

**General Manager's Annual Report on
District Activities**

January 1, 2023 through December 31, 2023

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Management Plan

Goal 1.0 : Providing the Most Efficient Use of Groundwater

Management Objective 1.a Groundwater Permitting

Require existing and new non-exempt wells constructed within the boundaries of the District to be permitted by the District and operated in accordance with District Rules. In addition, the District will require all exempt wells constructed within the District boundaries to be registered with the District.

Performance Standard – The number of exempt and permitted wells registered within the District will be reported annually in the District’s Annual Report submitted to the District’s Board of Directors.

Each month, permit applications are presented to the District’s Board of Directors along with a summary of the exempt well applications and the total permits by county are reported. The majority of the permits issued by the district are for exempt wells (See Table 1). However, it should be noted that many of the permit records reflect wells that not active, or have expired (See Table 2) and are being systematically addressed by District staff. During the reporting period, approximately 47 expired permits were addressed and updated.

Table 1. Total Permit Records by Exempt Status by County

	Frio	Atascosa	Wilson	Karnes	Total
Production	111	124	64	111	410
Unclassified	488	509	270	520	1787
Exempt	338	1059	1204	1026	3627
Total	937	1692	1538	1657	5824

Table 2. Active Permits by Exempt Status by County

	Frio	Atascosa	Wilson	Karnes	Total
Production	103	114	57	106	380
Unclassified	408	378	207	320	1313
Exempt	189	380	530	436	1535
Total	700	872	794	862	3228

Management Objective 1.2 Monitor Water Production Volumes

Each month the District will monitor the volume of water produced from all municipal and Rural water supply entities in the District.

The District coordinated with rural and municipal water supply entities to monitor volume of pumped. The annual total pumped volume by county is summarized in Table 3. See appendix A for the breakdown by public utility entity for reported annual pumping, summarized from the submitted monthly reports.

Table 3. Annual volume of water pumped by public water supply entities by county

County Totals	Permit (ac-ft)	State Water Plan 2030 Availability (ac-ft)	Annual Reported Pumping (ac-ft)		
			2021	2022	2023
Frio	3,881.25	7,590.00	2,006.00	6,099.20	3,325.61
Atascosa	14,409.90	13,136.00	6,407.30	8,443.53	6,125.86
Wilson	17,938.86	9,071.00	8,243.60	9,365.89	8,273.84
Karnes	5,151.92	955.00	2,984.60	2,990.48	2,328.28
Jurisdiction	41,381.92	30,752.00	19,641.50	26,899.10	20,053.59

Reported pumping reflected an average of 7.6% reduction from the previous years (2021 to 2022). The public water supply entities pumped on average 53.4% of their permitted amount. It should be noted that the Region L draft existing supply is 164% of the current permitted amount.

Management Objective 1.3 Monitor Water Produced for Irrigation

Each year the District will request production reports from the operators of 600 agricultural irrigation wells in the District.

Letters requesting pumping reports from all permit holders with a primary use of irrigation were sent in December. Letters were sent to request reports for 1,026 permit records associated with annual reporting. A total of 232 reports were made via the online portal and 101 reports were submitted in person, by phone, or postal mail. Reports were submitted by for approximately 31.8% percent of the total monthly reporting permits, and 37.3% of the total permitted irrigation volume.

The total pumped water is detailed by county in Table 4. Of the total permitted volume for irrigation, 13.4 % of pumping was reported. Of the subset of submitted reports, 29% of the permitted allocation for irrigation was pumped. The estimated amount of pumping by the Texas Water Development Board (See Table 5) was exceeded by the reported pumping by 128%. However, the Draft Technical Memo for the Region L Water Planning Process estimated the Irrigation Water Demand to be 110,236 act-ft/yr, 75.6% of which was reported to be pumped in 2023.

Table 4. Reported Volume of Water Pumped by User Group and County for 2023

	AGRICULTURE	PUBLIC SUPPLY	OIL & GAS	INDUSTRIAL	COUNTY TOTALS
Atascosa	26,272	6,126	5,746	5,751	43,895
Frio	51,166	3,326	21		54,513
Karnes	1,366	2,328	4,595	284	8,573
Wilson	4,565	8,274	1,306		14,145
Sub-Total	83,369	20,054	11,668	6,035	121,125

Table 5. Comparison of TWDB estimated irrigation need and draft Region L water demand for irrigation

	TWDB Estimated Irrigation 2021(ac-ft/yr)	Region L Draft 2030 Water Demand (ac-ft/yr)
Atascosa	21,728	25,441
Frio	32,480	70,567
Karnes	811	910
Wilson	10,015	13,318
	65,034	110,236

Management Objective 1.4 Groundwater Monitoring

Each month the District will measure the water levels in 20 water wells.

Performance Standard – A table showing the monthly water level measurements made by the District will be included in the Annual Report of District Activities made to the Board of Directors each year.

The District monitored water levels in 24 wells throughout the district conducting synoptic surveys the first week of each month (see Appendix B). Data was collected either using an e-line manual measurement or through the use of a pressure transducer and data logger.

The district monitoring network includes 24 monitoring wells that are measured at least monthly using sonic meter, electric line, and/or pressure transducer in compliance with Objective 1.4. The majority of wells that are monitored by sonic meter are wells from wells privately owned. Water levels in the

Carrizo show a wide range of levels with depths greater than 450 feet below ground surface (bgs) (See Figure 1) in far west of the district to shallow levels in far east of the district with levels less than 50 feet bgs. Water surface elevation shows an average drawdown of approximately 8 feet but will some wells that have extreme drawdown while others have slight increase to water surface elevation (See Figure 2). It is possible that drawdowns are reflective of localized pumping.

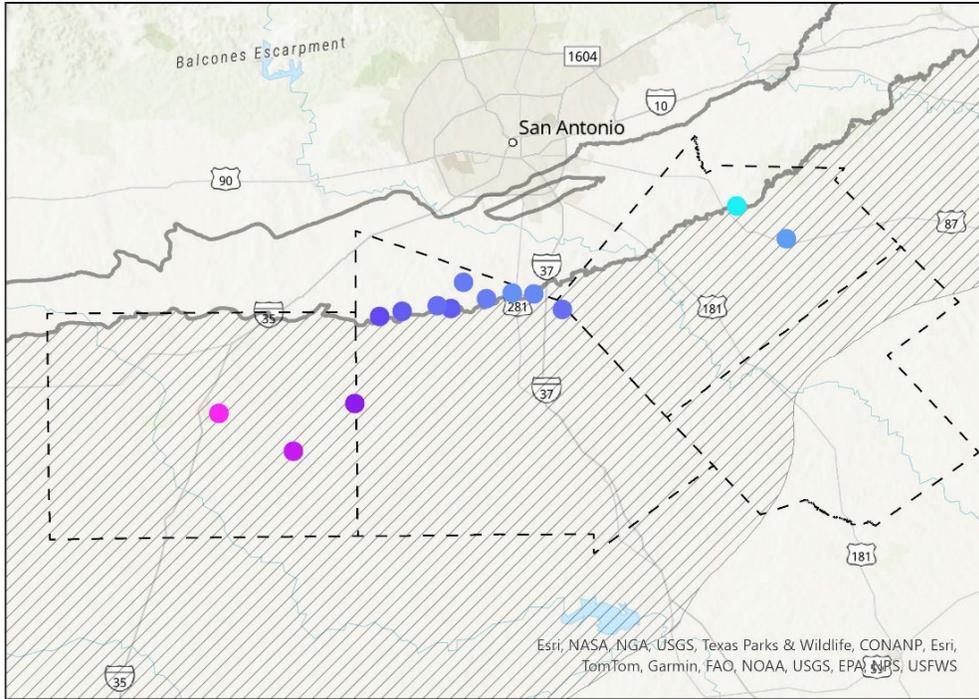


Figure 1. Average depth to groundwater for Carrizo monitoring wells

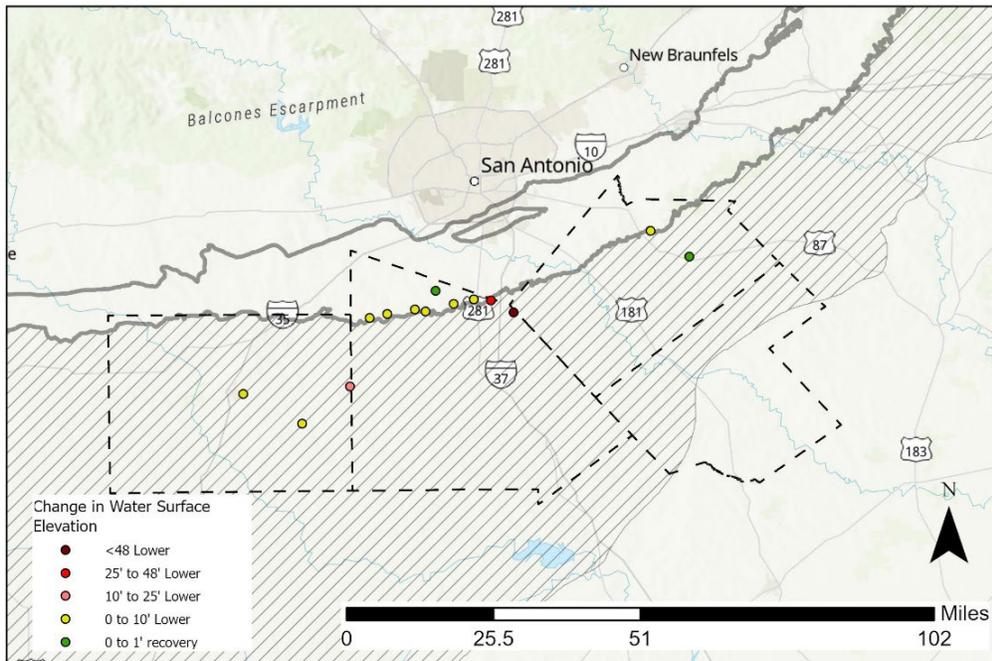
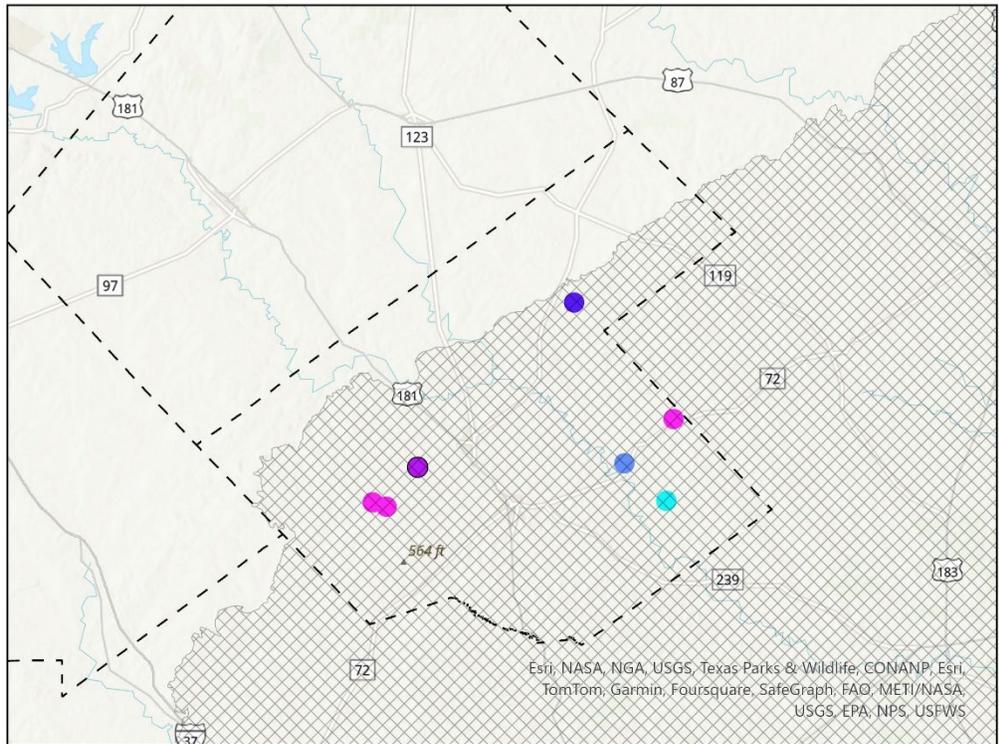


Figure 2. Change in water surface elevation for Carrizo monitoring wells.

Water levels in the Gulf Coast show a wide range of levels with depths greater than 250 feet bgs in far west of Karnes County to shallow levels in far east of Karnes County with levels less than 50 feet bgs (See Figure 3). Water surface elevation shows an average increase of approximately 7 feet (See Figure 4).



Depth to Groundwater (BSG)

- 60'
- 60'- 75'
- 75'-100'
- 100'-150'
- 150'-275'



Figure 3. Depth of Groundwater for Gulf Coast monitoring wells.

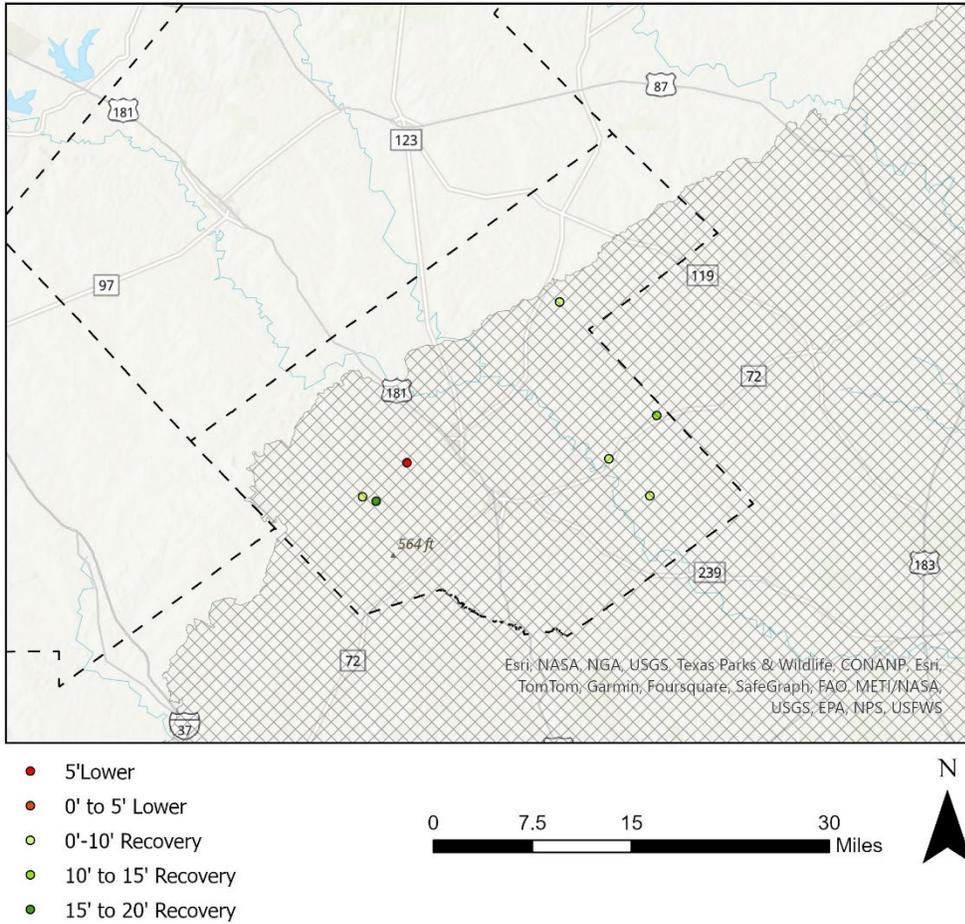


Figure 4. Change in Water Surface Elevation for Gulf Coast monitoring wells.

Water levels in the Queen City aquifer show a consistent trend of levels with averaging across the district around 50 feet bgs (See Figure 5). Water surface elevation shows an average increase of approximately 2.6 feet (See Figure 6).

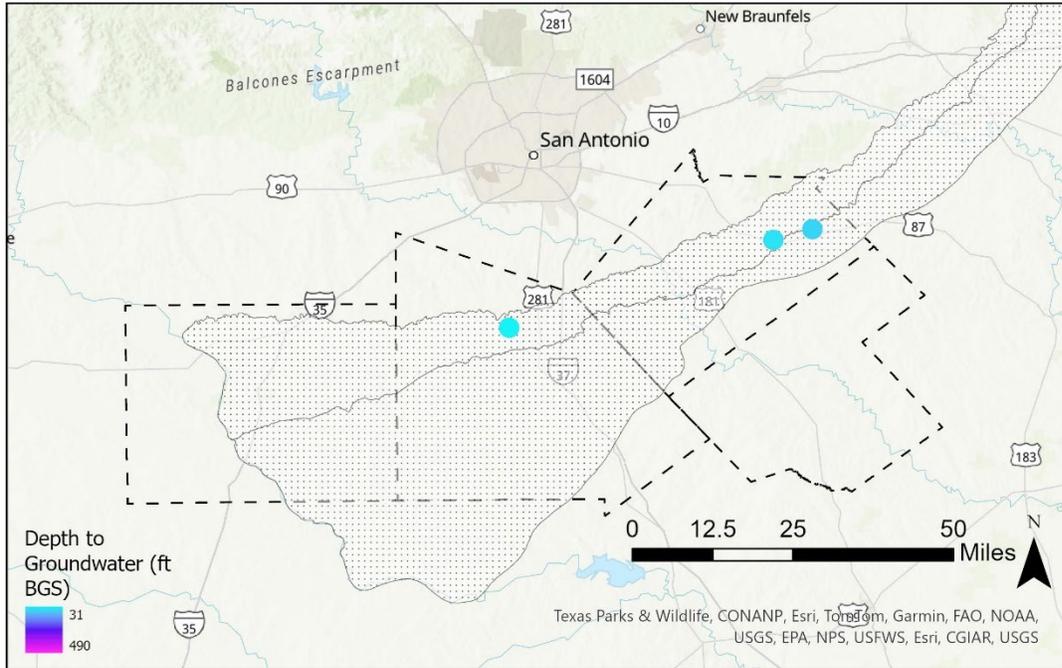


Figure 5. Depth of Groundwater for Queen City monitoring wells.

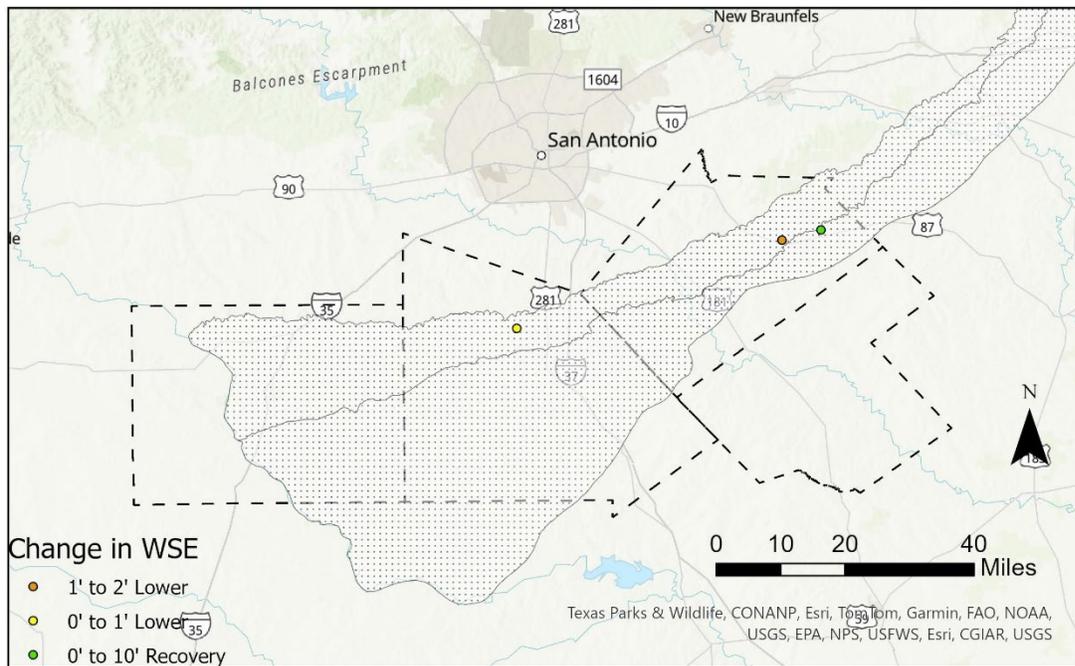


Figure 6. Change in water surface elevation for Queen City monitoring wells.

GOAL 2.0 - CONTROLLING AND PREVENTING WASTE OF GROUNDWATER

Management Objective 2.1 Water Waste Investigations

Each year the District will conduct an on-site investigation of all reports of waste of groundwater within two working days of the time of the receipt of report to the District.

The District responds to a variety of constituent requests for water level checks, water quality assessments, pressure checks, and other inquiries. Upon receipt of the request from a well owner, District staff conduct a site visit and determine an appropriate course of action. In calendar year 2023, no waste investigations were conducted.

GOAL 3.0 - ADDRESSING CONJUNCTIVE SURFACE WATER MANAGEMENT ISSUES

Management Objective 3a Encourage the use of surface water supplies where available to meet the needs of specific user groups within the District.

Performance Standard- The District will participate in the Region L Regional Water Planning process by attending at least two Region L meetings annually and will encourage the development of surface supplies where appropriate. This activity and involvement will be discussed in the Annual Report presented to the District Board of Directors.

The EUWCD is represented by both staff and elected officials at the South-Central Texas Regional Water Planning Group (See Table 6), including Diane Savage (Board Member) representing GMA 13, Weldon Riggs (Board Member) representing Agricultural Interest, and Russel Labus (General Manager, fmr) representing Water Districts. EUWCD participates in the process by:

- Providing information and data as requested
- Participating in discussions and working groups as appropriate
- Offering comment to reinforce a conjunctive use strategy that balances the needs of various use groups with a wholistic portfolio of groundwater sources.

Table 6. Region L Planning Group participation by EUWCD representatives.

Meeting	Date	Attendees
Planning Group Meeting	February 2, 2023	Russell Labus Weldon Riggs
Planning Group Meeting	May 4, 2024	Russell Labus Weldon Riggs Baine Schorp for Diane Savage
Planning Group Meeting	August 3, 2023	Russell Labus Weldon Riggs Darrell Brownlow for Diane Savage
Planning Group Meeting	November 2, 2023	Darrell Brownlow Aarin Teague

GOAL 4.0 - ADDRESSING NATURAL RESOURCE ISSUES THAT IMPACT THE USE AND AVAILABILITY OF GROUNDWATER AND WHICH ARE IMPACTED BY THE USE OF GROUNDWATER.

Management Objective 4.1 Water Quality Monitoring for Chemical Constituents of Concerns
 Each year the District will sample at least eight water wells in the District, two per county, for chemical analysis of water quality for chemical constituents of concern.

Performance Standard – A table giving the results of the chemical analyses of the water quality samples taken by the District each year will be included in the Annual Report of District Activities made to the Board of Directors each year.

Performance Standard – A discussion of whether any instances of groundwater contamination or issues of concern were noted in the water quality sample analyses will be included in the Annual Report of District Activities made to the Board of Directors each year.

Water quality samples were taken upon request throughout the Calander year of 2023 from constituents who had concerned about their water quality. A total of 12 water quality samples were taken with the minimal of 2 samples collected per county (See Figure 7). The water quality data shows results that are typical for the aquifers samples with no concerns to changes with time.

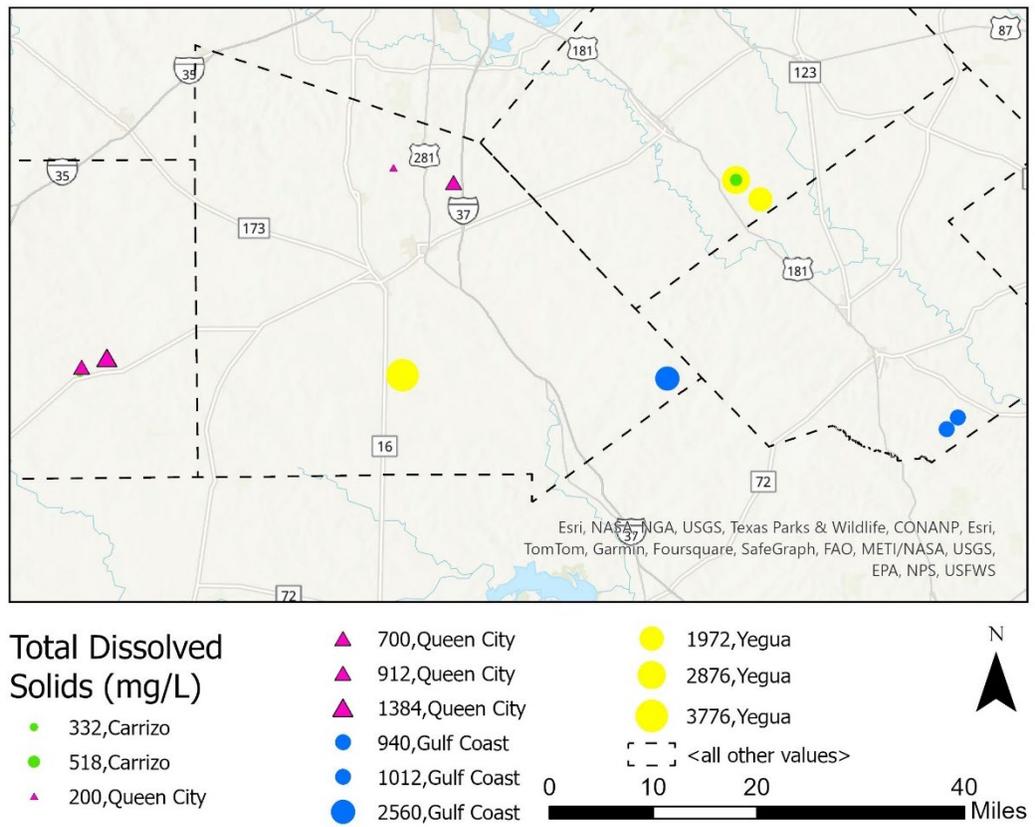


Figure 7. Total Dissolved Solids observed in water quality samples collected throughout the EUWCD jurisdiction

Addressing Drought Conditions:

Management Objective 5.1 Drought Monitoring

At least each quarter, the District will download at least one updated U.S. Drought Monitor map posted on The National Drought Mitigation Center at the University of Nebraska Lincoln website (<https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?TX>) and check for periodic updates to drought conditions as posted on the Texas Water Development Board website.

At each meeting, EUWCD briefs the Board of Directors and the public on the status of drought in the district, utilizing the National Drought Mitigation Center database of drought conditions (see Appendix D for the maps provided to the Board of Directors).

A summary of the precipitation data, (See Figure 8) shows that the total precipitation that fell in the jurisdiction varied from 16.8 inches in west Frio County to 38.9 inches in northern Karnes County. This range represents a plus/minus 10 inches from normal precipitation for the period of record which is roughly 60% to 127% of normal precipitation. However, it should be noted that the higher than normal rainfall in north Karnes County can be attributed to a single event April 8th-9th, 2023 in which 8.5 inches of rain fell.

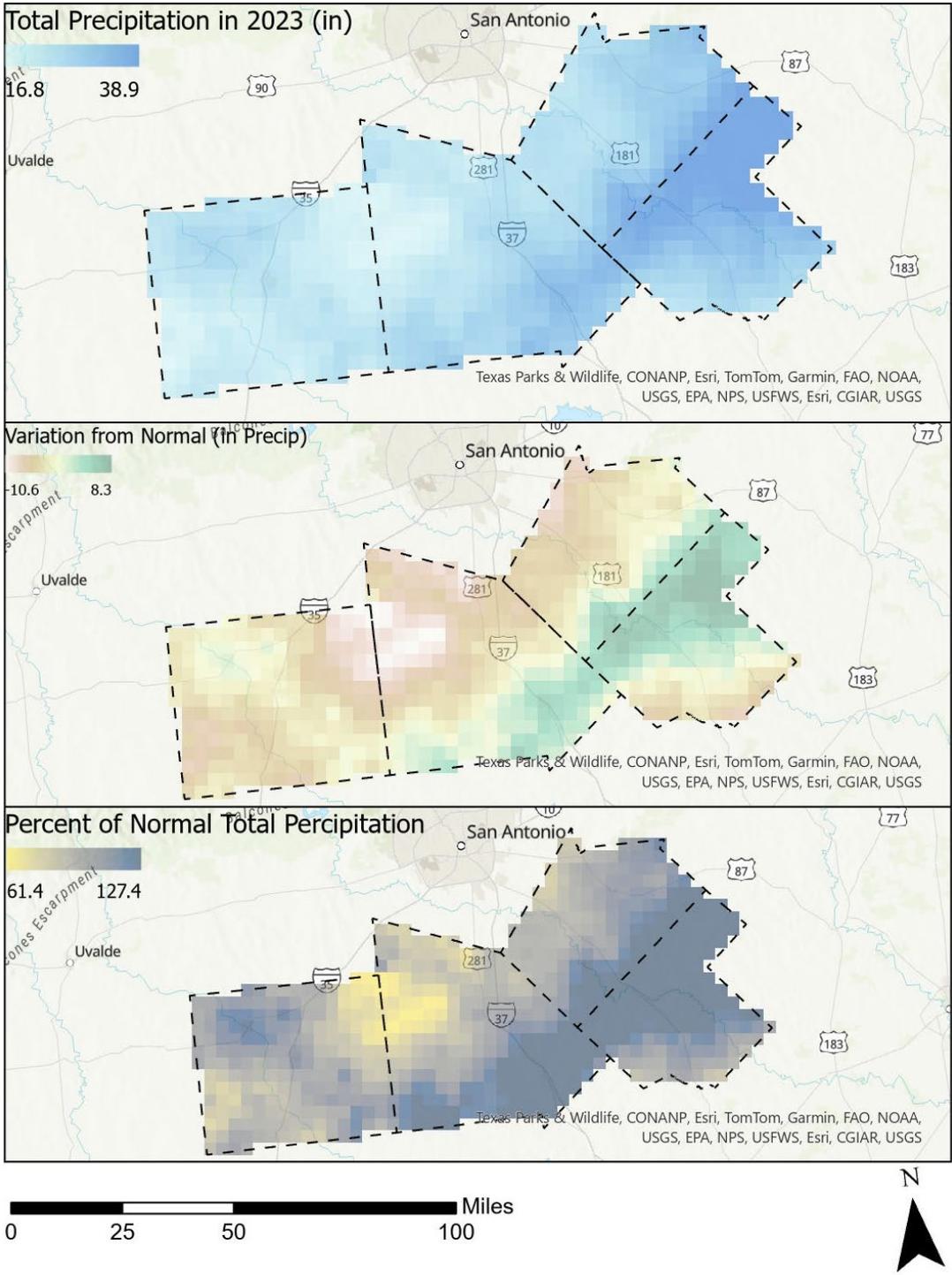


Figure 8. Assessment of 2023 annual precipitation.

Addressing Water Conservation:

Management Objective 6.1 Promote Water Conservation

Each year the District will provide several conservation website links on Districts websites and provide conservation fliers in the District office foyer.

The EUWCD created and posted two (2) conservation fliers on its website provided statistics about the impact of household leaks on water waste and strategies for reducing the water demand of household landscaping (See Appendix E). In addition, the district provided the following website links to external content (See Table 7).

Table 7. Links to external educational resources for conservation utilized in the EUWCD website

Link	Audience	Content
Water Smart Landscaping	Residential	Landscaping
Rainwater Harvesting	Residential	Rainwater Harvesting
Best Management Practices for Agricultural Users	Agricultural	BMPs for Irrigation
Best Management Practices for Industrial Users	Industrial	BMPs for Industrial Facilities

GOAL 7.0 ADDRESSING THE DESIRED FUTURE CONDITION (DFC)

Management Objective 7.1 Desired Future Conditions

The District monitors groundwater levels and evaluates whether the average change in groundwater levels is in conformance with the DFCs. The District will estimate the total annual groundwater production based on water use reports and other relevant information and compare these production estimates to the MAGs.

Based on the reported usage (See Table 8), approximately 52% of the modeled available groundwater (base year 2020) was pumped. However, it should be noted that the current issued permits are 386% of the modeled available groundwater.

Table 8. Comparison of Modeled Available Groundwater with reported pumping volumes.

County	Carrizo Wilcox	Queen City	Sparta	Yegua-Jackson	Gulf Coast	Modeled Available GW (ac-ft/yr)	Total Permitted (ac-ft/yr)	Total Reported (ac-ft/yr)
Atasosa	51,924	4,070	1,218			57,212	289,621	43,895
Frio	114,827	6,702	897			122,426	346,381	54,513
Karnes	63			2,013	10,694	12,770	129,355	8,573
Wilson	38,229	2,631	335			41,195	136,943	14,145
						233,603	902,300	121,125

Goal 8 Addressing Precipitation Enhancement

Management Objective 8.1 Precipitation Enhancement

The District participates in a cloudseeding program and plans on continuing this effort. Rainfall enhancement is conducted using cloud seeding techniques where aircraft release microscopic particles of silver iodide and calcium chloride into thunderstorms to increase rainfall efficiency. Any positive results from the cloudseeding program are estimated to be gauged over years of the collection and evaluation of precipitation data.

The South Texas Weather Modification Association conducted cloud seeding activities over 15 days from April through September 2023. A total of 30 clouds were seeded for a total increase in 165,276 ac-ft of precipitation (Ruiz-Columbie, 2024). For additional details, see Appendix F.

Appendix A: Management Objective 1.2 Reported Water of Volume Pumped by Municipal and Rural Public Water Supply Entities

2023 Public Supply Log	Operating As	County	Permit Expiration	Permit (ac-ft)	State Water Plan 2030 Existing Supply (ac-ft)	2021	2022	2023	
Benton City W.S.C.		Atascosa	2028	6,526.22	1,612	1,494.10	2,891.72	2,273.60	
CHARLOTTE Christine		Atascosa	** No Digital Record		1,098	241.40	300.73	50.79	^^, New Operator
FASHING-PEGGY WSC		Atascosa	** No Digital Record		No Data	46.20	48.56	30.60	
City of Jourdanton		Atascosa	2027	168.71		87.20	71.94	77.51	
Lytle		Atascosa	2026	1,881.84	2,250	613.60	674.98	0.00	^^, NRA ^^
McCOY WSC		Atascosa	** No Digital Record		351	504.40	555.81	125.22	Pending
City of Pleasanton		Atascosa	2026	2,184.28	1,991	1,097.80	1,310.00	1,204.51	
City of Poteet		Atascosa	Expired,2025/2027	2,842.72	5,028	1,955.60	2,203.62	1,983.63	
City Of Dilley		Atascosa	2026	806.13	806	367.00	386.17	380.00	
City of Pearsall		Frio	2028	2,147.20	2,147	165.20	1,223.45	1,207.25	
DERBY		Frio	Expired	1,409.73	1,410	1,739.00	1,761.40	2,013.19	
MOORE WSC		Frio	** No Digital Record	122.69	No Data		129.49	0.00	
City of Falls City		Frio	2024	201.62	4,033	101.80	2,984.86	105.17	
KARNES CITY		Karnes	2029	111.15	220	106.30	130.30	137.53	
City of Kenedy		Karnes	** No Digital Record		289	406.90	421.71	82.57	^^J-S, No Response
RUNGE		Karnes	2024	2,978.25		1,976.70	1,979.34	1,728.18	
El OSO Water Supply Corporation	EL OSO (CATAHOULA)	Karnes	** No Digital Record			173.20	142.51	119.35	
Aqua Texas Inc.		Karnes	2024	2,062.52	446	321.50	316.62	260.66	
C-Willow Water Co	ARROWHEAD	Wilson	2025	1,079.19	No Data	293.10	282.79	215.35	
.	C-WILLOW	Wilson	Expired			25.50	22.96	21.52	
	HICKORY HILL	Wilson	Expired	122.69		100.50	103.27	87.57	
	SHADY OAKS	Wilson	Expired			59.40	47.53	30.25	
El OSO Water Supply Corporation	EL OSO (CARRIZO)	Wilson	Expired	2,062.52	274	896.00	905.77	946.77	
City of Floresville		Wilson	Expired						^^ Nov Dec
City of La Vernia		Wilson	2027	2,821.28	2,486	1,086.40	1,015.99	1,189.14	
City of Nixon		Wilson	2026	765.24	699	356.60	476.35	386.34	
Oak Hills W.S.C.		Wilson	2029	1,533.74	No Data	439.70	453.20	0.00	^^ No response
PICOSA WSC.		Wilson	Expired	453.45	453	808.70	1,004.75	944.38	
City of Poth		Wilson	2028	631.76	306	242.20	266.40	304.18	
S.S. Water Supply Corp.		Wilson	2024	571.26	630	283.00	345.39	0.00	^^, NRA
STOCKDALE		Wilson	2024	2,940.60	1,778	2,238.40	2,561.20	2,292.52	
Sunko Water Supply Corp.		Wilson	Expired, 2024	2,940.60	920	561.70	734.47	721.47	
Three Oaks W. S. C.		Wilson	2024/2026	1,107.24	1,525	494.30	719.30	708.95	^^, Nov
		Wilson	Expired, 2026	909.28	No Data	301.50	382.15	346.85	

^^ Missing or flagged data submittal

Appendix B: Management Objective 1.4 Groundwater Monitoring

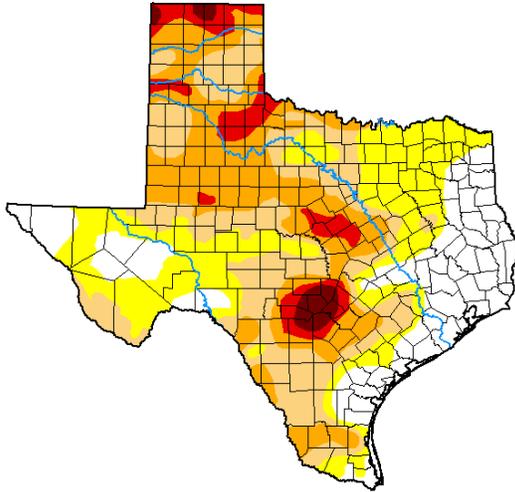
District ID	Well Name	County	Aquifer	Observed Water Level Measurement (ft BSG)												Average Depth to Groundwater (ft)	Change in Water Level (ft)
				January	February	March	April	May	June	July	August	September	October	November	December		
EUWCD-04313	CITY OF STOCKDALE #3 Carrizo	Wilson	Carrizo	146.5	138.6	130.8	132.0	139.3	138.0	130.0	142.3	146.1	145.7	140.7	145.6	139.6	0.9
EUWCD-09464	SS Water	Wilson	Carrizo	40.7	41.5	47.1	47.8	47.4	45.3	48.9	48.8	49.5	50.2	49.4	42.3	46.6	-1.6
EUWCD-04277	Michael Korus	Atascosa	Carrizo	156.9	156.3	156.7	156.9	157.2	157.5	158.1	158.6	158.9	159.6	189.0	183.4	162.4	-26.5
EUWCD-08500	Old Pleasanton Road	Atascosa	Carrizo	152.4	152.1	151.6	152.3	152.8	153.3	154.5	155.6	155.6	155.9	154.4	154.4	153.7	-2.0
EUWCD-04269	Jarret Akers	Atascosa	Carrizo	187.6	187.2	188.0	188.1	189.3	190.0	193.0	192.1	190.1	189.6		193.7	189.9	-6.1
EUWCD-09461	Milton Palmer	Atascosa	Carrizo	172.0	178.0	182.5	183.6	188.6	193.6	193.2	194.5	196.2	195.8	189.0	220.0	190.6	-48.0
EUWCD-08499	Old Applewhite	Atascosa	Carrizo	173.0	173.2	173.0	173.5	174.0	174.5	175.2	176.0	176.6	177.1	177.3	177.1	175.0	-4.1
EUWCD-09462	TWDB HWY 16 SAND PIT/ Palo Alto Sands	Atascosa	Carrizo	178.3	178.6	178.6	178.8	178.8	178.9	178.6	177.5	176.9	175.9	177.0	177.2	177.9	1.1
EUWCD-08498	Bailee Circle	Atascosa	Carrizo	206.8	208.8	206.7	206.9	207.1	207.5	208.6	209.5	208.3	206.3	211.6	211.3	208.3	-4.5
EUWCD-08497	River Oaks Dr.	Atascosa	Carrizo	207.7	207.6	207.7	207.9	208.1	210.3	211.1	211.5	211.8	211.6	211.2	211.8	209.9	-4.1
EUWCD-08496	Old Divine Rd.	Atascosa	Carrizo	227.8	227.1	227.8	228.1	228.5	228.8	229.2	230.0	229.2	227.5	231.2	231.6	228.9	-3.8
EUWCD-04288	Glenn Neuman	Frio	Carrizo		316.2	316.5	318.2	320.1	323.2	324.1	326.6	325.7	322.3	328.0	327.4	322.6	-11.2
EUWCD-03951	STACY - KEYSTONE #1	Frio	Carrizo	390.2	397.2	392.0	395.6	397.2	398.4	399.6	400.1	398.3	397.6	396.3	399.1	396.8	-8.9
EUWCD-09463	Clifton Stacy Home	Frio	Carrizo	483.2	483.9	484.2	485.2	488.7	489.5	490.8	492.4	491.0	489.0	486.0	484.5	487.4	-1.3
EUWCD-01893	Davilla Transducer	Karnes	Gulf Coast-Jasper	161.5	160.8	160.1	164.7	158.9	148.7	148.5	147.8	159.2	153.9	150.4	149.6	155.3	11.9
EUWCD-02612	Slaughter #2	Karnes	Gulf Coast-Jasper	79.8	79.8	72.0	70.8	68.3	69.7	71.4	74.2	74.2	75.1	72.1	72.9	73.4	6.9
EUWCD-09465	CR 115	Karnes	Gulf Coast-Jasper	64.4	61.9	61.7	61.2	62.4	62.7	64.2	64.9	64.4	63.9	64.1	63.9	63.3	0.5
EUWCD-04355	Yosko Ranch	Karnes	Gulf Coast-Catahoula	105.4	104.3	103.9	138.1	105.9	103.9	103.7	104.2	104.5	109.8	106.9	109.9	108.4	-4.5
EUWCD-04307	Russell Labus	Karnes	Gulf Coast-Catahoula	253.1	253.6	252.8	253.0	237.4	234.4	237.2	240.8	244.8	242.8	237.9	233.1	243.4	20.0
EUWCD-04297	EL OSO WSC Transducer	Karnes	Gulf Coast-Catahoula	274.9	267.4	265.9	265.2	267.9	257.0	266.2	274.1	275.8	271.1	264.6	265.6	268.0	9.3
EUWCD-07456	Janysek-Eclleto (Magnolia)	Karnes	Yegua	92.5	93.1	95.3	95.8	94.5	92.2	91.1	90.9	90.8	90.5	90.0	89.4	92.2	3.1
EUWCD-09466	Kay Love	Wilson	Queen City	76.8	73.2	61.9	62.8	60.4	62.7	63.3	64.0	64.2	63.5	68.9	67.2	65.7	9.6
EUWCD-04312	CITY OF STOCKDALE #2 QC	Wilson	Queen City	50.6	50.4	51.8	51.4	51.4	51.8	51.2	51.2	51.4	51.2	52.0	52.1	51.4	-1.5
EUWCD-04281	RED BARN RD - KR GRASS	Atascosa	Queen City	31.3	30.8	30.9	30.9	31.0	31.2	31.5	31.8	31.9	31.0	31.5	31.6	31.3	-0.3

Appendix C: Management Objective 4.1 Water Quality Monitoring

District ID	Date	Aquifer	County	Alkalinity mg/L	Aluminum mg/L	Arsenic mg/L	Calcium mg/L	Calcium Hardness mg/L	Chloride mg/L	Conductivity umhos/Cm	Copper mg/L	Fluoride mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nitrate mg/L	Nitrite mg/L	pH) S.U	Sodium mg/L	Sulfate mg/L	Total Dissolved Solids mg/L	Zinc mg/L
EUWCD-01743	12/8/2023	Queen City	Atascosa	48	0.00	0.00	27.00	67.40	42.00	320.00	0.00	0.00	0.66	0.00	0.73	0.00	0.00	6.60	22.00	32.00	200.00	0.01
EUWCD-09419	8/21/2023	Queen City	Atascosa	274	0.00	0.00	98.00	244.70	91.00	1,156.00	0.00	0.25	0.62	0.00	0.01	0.30	0.00	7.40	120.00	187.00	700.00	0.00
EUWCD-09543	6/15/2023	Queen City	Frio	278	0.00	0.00	48.20	120.40	164.00	1,556.00	0.02	0.51	0.98	0.00	0.02	0.00	0.00	7.80	251.00	232.00	912.00	0.07
EUWCD-08968	2/9/2023	Queen City	Frio	238	0.00	0.00	206.00	514.40	237.00	2,182.00	0.00	0.00	0.25	0.00	0.22	0.00	0.00	7.90	146.00	498.00	1,384.00	0.03
EUWCD-09510	12/7/2023	Yegua	Wilson	384	0.00	0.00	210.00	524.00	282.00	5,060.00	0.00	0.00	0.54	0.00	0.25	0.00	0.00	7.30	610.00	1,376.00	2,876.00	0.00
EUWCD-09145	2/10/2023	Yegua	Wilson	336	0.00	0.00	200.00	499.40	268.00	3,273.00	0.00	0.00	0.59	0.00	0.40	0.00	0.00	7.80	324.00	833.00	1,972.00	0.02
EUWCD-08166	1/16/2023	Yegua	Atascosa	332	0.01	0.00	212.00	529.40	877.00	6,705.00	0.00	0.00	0.28	0.00	0.03	0.00	0.00	7.50	822.00	1,362.00	3,776.00	0.02
EUWCD-03748	12/26/2023	Gulf Coast	Karnes	332	0.04	0.01	212.00	529.40	844.00	6,705.00	0.01	0.72	0.28	0.00	0.03	1.60	0.00	7.50	822.00	1,362.00	3,776.00	0.13
EUWCD-09525	12/26/2023	Gulf Coast	Karnes	266	0.00	0.00	150.00	374.60	329.00	1,630.00	0.00	0.62	0.00	0.00	0.00	1.60	0.00	7.70	150.00	68.00	1,012.00	0.01
EUWCD-09526	12/26/2023	Gulf Coast	Karnes	260	0.06	0.00	160.00	399.50	295.00	1,546.00	0.01	0.64	0.04	0.00	0.00	1.00	0.00	7.50	120.00	79.00	940.00	0.02
EUWCD-09517	12/7/2023	Carrizo	Wilson	384	0.00	0.00	2.40	6.00	36.00	914.00	0.00	0.00	0.23	0.00	0.03	0.00	0.00	8.50	200.00	23.00	518.00	0.01
EUWCD-09542	6/15/2023	Carrizo	Frio	274	0.00	0.00	98.00	244.70	81.00	1,156.00	0.00	0.39	2.20	0.00	0.02	0.30	0.00	7.50	120.00	187.00	700.00	0.02

Appendix D: Drought Monitor Maps

U.S. Drought Monitor Texas



January 24, 2023
(Released Thursday, Jan. 26, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	21.06	78.94	54.68	29.79	7.70	1.80
Last Week 01-17-2023	22.34	77.66	54.68	29.62	7.70	1.80
3 Months Ago 10-25-2022	6.59	93.41	74.73	43.05	13.04	1.39
Start of Calendar Year 01-01-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 01-25-2022	3.71	96.29	86.71	67.46	31.84	0.00

Intensity:

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

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

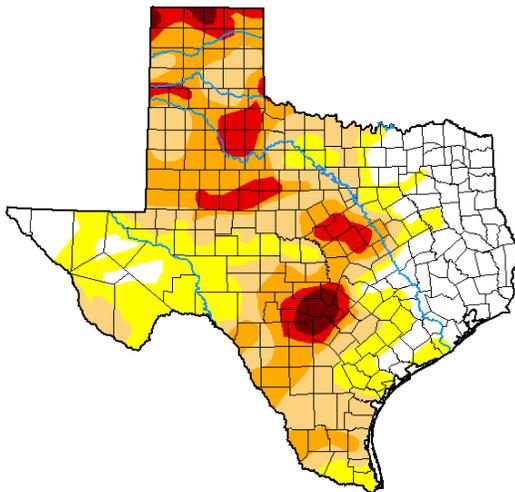
Author:

Rocky Bilotta
NCEI/NOAA



droughtmonitor.unl.edu

U.S. Drought Monitor Texas



February 14, 2023
(Released Thursday, Feb. 16, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	22.96	77.04	54.75	29.94	9.38	1.82
Last Week 02-07-2023	21.63	78.37	53.15	28.67	7.89	1.82
3 Months Ago 11-15-2022	10.77	89.23	64.16	38.96	14.93	2.05
Start of Calendar Year 01-01-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 02-15-2022	11.83	88.17	77.61	55.58	24.53	0.00

Intensity:

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

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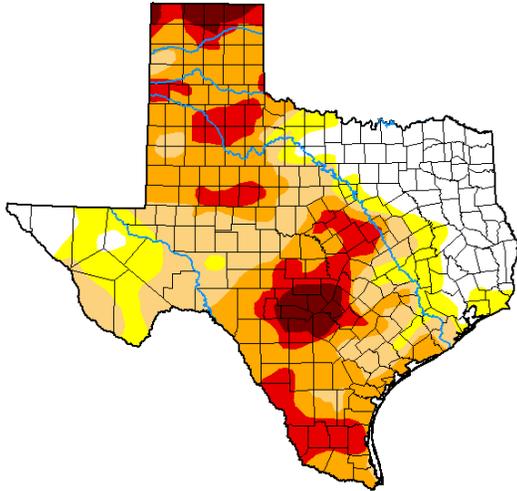
Author:

Brian Fuchs
National Drought Mitigation Center



droughtmonitor.unl.edu

**U.S. Drought Monitor
Texas**



March 28, 2023
(Released Thursday, Mar. 30, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	19.12	80.88	67.24	46.39	17.33	3.76
Last Week 03-21-2023	21.63	78.37	64.18	43.53	14.21	3.15
3 Months Ago 12-27-2022	27.57	72.43	48.59	25.88	7.13	1.24
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 03-29-2022	4.90	95.10	88.22	70.79	42.10	7.03

Intensity:

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

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

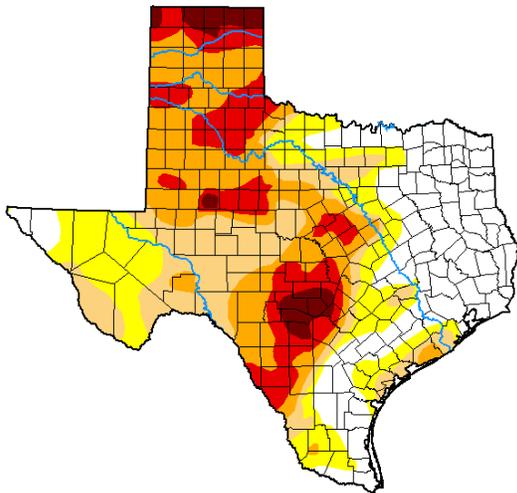
Author:

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

**U.S. Drought Monitor
Texas**



April 25, 2023
(Released Thursday, Apr. 27, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	26.78	73.22	55.32	38.21	16.58	3.50
Last Week 04-18-2023	22.37	77.63	58.15	38.98	17.67	4.14
3 Months Ago 01-24-2023	21.06	78.94	54.68	29.79	7.70	1.80
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 04-26-2022	6.21	93.79	82.11	70.28	50.25	19.62

Intensity:

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

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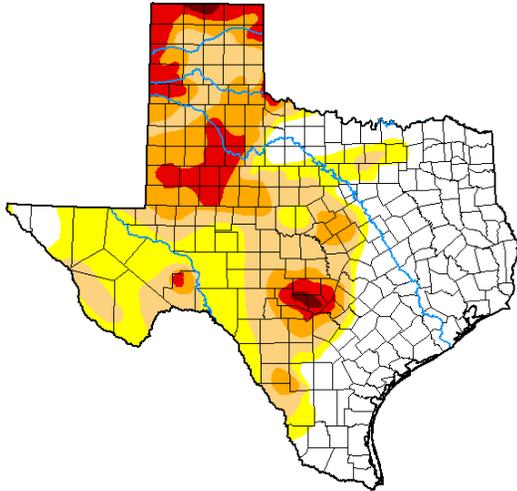
Author:

Richard Tinker
CPC/NOAA/NWS/NCEP



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U.S. Drought Monitor Texas



May 23, 2023

(Released Thursday, May. 25, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	39.03	60.97	42.30	21.48	7.79	0.51
Last Week 05-16-2023	38.22	61.78	49.31	27.76	11.73	1.58
3 Months Ago 02-21-2023	22.76	77.24	58.44	31.15	9.70	1.84
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 05-24-2022	12.92	87.08	79.11	66.94	46.05	22.08

Intensity:

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

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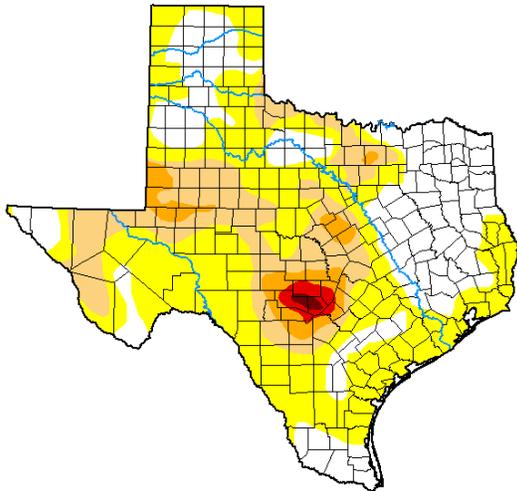
Author:

Brad Rippey
U.S. Department of Agriculture



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U.S. Drought Monitor Texas



June 27, 2023

(Released Thursday, Jun. 29, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	30.71	69.29	24.38	6.05	1.37	0.29
Last Week 06-20-2023	41.61	58.39	22.81	6.31	1.37	0.29
3 Months Ago 03-26-2023	19.12	80.88	67.24	46.39	17.33	3.78
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 06-28-2022	3.71	96.29	86.39	64.99	43.79	15.82

Intensity:

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

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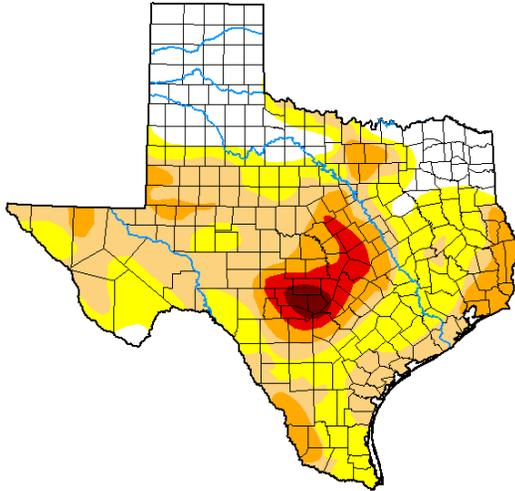
Author:

Curtis Riganti
National Drought Mitigation Center



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U.S. Drought Monitor Texas



July 25, 2023
(Released Thursday, Jul. 27, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	21.67	78.33	48.61	18.01	4.81	1.06
Last Week 07-16-2023	24.65	75.35	43.06	11.71	4.49	1.06
3 Months Ago 04-25-2023	26.78	73.22	55.32	38.21	16.58	3.50
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 07-26-2022	0.82	99.18	97.40	85.15	60.06	18.80

Intensity:



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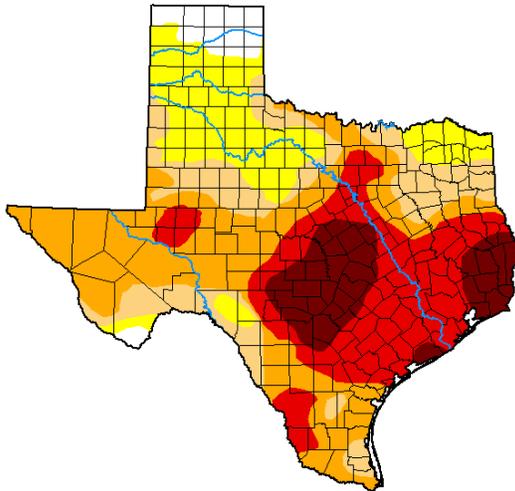
Author:

Brian Fuchs
National Drought Mitigation Center



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U.S. Drought Monitor Texas



August 22, 2023
(Released Thursday, Aug. 24, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4.13	95.87	78.71	62.10	33.99	11.67
Last Week 08-15-2023	11.85	88.15	71.37	46.46	15.75	1.49
3 Months Ago 05-23-2023	39.03	60.97	42.30	21.48	7.79	0.51
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 08-23-2022	5.21	94.79	87.18	71.11	43.13	12.42

Intensity:



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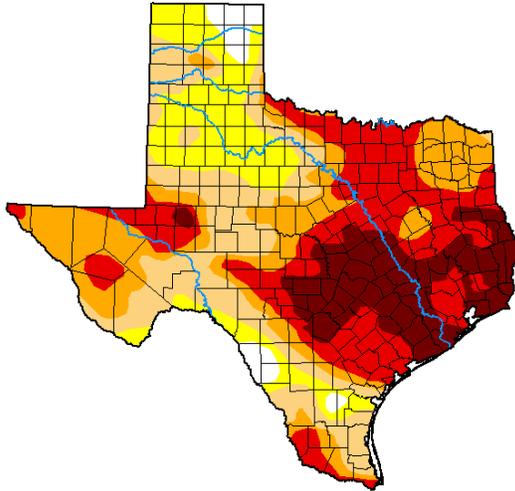
Author:

David Simeral
Western Regional Climate Center



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**U.S. Drought Monitor
Texas**



September 19, 2023
(Released Thursday, Sep. 21, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	3.03	96.97	81.91	61.33	40.76	16.02
Last Week 09-12-2023	3.04	96.96	85.67	68.27	43.59	18.56
3 Months Ago 06-20-2023	41.61	58.39	22.81	6.31	1.37	0.29
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 09-20-2022	21.16	78.84	60.11	31.76	8.34	0.62

Intensity:



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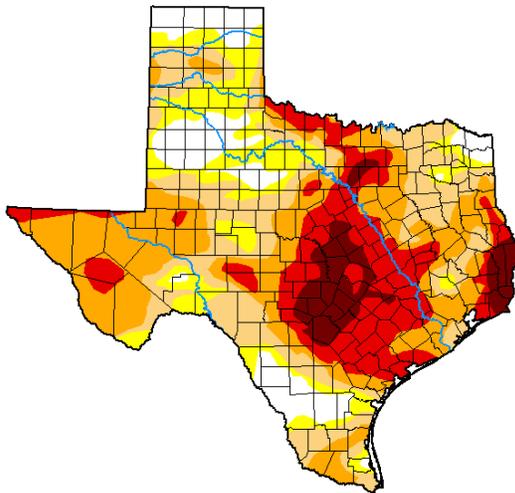
Author:

Richard Heim
NCEI/NOAA



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**U.S. Drought Monitor
Texas**



October 24, 2023
(Released Thursday, Oct. 26, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	10.99	89.01	75.21	52.70	25.15	6.80
Last Week 10-17-2023	11.24	88.76	74.43	53.45	26.75	7.02
3 Months Ago 07-25-2023	21.67	78.33	48.61	18.01	4.81	1.06
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-26-2022	3.03	96.97	80.64	59.66	38.06	12.68
One Year Ago 10-25-2022	6.59	93.41	74.73	43.05	13.04	1.39

Intensity:



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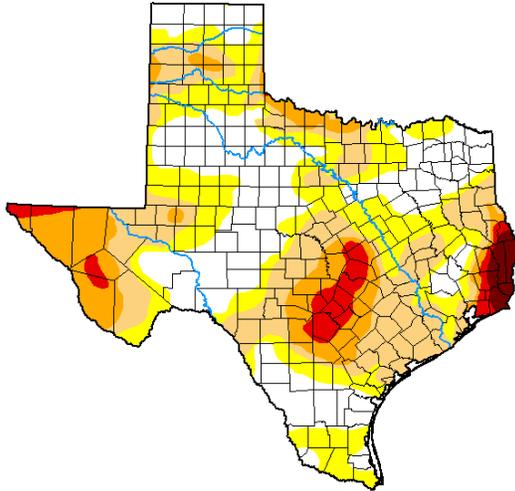
Author:

Rocky Bilotta
NCEI/NOAA



droughtmonitor.unl.edu

U.S. Drought Monitor Texas



November 28, 2023
(Released Thursday, Nov. 30, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	31.32	68.68	42.84	18.38	5.94	1.51
Last Week 11-21-2023	25.27	74.73	44.46	20.73	5.71	1.51
3 Months Ago 08-29-2023	1.55	98.45	75.83	61.41	32.33	12.64
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-26-2023	3.03	96.97	80.64	59.66	38.06	12.68
One Year Ago 11-29-2022	25.86	74.14	51.97	29.26	9.23	1.39

Intensity:



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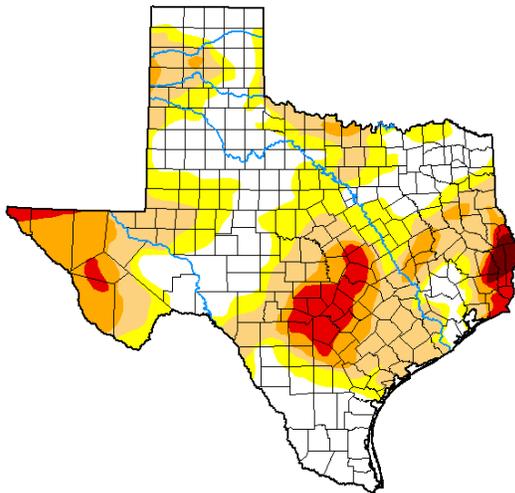
Author:

David Simeral
Western Regional Climate Center



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U.S. Drought Monitor Texas



December 19, 2023
(Released Thursday, Dec. 21, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.24	64.76	42.68	18.20	6.47	0.86
Last Week 12-12-2023	32.59	67.41	43.80	18.04	6.48	0.86
3 Months Ago 09-19-2023	3.03	96.97	81.91	61.33	40.76	16.02
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-26-2023	3.03	96.97	80.64	59.66	38.06	12.68
One Year Ago 12-20-2022	27.57	72.43	48.59	25.88	7.13	1.24

Intensity:



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Author:

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

Appendix E: Conservation Education
 Fliers

Household *WATER* CONSERVATION

Did you know?



10% of homes have leaks greater than 90 gallons per day.



A faucet leaking one drop per second will waste 3,000 gallons per year.



The average homeowner could save 10% on their water bill by repairing their leaks.



Look for the Water Sense Logo when buying appliances. These appliances are certified by a third party to meet EPA standards for water efficiency and performance.

Easy Solutions for Saving Water in your Landscape



- 30% to 60% of an average household's water use will be for outdoor irrigation,
- Homeowners tend to overwater landscapes by as much as two to three times the amount actually needed.
- Water smart landscaping using native, well adapted plants can reduce water use by approximately 40%.

STRATEGIES FOR A BEAUTIFUL LANDSCAPE



D RIP IRRIGATION



MULCH



NATIVE, DROUGHT TOLERANT PLANTS



COMPOST

Dr. Arquímedes Ruiz-Columbié
Active Influence & Scientific Management

Cloud seeding operations in the year 2023 began over the South Texas Weather Modification Association target area in April. This annual report serves as a summary of the results. A total of **30 clouds** were seeded and identified by TITAN in **15 operational days**. Table 1 on page 1 summarizes the general figures:

Table 1: Generalities

First operational day: **April 4th, 2023**
Last operational day: **September 30th, 2023**

Number of operational days: 15
(One in April, three in May, two in June, four in July, one in August, and four in September)

According to the daily reports, operational days were qualified as:

Seven with excellent performance
Six with very good performance
Two with good performance

Three with technical problems (no TITAN data available)

Number of seeded clouds: 30
(16 small-seeded clouds, 6 large-seeded clouds, 8 type B clouds)

Flares used: 248 BIP-AgI flares

Missed Opportunities: two (with lifetime longer than 1 hour), ~ 6 % of resources.

Storm # 6 on September 10th over Bandera, Medina, and Uvalde Counties (22:16-23:20 Z)

Storm # 549 on September 30th over McMullen, Atascosa, and Frio Counties (19:00-20:20 Z)

Small Clouds

Evaluations were done using TITAN and NEXRAD data.

Table 2 shows the results from the classic TITAN evaluation for the 16 small-seeded clouds that obtained proper control clouds.

Table 2: Seeded Sample versus Control Sample (16 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	50 min	40 min	1.25	25 (19)
Area	56.0 km ²	43.7 km ²	1.28	28 (14)
Volume	195.7 km ³	124.3 km ³	1.57	57 (35)
Top Height	8.7 km	8.2 km	1.06	6 (2)
Max dBz	52.4	51.0	1.03	3 (1)
Top Height of max dBz	3.6 km	4.0 km	0.90	-10 (-2)
Volume Above 6 km	57.5 km ³	22.2 km ³	2.59	159 (15)
Prec.Flux	456.6 m ³ /s	301.3 m ³ /s	1.52	52 (27)
Prec.Mass	1471.7 kton	806.1 kton	1.83	83 (52)
CloudMass	187.1 kton	105.6 kton	1.77	77 (44)
η	7.9	7.6	1.04	4 (7)

Bold values in parentheses are modeled values, whereas **η** is defined as the quotient of Precipitation Mass divided by Cloud Mass and is interpreted as efficiency. A total of **98 AgI-BIP flares** were used in this sub-sample with a good timing (**70 %**) for an average silver iodide effective dose of about **60 ice nuclei per liter**. The seeding operation for small clouds lasted about **6 minutes** on average. A good increase of 52 % in precipitation mass together and an increase of 44 % in cloud mass illustrates that the seeded clouds grew at the expense of the environmental moisture (they are open systems) and used only a fraction of this moisture for their own maintenance. The increases in lifetime (19 %), in area (14 %), in volume (35 %), in volume above 6 km (15 %), and in precipitation flux (27 %) are noticeable. There was a slight increase in top

height (2 %) and in maximum reflectivity (1 %). The seeded sub-sample was 7 % more efficient than the control sub-sample. Results are evaluated as **good** for this subsample.

An increase of 52 % in precipitation mass for a control value of 806.1 kilotons in 16 cases means:

$$\Delta 1 = 16 \times 0.52 \times 806.1 \text{ kilotons} \approx 6\,707 \text{ kilotons} \approx 5\,439 \text{ ac-f (layer: 7.5 mm} \approx 0.29 \text{ in)}$$

Large Clouds

The sub-sample of 6 large-seeded clouds received a synergetic analysis. On average, the seeding operations on these large clouds affected 62 % of their whole volume with perfect timing (100 % of the material went to the clouds in their first half-lifetime). A total of **70 AgI-BIP flares** were used in this sub-sample for an average effective silver iodide dose of about **20 ice nuclei per liter**.

Also, on average, large clouds were 30 minutes old when the operations took place; the operation lasted about 7 minutes, and the large-seeded clouds lived 175 minutes.

Table 3 shows the corresponding results:

Table 3: Large Seeded Sample versus Virtual Control Sample (6 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	175 min	160 min	1.09	9
Area	613 km ²	566 km ²	1.08	8
Volume	2254 km ³	1883 km ³	1.20	20
Volume Above 6 km	1214 km ³	1114 km ³	1.09	9
Prec.Flux	7515 m ³ /s	6508 m ³ /s	1.15	15
Prec.Mass	88 836 kton	69 689 kton	1.27	27

An increase of 27 % in precipitation mass for a control value of 69 689 ktons in 6 cases may mean:

$$\Delta 2 = 6 \times 0.27 \times 69\,689 \text{ kilotons} \approx 112\,896 \text{ kilotons} \approx 91\,559 \text{ ac-f (Layer: 30.7 mm} \approx 1.21 \text{ in)}$$

Type B Clouds

The sub-sample of 8 type B seeded clouds also received a synergetic analysis. On average, the seeding operations on these type B clouds affected 13 % of their whole volume with very good timing (86 % of the material went to the clouds in their first half-lifetime). A total of **80 AgI-BIP** were used in this sub-sample for an average effective silver iodide dose of about **45 ice nuclei per liter**.

Also, on average, type B clouds were 100 minutes old when the operations took place; the operation lasted about 9 minutes, and the type B seeded clouds lived 300 minutes.

Table 4 shows the results:

Table 4: Type B Seeded Sample versus Virtual Control Sample (8 couples, averages)

Variable	Seeded Sample	Control Sample	Simple Ratio	Increases (%)
Lifetime	300 min	290 min	1.03	3
Area	630 km ²	620 km ²	1.02	2
Volume	1899 km ³	1834 km ³	1.04	4
Volume Above 6 km	467 km ³	459 km ³	1.02	2
Prec.Flux	12729 m ³ /s	12377 m ³ /s	1.02	2
Prec.Mass	220 999 kton	210 475 kton	1.05	5

An increase of 5 % in precipitation mass for a control value of 210 475 ktons in 8 cases may mean:

$$\Delta 3 = 8 \times 0.05 \times 210\,475 \text{ kilotons} \approx 84\,190 \text{ kilotons} \approx 68\,278 \text{ ac-f}$$

(Layer: 16.7 mm \approx 0.66 in)

$$\text{The total increase: } \Delta 1 + \Delta 2 + \Delta 3 = 165\,276 \text{ ac-f}$$

(~ 340 ac-f per small, 15 260 ac-f per large, 8 535 ac-f per type B)

Micro-regionalization

Increases in precipitation mass were analyzed county by county in an attempt to better describe the performance and corresponding results. **Table 5** below offers the details for operations (season: May to October):

County Seeding	Initial Seeding	Extended Seeding	Acre-feet (increase)	Inches (increase)	Rain Gage (season value*)	% (increase)
Uvalde	5	6	14 600	0.17	11.46 in	1.5
Bandera	3	3	16 100	0.44	14.99 in	2.9
Medina	9	11	14 100	0.19	14.73 in	1.3
Bexar		1	1 600	0.02	13.79 in	0.1
Frio	2	4	8 800	0.16	13.27 in	1.2
Atascosa	5	8	50 100	0.76	15.84 in	4.8
McMullen	1	3	10 400	0.18	19.23 in	0.9
Wilson	3	5	28 000	0.29	12.44 in	2.3
Karnes	2	2	12 500	0.42	18.24 in	2.3
Bee		2	17 000	0.36	12.37 in	2.9
Subtotal	30	45	161 200			
Outside		3	4 300 (~ 3 % of total)			
Total	30	48	165 500			
Average				0.30	14.64 in	2.0 %

(**Initial seeding** means the counties where the operations began, whereas **extended seeding** means the counties favored by seeding after the initial operations took place).

* **Seasonal precipitation values: April-September 2023**

Final Comments

- Results are evaluated in two dimensions; the operations, with an average timing of **80 %**, an average dose of **about 50 ice-nuclei per liter**, and **two missed opportunities** (about 6 % of resources) are evaluated as very good, whereas in terms of increases, the results are evaluated as good. This apparent tension between well-done operations and modest increases is associated with the limited cloud resources available during the 2023 campaign.
- The micro-regionalization analysis showed increases per county; different zones received downwind benefits; the average increase in precipitation, referred to as rain gauge seasonal value (April-September), was about **2 %**
- Radar estimations of precipitation should be considered as measurements of trend. Seeding operations improved the dynamics of seeded clouds.
- In 2023, the total increase in the region, estimated at about 0.17 million acre-feet over the target area, should be considered a visible help to freshwater natural resources.
- Dual seeding was not used during the 2023 campaign: no hygroscopic flares were utilized due to the relatively high temperatures of the cloud bases. .

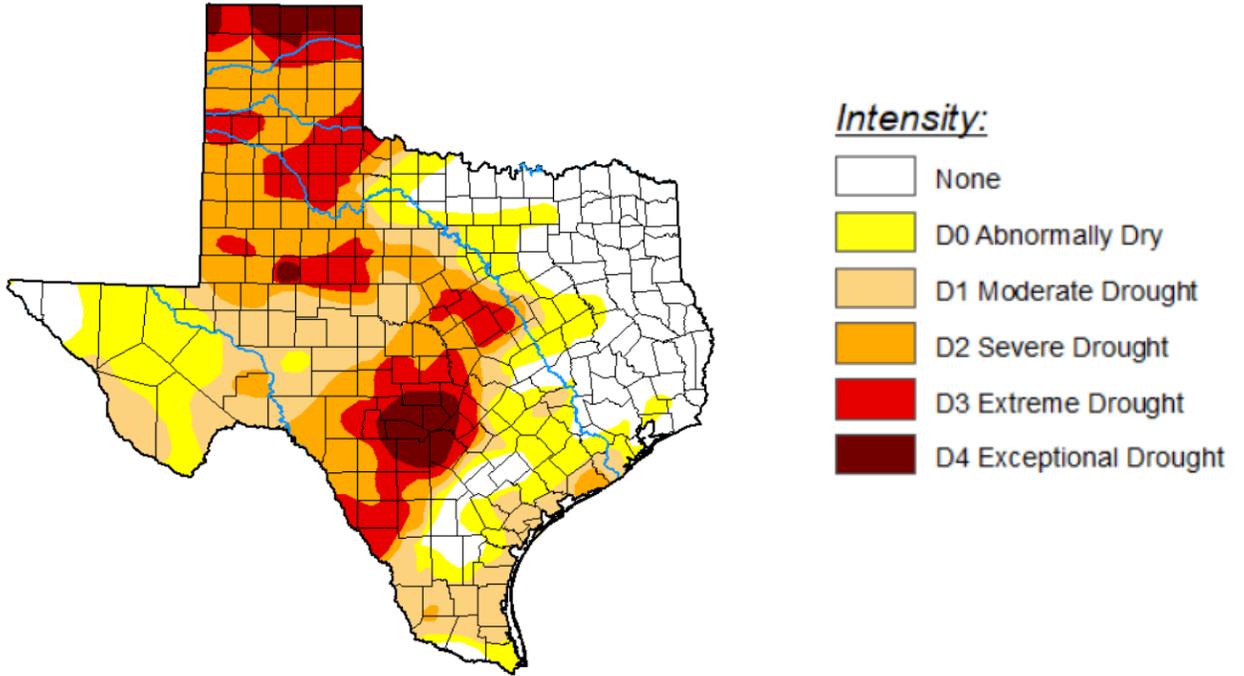
Addendum: a brief comparison among the last five SWTWMA cloud seeding campaigns.

Year	seeded storms	operational days	increase (million ac-f)	%	season precipitation (inches)
2019	124	40	0.77	11.5	12.31 (May-October)
2020	152	42	2.35	15.5	16.33 (April-September)
2021	55	29	0.48	3.8	23.34 (April-September)
2022	98	32	0.34	7.5	8.53 (April-August)
2023	30	15	0.17	2.0	14.62 (April-September)

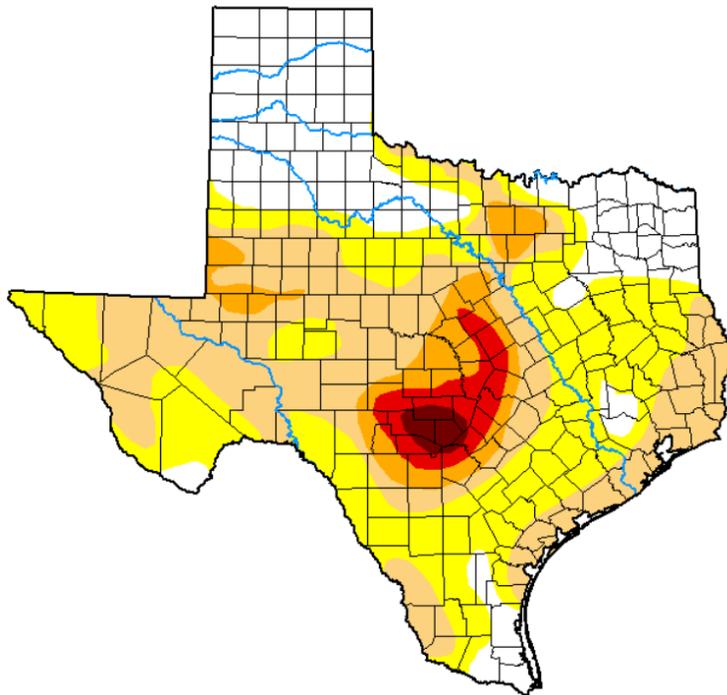
Notice the minimum number of seeded storms, operational days, and increases in 2023.

Evolution of the drought during the 2023 campaign

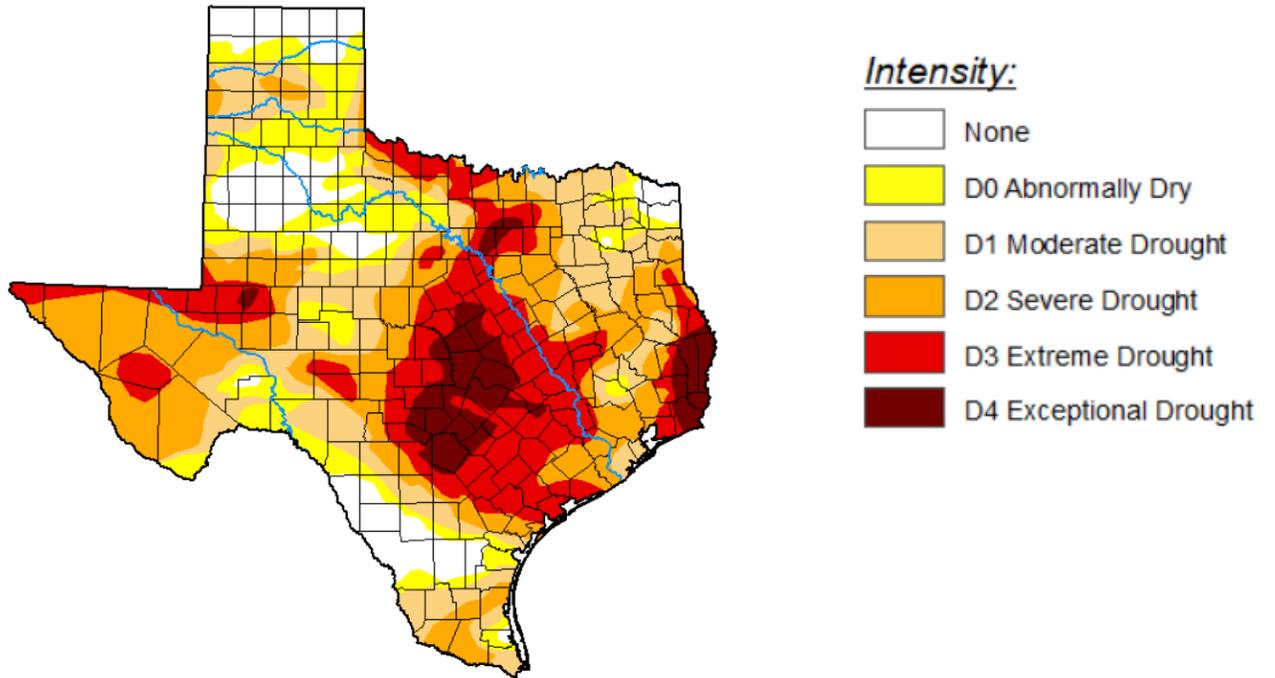
April 18, 2023



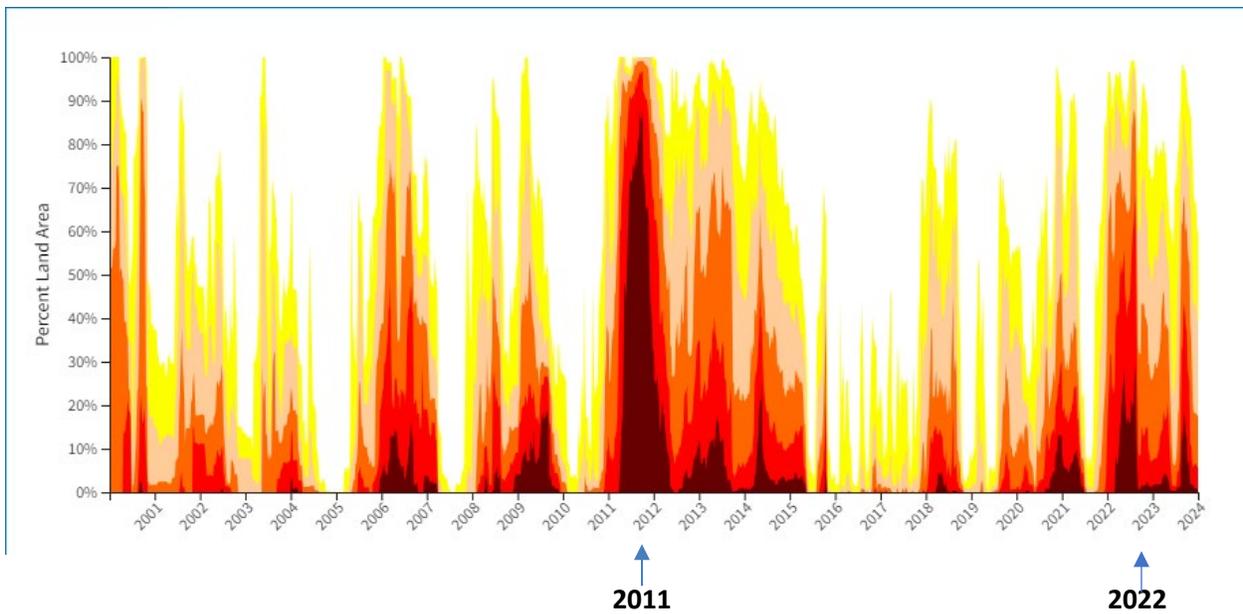
July 18, 2023



October 17, 2023



Notice the persistence of the drought’s core on Central Texas which touched the northern part of the STWMA target area. Texas has experienced two very dry years in a row, and the 2023 drought came after one of the worst droughts on record. Check the graphic below.



<https://www.drought.gov/states/texas>