil information.

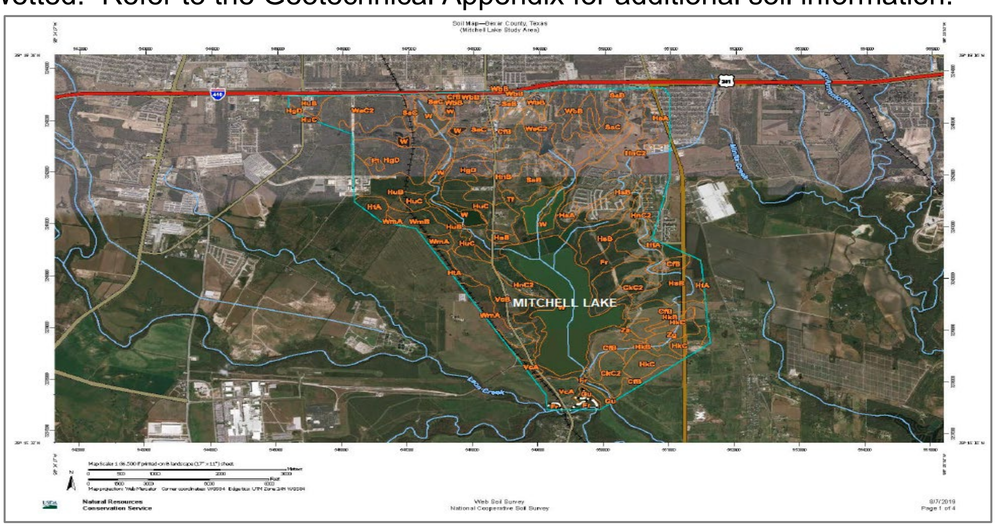


Figure A-1. General Soil Classification of the Mitchell Lake Area

1.2 Climate

1.2.1 General climate data. The city of San Antonio is located in the south-central portion of Texas on the Balcones escarpment. Northwest of the city, 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 silty loam on the Plains and thin limestone soils on the Edwards Plateau. With its location on the northwest edge of the Gulf Coastal Plain, San Antonio experiences a modified subtropical climate. During the summer the climate becomes more tropical like with prevailing south and southeast winds. The moderating effects of the Gulf of Mexico prevent extremely high temperatures. Summers are usually long and hot with daily maximum temperatures above 90ºF more than 80 percent of the time. In many years, summer conditions continue into September and sometimes to October. The average monthly temperatures range from the 50sºF in winter to 80sºF in summer. The historic recorded high and low temperatures occurred 6 September 2000 (111ºF) and 21 January 1949 (0º F).

1.3 Precipitation

1.3.1 General precipitation data. San Antonio is situated between a semi-arid area to the west and a much wetter and more humid area to the east, allowing for large variations in monthly and annual precipitation amounts. The average long-term annual precipitation for San Antonio is around 29 inches, although, it may range from as low as 10 to near 50 inches from one year to another. Precipitation extremes vary from 10.11 inches in 1917 to 52.28 inches in 1973. Most precipitation occurs in May, June, September, and October. During some of these events, rain has exceeded 5 inches in several hours and caused flash flooding. The net lake evaporation rates range from 0.08 inches per day in January to 0.29 inches per day in August. Monthly and yearly precipitation totals from 2000 to 2019 are shown in Table A-1. Yearly precipitation totals from 1934 – 2018 are shown in Figure A-2.

Table A-1. Monthly and Yearly Precipitation 2000 – 2019

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2000	1.40	2.20	0.91	1.22	3.59	7.61	0.34	0.16	2.65	5.62	8.58	1.57	35.85
2001	2.85	0.70	2.77	2.29	2.48	3.39	0.50	7.83	4.05	2.06	4.37	3.43	36.72
2002	0.37	0.42	1.19	3.82	2.26	1.48	16.92	0.54	7.02	7.64	2.08	2.53	46.27
2003	0.99	2.15	0.77	0.17	0.12	2.90	8.12	1.65	9.21	1.94	0.32	0.11	28.45
2004	2.31	1.73	2.35	5.02	1.80	9.47	0.61	1.10	1.92	9.47	9.46	0.08	45.32
2005	2.18	2.42	2.00	0.01	2.97	0.81	2.10	1.22	1.39	1.14	0.20	0.10	16.54
2006	0.35	0.62	1.36	1.40	3.80	1.63	1.41	0.03	4.11	3.44	0.75	2.44	21.34
2007	4.33	0.08	7.24	4.61	3.35	6.47	11.76	6.77	1.09	0.75	0.40	0.40	47.25
2008	0.42	0.20	1.82	0.83	0.66	0.01	3.86	4.98	0.46	0.26	0.01	0.25	13.76
2009	0.27	0.65	2.51	2.05	1.57	0.45	0.48	0.45	6.35	11.90	2.09	1.92	30.69
2010	4.45	4.38	2.09	3.57	4.48	4.24	3.68	0.07	9.37	0.17	0.26	0.63	37.39
2011	2.66	0.49	0.01	0.03	0.84	1.58	0.96	0.15	2.93	3.28	1.81	2.84	17.58
2012	3.99	5.63	3.24	0.04	9.84	0.11	3.79	2.41	7.31	2.40	0.27	0.37	39.40
2013	2.83	0.10	0.95	2.77	13.19	2.02	0.73	0.85	3.70	2.81	1.50	0.55	32.00
2014	0.23	0.42	1.06	0.68	4.97	5.38	3.25	0.08	1.77	1.91	7.21	1.24	28.20
2015	3.67	0.53	2.97	7.54	8.57	6.42	0.07	0.29	2.32	7.78	2.58	1.48	44.22
2016	1.38	1.55	3.56	6.19	9.14	2.39	0.33	4.91	6.30	0.16	1.79	6.22	43.92
2017	2.72	3.61	2.09	2.89	1.76	0.40	0.16	5.87	2.80	0.46	0.53	4.04	27.33
2018	0.28	1.91	4.02	0.36	0.97	0.71	4.87	0.62	16.86	6.47	1.78	2.35	41.20
2019	1.63	0.47	0.46	3.47	3.30	5.51	0.14	0.31	1.45	4.02	0.74	0.52	22.02

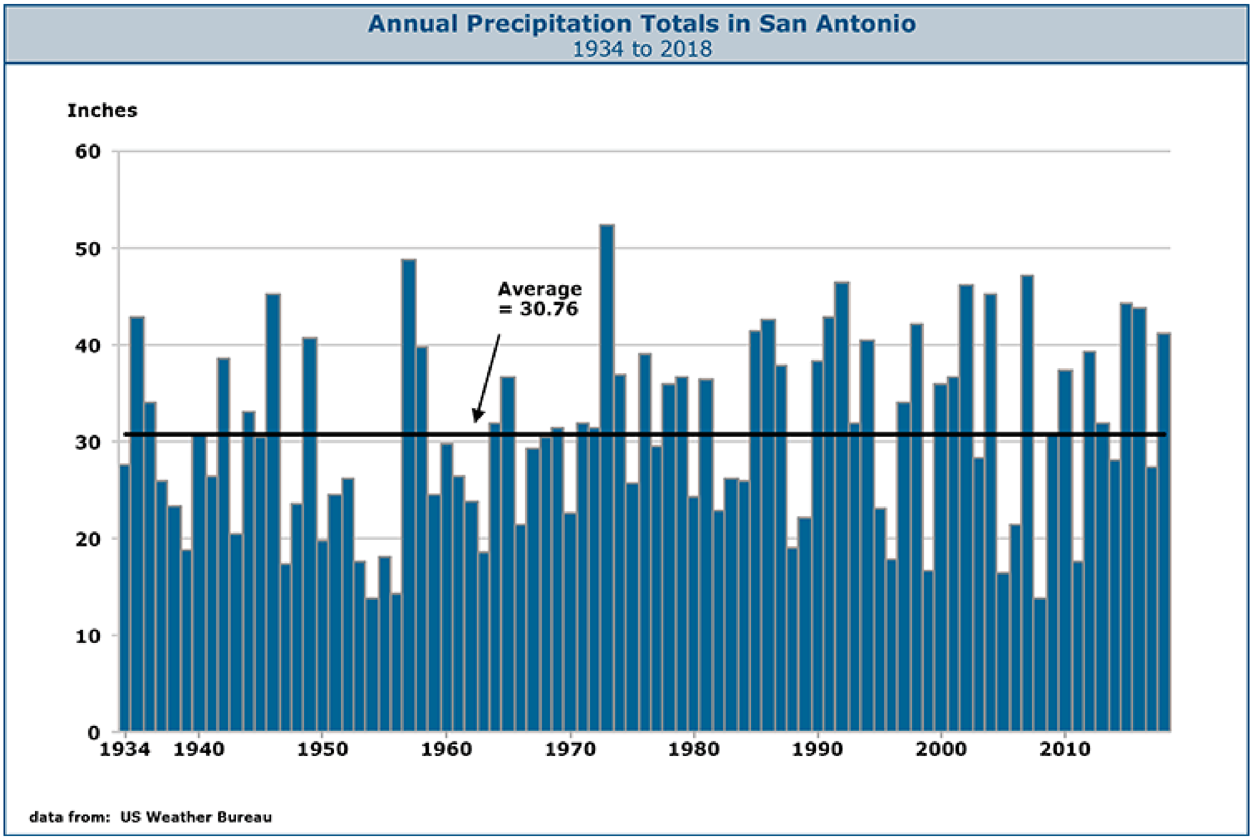


Figure A-2. Yearly Precipitation Totals 1934 - 2018

1.4 Mitchell Dam and Lake Photographs and Maps

Historical maps and photographs of Mitchell Dam and Lake follow which show the changing study area watershed.

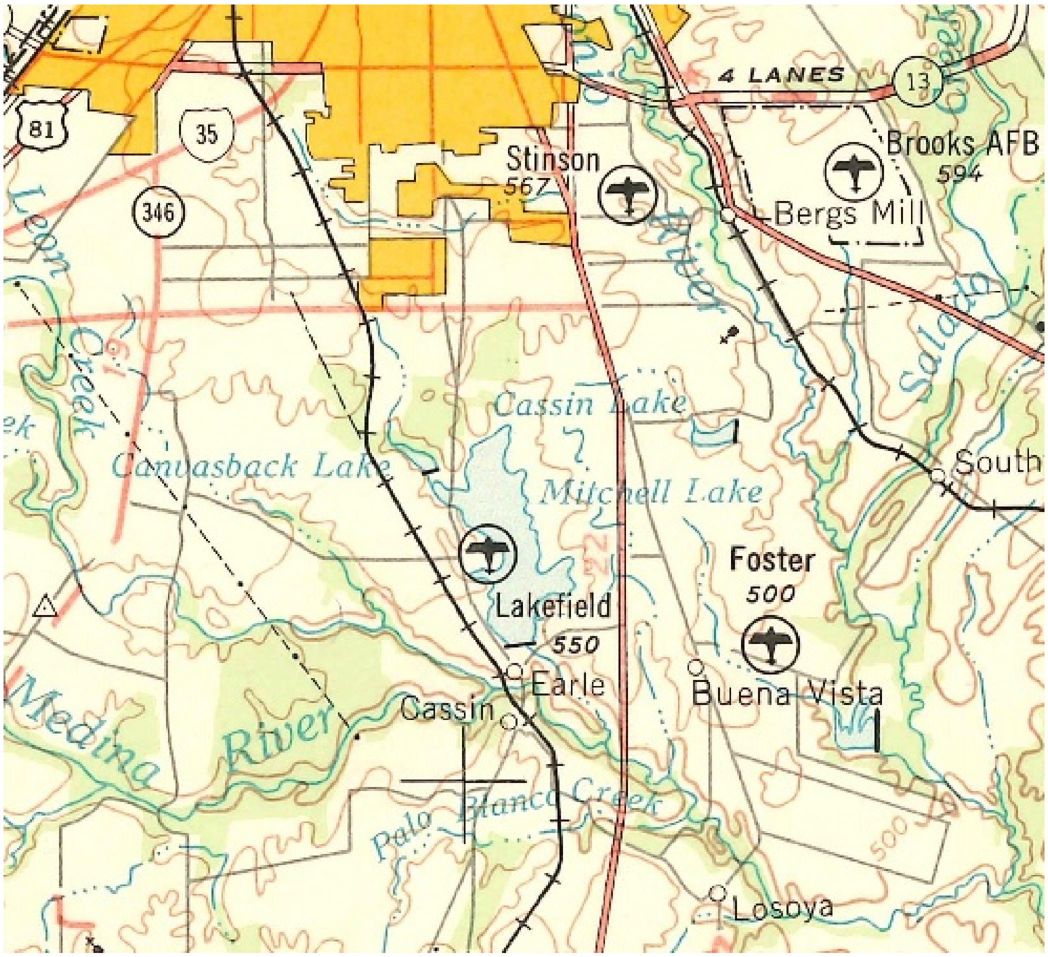


Figure A-3. USGS 1954 Topographic Map (1927 North American datum)

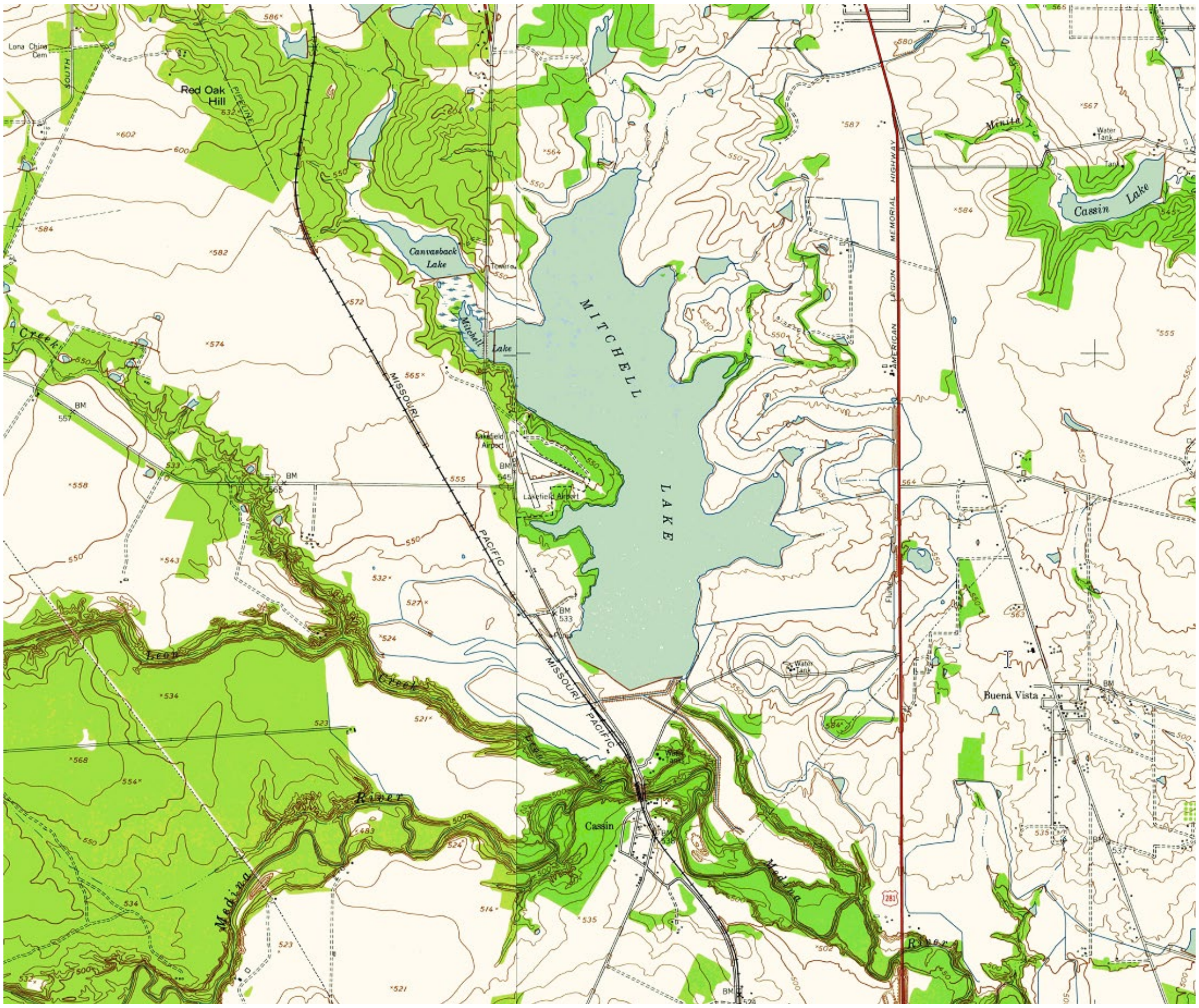


Figure A-4. 1953 USGS Topographic Map (1927 North American datum)

Figure A-5. 1967 Aerial Photograph of Mitchell Lake

Figure A-6. Mitchell Lake Dam Looking East Towards Gated Spillway

Figure A-7. Mitchell Lake Dam Gated Spillway

Figure A-8. Mitchell Lake Dam Gated Spillway Downstream Channel

Figure A-9. Mitchell Lake Dam and Spillway

1.5 Technical Analysis

1.5.1 General. A technical hydrology and hydraulics analysis was not performed, and hydrology and hydraulics models were not developed by the Fort Worth District Water Resources Branch for this study. The majority of the technical data in this Appendix was developed by private engineering firms (footnotes and references are included). Pertinent technical information was extracted from these sources to develop a representative summary of the project area site conditions. Additional technical data was developed from the Fort Worth District Water Resource Branch files and the sources noted.

1.6 Mitchell Dam and Lake

1.6.1 Lake history and characteristics. Mitchell Lake has a surface area covering approximately 600 acres with an average water depth of less than 8 feet. It is located in southern Bexar County and was purchased by the City of San Antonio in 1901. It is currently operated and managed by San Antonio Water System. Mitchell Lake Dam was constructed in 1901 by the San Antonio Irrigation Company. In the 1970's, an eighty-seven-acre polder complex was constructed at the northern end of the lake to accept waste activated sludge from the Rilling Road Wastewater Treatment Plant. This practice continued until 1987, when the Dos Rios Wastewater Treatment Plant started operations. The upper complex currently consists of five decant basins (constructed in the 1980s) designated 1 through 5, and two polders (East and West). The polder complex area is protected by dikes and does not receive storm water runoff. Polder and basin sizes are shown in Table A-2. The depths of the polders are generally 2-3 feet in most places, and up to 4-5 feet in some spots. Regarding the water surface levels of Mitchell Lake and the polders, there are no "normal" levels - they are variable depending on hydrologic conditions and availability of effluent. The Mitchell Lake wetland cells are designed to mimic natural wetland processes such as removing water contaminants and providing wildlife habitat. The proposed water control structures, pipeline, berms, and wetland cell creation are designed to address these processes in a controlled and constrained system.

Table A.2 Upper Mitchell Lake Area Estimates[1]

Cell	Area (acres)
Basin 1	11
Basin 2	7
Basin 3	19
Basin 4	21
Basin 5	22
East Polder	47
West Polder	32

[1] Mitchell Lake Wetland Feasibility Study, Simpson Group, November 1997

Figure A-10 shows the configuration and connectivity of the polder complex along with the control structures and pump locations. Figures A-11 and A-12 show the pumps.

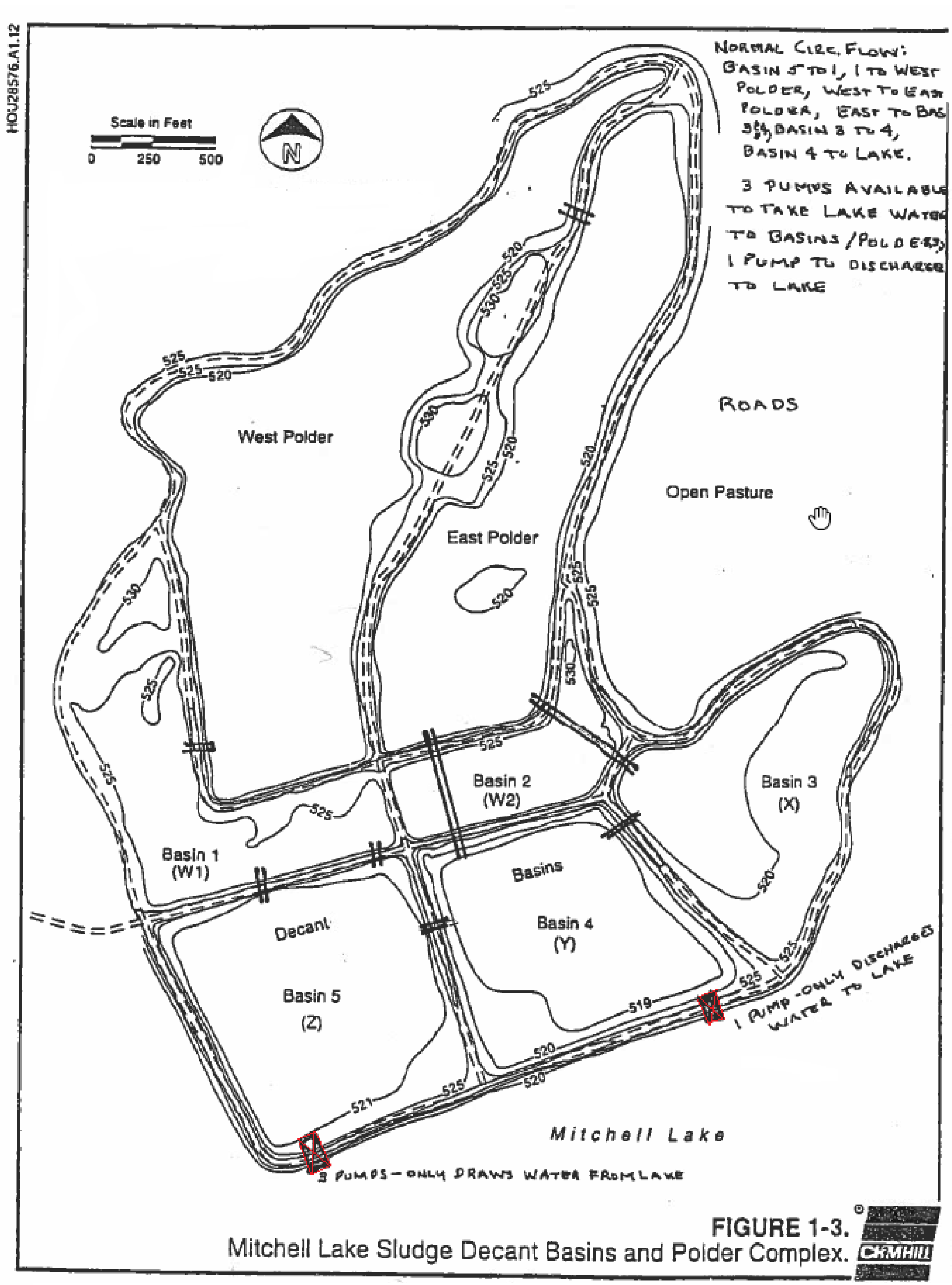


Figure A-10. Polder Complex (NAVD 1988)

Figure A-11. Polders Pump

Figure A-12. Polders Pump

1.6.2 Water supply contract. San Antonio Water System has a contractual agreement with the Audubon Society to provide water to the polders. The pumps are operated intermittently on an as-needed basis - the Audubon Society notifies SAWS when the polders water levels are getting low and the polders are filled accordingly. San Antonio Water System recently signed a 10-year contract extension with the Audubon Society to provide water. The pumps were installed in 1983. The pumps have proven to be functional and reliable and are regularly maintained and inspected by SAWS.

1.6.3 Pertinent data. Mitchell Lake Dam consists of an earthen embankment that varies from 2 to 10-feet in height and is approximately 3,200 feet long. The embankment crest is 15 feet wide and its elevation varies from 525.5 to 528.9 feet above mean sea level (msl). The upstream slope is 2 feet horizontal to 1 foot vertical and the downstream slope is 2.5-ft horizontal to 1-foot vertical. Concrete rubble used for erosion protection is located at various locations along the upstream face of the dam. The dam is vegetated and there are large trees present at various points adjacent to the toe of the dam. A 55 feet wide concrete spillway is located along the eastern abutment and the normal water surface varies between 520 ft-msl and 523 ft-msl. The dam's spillway consists of eight (8), 36-inch diameter gate valves with invert elevations at 520.7 ft-msl. The gate valves are permanently rusted open with one partially closed and assumed to remain this way. A ninth gate at the primary spillway outfalls to a 36-inch reinforced concrete pipe discharging to an irrigation canal that carries water away from Cottonmouth Creek. A 250-foot stone and mortar outfall channel proceeds from the spillway into a heavily eroded plunge pool. The pool discharges into Cottonmouth Creek which flows into the Medina River. Treated effluent (recycled water) is piped to the lake from the Leon Creek Water Recycling Center. Water is used to maintain lake levels during dry periods. Pertinent data for Mitchell Dam and Lake is shown in Table A-3.

Note: All water surface elevations computed as part of the ARCADIS hydrology analysis presented in this study are based on the North American Vertical Datum (NAVD) of 1988. The elevations in this appendix related to the pertinent data of Mitchell Dam and Lake are based on msl and have not been converted to NAVD 1988.

Table A-3. Mitchell Dam and Lake Pertinent Data[2]
(feet msl)

Year Constructed	1901
Length	3,200 feet
Height	10 feet
Hazard Classification	Low
Drainage Area	9.76 square miles
Normal Water Level Elevation	520.4 feet
Normal Water Level Surface Area	670 acres
Normal Water Level Storage	2,640 acre-feet
Maximum Storage	5,000 acre-feet
Top of Dam Elevation	528 feet
Primary Service Spillway Crest	520.73 feet
Emergency Spillway Crest	527 feet
Top Width	15 feet

1.6.4 Spillway study. ARCADIS also analyzed the capacity of the existing spillway at Mitchell Lake Dam per the request by the Texas Commission on Environmental Quality (TCEQ). The reason for the request was due to the increased development in the watershed while using current engineering standards. Mitchell Lake Dam is classified by TCEQ as an intermediate size, low hazard dam. The results of this hydrologic and hydraulic analysis indicated that the existing spillway at Mitchell Lake Dam is adequate to pass 28 percent of the Probable Maximum Flood (PMF), as required by TCEQ. The study concluded that based on TCEQ requirements for existing conditions, no modifications to the dam are necessary at this time.

1.6.5 Sedimentation. Mitchell Lake sedimentation data (elevation-volume-area relationships) were updated by Alan Plummer Associates, Inc. (API) and presented in report "Mitchell Lake Downstream Wetlands Desktop Feasibility Study, 10 January 2019". This was the only historic lake sedimentation data found during the data search. The data was based on a recent survey of the lake bathymetry and it shows a reduction in lake capacity. This could be attributed to sedimentation of the lake or perhaps different methods of obtaining lake bathymetric data. The Merrick data (2015) and the API data (2019) are four years apart. Figure A-13 shows the revised relationships.

[2] Hydrologic and Hydraulic Analysis Mitchell Lake Dam, Cottonmouth Creek, Bexar County, ARCADIS, 30 December 2014

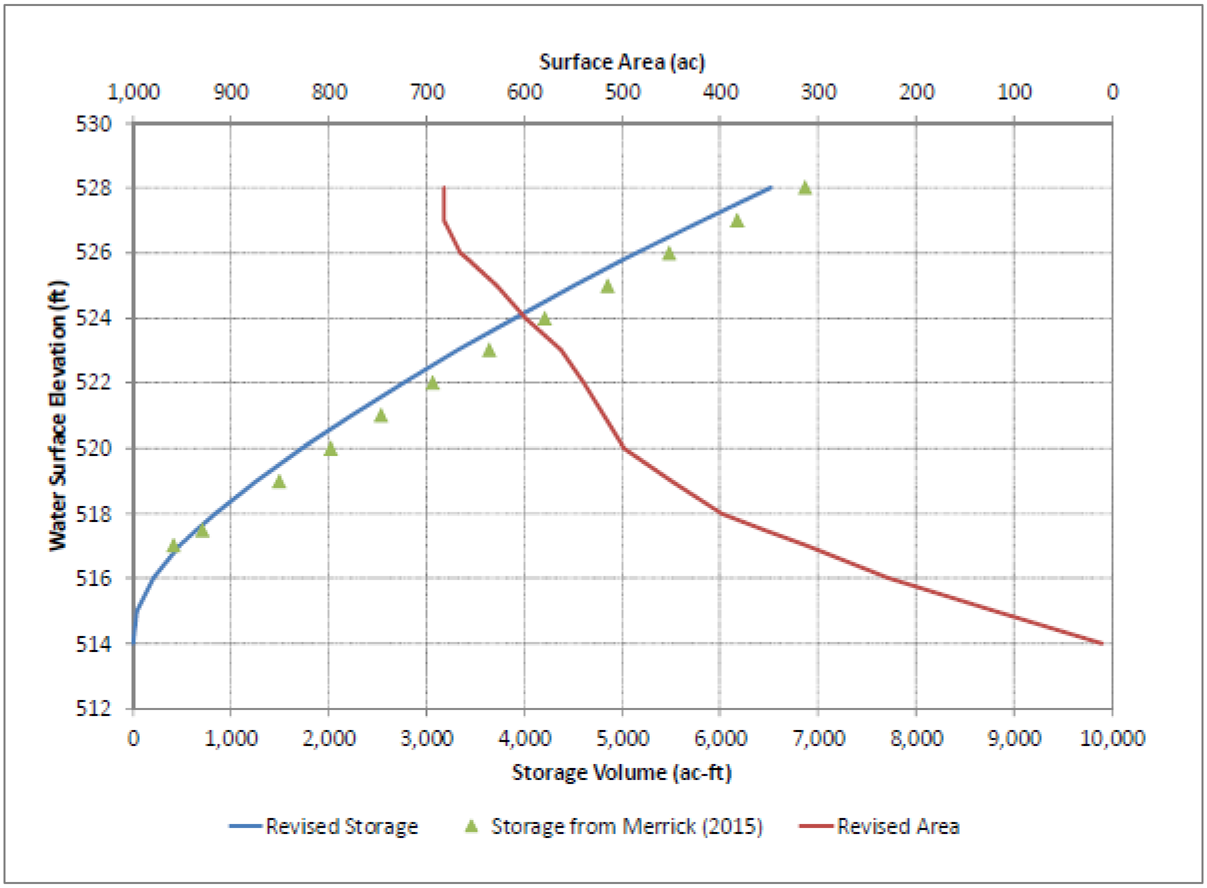


Figure A-13. Mitchell Lake Elevation-Volume-Area Data (NAVD 1988 datum)

2 Existing Conditions

2.1 Hydrology Analysis

2.1.1 Model Development. ARCADIS developed an existing conditions hydrologic model of the Mitchell Lake watershed. The following technical information in this section is from their 2014 report:

> "The U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) version 3.5 was used to develop to generate runoff hydrographs and peak inflows for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm events. The Natural Resources Conservation Service (NRCS) Curve Number Method, formerly the Soil Conservation Service (SCS) Curve Number Method, was used to determine rainfall losses. The NRCS Curve Number Method requires input parameters such as sub-basin area, curve numbers (CNs), hydrograph type, design storm rainfall depth, basin lag times, and channel routing parameters. Digital soil maps obtained from NRCS were used to determine the hydrologic soil groups within the Mitchell Lake watershed. Available aerial photography, field reconnaissance of the study area, and guidance presented in SCS Technical Release 55 were used to select CNs representative of the land uses and hydrologic soil groups identified within the watershed and ultimately to develop composite CNs for each modeled subarea. The SCS Type III rainfall distribution was selected as the rainfall distribution curve for this project. Twenty-four-hour rainfall depths for the 2-, 5-, 10-, 25-, 50-, 100-, and 500- year storm events were obtained from the City of San Antonio's Unified Development Code."

Figure A-14 shows the watershed sub-basins as defined in the HEC-HMS model. Figure A-15 shows the Mitchell Lake topographic map with the sub-basins.

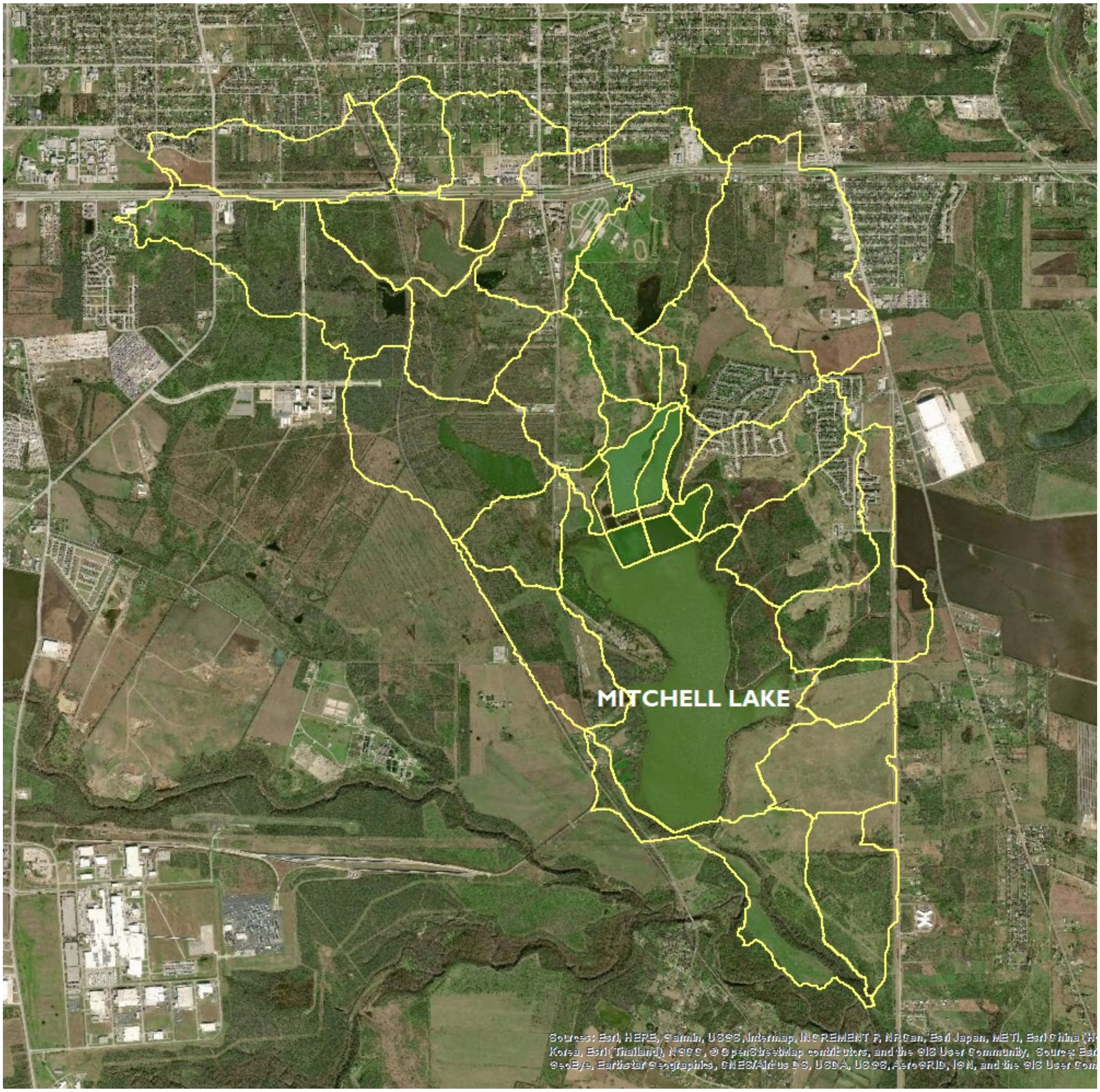


Figure A-14. Mitchell Lake Sub-Basin Areas Used in the HEC-HMS Model

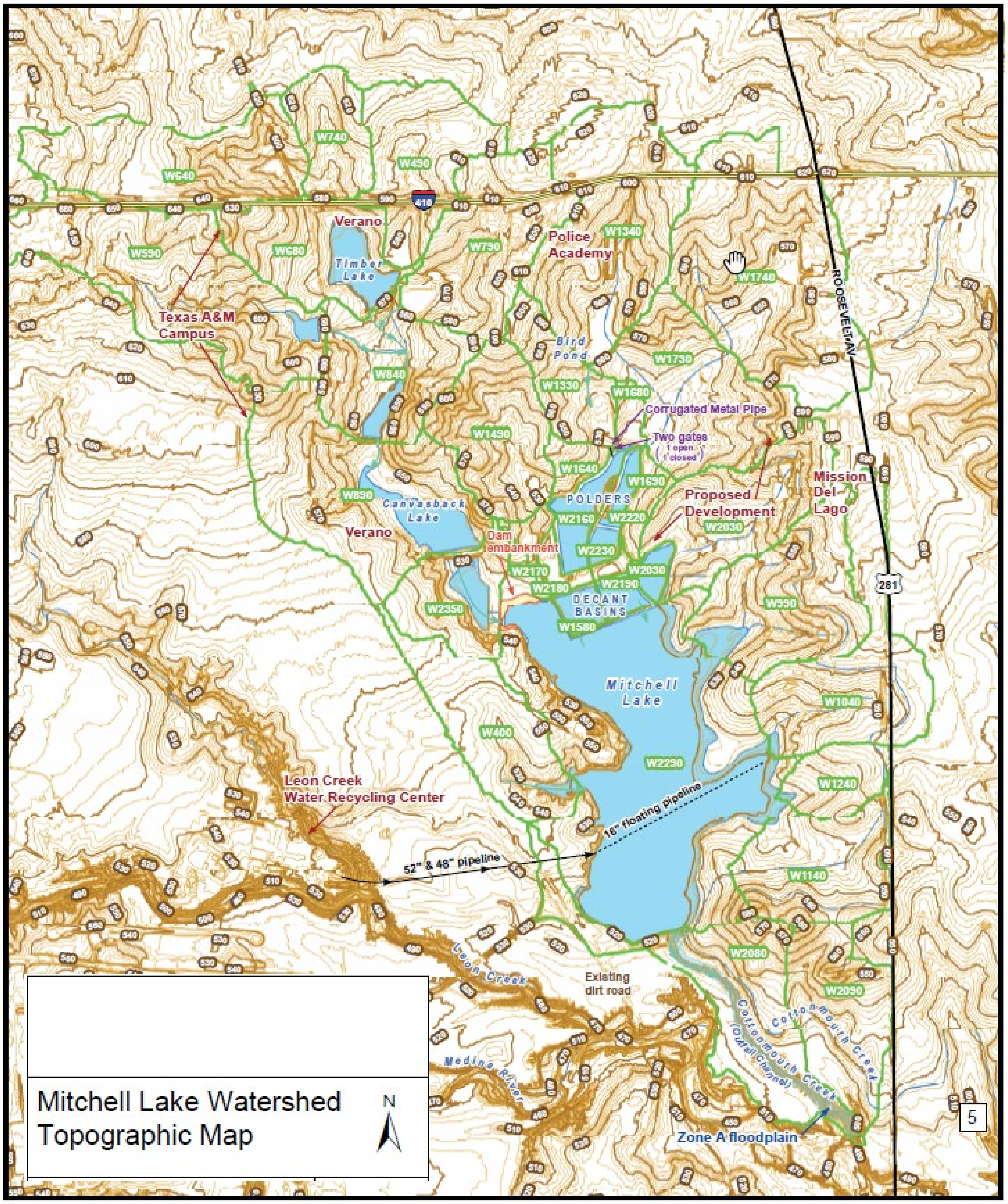


Figure A-15. Mitchell Lake Watershed Topographic Map (NAVD 1988)

2.2.2 Precipitation Analysis. The Natural Resources Conservation Service (NRCS) Curve Number Method, formerly the Soil Conservation Service (SCS) Curve Number Method, was used to determine rainfall losses. The NRCS Curve Number Method requires input parameters such as subbasin area, curve numbers (CNs), hydrograph type, design storm rainfall depth, basin lag times, and channel routing parameters. “The SCS Type III rainfall distribution was selected as the rainfall distribution curve for this project. Twenty-four-hour rainfall depths for the 2-, 5-, 10-, 25-, 50-, 100-, and 500- year storm events were obtained from the City of San Antonio’s Unified Development Code” and are listed in Table A-4. Table A-5 shows the Mitchell Lake computed peak inflows and peak water surface elevations for the range of flood events.

NOAA Atlas 14 Volume 11 provides precipitation frequency estimates for durations of 5-minute through 60-day at average recurrence intervals of 1-year through 1,000-year for the State of Texas. NOAA Atlas 14 is the product of a study used to analyze historical rainfall data in order to update statistical hypothetical rainfall events in Texas. This precipitation data was published on 27 September 2018, after the ARCADIS study was completed. Comparisons between the Atlas 14 precipitation data and existing data for the San Antonio area show very minor differences which would not result in meaningful changes to peak flood flows. Table A-5 shows the computed peak inflows and corresponding peak water surface elevations based on model results. ARCADIS validated the computed peak flows by comparing the values to published Bexar County Flood Insurance Study flows for nearby Polecat Creek, which is of similar drainage area size. The flows compared favorably with the effective published flows. Pertinent information on Polecat Creek was not available in the ARCADIS report. No calibration information was presented in the report.

Table A-4. 24-hour Rainfall Depths

Annual Exceedance Probability	**Rainfall Depth (inch)**
0.50 (2-year)	3.96
0.20 (5-year)	5.00
0.10 (10-year)	6.00
0.04 (25-year)	7.50
0.02 (50-year)	9.00
0.01 (100-year)	10.00
0.002 (500-year)	13.70

Table A-5. Mitchell Lake Peak Inflows and Water Surface Elevations (NAVD 1988)

Annual Exceedance Probability	Peak Inflow (cfs)	Peak Water Surface Elevation (feet)
0.50 (2-year)	1,798	522.2
0.20 (5-year)	2,697	522.6
0.10 (10-year)	3,643	523.1
0.04 (25-year)	5,181	524.0
0.02 (50-year)	6,775	525.0
0.01 (100-year)	7,863	525.6
0.002 (500-year)	12,703	527.4

2.2.3 FEMA floodplain. The current FEMA map shows that the Mitchell Lake area and a portion of Cottonmouth Creek are designated as Zone A ((effective Flood Insurance Rate Map (FIRM) 48029C059G 29 September 2010)). Zone A is defined as areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies, i.e. no detailed hydraulic analyses have not been performed. Therefore, no Base Flood Elevations (BFEs) are shown on the FIRM. A constant BFE of 491 feet NAVD 1988 is defined on the lower portion of Cottonmouth Creek, which appears to be a backwater ponding elevation from the Medina River.

Figures A-16 and A-17 shows the current FEMA map for the Mitchell Lake area and the downstream reach of Cottonmouth Creek and the Medina River.

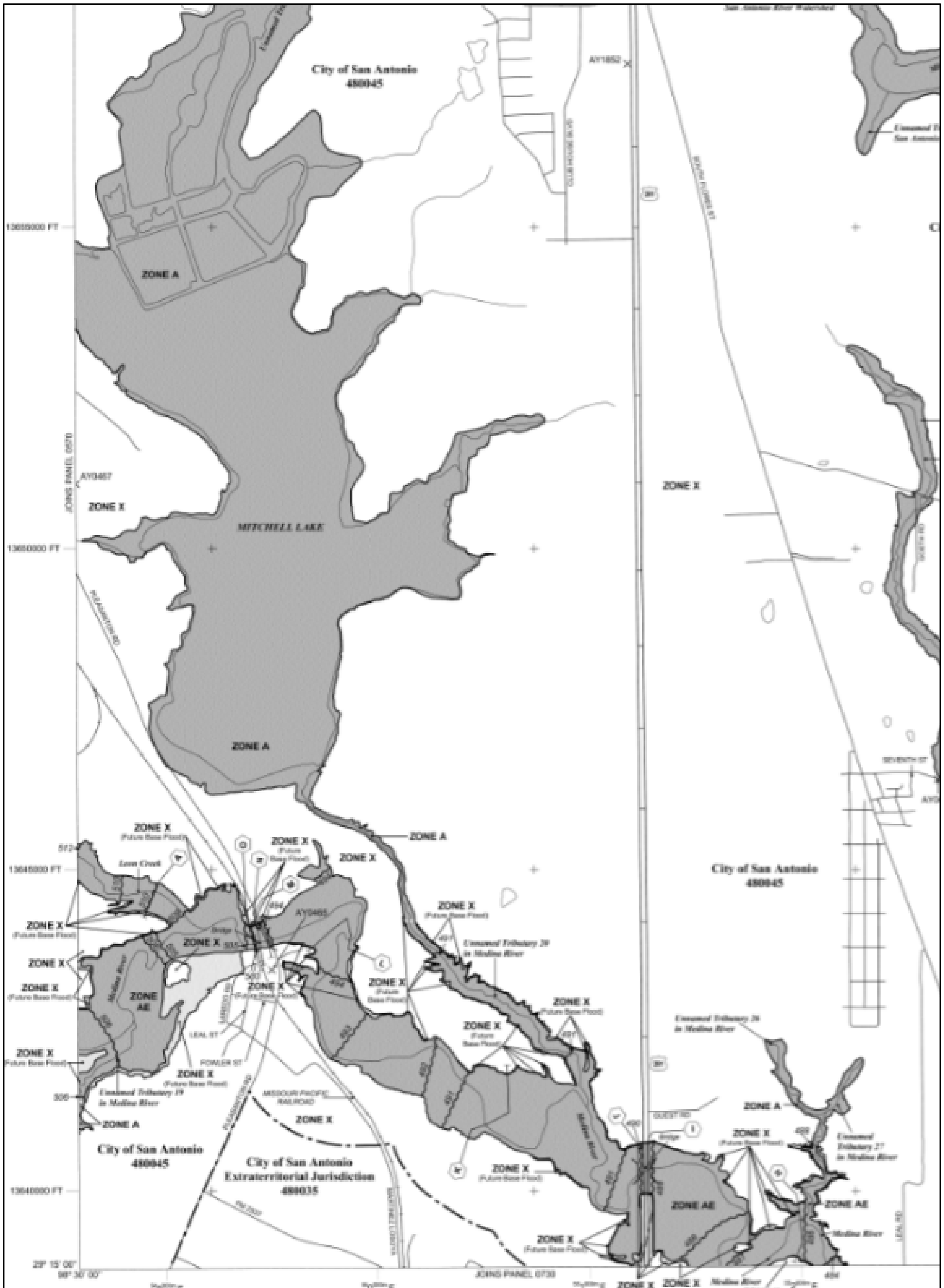


Figure A-16. Current Study Area FEMA Map (NAVD 1988)

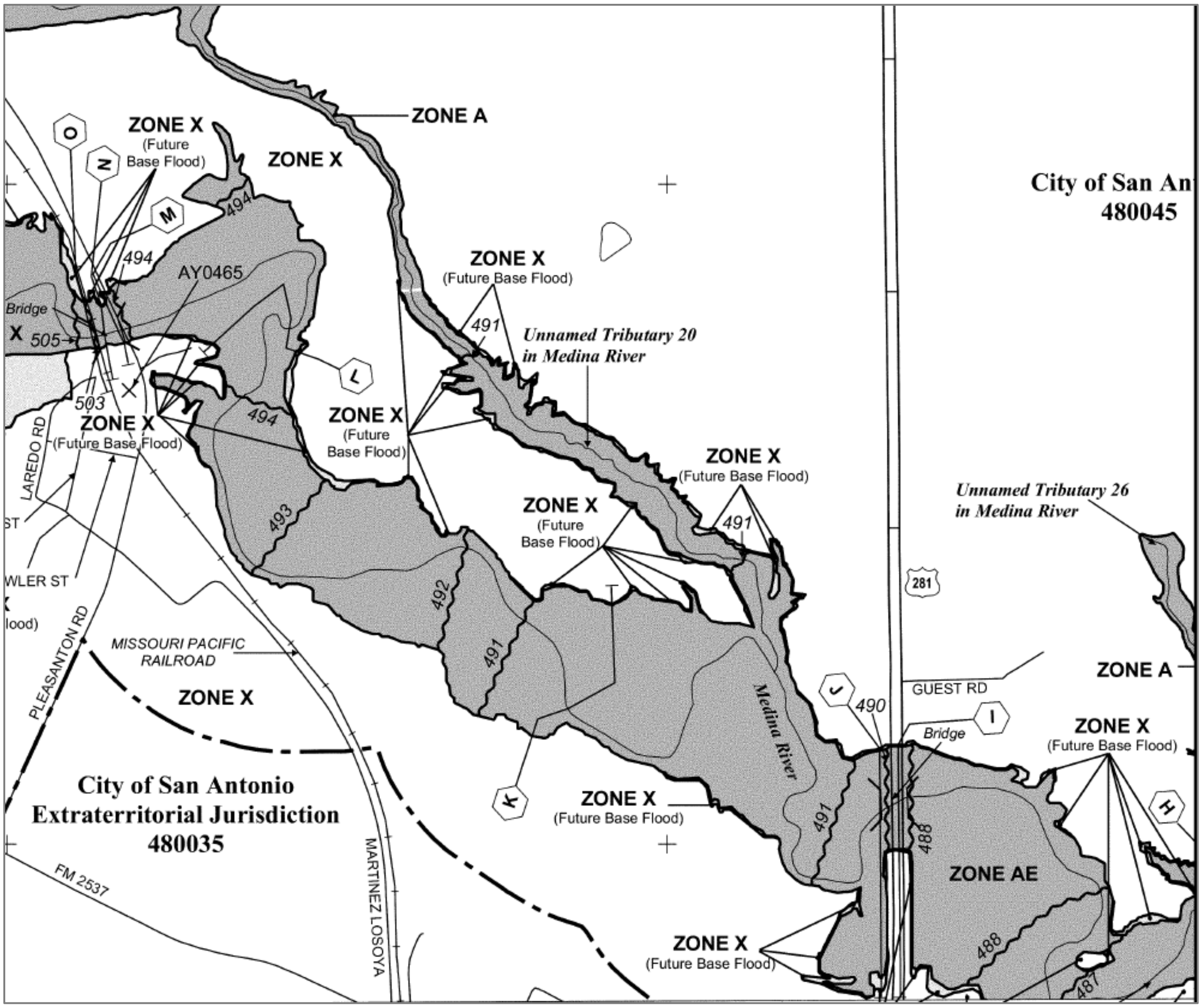


Figure A-17. Current Study Area FEMA Map (NAVD 1988)

3 Future Without Project Conditions

3.1 Future Without Project Conditions

3.1.1 General. Future Without Project conditions is based on the premise that the Mitchell Lake and watershed area would be allowed to develop without a constructed ecosystem restoration project. The expected Future Without Project conditions include reducing the Mitchell Lake elevation, thereby decreasing the lake surface area as well. The watershed may continue to develop. For example, the nearby Texas A&M Campus has a master plan for campus expansion as enrollment increases, with the final stage of development beginning once enrollment surpasses 25,000 students. The City of San Antonio and Bexar County have floodplain ordinances that limit stormwater runoff impacts of new development. The City of San Antonio Unified Developed Code (UDC) and Storm Water Design Criteria Manual give criteria for effective stormwater management and the mitigation of downstream impacts. According to the City of San Antonio UDC, "Peak stormwater runoff rates from all new development shall be less than or equal to the peak runoff rates from the site's predevelopment conditions for the 5-year, 25-year and 100-year design storm events. Peak stormwater runoff rates from an area of redevelopment due to zoning or replatting shall be less than or equal to the peak runoff rates produced by existing development conditions for the 5-year, 25-year and 100-year design storm events." These programs were developed to prevent increases of downstream impacts due to proposed future development within the city of San Antonio. Although the precipitation values and flood peak flows may change in the future as additional historical data is considered, the goal is to stabilize flood risks. Refer to Section 5 - Qualitative Climate Assessment for a discussion of predicted future climate conditions.

The Future Without Project conditions lake elevation of 517 (NAVD 1988) will be supplemented by Leon Creek Water Recycling Center during drought periods. Prolonged wet periods or large storm events will prompt water release. The northern chain of wetlands is supplemented through pumping from Mitchell Lake. Water will always be available because Mitchell Lake is supplemented by the Leon Creek Water Recycling Center.

3.1.2 Land Use. The Mitchell Lake drainage area consists of different types of land use. Land use information was obtained from the City of San Antonio zoning web site. Figure A-18 shows the City of San Antonio zoning classifications within the Mitchell Lake watershed area. Table A-6 lists the zoning classifications and respective land areas.

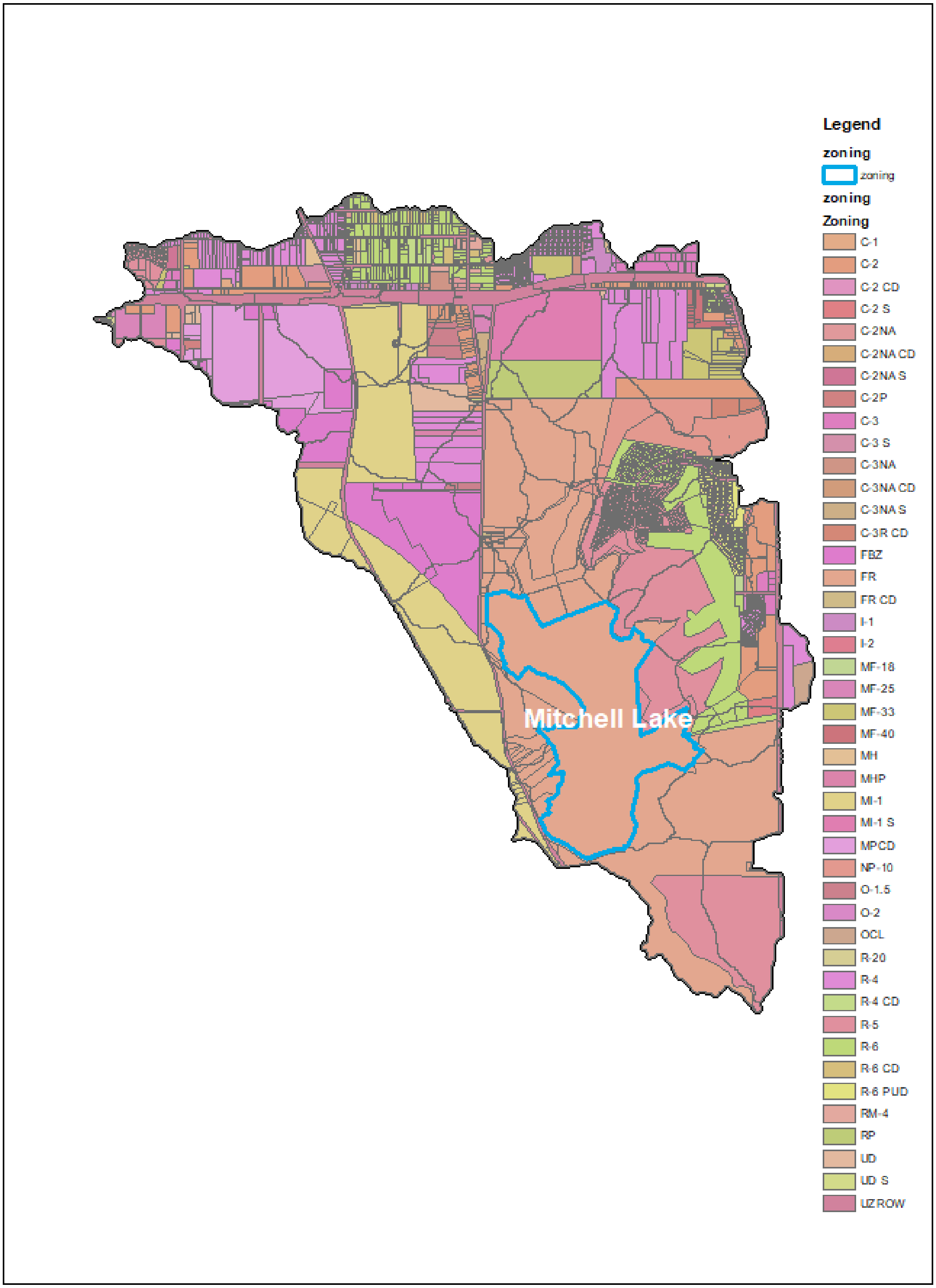


Figure A-18. Mitchell Lake Watershed Zoning Classifications

Table A-6. Mitchell Lake Watershed Zoning

Zoning	Zoning District	Number	Area (sq. mile)
C-1	Light Commercial District	2	0.004
C-2	Commercial District	135	0.502
C-2 CD	Commercial District	4	0.004
C-2 S	Commercial District	2	0.019
C-2NA	Commercial Nonalcoholic Sales District	25	0.019
C-2NA CD	Commercial District	3	0.001
C-2NA S	Commercial District	1	0.009
C-2P	Commercial Pedestrian District	2	0.006
C-3	General Commercial District	48	0.092
C-3 S	General Commercial District	1	0.016
C-3NA	General Commercial Nonalcoholic Sales District	34	0.031
C-3NA CD	General Commercial Nonalcoholic Sales District	1	0.002
C-3NA S	General Commercial Nonalcoholic Sales District	2	0.012
C-3R CD	General Commercial Restrictive Alcoholic Sales	2	0.029
FBZ	Form Base Zoning District	23	0.593
FR	Farm and Ranch District	88	2.981
FR CD	Farm and Ranch District	2	0.001
I-1	General Industrial District	20	0.036
I-2	Heavy Industrial District	2	0.001
MF-18	Limited Density Multi-Family District	1	0.005
MF-25	Low Density Multi-Family District	6	0.069
MF-33	Multi-Family District	60	0.140
MF-40	Multi-Family District	13	0.030
MH	Manufactured Housing District	12	0.022
MHP	Manufactured Housing Park District	2	0.015
MI-1	Mixed Light Industry	43	1.004
MI-1 S	Mixed Light Industry	3	0.266
MPCD	Master Planned Community Districts	21	0.490
NP-10	Neighborhood Preservation District	19	0.290
O-1.5	Office District	10	0.055
O-2	High-Rise Office District	1	0.002
OCL	Outside City Limits	1	0.024
R-20	Residential Single-Family District	11	0.003
R-4	Residential Single-Family District	668	0.891
R-4 CD	Residential Single-Family District	5	0.017
R-5	Residential Single-Family District	655	1.105
R-6	Residential Single-Family District	596	0.733
R-6 CD	Residential Single-Family District	19	0.022
R-6 PUD	Residential Single-Family District	289	0.088
RM-4	Residential Mixed District	116	0.037
RP	Resource Protection District	4	0.161
UD	Urban Development	18	0.080
UD S	Urban Development	4	0.005
UZROW	Unzoned Right of Way	66	0.646

4 With Project Conditions

4.1 Tentatively Selected Plan

4.1.1 General. The study Project Delivery Team (PDT) performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objective. Numerous alternatives were considered, evaluated, and screened in producing a final array of alternatives. The PDT identified Plan 6 as the Tentatively Selected Plan (TSP). Plan 6 includes the restoration of 49.52 acres of mudflats associated with the polders, 53.68 acres of emergent/submergent wetlands associated with Cove 1, and 51.32 acres of emergent wetlands associated with the downstream wetlands. The 53.68 acres of emergent/submergent wetland provided by Plan 6 would result in restoration of the northernmost cove of Mitchell Lake.

4.1.2 Polders. The TSP predominantly consists of environmental modifications. A minimal amount of fill will be placed within the project area. The TSP includes modification to the polders area in the following manner:

- Additional berms would be added to the following cells from excavated materials of the constructed wetland cells
- Construction of two berms at the south end of the West Polder
- Construction of one berm at the south end of the East Polder
- Construction of one berm at the southwest corner of Basin 1
- Modification/replacement of existing water control structures to drop the invert to a level that would allow the draining of the mudflat cells
- Installation of new water control structures to facilitate transfer of water across the new berms in the West Polder, East Polder, and Basin 1

The amount of fill material to construct the berms is about 3,309 cubic yards. A portion of berms would be inundated due to the pool elevations of the individual cells.

The existing pumps at the polders will continue to be utilized to supply water. The pumps have proven to be functional and reliable. They are regularly maintained and inspected by SAWS and will provide water to the system as needed.

4.2 Impacts of the Tentatively Selected Plan

4.2.1 Evaluation. Mitchell Lake Dam controls the upstream study area in terms of water surface profiles. An evaluation of the TSP features suggests that no adverse impacts to the flood event water surface profiles would be produced as a result of the TSP. A minimal amount of fill will be placed upstream of Mitchell Lake Dam as part of the TSP. This minimal fill along with the ecosystem enhancements of the TSP would not adversely impact the watershed floodplain characteristics in any appreciable manner as to cause an increase in flood event peak flows or corresponding peak water surface elevations. Note that there is no available hydraulic model that represents the floodplain upstream of Mitchell Lake Dam.

5 Qualitative Climate Assessment

5.1 Literature Review

5.1 General. Engineering and Construction Bulletin No. 2018-14 “Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects” provides guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate preparedness and resilience policy and ER 1105-2-101. The objective of ECB-2018-14 is to enhance USACE climate preparedness and resilience by incorporating relevant information about observed and expected climate change impacts in hydrologic analyses for planned, new, and existing USACE projects. This includes consideration of both past (observed) changes as well as potential future (projected) changes to relevant climatic and hydrologic variables. The ECB helps support a qualitative assessment of potential climate change threats and impacts, focusing on those aspects of climate and hydrology relevant to the project’s problems, opportunities, and alternatives, and include consideration of both past (observed) changes as well as projected, future (modeled) changes.

Several on-line tools developed by the USACE were used in this analysis: Climate Hydrology Assessment Tool, Nonstationarity Detection Tool, and the Civil Works Vulnerability Assessment Tool. Other literature sources, as listed in Section 6 – References, were also used in this assessment.

5.1.2 Project hydrologic location and gage resources. The Mitchell Lake drainage area is located in the southern San Antonio regional area. It is located within Hydrologic Unit Code (HUC) 121003 - Central Texas Coastal. Figure A-19 shows the HUC location map for Texas and the location of the study area.

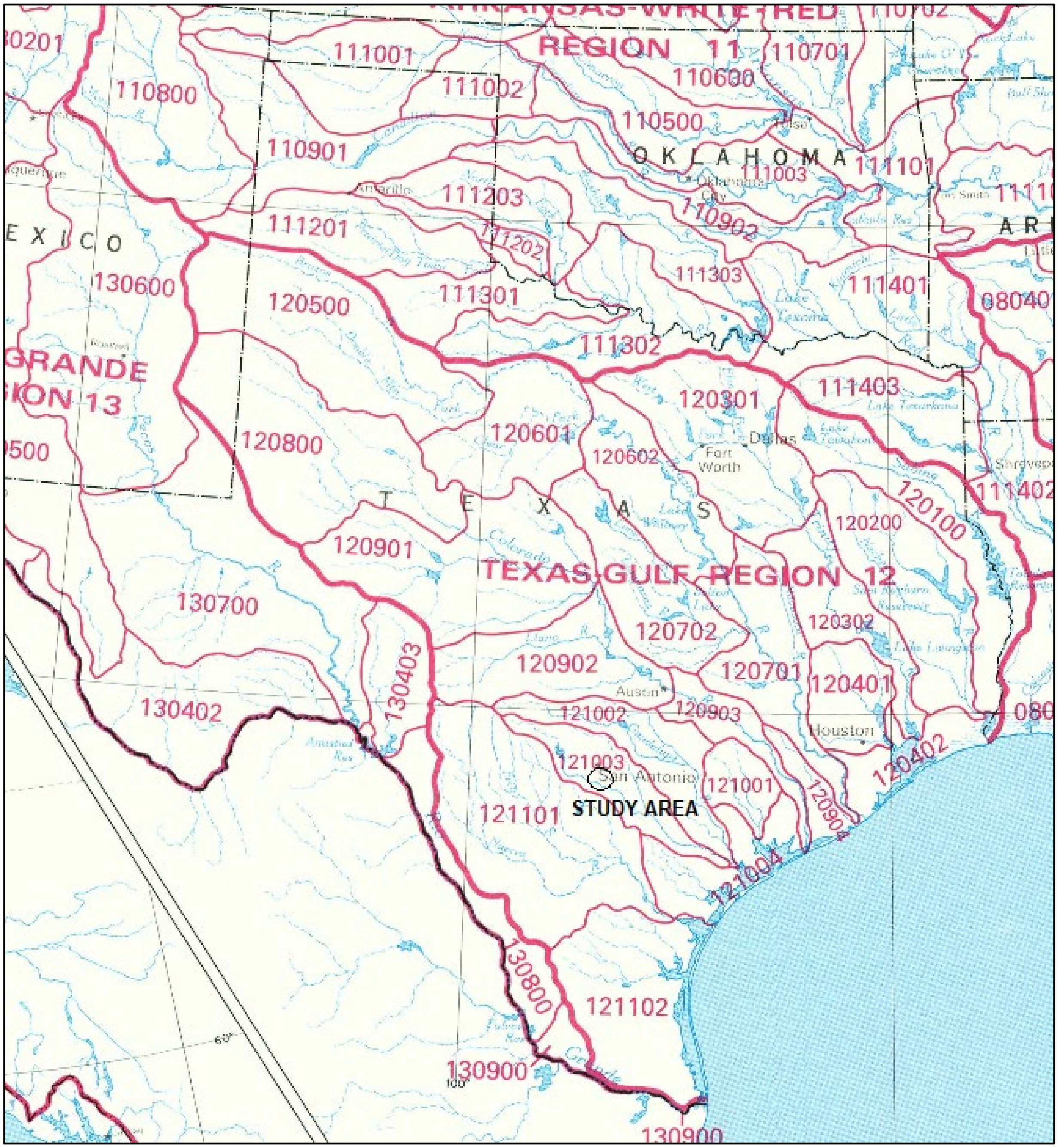


Figure A-19. HUC locations in Texas

The nearest stream gage to the project area is the USGS 08181500 Medina River at San Antonio, Texas. The gage is located along the Medina River on the upstream side of the US 281/Pleasanton Road bridge, within a mile downstream of Mitchell Lake Dam. Pertinent gage data is as follows:

Bexar County, Texas
Hydrologic Unit Code 12100302!
Latitude 29°15'50", Longitude 98°29'26" NAD27
Drainage area 1,317 square miles
Gage datum 439.03 feet above NGVD29
Gage installed in 1939

The gage is only slightly affected by regulation. The sole dam on the river is Medina Dam and Lake located about 40 miles northwest of San Antonio. The dam is basically a pass-through structure with incidental flood control capacity.

Figure A-20 shows the location of the gage and its proximity to Mitchell Lake.

Figure A-20. USGS 08181500 Medina River at San Antonio, Texas

5.1.3 Temperature. A literature search was conducted to locate information related to observed and projected climate trends. On a larger scale, there has been an increase in the average temperature of the contiguous United States over the past several decades. Table A-7 and Figure A-21 show the change in annual average temperature across the United States. Texas is located in the Great Plains South region and is shown in comparison with the other regions in the United States. Figure A-24 shows the trend in San Antonio temperatures.

Table A-7. Change in Average Annual Temperature United States[3]

NCA Region	Change in Annual Average Temperature	Change in Annual Average Maximum Temperature	Change in Annual Average Minimum Temperature
Contiguous U.S.	1.23°F	1.06°F	1.41°F
Northeast	1.43°F	1.16°F	1.70°F
Southeast	0.46°F	0.16°F	0.76°F
Midwest	1.26°F	0.77°F	1.75°F
Great Plains North	1.69°F	1.66°F	1.72°F
Great Plains South	0.76°F	0.56°F	0.96°F
Southwest	1.61°F	1.61°F	1.61°F
Northwest	1.54°F	1.52°F	1.56°F
Alaska	1.67°F	1.43°F	1.91°F
Hawaii	1.26°F	1.01°F	1.49°F
Caribbean	1.35°F	1.08°F	1.60°F

Analysis of observed daily temperature and rainfall records at the San Antonio International Airport weather station shows trends that are consistent with those observed for the United States. Table A-8 shows the monthly and yearly average temperatures from 1960 – 2019 for the San Antonio area.

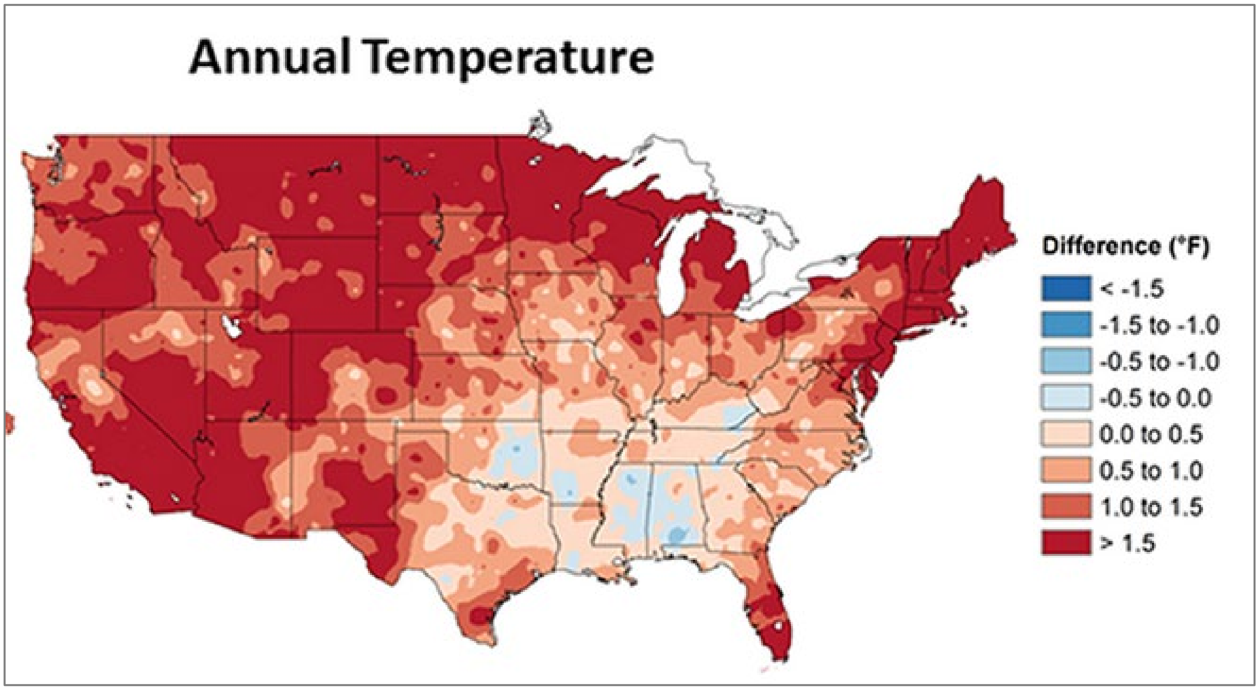


Figure A-21. Change in Average Annual Temperature United States

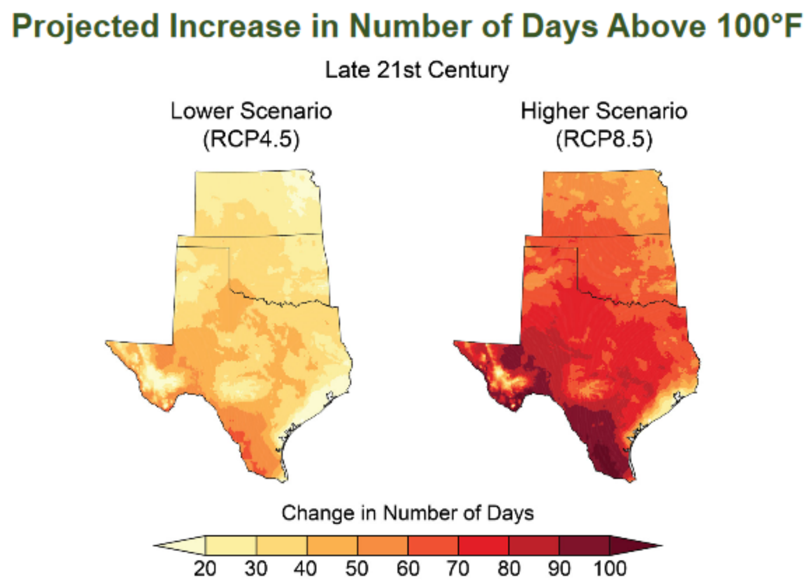
Figure A-22 shows the projected increase in the number of days above 100ºF for Texas for both the lower and higher predicted scenario. Figure A-23 shows the trend in the temperature data in graphical form.[3] The data trend to the increase of average temperature for the San Antonio area in the future. Mean temperatures are trending upward.

Table A-8. San Antonio Monthly and Yearly Average Temperatures 1960 - 2019

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1960	50.0	49.8	56.0	69.7	74.0	83.2	84.2	83.5	78.6	73.2	62.2	50.1	67.9
1961	47.9	55.8	65.6	68.5	78.4	81.3	82.5	82.5	80.5	71.1	58.0	54.2	68.9
1962	45.8	62.8	59.1	69.7	77.9	82.3	86.8	87.5	80.9	75.5	60.3	52.1	70.1
1963	46.2	52.5	65.5	74.6	77.7	83.4	85.4	85.7	81.1	74.1	62.4	45.6	69.5
1964	51.0	49.8	61.5	70.5	77.6	82.4	86.3	86.2	80.0	66.3	62.6	52.2	68.9
1965	54.4	49.8	54.9	71.6	75.0	81.6	84.9	84.0	80.7	66.8	64.5	55.5	68.6
1966	45.3	49.7	60.0	68.6	73.5	78.8	84.2	81.9	77.5	66.9	63.0	50.6	66.7
1967	50.2	51.8	66.9	76.5	76.6	84.5	85.2	82.6	75.5	66.9	60.4	51.0	69.0
1968	49.8	48.2	58.0	68.1	75.3	80.5	82.7	84.1	75.9	72.2	56.4	50.7	66.8
1969	52.5	53.6	54.9	69.0	73.4	81.2	86.8	85.7	79.6	69.8	58.1	55.1	68.3
1970	45.5	54.8	56.8	70.1	72.9	80.6	83.9	85.6	81.1	67.7	58.0	60.1	68.1
1971	56.0	57.4	64.6	69.4	78.1	83.6	85.9	81.5	80.1	73.8	63.1	57.2	70.9
1972	52.8	56.7	66.2	73.7	72.8	80.3	82.2	82.1	81.9	71.9	54.0	50.2	68.7
1973	47.2	51.9	66.1	66.0	74.7	79.2	83.1	82.1	79.3	72.5	65.7	52.1	68.3
1974	51.0	56.4	67.9	69.7	77.3	79.4	83.0	81.1	72.3	68.1	57.3	50.9	67.9
1975	53.2	53.5	61.4	68.4	73.5	80.0	80.9	81.7	76.0	71.1	60.3	53.0	67.8

[3] Climate trends in San Antonio and an Overview of Climate projections for the South-Central Region, Katherine Hayhoe, Ph.D., ATMOS research & Consulting, May 2015 Revised

1976	49.6	61.2	63.8	68.9	71.3	79.8	79.8	81.6	77.5	61.0	52.1	49.8	66.4
1977	44.0	52.8	61.8	66.9	74.8	81.5	84.8	84.7	82.3	71.2	61.4	53.3	68.3
1978	43.3	46.4	59.6	68.9	77.0	82.7	86.0	83.0	78.5	69.3	62.4	51.7	67.4
1979	43.7	52.4	63.3	69.7	73.8	80.8	84.7	83.1	78.7	74.7	58.2	55.3	68.2
1980	52.6	53.6	61.4	67.5	76.1	85.1	88.1	85.3	83.6	70.7	58.3	55.0	69.8
1981	50.8	53.7	60.6	72.9	75.3	81.5	84.2	84.7	78.9	71.8	62.4	53.0	69.1
1982	50.8	49.6	63.0	66.9	74.5	81.6	85.5	86.0	80.0	69.3	59.3	52.4	68.2
1983	48.9	52.1	58.7	65.2	73.6	79.2	82.9	84.5	78.5	70.8	62.5	43.0	66.7
1984	46.6	54.1	64.2	69.7	77.0	82.7	84.9	84.7	77.6	71.2	58.7	59.6	69.3
1985	44.2	50.5	64.0	69.4	76.6	80.2	82.2	85.5	79.4	71.7	64.4	49.9	68.2
1986	53.4	58.0	62.9	72.6	74.6	81.4	85.8	85.7	83.7	69.7	59.3	51.6	69.9
1987	50.6	55.8	57.8	66.1	75.7	80.5	83.8	86.0	79.2	71.2	60.6	54.2	68.5
1988	47.5	54.2	61.3	69.0	76.1	81.1	84.6	86.4	80.7	73.2	65.1	56.0	69.6
1989	56.1	51.6	61.9	70.3	81.7	83.3	86.6	86.0	79.0	71.2	61.8	43.4	69.4
1990	56.4	58.8	61.5	69.6	79.3	87.4	83.3	85.2	80.0	69.3	63.0	51.9	70.5
1991	48.9	56.6	64.0	72.4	77.6	82.8	84.5	85.8	77.8	73.2	57.4	55.5	69.7
1992	50.7	59.1	63.3	69.0	73.7	82.5	84.7	82.1	81.7	73.4	57.2	56.2	69.5
1993	51.1	55.5	61.5	67.3	73.9	81.5	86.0	87.2	81.5	70.6	56.3	55.0	69.0
1994	52.3	56.1	63.9	69.8	76.0	84.5	87.8	86.1	78.4	72.6	64.7	56.9	70.8
1995	53.5	57.4	61.8	69.8	78.6	79.3	84.3	85.5	80.1	69.8	59.5	55.6	69.6
1996	51.0	57.9	57.6	69.5	81.9	84.1	87.3	84.4	78.4	71.0	61.3	54.5	69.9
1997	49.1	53.1	63.2	63.9	74.0	79.8	85.0	86.1	82.2	70.2	57.3	50.2	67.8
1998	56.4	55.3	59.7	66.7	79.8	86.3	88.0	83.6	80.5	71.4	62.4	52.7	70.2
1999	54.6	61.8	62.6	71.2	76.1	81.8	82.8	86.1	80.3	69.6	63.0	54.0	70.3
2000	55.2	62.6	67.0	70.7	78.6	81.0	85.9	86.3	80.9	73.0	56.9	46.4	70.4
2001	49.2	57.5	56.5	70.8	76.3	82.6	85.4	85.5	76.9	67.9	62.9	53.7	68.8
2002	54.0	50.8	60.3	73.2	76.8	83.4	82.5	85.3	78.7	70.7	57.8	53.8	68.9
2003	50.1	53.1	60.6	71.6	80.3	81.7	81.9	83.7	76.7	70.6	63.0	53.9	68.9
2004	54.5	52.6	65.9	67.2	76.1	80.8	82.9	83.3	80.5	76.9	61.1	53.1	69.6
2005	55.9	56.3	61.3	68.4	75.0	82.6	85.3	85.7	84.3	70.9	64.9	53.0	70.3
2006	58.2	55.9	67.5	76.7	78.7	83.6	85.7	88.3	79.7	72.4	63.8	54.4	72.1
2007	48.3	54.8	65.0	65.2	75.5	80.7	80.4	83.7	80.2	73.1	62.7	56.1	68.8
2008	51.8	61.7	64.5	70.6	80.1	86.8	84.1	84.4	79.5	71.4	63.7	55.0	71.1
2009	54.9	62.9	65.1	69.8	79.5	86.3	88.7	88.3	78.4	69.9	60.7	48.3	71.1
2010	49.7	49.4	59.3	68.6	77.5	83.5	84.0	87.5	80.1	70.2	62.1	53.8	68.8
2011	50.5	55.4	66.8	75.7	78.6	86.2	87.9	90.0	82.9	71.0	62.9	53.8	71.8
2012	56.2	57.4	66.4	73.9	78.1	84.8	85.4	87.2	79.6	70.7	63.2	57.1	71.7
2013	53.9	59.0	62.7	67.6	75.8	83.9	86.1	88.6	83.4	73.5	59.9	52.1	70.5
2014	51.1	57.4	60.6	71.3	75.7	83.1	84.9	88.1	82.0	76.3	57.3	56.7	70.4
2015	49.5	53.2	60.9	71.7	76.3	81.6	85.6	87.4	83.5	75.7	63.1	58.2	70.6
2016	51.8	59.2	65.9	69.7	75.1	82.0	86.9	83.9	81.8	74.4	66.4	55.8	71.1
2017	57.5	64.1	67.5	71.1	75.6	83.3	87.6	84.6	79.4	70.4	66.5	52.9	71.7
2018	49.3	58.4	67.0	68.0	80.5	86.4	86.1	86.6	79.3	69.8	56.7	53.7	70.2
2019	52.1	57.5	60.6	68.6	77.0	81.7	84.8	88.6	85.8	71.5	58.7	55.5	70.2



Under both lower- and higher-scenario climate change projections, the number of days exceeding 100°F is projected to increase markedly across the Southern Great Plains by the end of the century (2070–2099 as compared to 1976–2005). *From Figure 23.4 (Sources: NOAA NCEI and CICS-NC).*

Figure A-22. Projected Increase in the Number of Days Above 100ºF

The maximum temperatures reach more than 100ºF in the Southern Plains for an average of seven days per year. These high temperatures are projected to occur much more frequently and projected to double in number in the north regions and quadruple in the south by mid-century. A summary matrix of the trends and literary consensus of observed and projected primary variables, including temperature, for the Texas Gulf Region is shown in Figure A-24.

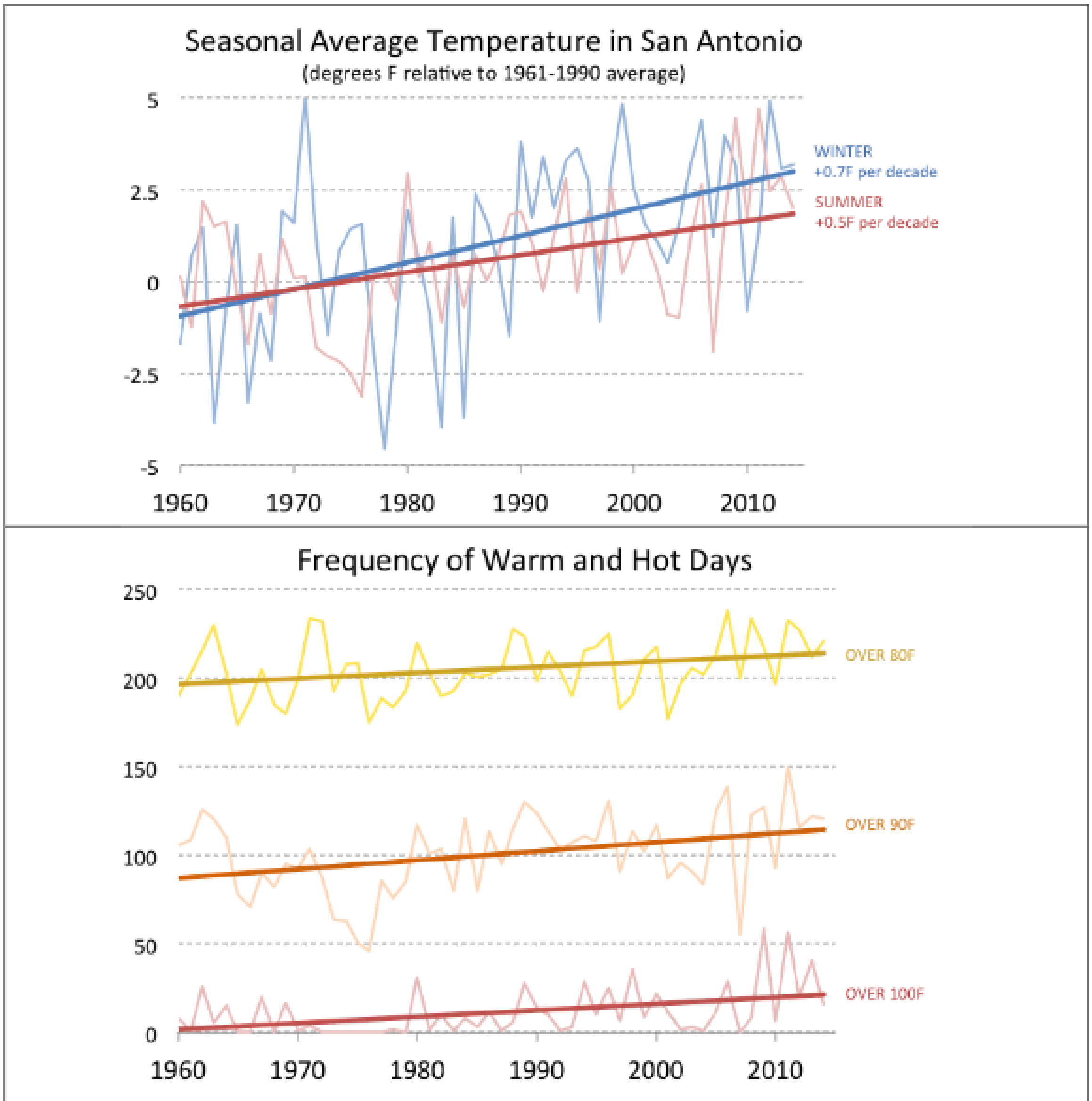


Figure 8. Observed year-to-year values (thin lines) and long-term trends (thick lines) in winter and summer mean temperature (top), and in the number of days per year with maximum temperature exceeding 80, 90, and 100°F (bottom) at the San Antonio International Airport weather station from 1960 to 2014. All trends are significant. *Source: K. Hayhoe*

Figure A-23. Trend in San Antonio Temperatures

Temperature summary. The proposed project area will be impacted by the future temperature trend. Annual evaporation will increase, which will affect the surface area and volume of the existing and proposed water dependent features. The trend towards more frequent and longer duration droughts will also affect the functionality of the proposed system. However the long term operational features of the Future Without Conditions or the proposed project should not be adversely impacted as the project area can be supplemented by water supplied by the Leon Creek Wastewater Recycling Center (see paragraph 5.2), which would offset periodic spikes in temperature increases and or drought occurrences.

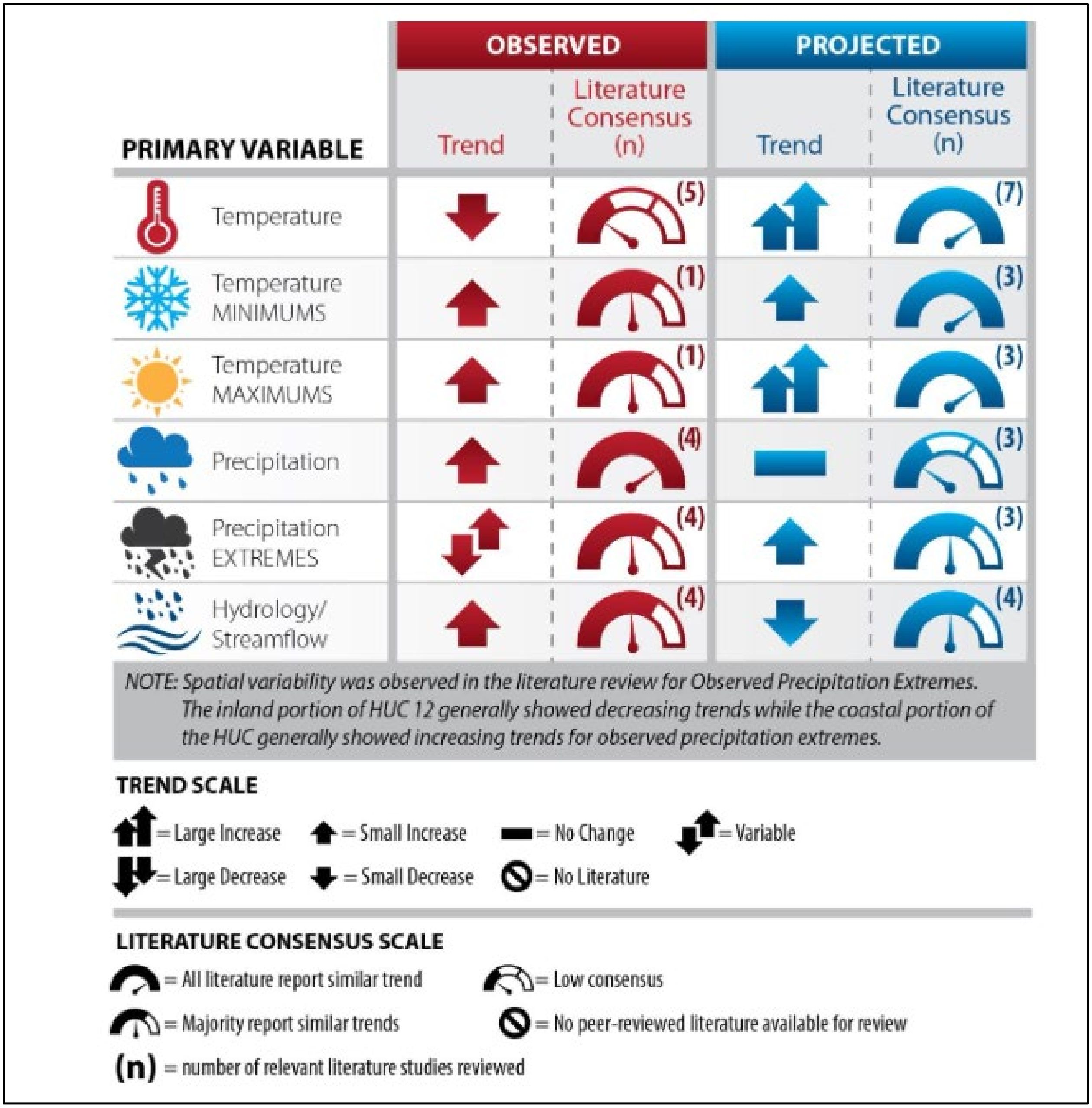
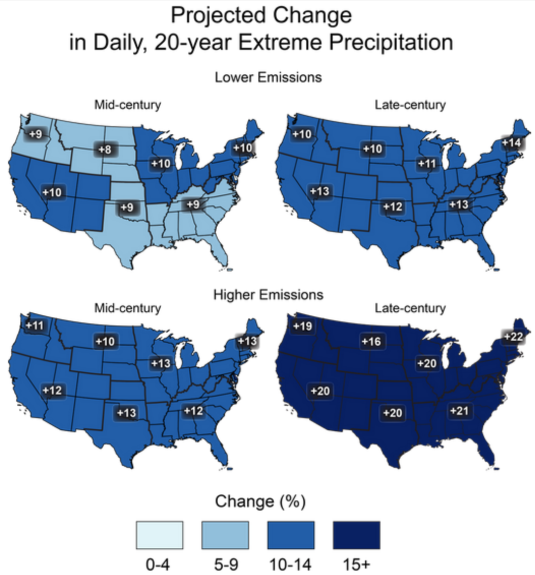


Figure A-24. Summary Matrix of Observed and Projected Climate Trends and Literary Consensus, (Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions Texas Gulf Region 12, 2015)

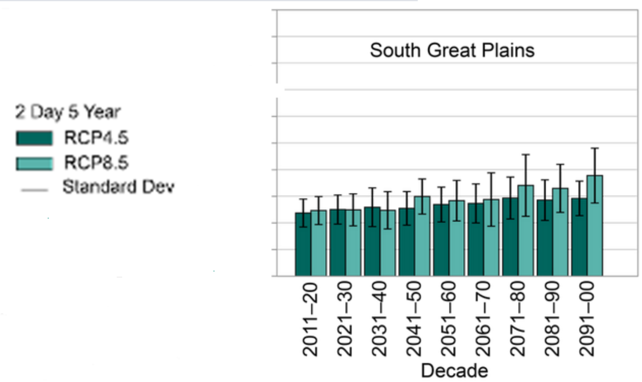
5.1.4 Precipitation. Climate studies project that the observed increase in heavy precipitation events will continue in the future and increases are expected in all regions, even those regions where total annual precipitation is projected to decline, such as the southwestern United States. The projections indicate a slight increase in the numbers of dry days and the very lightest precipitation days and a large increase in the heaviest days. Figure A-25 shows projections of changes in the 20-year return period amount for daily precipitation - large percentage increases for both the middle and late 21st century. A lower scenario show increases of around 10% for mid-century and up to 14% for the late century projections. A higher scenario shows even larger increases for both mid- and late-century projections, with increases of around 20% by late 21st century.

Drought conditions in Texas have been an on-going concern. Several Texas state agencies monitor drought conditions and develop drought contingency plans and guidance to local communities. The San Antonio Water System proactively manages the region's water resources by using rules and restrictions established by city ordinance. The rules and restrictions limit water use based on specific levels of the Edwards Aquifer.

Future projected precipitation information from the Fourth National Climate Assessment for the Southern Great Plains region is shown in Figures A-26 and A-27. Figure A-26 shows that the study area will be subject to a general decrease in projected seasonal precipitation. Figure A-27 shows that parts of Texas are projected to experience more frequent hot days.



Projected change in the 20-year return period amount for daily precipitation for mid- (left maps) and late-21st century (right maps). Results are shown for a lower scenario (top maps; RCP4.5) and for a higher scenario (bottom maps, RCP8.5). These results are calculated from the LOCA downscaled data. (Figure source: CICS-NC and NOAA NCEI).



Regional extreme precipitation event frequency for a lower scenario (RCP4.5) (green; 16 CMIP5 models) and the higher scenario (RCP8.5) (blue; 14 CMIP5 models) for a 2-day duration and 5-year return. Calculated for 2006–2100 but decadal anomalies begin in 2011. Error bars are ±1 standard deviation; standard deviation is calculated from the 14 or 16 model values that represent the aggregated average over the regions, over the decades, and over the ensemble members of each model. The average frequency for the historical reference period is 0.2 by definition and the values in this graph should be interpreted with respect to a comparison with this historical average value. (Figure source: Janssen et al. 2014[84]).

Figure A-25. Future Projected Precipitation Information for the Southern Great Plains Region (USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I)

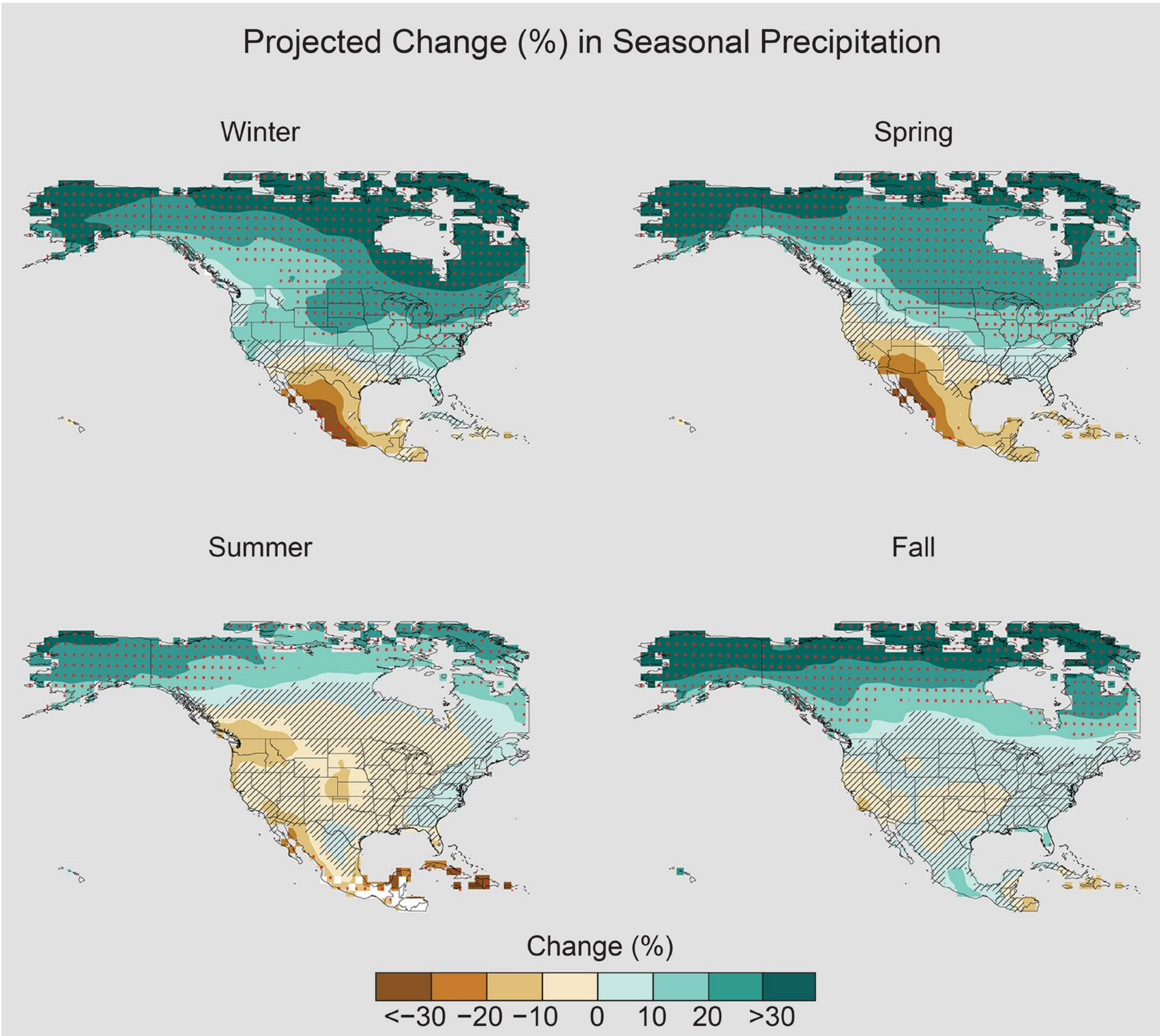


Figure A-26. Projected Change (%) in Seasonal Precipitation (USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I). Projected change (%) in total seasonal precipitation from CMIP5 simulations for 2070–2099. The values are weighted multi-model means and expressed as the percent change relative to the 1976–2005 average.

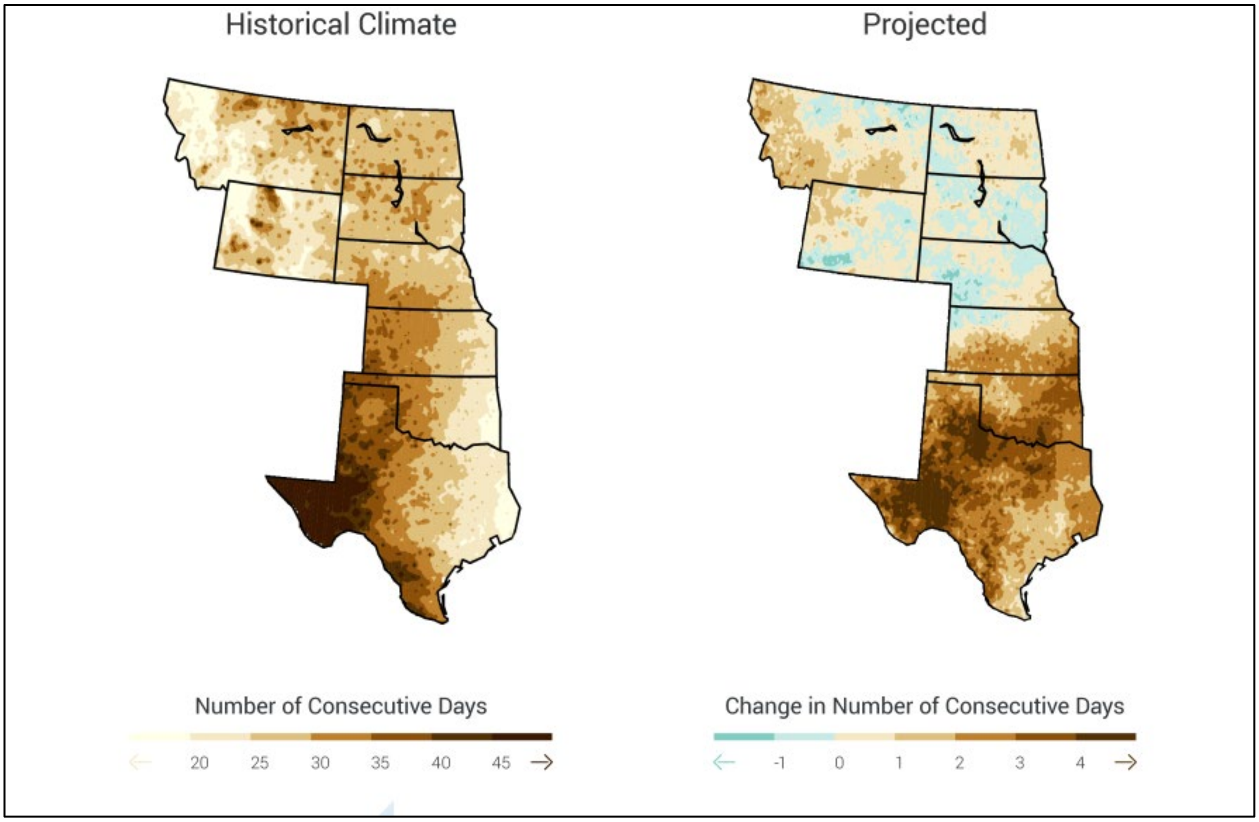


Figure A-27. Projected Change in Number of Hot Days (USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I)

Precipitation summary. The proposed project area will be impacted by the future precipitation trend. Annual precipitation will decrease, which will affect the surface area and volume of the existing and proposed water dependent features. The trend towards more frequent and longer duration droughts will also affect the functionality of the proposed system. More frequent, intense precipitation events would help to recharge the system affected by droughts. However the long term operational features of the proposed project should not be adversely impacted as the project area can be supplemented by water supplied by the Leon Creek Wastewater Recycling Center (see paragraph 5.2), which would offset the annual downward trend in decreased annual precipitation.

5.1.5 USACE Climate Hydrology Assessment Tool (CHAT). The CHAT was used to provide information on historic trends in observed data. This tool aids in preparing a qualitative analysis regarding climate change impacts for projects with hydrologic based aspects. The tool utilizes selected gage data located within the project area. For this qualitative assessment, the USGS 08181500 Medina River at San Antonio, Texas gage was used in the analysis, based on the proximity to the project area. A plot of the observed annual peak stream flow at the gage is shown in Figure A-28. There is not a statistically significant trend for this region as the p value is approximately 0.66. This p value is significantly greater than the typically adopted threshold of significance of less than 0.05.

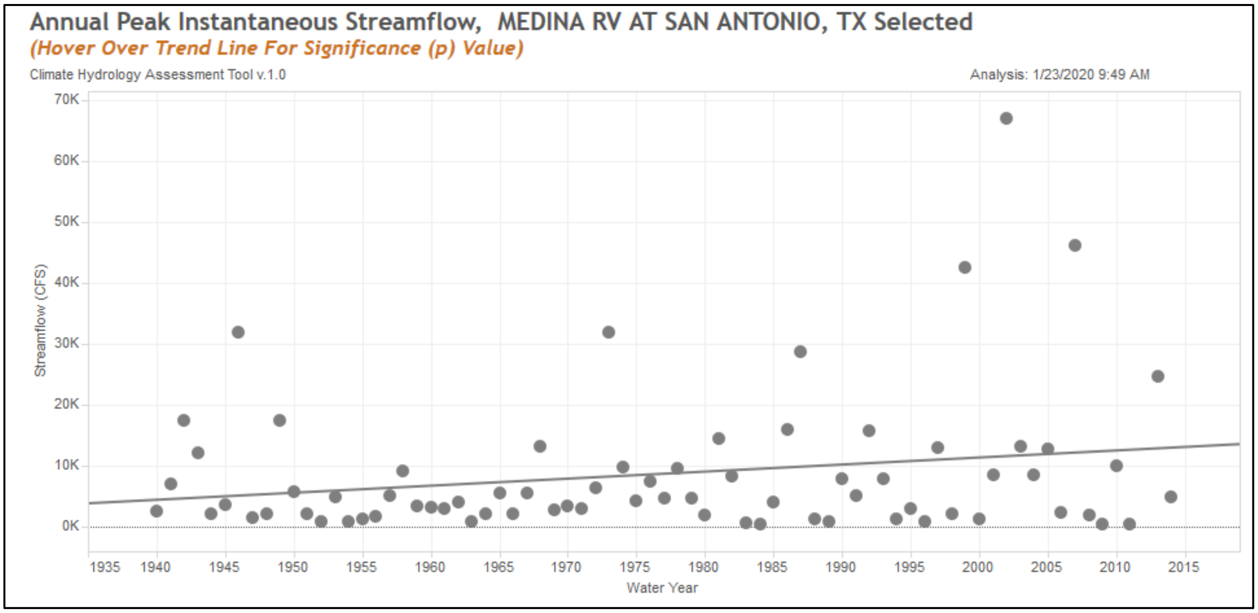


Figure A-28. Annual Peak Instantaneous Streamflow Medina River at San Antonio, Texas Gage

The USACE Climate Hydrology Assessment Tool was also used to investigate potential future trends in stream flow for the Medina River watershed. Figure A-29 displays the range of projected annual maximum monthly stream flow computed from 93 different climate changed hydrologic model runs for the period of 2005-2099.

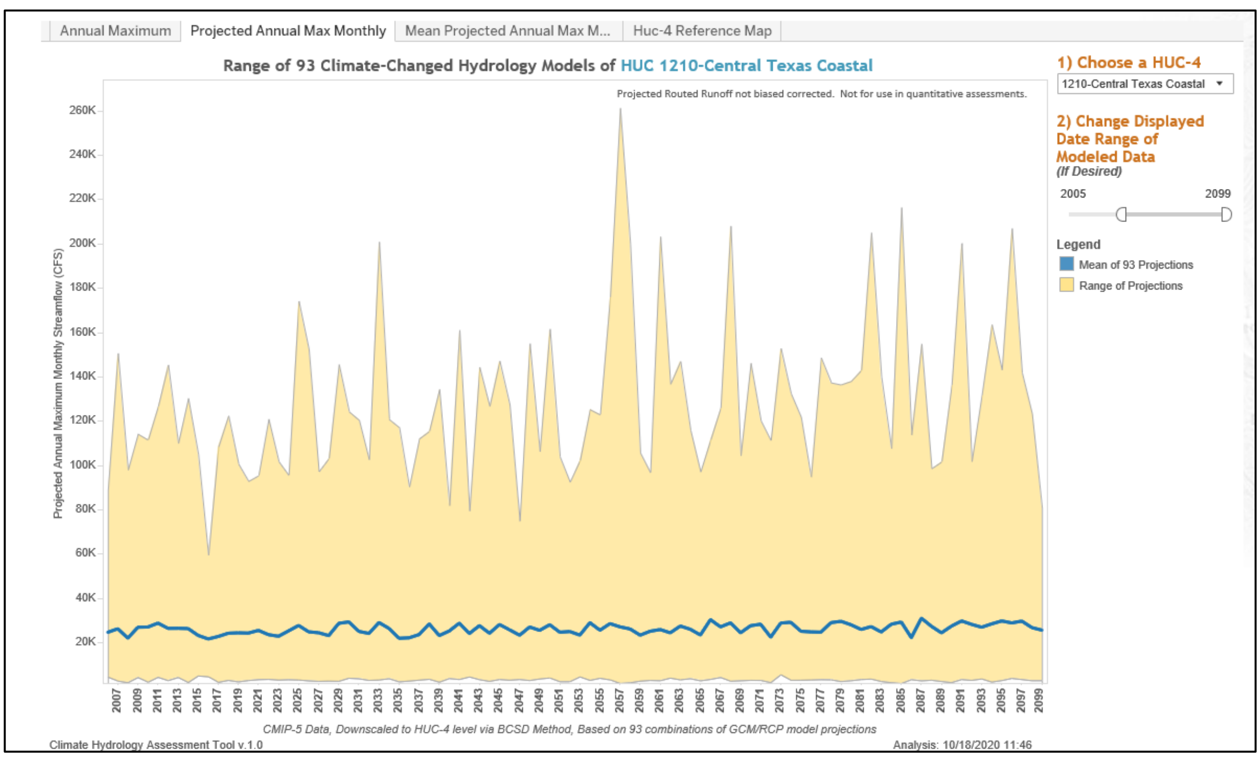


Figure A-29. Range of Projected Annual Maximum Monthly Streamflow

Figure A-30 shows the mean projected annual maximum flows. The p value is 0.000104, which indicates a significant trend in the future projection.

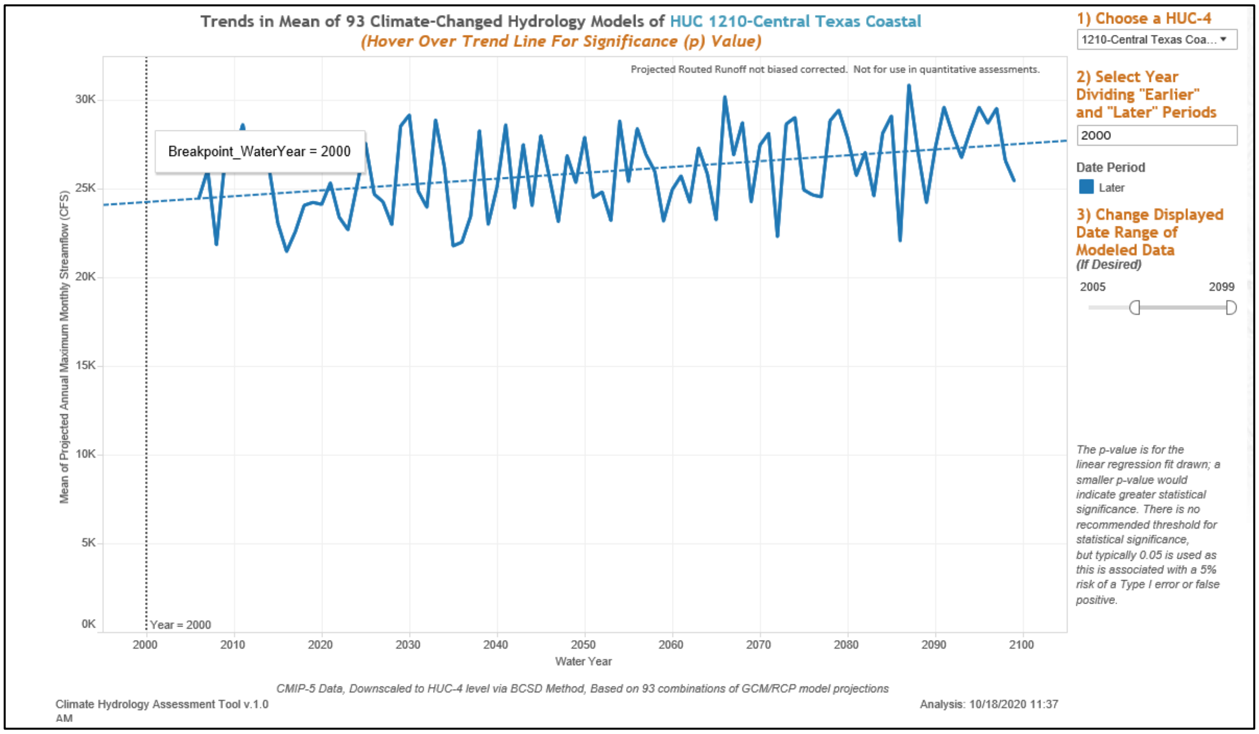


Figure A-30. Mean Projected Annual Maximum Flows

The USACE Nonstationarity Detection Tool was developed in conjunction with USACE Engineering Technical Letter (ETL) 1100-2-3, Guidance for Detection of Nonstationarities in Annual Maximum Discharges, to detect nonstationarities in maximum annual flow time series. This tool was also used to assess abrupt or slowly varying changes in observed peak flow data collected by the USGS gage located along the Medina River for the period of record spanning 1946 – 2015. Figure A-31 shows the nonstationarities detected using maximum annual flow/height analysis for the USGS 08181500 Medina River at San Antonio, Texas gage.

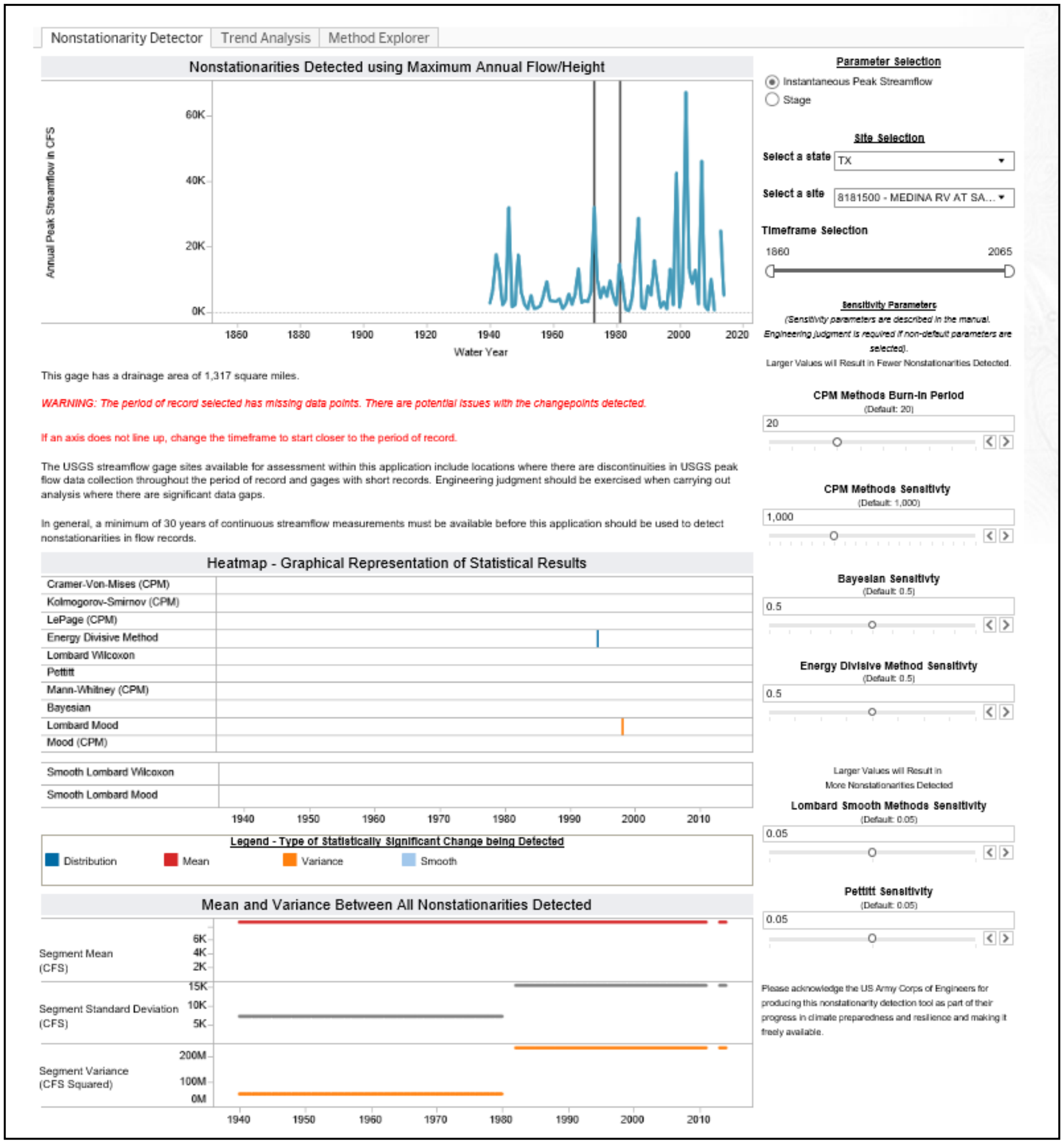


Figure A-31. Nonstationarities Detected Using Maximum Annual Flow/height at the USGS gage 08181500 Medina River at San Antonio, Texas Gage

5.2 Vulnerability Assessment to Climate Change Impacts

<u>5.2.1 Analysis</u>. The USACE Watershed Climate Vulnerability Assessment Tool was used to compare the relative vulnerability of the HUC 121003, Texas Gulf Region, to climate change to the other watersheds across the continental United States. The tool facilitates a screening level, comparative assessment of how vulnerable a given watershed is to the impacts of climate change. The Climate Vulnerability Assessment Tool is used to assess the vulnerability of the Texas Gulf Region for the USACE Ecosystem Restoration business line to projected climate change impacts relative to the effects that climate change might have on the USACE ecosystem restoration business line in the other watersheds in the continental United States. The tool uses the Weighted Order Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a

given business line. The USACE Climate Vulnerability Assessment Tool makes an assessment for two 30-year epochs of time centered at 2050 and 2085. These two periods were selected to be consistent with many of the other national and international analyses. The tool assesses how vulnerable a given watershed is to the impacts of climate change for a given business line. The top 50% of the traces is called the “wet” subset of traces and the bottom 50% of the traces is called the “dry” subset of traces. There is a combination of four epoch subset combinations, which provide for an indication of the variability/uncertainty in the outputs. Results of the analysis are shown in Figures A-32 to A-37. Figure A-32 shows that relative to the other HUC-4 watersheds in SWD, the watershed is relatively more vulnerable to the impacts of climate change on ecosystem restoration the Central Texas Coastal area in both the wet and dry scenarios.

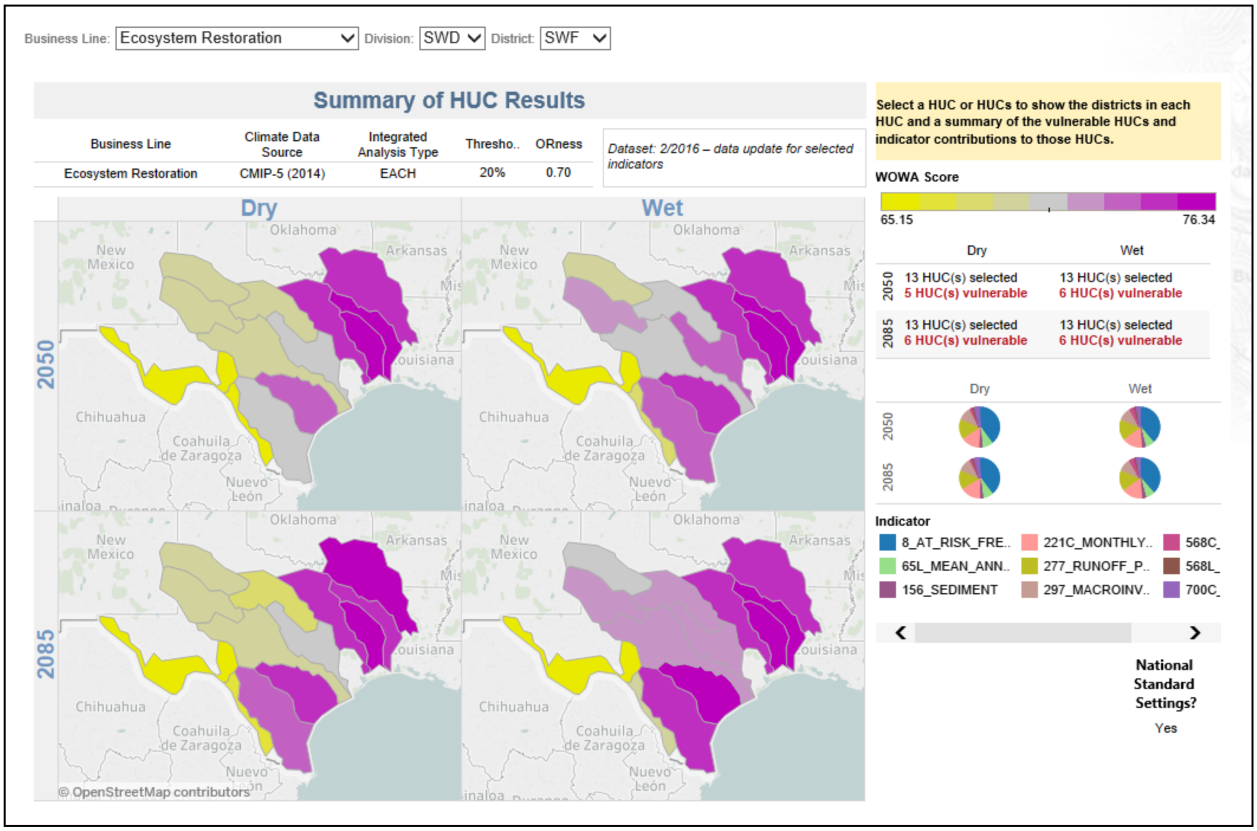


Figure A-32. Vulnerability Assessment Results

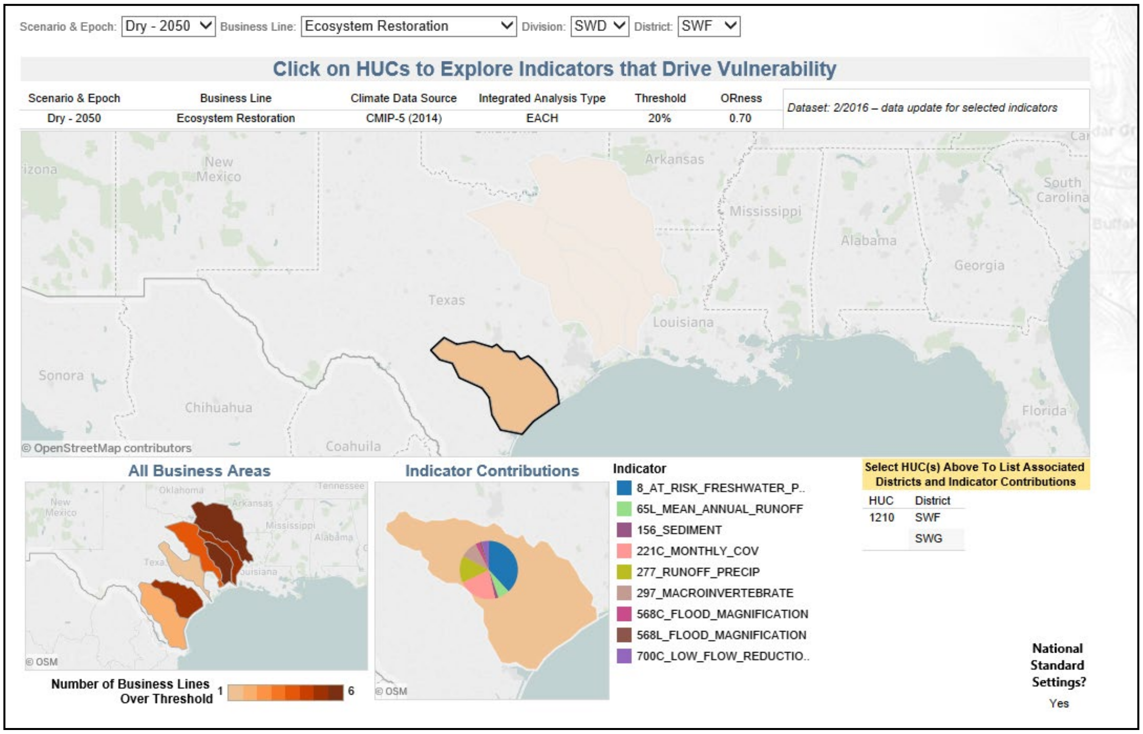


Figure A-33. Vulnerability Assessment Results

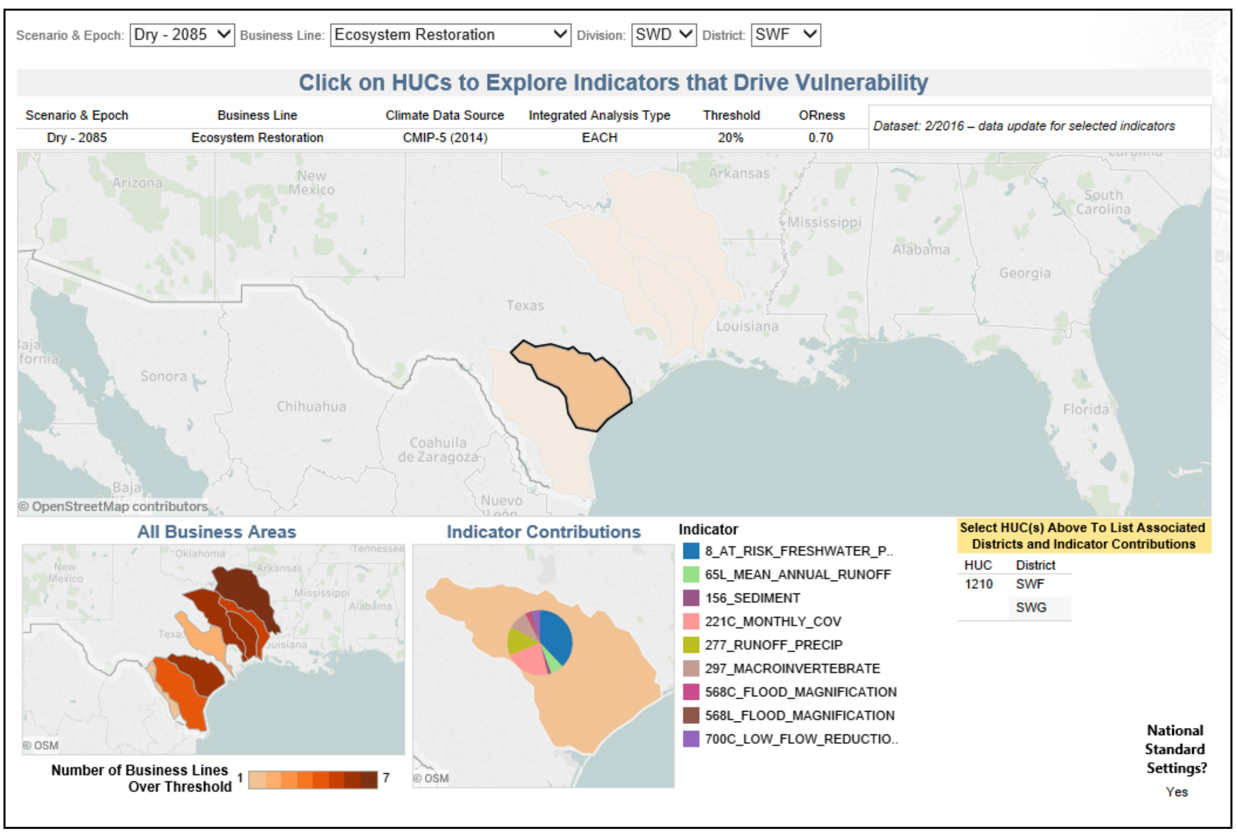


Figure A-34. Vulnerability Assessment Results

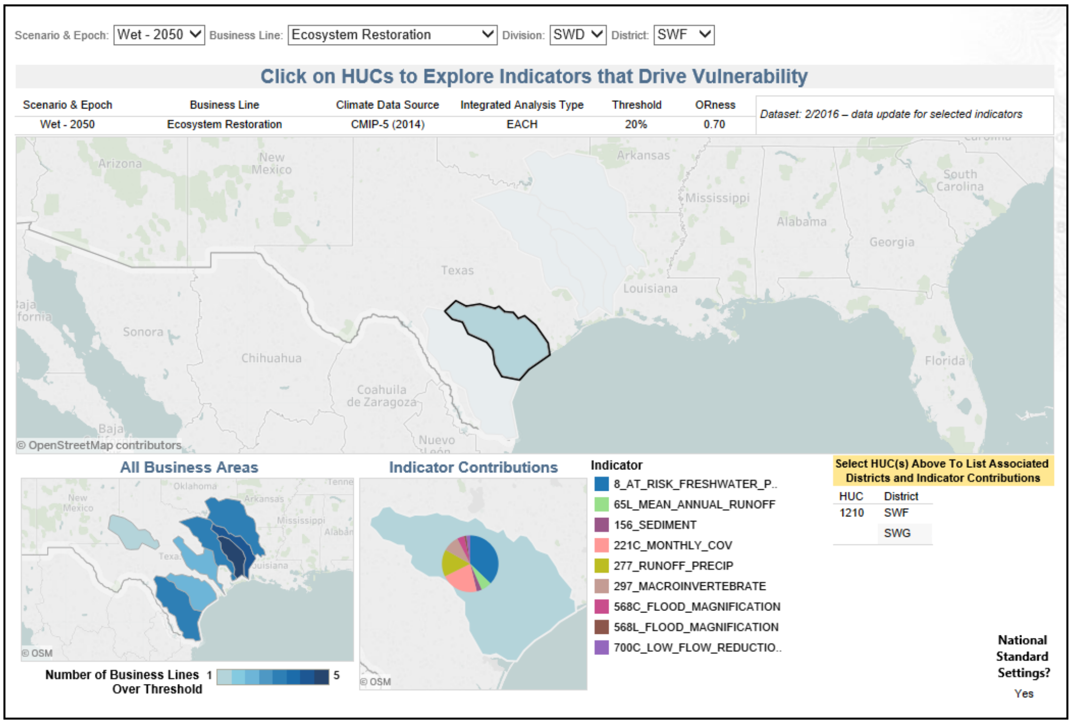


Figure A-35. Vulnerability Assessment Results

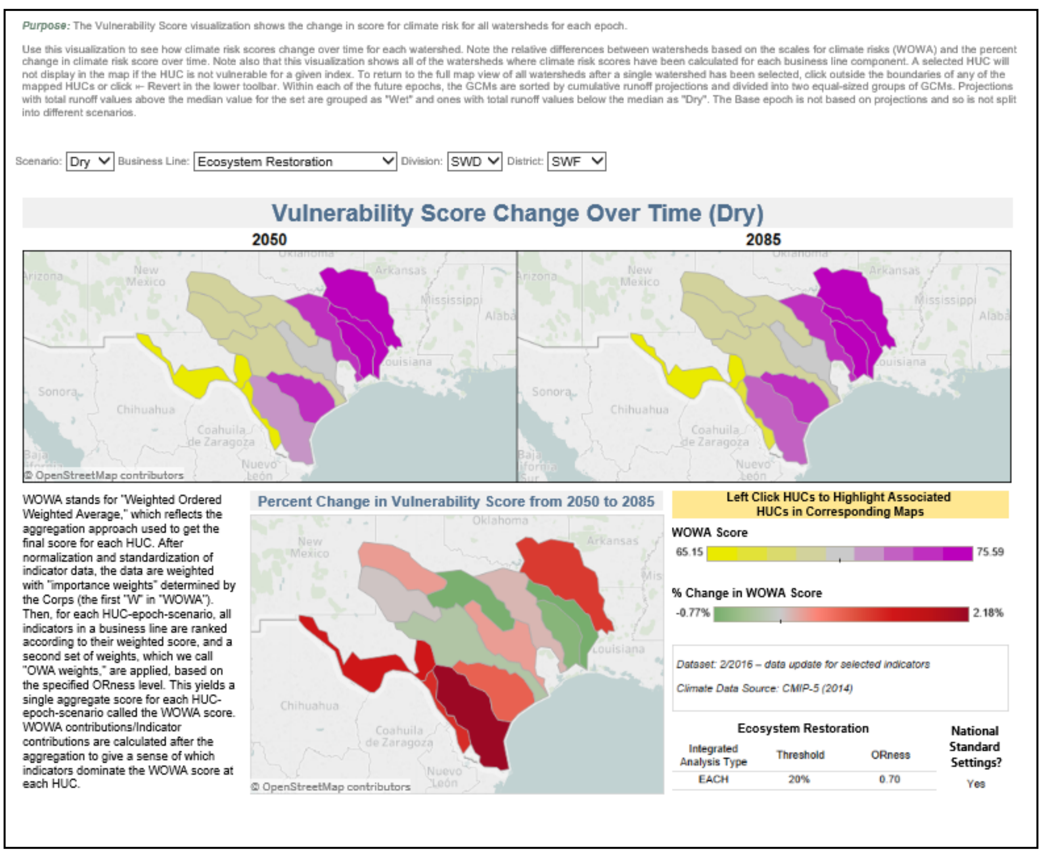


Figure A-36. Vulnerability Assessment Results

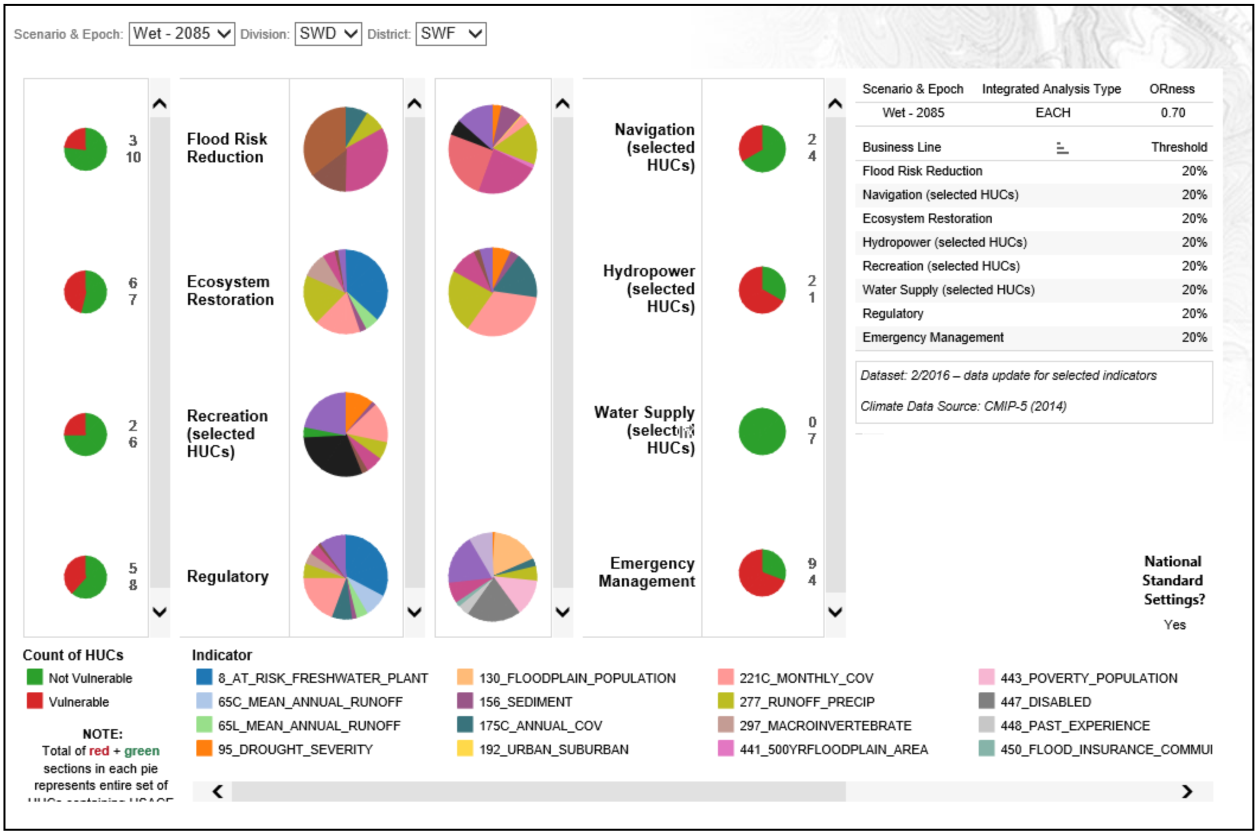


Figure A-37. Vulnerability Assessment Results

Table A-9 is a summary table of the contributing variables to the vulnerability of the study watershed for the Ecosystem Restoration business line. The values show that the dominant indicator is 8_At_Risk_Freshwater_Plants, an essential element of this project. The values tend to substantiate the trends in precipitation and temperature discussed earlier in this appendix, i.e. increases in temperature, more frequents periods of drought with more periods of intense precipitation.

Table A-9. Summary of Vulnerability Factors

Indicator	Scenario and Epoch			
	Dry 2050	Dry 2085	Wet 2050	Wet 2085
8_At_Risk_Freshwater_Plants	28.01	28.01	27.79	27.72
65L_Mean_Annual_Runoff	4.76	4.79	4.60	3.51
156_Sediment	1.34	1.30	2.14	2.20
221C_Monthly_Cov	15.71	16.62	16.01	16.71
277_Runoff_Precip	10.99	10.56	11.56	11.68
297_Macroinvertabrate	7.00	7.00	6.94	6.93
568C_Flood Magnification	1.82	1.79	3.07	4.78
568L_Flood_Magnification	0.72	0.71	0.93	1.12
700C_Low_Flow_Reduction	2.99	3.08	1.62	1.69

The results of the USACE Watershed Climate Vulnerability Assessment Tool are presented in Table A-10. The tool uses the Weighted Order Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a given business line. WOWA stands for "Weighted Ordered Weighted Average," which reflects the aggregation approach used to get the final score for each HUC. Results show that the Central Texas Coastal Watershed is vulnerable to the impacts of climate change on Ecosystem Restoration.

Table A-10. Projected Vulnerability with Respect to Ecosystem Restoration

HUC-4 Watershed	Projected Vulnerability with Respect to Ecosystem Restoration			
	Ecosystem Reduction Vulnerability Score			
Central Texas Coastal 121003	2050 Dry	2050 Wet	2085 Dry	2085 Wet
	73.34	74.66	73.87	76.34

5.3 Climate Change Impacts to the Project

5.3.1 General. One of the main purposes of the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study is to provide quality aquatic/wetland habitat within the study area. There are several key components to providing quality habitat for migratory neo-tropical birds and waterfowl: water access and appropriate native species plantings.

The climate change analysis for this project identified that average temperatures are trending upward along with the occurrence of high intensity rainfall events. Increased rainfall intensity may increase the frequency of releases out of Mitchell Lake. The releases would flow out of the lake through the uncontrolled spillway. Outflows from Mitchell Lake during wet seasons may help remove undesirable (woody) vegetation from encroaching upon the project areas. The Leon Creek Wastewater Recycling Center (WRC) is necessary to ensure appropriate hydrologic conditions within all of the project areas during high temperature months, offsetting the likely increased evaporation rates dues to the increased temperatures. Mitchell Lake will be supplemented with water from the WRC to maintain the lake elevation at approximately 518.5' above mean sea level in the Future Without Project condition, thereby keeping Mitchell Lake wet and fully functional.

Without construction of the TSP, conditions in the northern chain of wetlands (Bird Pond Wetlands, Central Wetlands, and Skip's Pond) would not be supplemented by water from Mitchell Lake and would have the possibility of drying more quickly as a result of the increasing temperatures. The existing northern wetlands provide some habitat for migrating neo-tropical birds and other wetlands species. The project will provide some resiliency to the ecosystem that will allow it to thrive even with the impacts of the project climate changes.

The operations of Mitchell Lake will not be modified as a result of this ecosystem restoration project. Releases from the WRC are not anticipated to decrease as household effluent water requirements will continue to be necessary to provide adequate services to homes within the San Antonio area. SAWS combined WRCs can provide up to 29 million gallons of highly treated effluent per day, approximately 35,000 acre-feet per year. This water is utilized for golf courses, parks, commercial and industrial customers, and as a supplement in the upper San Antonio River and Salado Creek.

The treated effluent from the Leon Creek WRC will provide additional water for the northern chain of wetlands, the polders, and the coves through dry periods. This water will be supplied to the project areas through a permanent pump and pipeline running from Mitchell Lake to the northernmost section of the Bird Pond Wetlands. Water will then naturally drain from the Bird Pond Wetlands, through the Central Wetlands and Skip's Pond back into Mitchell Lake.

The polders are currently managed as open water habitat for waterfowl and water birds by the Mitchell Lake Audubon Center and SAWS. The goal of the TSP is to drain the polders to provide adequate shorebird (mudflat) habitat March-May and August-October. Otherwise, the polders are already supplemented with water from Mitchell Lake and would minimally be affected by the future trends in climate.

Summary. The Vulnerability Assessment shows increases in temperature and more frequents periods of drought with more periods of intense precipitation. The climate risks and potential harm to the study area associated with the increased temperatures (water may no longer inundate restoration features during all or part of year, resulting in loss of habitat and reducing project benefits, increased surface water evaporation) will be mitigated by water supplemented from the Leon Creek WRC, Mitchell Lake, and natural rainfall events. Intense precipitation events would not degrade the intent of the project – the operational features should be able to withstand these intense events. Table A-11 identifies the climate risks of the TSP.

Table A-11. Climate Risks

Feature or Measure	Trigger	Hazard	Harm	Qualitative Likelihood
Wetland restoration features	More frequent periods of drought and periods of intense precipitation	Lower water availability Periods of large flood volumes	Water may not inundate some, or all, of the wetland features part of the year Higher flows may be passed downstream more frequently	Likely

5.3.2 Leon Creek WRC. Information regarding the Leon Creek WRC, as supplied by SAWS, is as follows:

> "The following charts show annual, monthly, and daily volumes to Mitchell Lake. Demand is highly variable, but peak annual demand has been about 3,200 acre-feet in very dry years. When discharges are occurring, they tend to be 5-10 mgd but can sometimes be higher. Historically, the volume allocated for Mitchell Lake has been 3,583 acre-feet/year. This was the volume that modeling in the 1990s suggested would be needed to maintain lake levels in a very dry year. In practice that number turned out to be about right. But in the future we will be maintaining a lower normal operating elevation of 518.5. Our recent modeling suggested the annual demand in that case would be 1,968 af for a flow to our constructed wetlands of 2 mgd and 2,682 acre-feet for a flow of 7 mgd. So that is the range of demand we expect in the future."

Note that Mitchell Lake has been lowered to elevation 518.5 in the summer of 2020.

Figures A-38 to A-40 represent inflows to Mitchell Lake developed by SAWS.

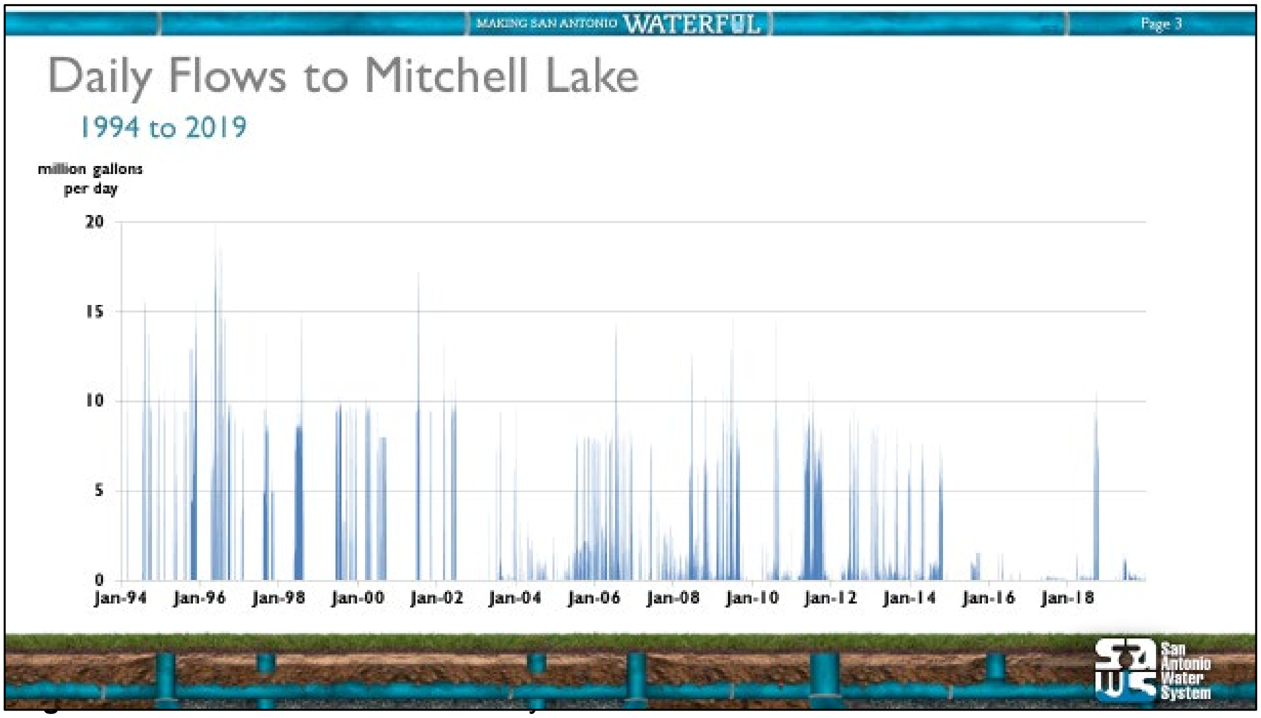


Figure A-38. Leon Creek WRC Daily Flows to Mitchell Lake

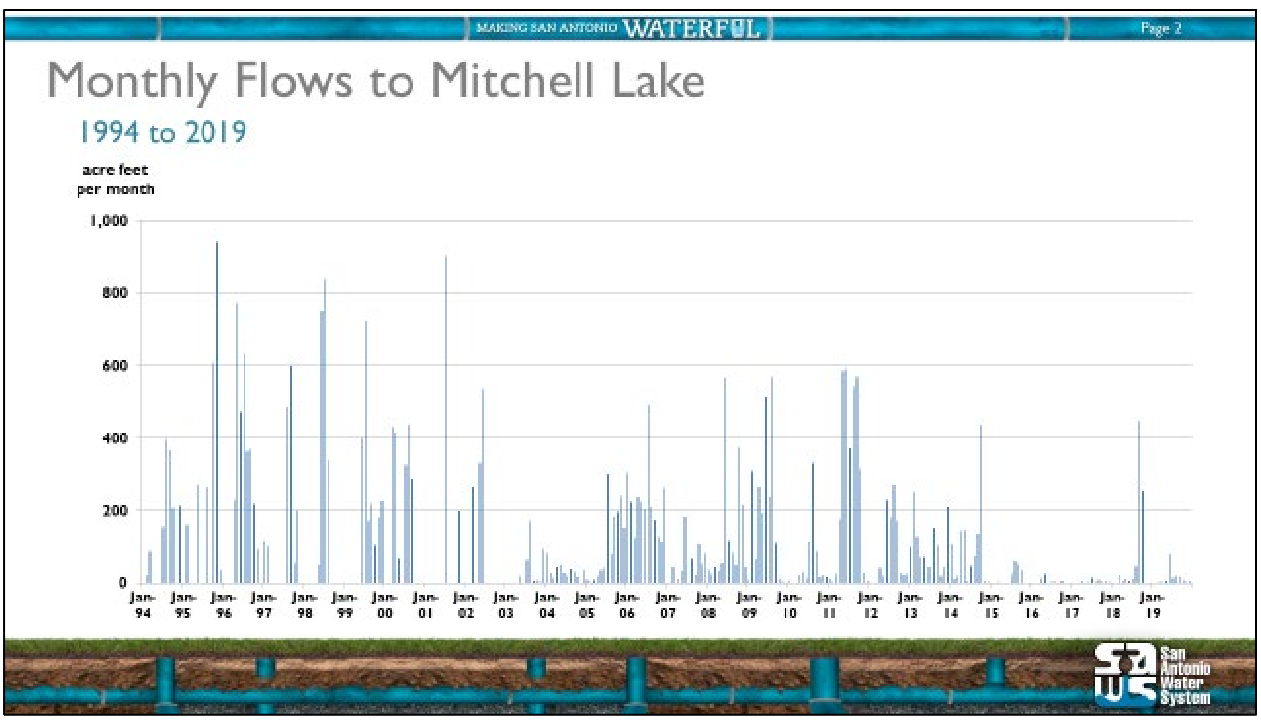


Figure A-40. Leon Creek WRC Annual Flows to Mitchell Lake

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