Appendix A – Hydrology and Hydraulics

Mitchell Lake

San Antonio, Texas

General Investigations Feasibility Study

Integrated Draft Feasibility Report and Environmental Impact Assessment

September 2019

US Army Corps of Engineers®

Fort Worth District

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EXECUTIVE SUMMARY

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1 Background

A technical hydrology and hydraulics analysis was not performed by the Fort Worth District Water Resources Branch. The majority of the technical data in this Appendix was developed by private engineering firms (footnotes and references are included). This information was extracted to develop a representative summary of the project area site existing conditions. Other technical data was developed from Water Resource Branch files and a variety of other sources.

1.1 Watershed

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.

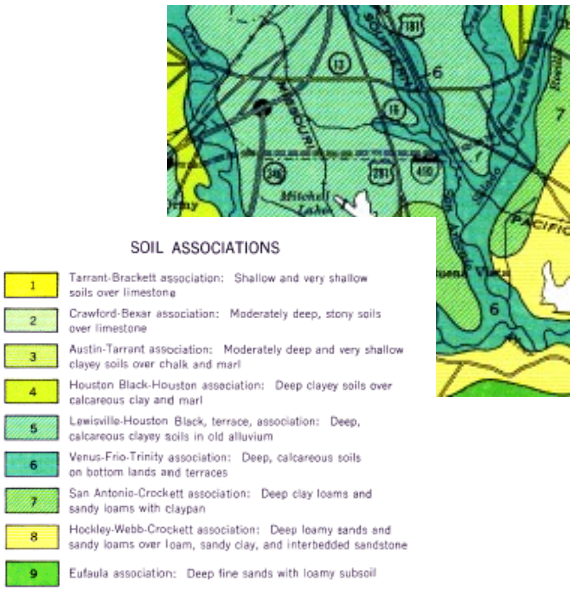


Figure A-1. General Soil Classification of the Mitchell Lake Area

1.2 Climate

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, however, summers are usually long and hot with daily maximum temperatures above 90 over 80 percent of the time. In many years, summer conditions continue into September and sometimes to October. The average monthly temperatures range from the 50s in winter to 80s in summer. The historic recorded high and low temperatures occurred 6 September 2000 (111º F) and 21 January 1949 (0º F).

1.3 Precipitation

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. The 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	M	M	M	M	M	M	M

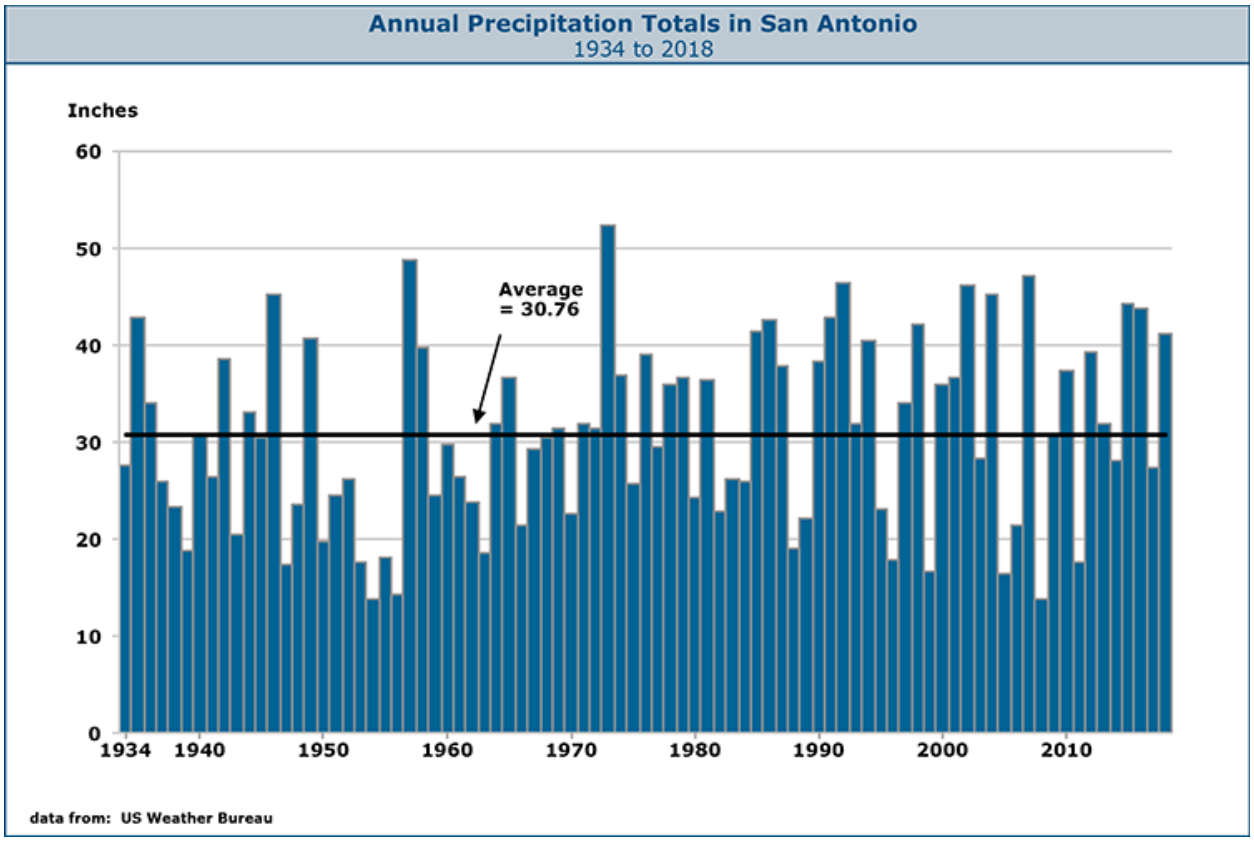


Figure A-2. Yearly Precipitation Totals 1934 - 2018

1.4 Mitchell Dam and Lake

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.

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

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. The upstream slope is 2 feet horizontal to 1 feet 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 gates are rusted open and inoperable. 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 - it enters the lake within the polder complex and is used to maintain lake levels during dry periods. Pertinent data for Mitchell Dam and Lake is shown in Table A-3.

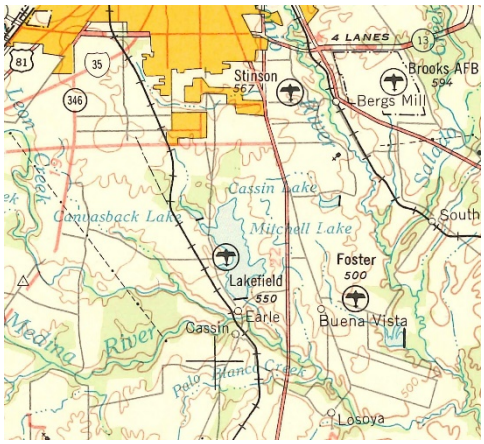
[1] Mitchell Lake Wetland Feasibility Study, Simpson Group, November 1997

Table A-3. Mitchell Dam and Lake Pertinent Data[2]

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

1.4.1 Mitchell Dam and Lake Photographs and Maps

Photographs and maps of Mitchell Dam and Lake follows.



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

Figure A-3. USGS 1954 Topographic Map

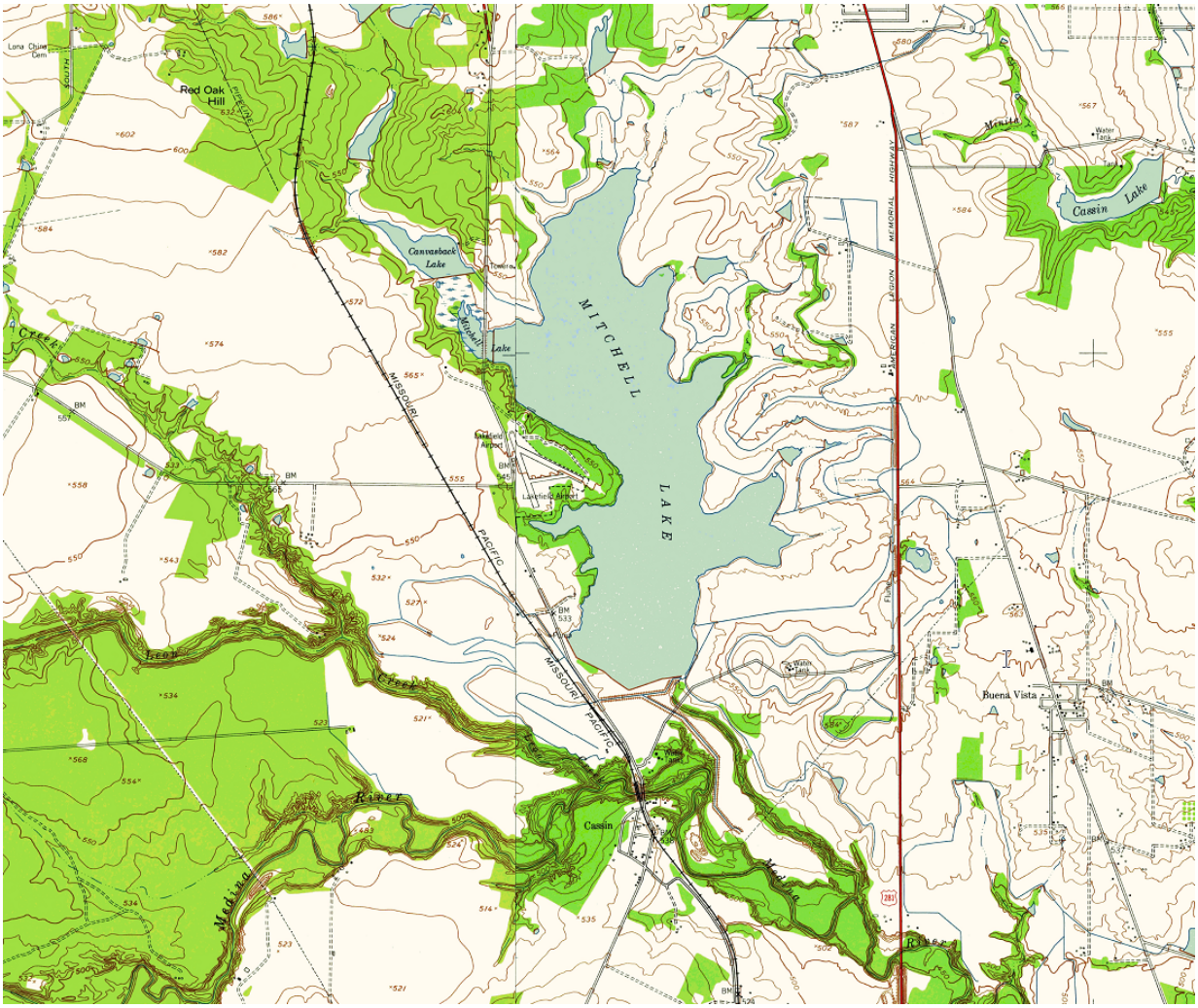


Figure A-4. 1953 USGS Topographic Map

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

Figure A-5. 1967 A

Figure A-7. Mitchell Lake Dam Gated Spillway

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

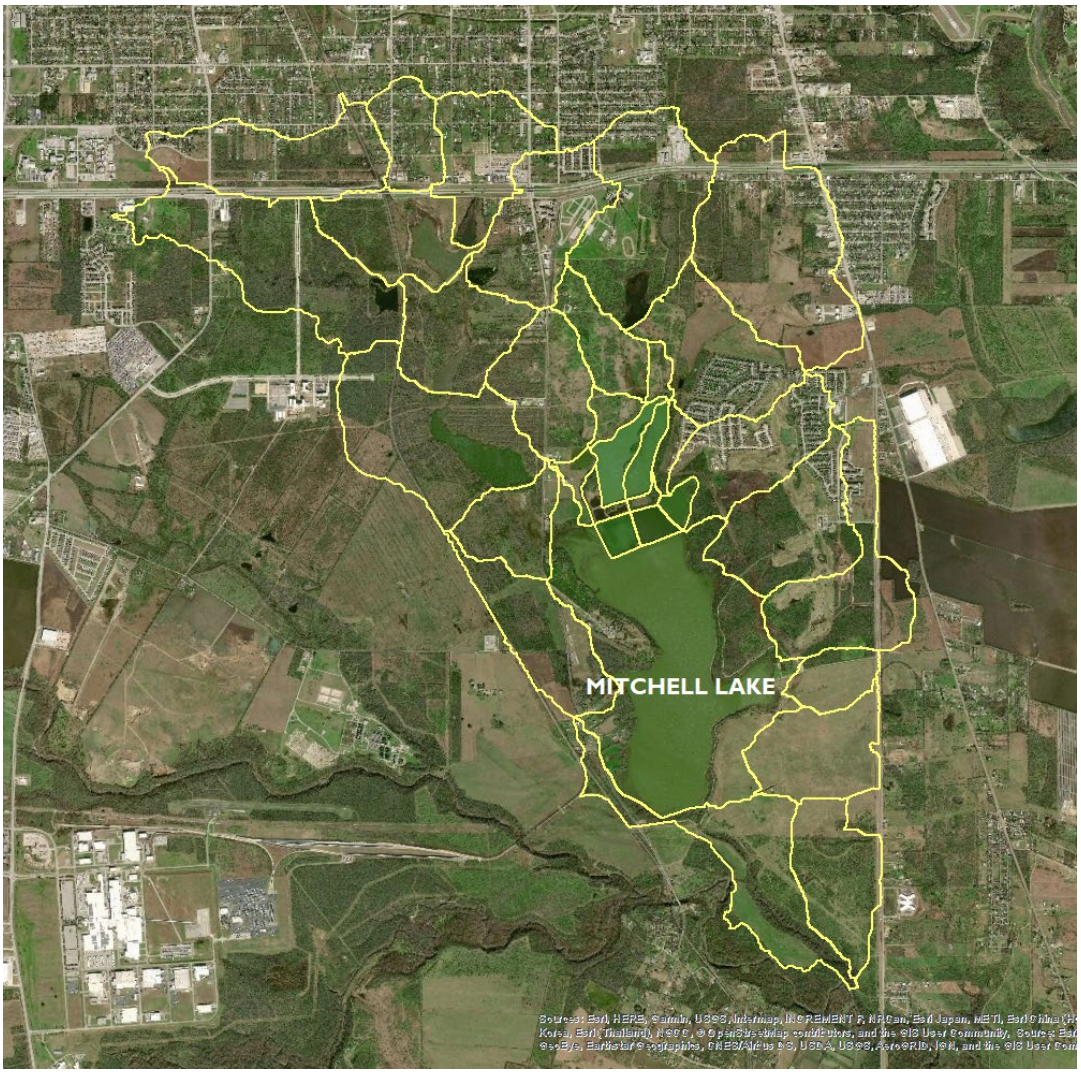
2 Existing Conditions

2.1 Hydrology and Land Use

ARCADIS developed an existing conditions hydrologic model of the Mitchell Lake watershed. The following 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-9 shows the watershed sub-basins as defined in the HEC-HMS model.



The Mitchell Lake drainage area consist of different types of land use. Figure A-10 shows the City of San Antonio zoning classifications within the Mitchell Lake watershed area. Table A-4 lists the zoning classifications and respective land areas.

Figure A-9. Mitchell Lake Sub-Basin Areas Used in the HEC-HMS Model

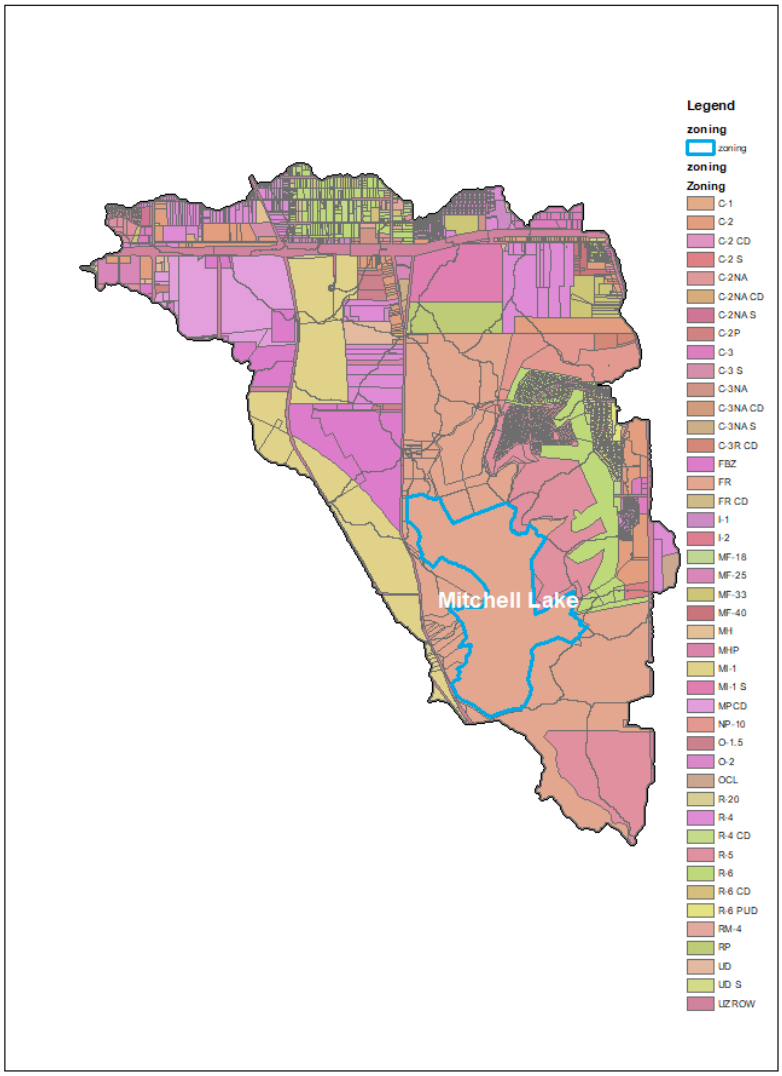


Table A-4. Mitchell Lake Watershed Zoning

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

Figure A-10. Mitchell Lake Watershed Zoning Classifications

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

Table A-5 shows the peak water surface elevations in Mitchell Lake and peak inflows to the lake based on model results.[3]

[3] Hydrologic and Hydraulic Analysis Mitchell Lake Dam, Cotton Mouth Creek, Bexar County, ARCADIS, 30 December 2014

Table A-5. Mitchell Lake Peak Inflows and Water Surface Elevations

Storm Event	Peak Inflow (cfs)	Peak Water Surface Elevation (feet)
2-year	1,798	522.2
5-year	2,697	522.6
10-year	3,643	523.1
25-year	5,181	524.0
50-year	6,775	525.0
100-year	7,863	525.6
500-year	12,703	527.4

The current FEMA map shows the Mitchell Lake area designated as Zone A. Zone A is defined as areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Figure 4-10 shows the current FEMA map for the Mitchell Lake area and the downstream reach of Cottonmouth Creek and the Medina River.

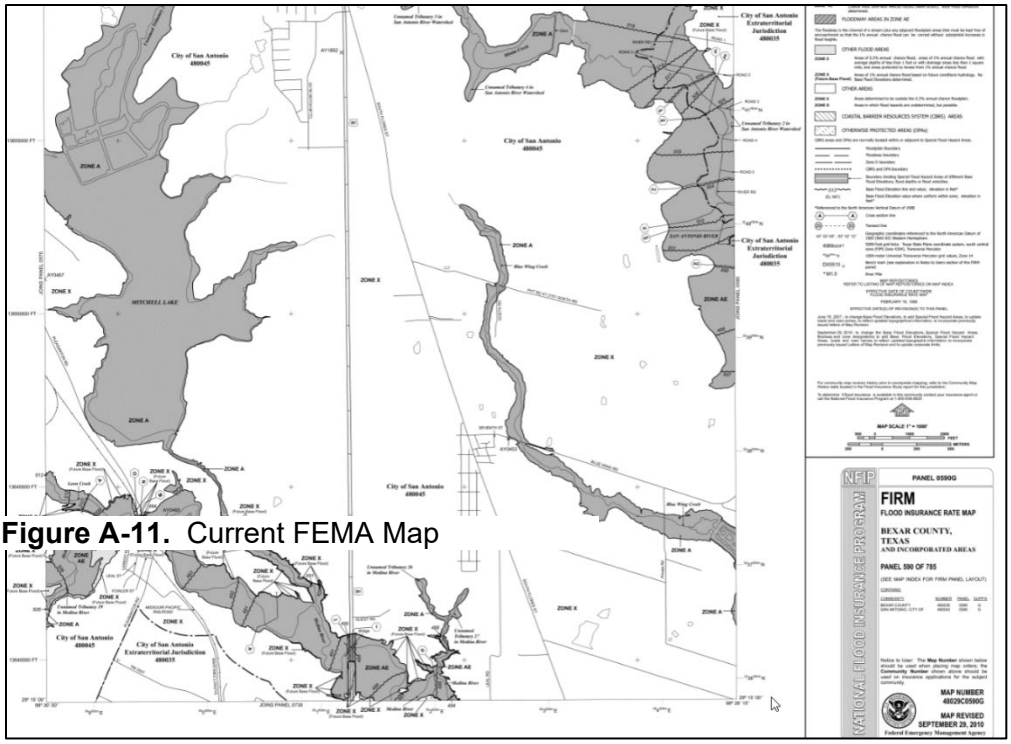


Figure A-11. Current FEMA Map

Future Without Project Conditions

Future Without Project Conditions is based on the premise that the Mitchell Lake and watershed area would be allowed to develop without a constructed environmental restoration project. 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 future hydrologic conditions would likely remain constant, that is, the magnitude of the frequency flood event discharges would not increase in any significant way. 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 gives 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 would prevent increased downstream impacts and the possibility of overtopping of Mitchell Dam.

4 References

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

The Edwards Aquifer Website, by Greg Eckhardt, https://www.edwardsaquifer.net/index.html

Mitchell Lake Wildlife Refuge: An Illustrated History, 2012 Edition, Dwight Henderson and Ruth Lofgren

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