2021

GROUNDWATER DISCHARGE AND USAGE

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AUTHORITY

2021 GROUNDWATER DISCHARGE AND USAGE

Groundwater discharges from the Edwards Aquifer either as springflow or as pumping from wells. Comal and San Marcos springs, the largest and second-largest springs in Texas, respectively, are fed by the Edwards Aquifer. This springflow greatly benefits the recreational economies in New Braunfels and San Marcos, and both springs provide habitat for threatened and endangered species. Figure 1 shows locations of the major springs in the Edwards Aquifer region. Wells drilled into the Edwards Aquifer throughout the region provide water for many diverse uses, including irrigation, municipal water supplies, industrial applications, and domestic/livestock consumption.

Estimates of total annual groundwater discharge from combined springflow and pumping for the Edwards Aquifer are provided in Table 1 for the period of record (1934–2021). Annual total groundwater discharge estimates range from a low of 388,800 acre-feet in 1955 to a high of 1,130,000 acre-feet in 1992. In 2021, the total groundwater discharged from the Edwards Aquifer from both wells and springs is estimated at 667,100 acre-feet: 340,500 acre-feet as springflow and 326,600 acre-feet as pumping from wells.

The portion of discharge as springflow is estimated by measuring streamflow downstream of the springs and converting the streamflow measurements to spring discharge by subtracting any estimated contributions from surface runoff. Total annual spring discharge has varied from a low of 69,800 acre-feet in 1956 to a high of 802,800 acre-feet in 1992. Monthly springflow estimates for 2021 at each of the six major Edwards Aquifer springs are provided in Table 2.

In Figures 2 and 3, flows at Comal and San Marcos springs are shown as mean annual flows compared with the long-term historical mean annual flow rate for the available period of record. The 2021 mean annual flow rate was less than the historical mean discharge at both Comal Springs and San Marcos Springs.

Discharge as well pumping can be classified as either reported or unreported discharge. Reported discharge refers to water pumped from the aquifer by a person or entity holding a groundwater withdrawal permit. These users, who are typically larger quantity users, meter their withdrawals and report the totals to the EAA. Unreported discharge refers to use that does not require a groundwater withdrawal permit from the EAA, such as domestic, livestock, or federal facility use. Unreported discharge is estimated based on numbers of wells and statistical estimates of per-well usage. In 2021, unreported discharge for domestic and livestock wells was estimated at 14,539 acre-feet, and non-reporting federal facility discharge was estimated at 5,432 acre-feet, for a total of 19,971 acre-feet of unreported discharge. Reported discharge totaled 306,609 acre-feet. The total of all reported and unreported pumping discharge is 326,580 acre-feet.

Table 3 provides a summary of well and spring discharge for 2021 based on type of use and county. The distribution of discharge from springflows and the different types of pumping for 2021 is

shown graphically in Figure 4. Total annual discharge from pumping and springflow are compared in Figure 5 for the period of record from 1934–2021. The years when springflow exceeds pumping tend to be wet years when pumping demand is lowered by more frequent rainfall and higher aquifer levels produce increased springflows. Conversely, during dry years pumping tends to exceed springflow due to increased municipal and agricultural demand and lower aquifer levels. Since 1997, however, the increase in pumping demand during dry years has been limited by the withdrawal permit system and critical period pumping reductions implemented under the Edwards Aquifer Authority Act. Table 4 provides a historical list of total annual discharge by type of use for the period 1955–2021.

Figure 1. Major Springs in the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer

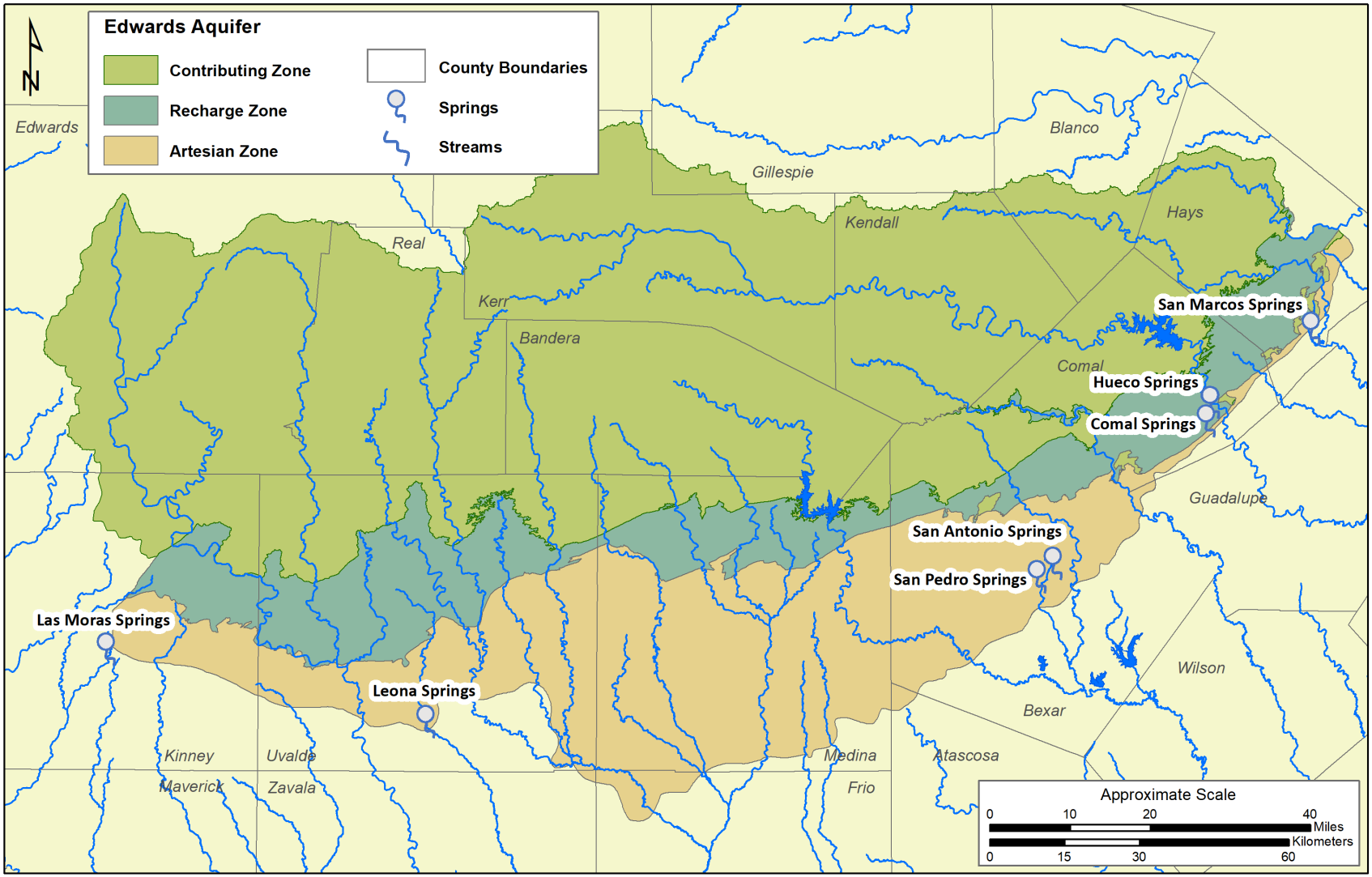

Table 1. Annual Estimated Groundwater Discharge Data by County for the Edwards Aquifer 1934–2020 (measured in thousands of acre-feet)

Year	Uvalde[a]	Medina	Bexar[b]	Comal[c]	Hays	Total	Total Wells	Total Springs
1934	12.6	1.3	109.3	229.1	85.6	437.9	101.9	336.0
1935	12.2	1.5	171.8	237.2	96.9	519.6	103.7	415.9
1936	26.6	1.5	215.2	261.7	93.2	598.2	112.7	485.5
1937	28.3	1.5	201.8	252.5	87.1	571.2	120.2	451.0
1938	25.2	1.6	187.6	250.0	93.4	557.8	120.1	437.7
1939	18.2	1.6	122.5	219.4	71.1	432.8	118.9	313.9
1940	16.1	1.6	116.7	203.8	78.4	416.6	120.1	296.5
1941	17.9	1.6	197.4	250.0	134.3	601.2	136.8	464.4
1942	22.5	1.7	203.2	255.1	112.2	594.7	144.6	450.1
1943	19.2	1.7	172.0	249.2	97.2	539.3	149.1	390.2
1944	11.6	1.7	166.3	252.5	135.3	567.4	147.3	420.1
1945	12.4	1.7	199.8	263.1	137.8	614.8	153.3	461.5
1946	6.2	1.7	180.1	261.9	134.0	583.9	155.0	428.9
1947	13.8	2.0	193.3	256.8	127.6	593.5	167.0	426.5
1948	9.2	1.9	159.2	203.0	77.3	450.6	168.7	281.9
1949	13.2	2.0	165.3	209.5	89.8	479.8	179.4	300.4
1950	17.8	2.2	177.3	191.1	78.3	466.7	193.8	272.9
1951	16.9	2.2	186.9	150.5	69.1	425.6	209.7	215.9
1952	22.7	3.1	187.1	133.2	78.8	424.9	215.4	209.5
1953	27.5	4.0	193.7	141.7	101.4	468.3	229.8	238.5
1954	26.6	6.3	208.9	101.0	81.5	424.3	246.2	178.1
1955	28.3	11.1	215.2	70.1	64.1	388.8	261.0	127.8
1956	59.6	17.7	229.6	33.6	50.4	390.9	321.1	69.8
1957	29.0	11.9	189.4	113.2	113.0	456.5	237.3	219.2
1958	23.7	6.6	199.5	231.8	155.9	617.5	219.3	398.2
1959	43.0	8.3	217.5	231.7	118.5	619.0	234.5	384.5
1960	53.7	7.6	215.4	235.2	143.5	655.4	227.1	428.3
1961	56.5	6.4	230.3	249.5	140.8	683.5	228.2	455.3
1962	64.6	8.1	220.0	197.5	98.8	589.0	267.9	321.1
1963	51.4	9.7	217.3	155.7	81.9	516.0	276.4	239.6
1964	49.3	8.6	201.0	141.8	73.3	474.0	260.2	213.8
1965	46.8	10.0	201.1	194.7	126.3	578.9	256.1	322.8
1966	48.5	10.4	198.0	198.9	115.4	571.2	255.9	315.3
1967	81.1	15.2	239.7	139.1	82.3	557.4	341.3	216.1
1968	58.0	9.9	207.1	238.2	146.8	660.0	251.7	408.3
1969	88.5	13.6	216.3	218.2	122.1	658.7	307.5	351.2
1970	100.9	16.5	230.6	229.2	149.9	727.1	329.4	397.7
1971	117.0	32.4	262.8	168.2	99.1	679.5	406.8	272.7
1972	112.6	28.8	247.7	234.3	123.7	747.1	371.3	375.8
1973	96.5	14.9	273.0	289.3	164.3	838.0	310.4	527.6
1974	133.3	28.6	272.1	286.1	141.1	861.2	377.4	483.8
1975	112.0	22.6	259.0	296.0	178.6	868.2	327.8	540.4
1976	136.4	19.4	253.2	279.7	164.7	853.4	349.5	503.9
1977	156.5	19.9	317.5	295.0	172.0	960.9	380.6	580.3
1978	154.3	38.7	269.5	245.7	99.1	807.3	431.8	375.5
1979	130.1	32.9	294.5	300.0	157.0	914.5	391.5	523.0
1980	151.0	39.9	300.3	220.3	107.9	819.4	491.1	328.3
1981	104.2	26.1	280.7	241.8	141.6	794.4	387.1	407.3
1982	129.2	33.4	305.1	213.2	105.5	786.4	453.1	333.3
1983	107.7	29.7	277.6	186.6	118.5	720.1	418.5	301.6
1984	156.9	46.9	309.7	108.9	85.7	708.1	529.8	178.3
1985	156.9	59.2	295.5	200.0	144.9	856.5	522.5	334.0
1986	91.7	41.9	294.0	229.3	160.4	817.3	429.3	388.0

(Table 1. continued)

Year	Uvalde[a]	Medina	Bexar[b]	Comal[c]	Hays	Total	Total Wells	Total Springs
1987	94.9	15.9	326.6	286.2	198.4	922.0	364.1	557.9
1988	156.7	82.2	317.4	236.5	116.9	909.7	540.0	369.7
1989	156.9	70.5	305.6	147.9	85.6	766.5	542.4	224.1
1990	118.1	69.7	276.8	171.3	94.1	730.0	489.4	240.6
1991	76.6	25.6	315.5	221.9	151.0	790.6	436.0	354.6
1992	76.5	9.3	370.5	412.4	261.3	1130.0	327.2	802.8
1993	107.5	17.8	371.0	349.5	151.0	996.7	407.3	589.4
1994	95.5	41.1	297.7	269.8	110.6	814.8	424.6	390.2
1995	90.8	35.2	272.1	235.0	127.8	761.0	399.6	361.3
1996	117.6	66.3	286.8	150.2	84.7	705.6	493.6	212.0
1997	77.0	31.4	260.2	243.3	149.2	761.1	377.1	383.9
1998	113.1	51.3	312.4	271.8	168.8	917.6	453.5	464.1
1999	104.0	49.2	307.1	295.5	143.0	898.8	442.7	456.1
2000	89.1	45.1	283.6	226.1	108.4	752.3	414.8	337.5
2001	68.6	33.9	291.6	327.7	175.4	890.0	367.7	529.6
2002	76.2	40.6	311.9	350.4	202.1	981.2	371.3	609.9
2003	89.4	34.8	331.7	344.7	176.3	976.9	362.1	621.5
2004	91.3	22.5	331.9	341.4	153.1	940.3	317.4	622.9
2005	107.4	37.3	366.1	349.3	175.6	1035.7	388.5	647.1
2006	107.5	64.9	289.5	216.7	87.9	766.5	454.5	312.0
2007	64.6	18.4	330.2	331.7	196.0	940.9	319.9	621.0
2008	102.0	48.8	320.4	266.6	108.0	845.7	428.6	417.1
2009	76.9	47.3	265.2	206.6	87.8	683.7	395.7	287.9
2010	53.1	36.4	298.5	312.1	162.5	862.6	372.6	490.0
2011	79.6	57.4	277.2	187.7	91.0	692.9	427.7	265.2
2012	57.6	44.3	267.5	193.4	124.2	687.0	384.7	302.3
2013	43.6	42.8	251.0	154.9	96.0	588.6	355.8	232.8
2014	41.5	43.1	230.5	114.5	97.9	527.5	332.2	195.4
2015	27.1	27.6	256.3	239.8	178.8	729.7	325.2	404.5
2016	46.9	31.9	262.6	320.7	208.3	870.3	325.3	545.0
2017	63.0	43.6	305.3	294.0	166.8	872.2	379.2	493.0
2018	69.9	42.0	277.1	244.0	130.4	763.6	370.6	393.0
2019	76.8	40.9	290.7	306.1	225.0	884.6	358.6	526.0
2020	79.1	50.5	236.6	235.2	114.7	716.2	362.4	353.7
2021	56.1	39.8	222.3	235.2	113.7	667.1	326.6	340.5
For period of record 1934–2021:								
Median	69.3	21.2	257.7	235.2	118.5	706.9	330.8	384.2
Mean	71.1	24.9	249.7	229.5	124.3	701.4	318.0	383.6
For last 10 years, 2012–2021:								
Median	56.8	42.4	259.5	237.5	127.3	722.9	357.2	373.4
Mean	56.2	40.6	260.0	219.6	136.5	730.7	352.1	378.6

Data source: USGS Letter Report to Edwards Aquifer Authority files, dated April 8, 2022.

a = As of 2008, no longer includes Kinney County discharge; prior years include 1,900 acre-feet of discharge for Kinney County.

b = Includes reports of Edwards Aquifer irrigators in Atascosa County.

c = Includes reports of Edwards Aquifer industrial and municipal users in Guadalupe County.

Differences in totals may occur due to rounding.

Table 2. Estimated Spring Discharge from the Edward Aquifer in 2021 (in acre-feet)

Month	Leona Springs and Leona River	San Pedro Springs	San Antonio Springs	Comal Springs	Hueco Springs	San Marcos Springs	Total Monthly Discharge
Jan	1,090	161	0	16,700	526	7,240	25,700
Feb	1,030	95.5	0	14,500	500	6,140	22,200
Mar	953	105	0	15,400	542	6,660	23,700
Apr	566	13.7	0	12,800	509	6,090	20,000
May	829	218	0	16,600	3,380	8,470	29,500
Jun	685	228	81	17,500	4,360	10,200	33,100
Jul	520	261	66	17,900	4,190	10,300	33,200
Aug	512	175	0	17,700	3,380	9,840	31,600
Sep	495	95.8	0	15,700	1,650	8,720	26,600
Oct	529	164	0	16,500	3,780	11,000	32,000
Nov	537	198	0	17,100	2,670	12,200	32,700
Dec	550	170	0	17,200	1,730	10,800	30,500
Total	**8,300**	**1,880**	**147**	**195,000**	**27,200**	**108,000**	**341,000**

Data source: USGS letter report dated April 8, 2022
Totals may not equal sum of discharge values due to rounding

Table 3. Discharge Summary for Calendar Year 2021 (in acre-feet)

	Wells – measured			Wells – not measured				
County	Irrigation	Municipal	Industrial	Domestic, Livestock, Limited Pumping†	Federal Facilities†	Total Well Discharge	Spring Discharge	Total Discharge Wells and Springs
Atascosa	1,383	0	0	0	0	1,383	0	1,383
Bexar	3,290	185,352	15,942	9,247	5,100	218,932	2,030	220,962
Comal	43	7,697	4,422	691	0	12,853	222,200	235,053
Guadalupe	0	11	141	19	0	170	0	170
Hays	84	3,305	1,059	907	332	5,687	108,000	113,687
Medina	27,167	7,403	4,094	1,129	0	39,794	0	39,794
Uvalde	42,315	2,813	86	2,547	0	47,761	8,300	56,061
Total	**74,283**	**206,580**	**25,744**	**14,539**	**5,432**	**326,580**	**340,530**	**667,110**

†Federal facilities, and domestic and livestock wells are not required to report annual use; these quantities are estimated.
Totals may not equal sum of discharge values due to rounding.

Figure 2. Historical Mean Annual Discharge at Comal Springs

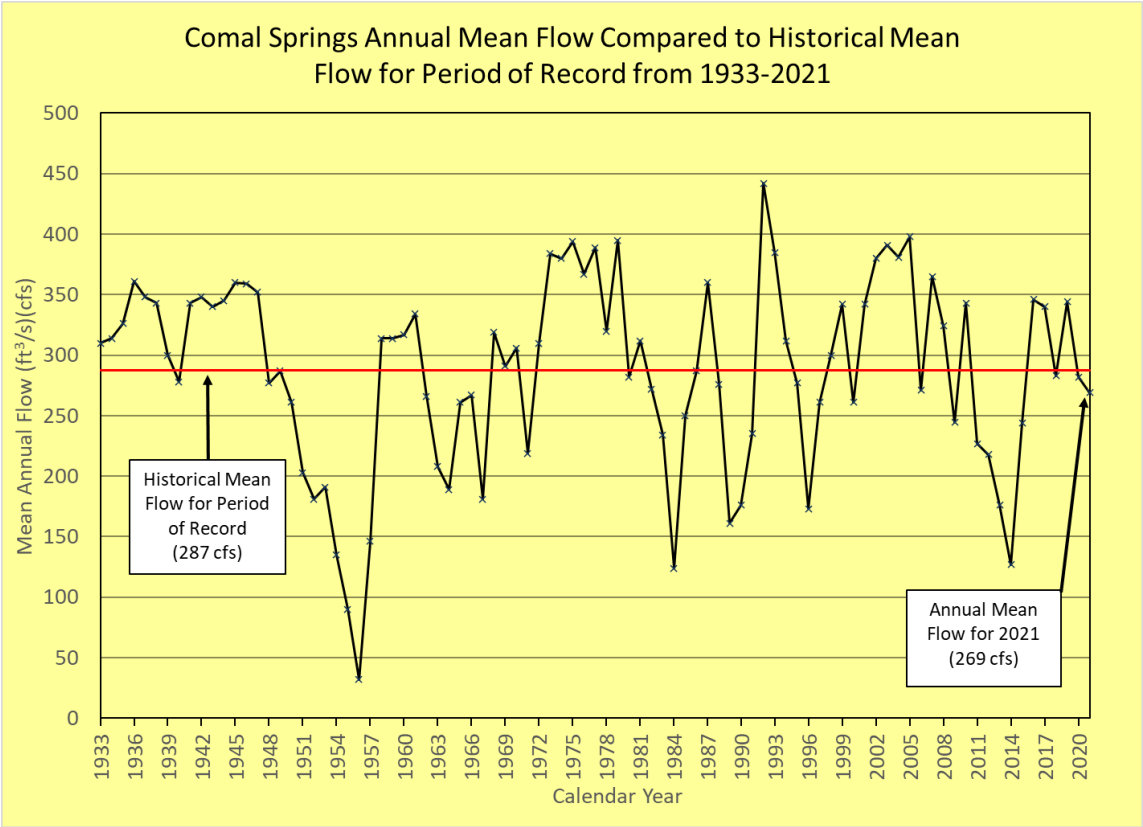

Figure 3. Historical Mean Annual Discharge at San Marcos Springs

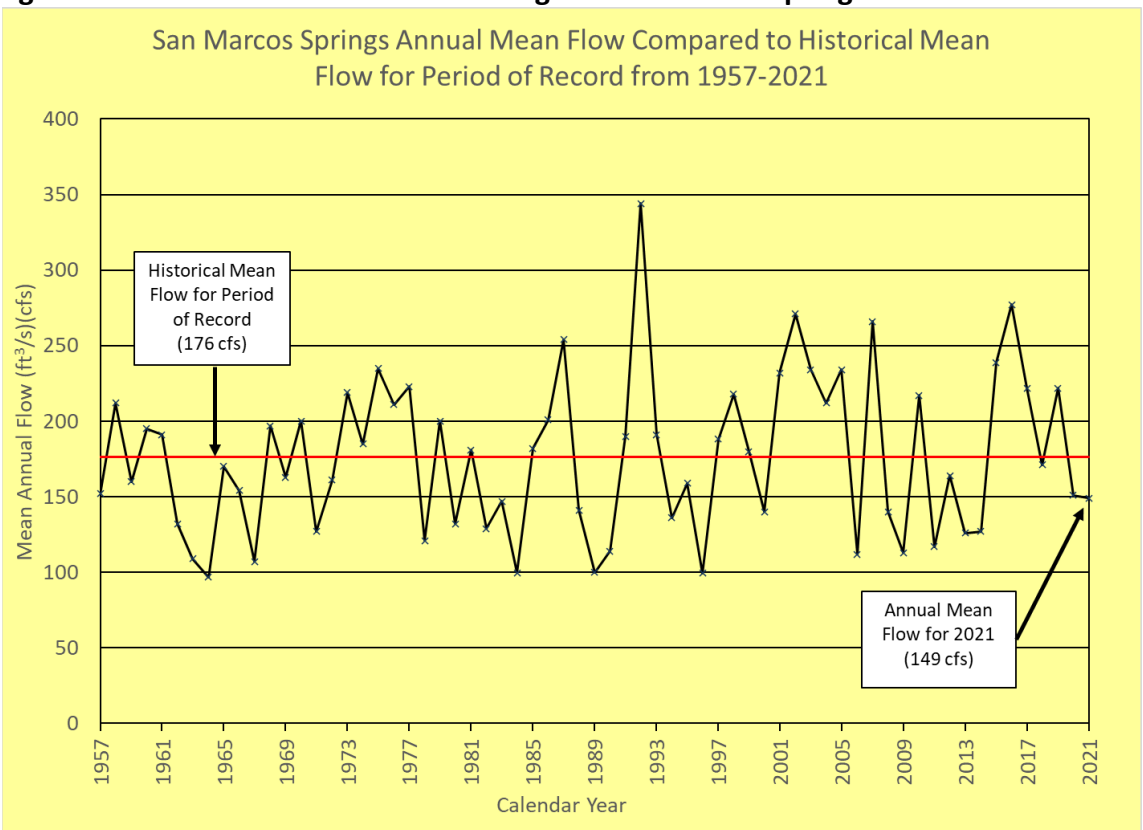

Figure 4. 2021 Discharge by Type of Use

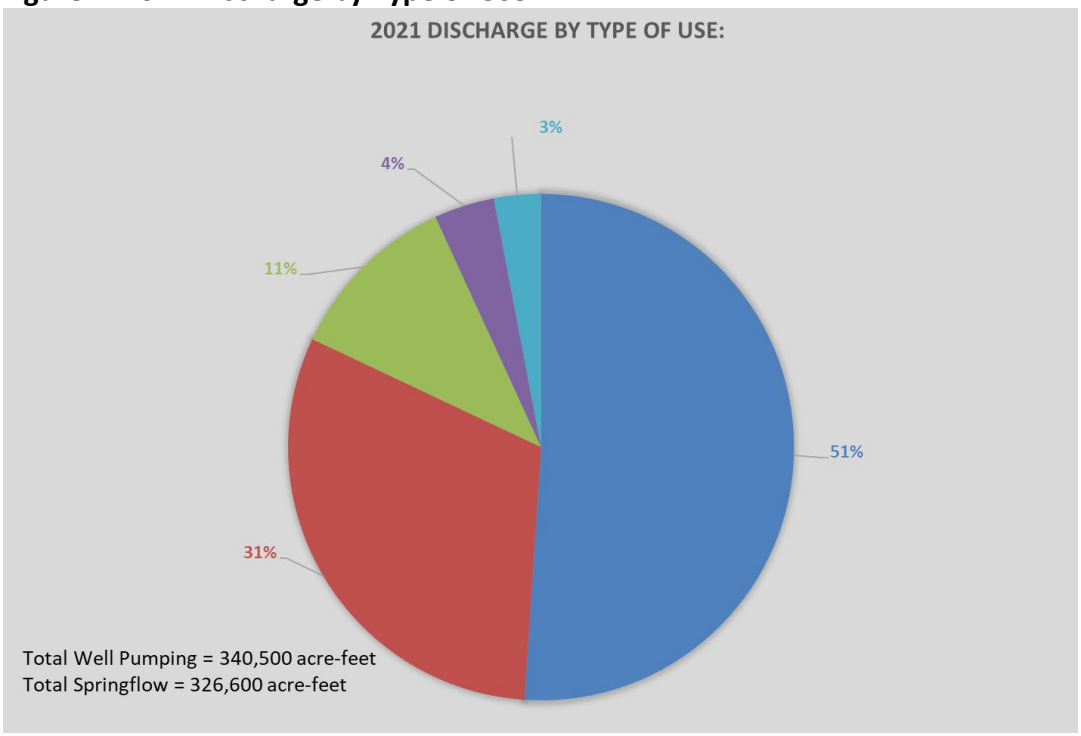

Figure 5. Groundwater Pumping Compared with Springflow

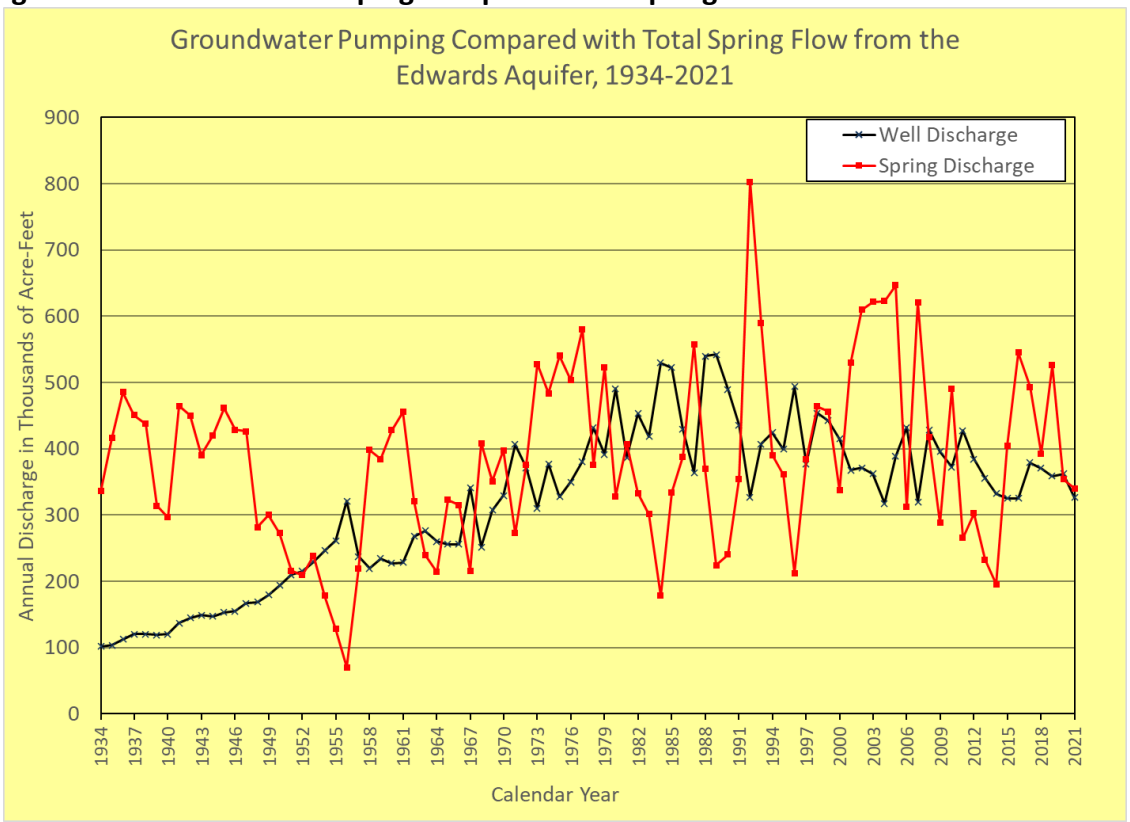

Table 4. Annual Estimated Edwards Aquifer Groundwater Discharge by Use, 1955–2021 (in thousands of acre-feet)

Year	Irrigation	Municipal	Domestic/ Livestock	Industrial/ Commercial	Springs
1955	85.2	120.5	30.1	25.1	127.8
1956	127.2	138.3	28.9	22.4	69.8
1957	68.8	116.1	29.8	22.6	219.2
1958	47.2	113.7	33.4	25.1	398.2
1959	60.0	118.9	31.5	24.2	384.5
1960	54.9	121.1	29.1	23.3	428.3
1961	52.1	124.5	29.6	22.2	455.3
1962	72.7	143.7	28.8	22.8	321.1
1963	75.4	151.8	27.8	21.8	239.6
1964	72.6	140.2	26.3	21.7	213.8
1965	68.0	138.8	27.0	22.3	322.8
1966	68.2	141.8	23.3	22.6	315.3
1967	119.4	171.0	25.1	25.8	216.1
1968	59.3	146.9	25.5	20.0	408.3
1969	95.2	162.0	29.2	21.1	351.2
1970	110.1	167.5	29.3	22.5	397.7
1971	159.4	196.2	28.6	22.6	272.7
1972	128.8	190.5	30.8	21.1	375.8
1973	82.2	177.1	32.3	18.8	527.6
1974	140.4	174.6	33.5	15.1	483.3
1975	96.4	182.5	33.6	15.3	540.4
1976	118.2	182.1	34.6	14.7	503.9
1977	124.2	205.3	38.1	13.0	580.3
1978	165.8	214.2	40.3	11.5	375.5
1979	126.8	208.9	40.7	15.2	523.0
1980	177.9	256.2	43.3	13.7	328.3
1981	101.8	231.8	40.9	12.6	407.3
1982	130.0	268.6	39.5	15.0	333.3
1983	115.9	249.2	38.8	14.7	301.5
1984	191.2	287.2	36.2	15.2	178.3
1985	203.1	263.7	39.2	16.5	334.0
1986	104.2	266.3	42.0	16.8	388.0
1987	40.9	260.9	43.5	18.7	557.9
1988	193.1	286.2	41.9	18.8	369.7
1989	196.2	285.2	38.2	22.9	224.1
1990	172.9	254.9	37.9	23.7	240.6
1991	88.5	240.5	39.5	67.5	354.6
1992	27.1	236.5	34.8	29.0	802.8
1993	69.3	252.0	49.9	36.1	589.4
1994	104.5	247.0	33.9	39.3	390.2
1995	95.6	255.0	11.6*	37.3	361.3
1996	181.3	261.3	12.3	38.8	212.0

(Table 4. continued)

Year	Irrigation	Municipal	Domestic/ Stock	Industrial/ Commercial	Springs
1997	77.4[a/b]	253.0	12.3	34.4	383.9
1998	131.9[a]	266.5	13.4	41.7[b]	464.1
1999	113.6	273.3	13.4	42.4	456.1
2000	106.3	261.3	13.4	33.8	337.5
2001	79.0	245.9	13.4	29.4	529.4
2002	97.1	228.4	13.6	32.3	609.9
2003	79.6	237.2	13.7	31.7	621.5
2004	55.4	220.3	13.8	28.1	622.9
2005	85.3	255.1	13.8	34.3	647.1
2006	149.1	259.1	13.8	34.5	312.0
2007	42.5	236.0	13.8	27.6	620.6
2008	112.7	273.6	13.5**	28.8	417.1
2009	108.9	247.5	13.6	25.7	288.0
2010	72.7	259.9	13.6	26.4	490.0
2011	124.9	265.5	13.6	23.6	265.2
2012	90.6	257.9	13.7	22.6	302.3
2013	76.3	239.5	13.7	26.3	232.8
2014	75.3	220.1	13.9	22.8	195.4
2015	42.2	247.2	13.9	21.9	404.5
2016	54.7	232.6	14.0	24.0	545.0
2017	74.1	268.3	14.0	22.8	493.0
2018	84.0	250.5	14.1	22.1	393.0
2019	73.7	241.5	14.1	23.8	526.0
2020	97.7	223.4	14.6	26.8	353.7
2021	74.3	212.0	14.5	25.7	340.5
For period of record 1955–2021:					
Median	95.2	236.5	13.9**	22.8	383.9
Mean	100.8	216.8	13.9**	24.8	392.2
For 2012–2021 (last ten years):					
Median	74.8	240.5	14.0	23.3	373.4
Mean	74.3	239.3	14.0	23.9	378.6

Data source: USGS unpublished report and Edwards Aquifer Authority files (2022).
a = Includes estimates from Atascosa County discharge by Edwards Aquifer users.
b = Includes estimates from Guadalupe County discharge by Edwards Aquifer users.
* = In 1995 USGS revised the method of calculating domestic/livestock pumpage, which significantly decreased the estimated pumping; EAA believes the post-1995 estimates to be more accurate than the previous method.
** = In 2008, EAA began to estimate domestic/livestock pumping based on number of new wells permitted annually and discontinuation of Kinney County pumping in total. Period of record mean and median only include post 2008 estimates. Differences in totals may occur due to rounding.