

Assessment of Nitrate in Groundwater and Public Water Systems in Texas



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The University of Texas at Austin



Outline

Introduction

Nitrate Violations in
Public Water
Systems

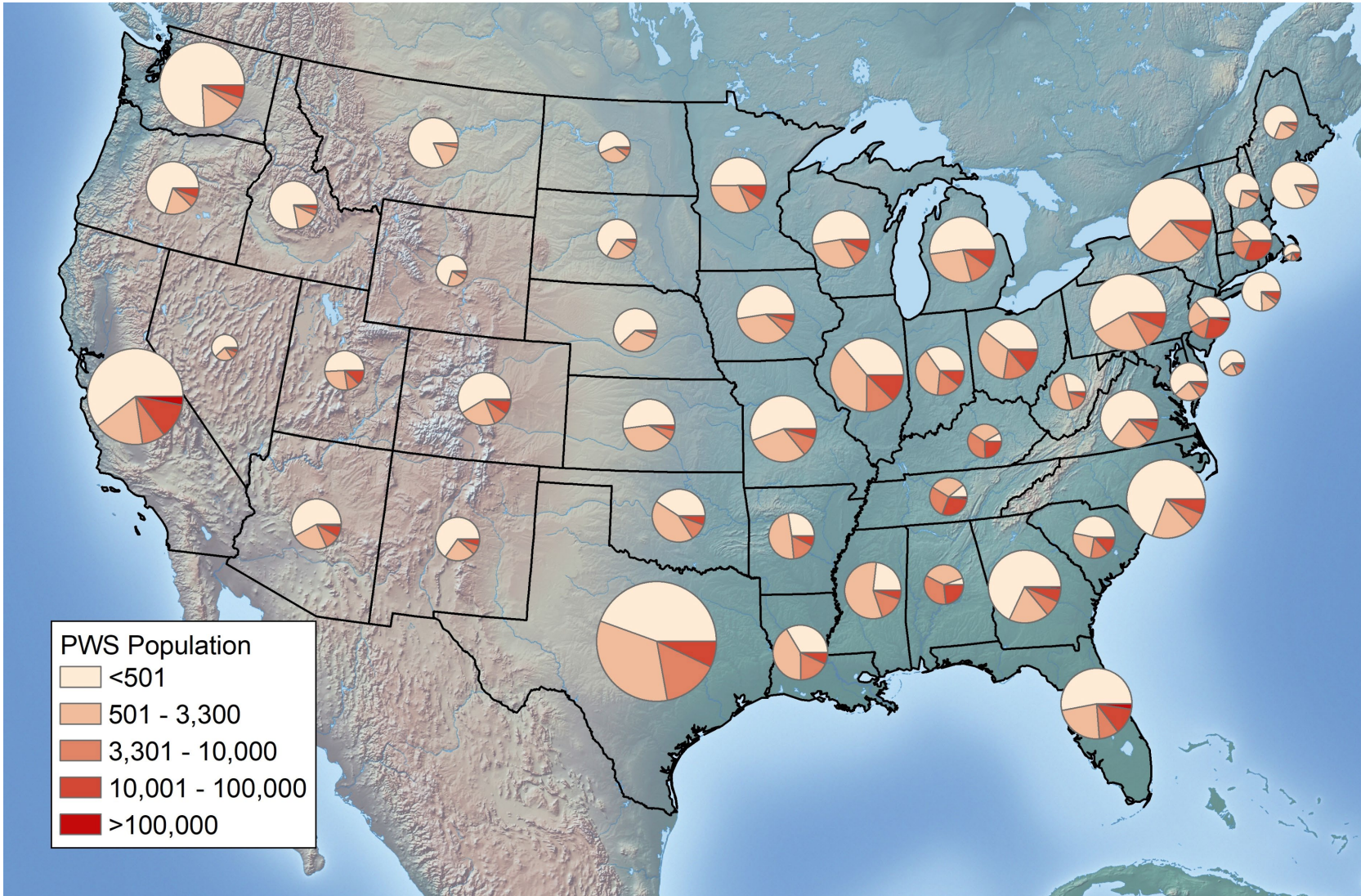
Nitrates in Major
Aquifers

Nitrates in Minor
Aquifers

What's Next?

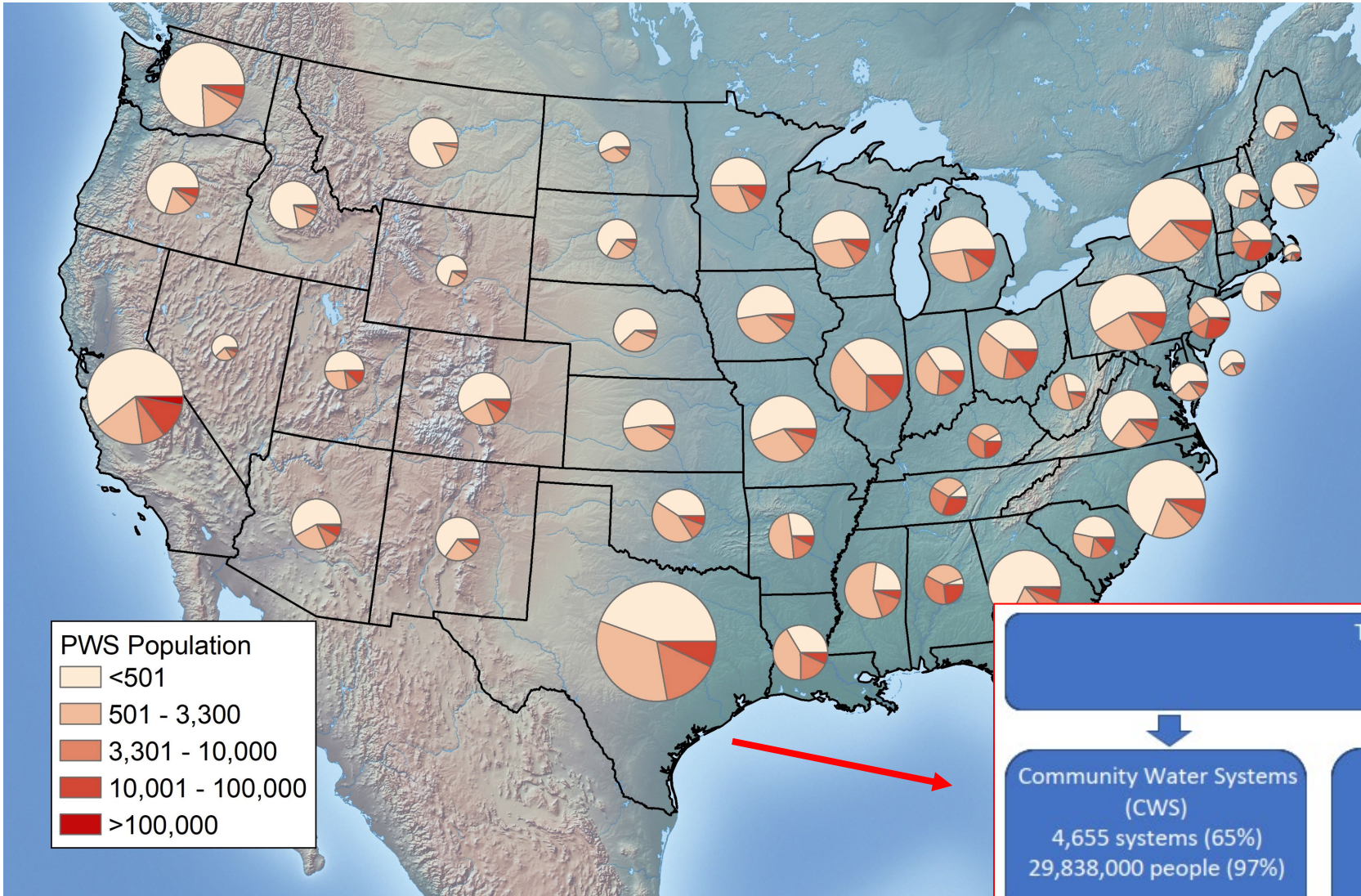


State Distribution of Number of Community Water Systems

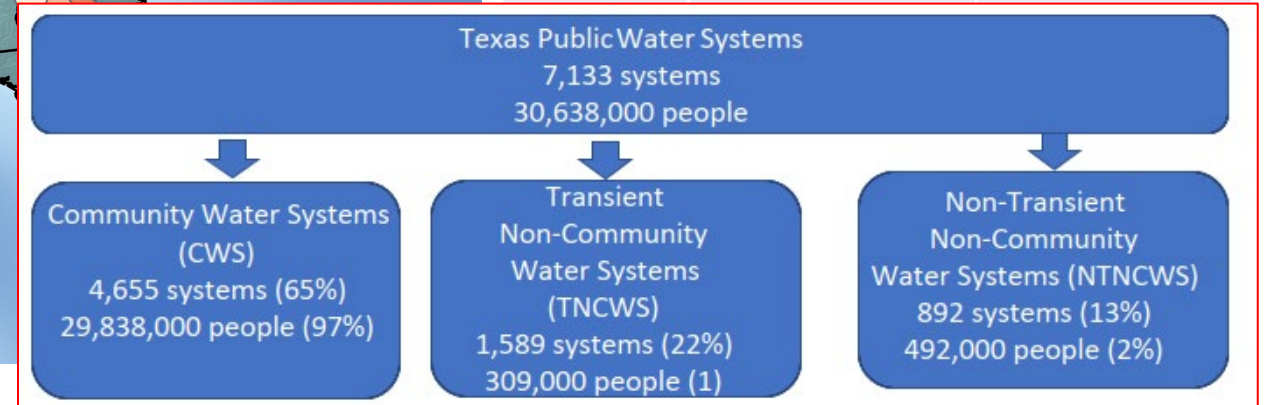


	State	CWS Systems
1	Texas	4653
2	California	2981
3	Washington	2356
4	New York	2300
5	N. Carolina	2005
6	Pennsylvania	1911
7	Illinois	1759
8	Georgia	1726
9	Florida	1626
10	Missouri	1431

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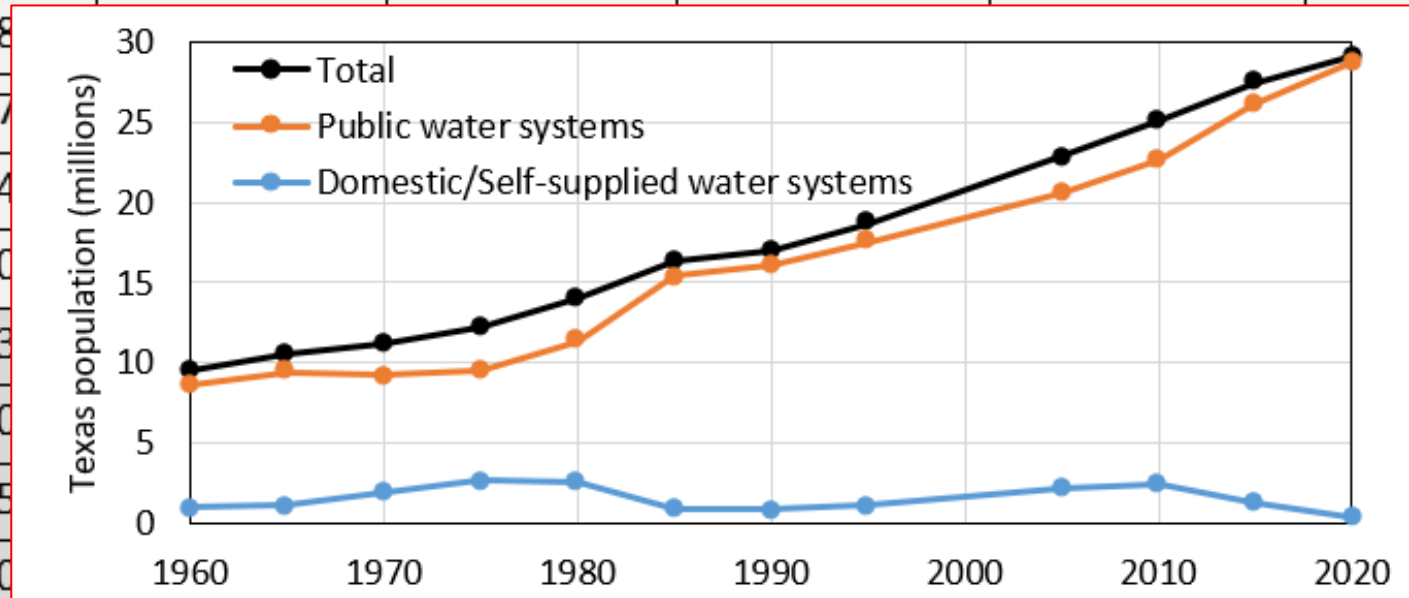
Rapid growth in populations served by Community Water Systems, and a shift towards larger systems

Region	System Type	Populations Served by System Size Category					
		≤500	501 – 3,300	3,301 – 10,000	10,001 – 100,000	>100,000	All
Texas Apr 2021	CWS	388,853	2,340,246	4,001,194	8,156,665	13,860,559	28,747,517
	NTNCWS	94,743	151,816	53,897	-	203,375	503,831
	TNCWS	191,449	89,633	7,896	-	-	285,567
	All	675,045	2,581,695	4,062,987	8,156,665	14,063,934	29,536,915
Texas Jul 2023	CWS	380,377	2,318,381	4,152,165	8,748,278	14,238,835	29,838,036
	NTNCWS	96,078	155,654	62,154	-	177,673	491,559
	TNCWS	201,573	99,336	7,896	-	-	308,805
	All	678,028	2,573,371	4,222,215	8,748,278	14,416,508	30,638,400
Net CWS Change		-2.2%	-0.9%	+3.8%	+7.3%	+2.7%	+3.8%



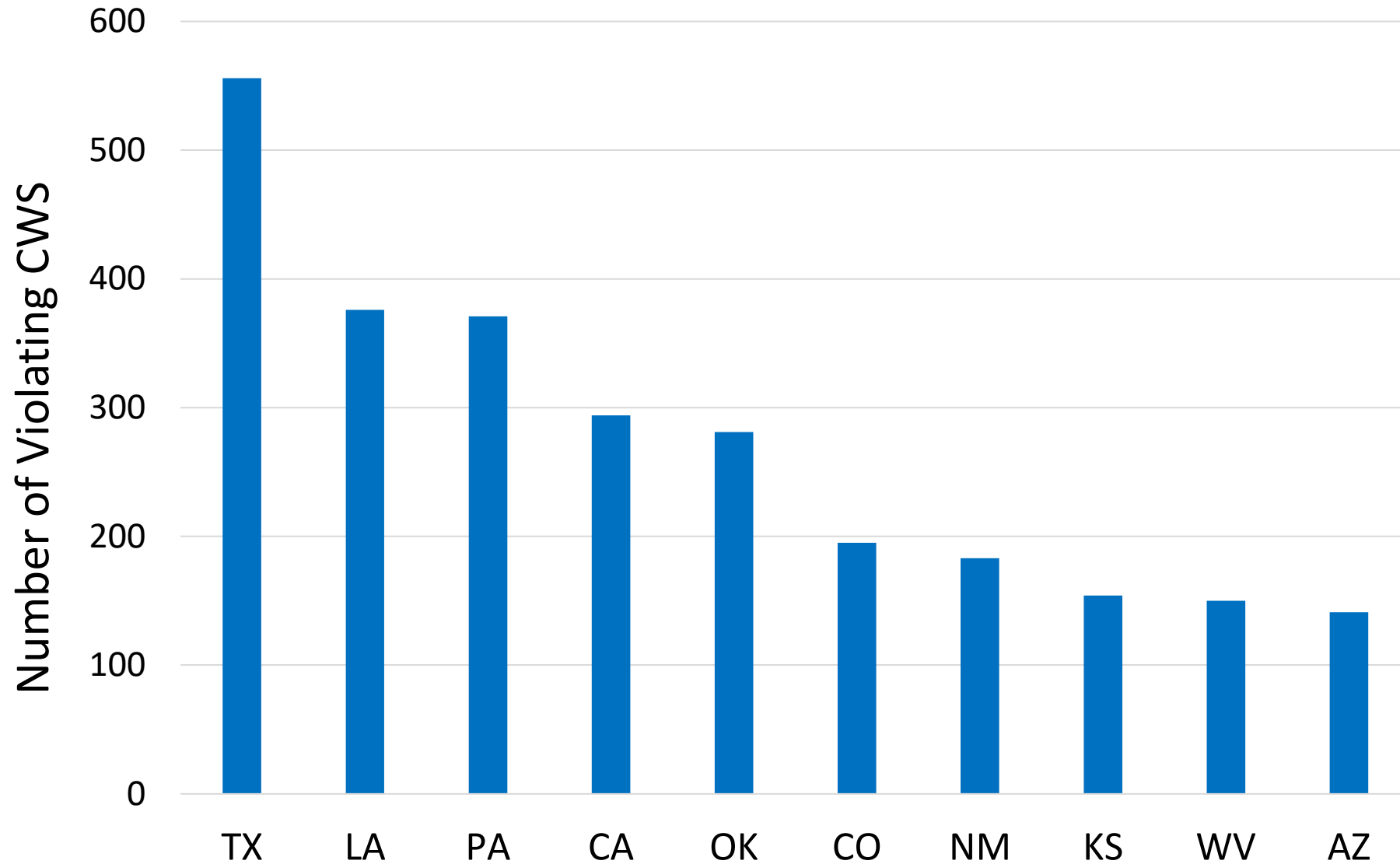
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Given the abundance of Community Water Systems, Texas has the highest number of health-based violations



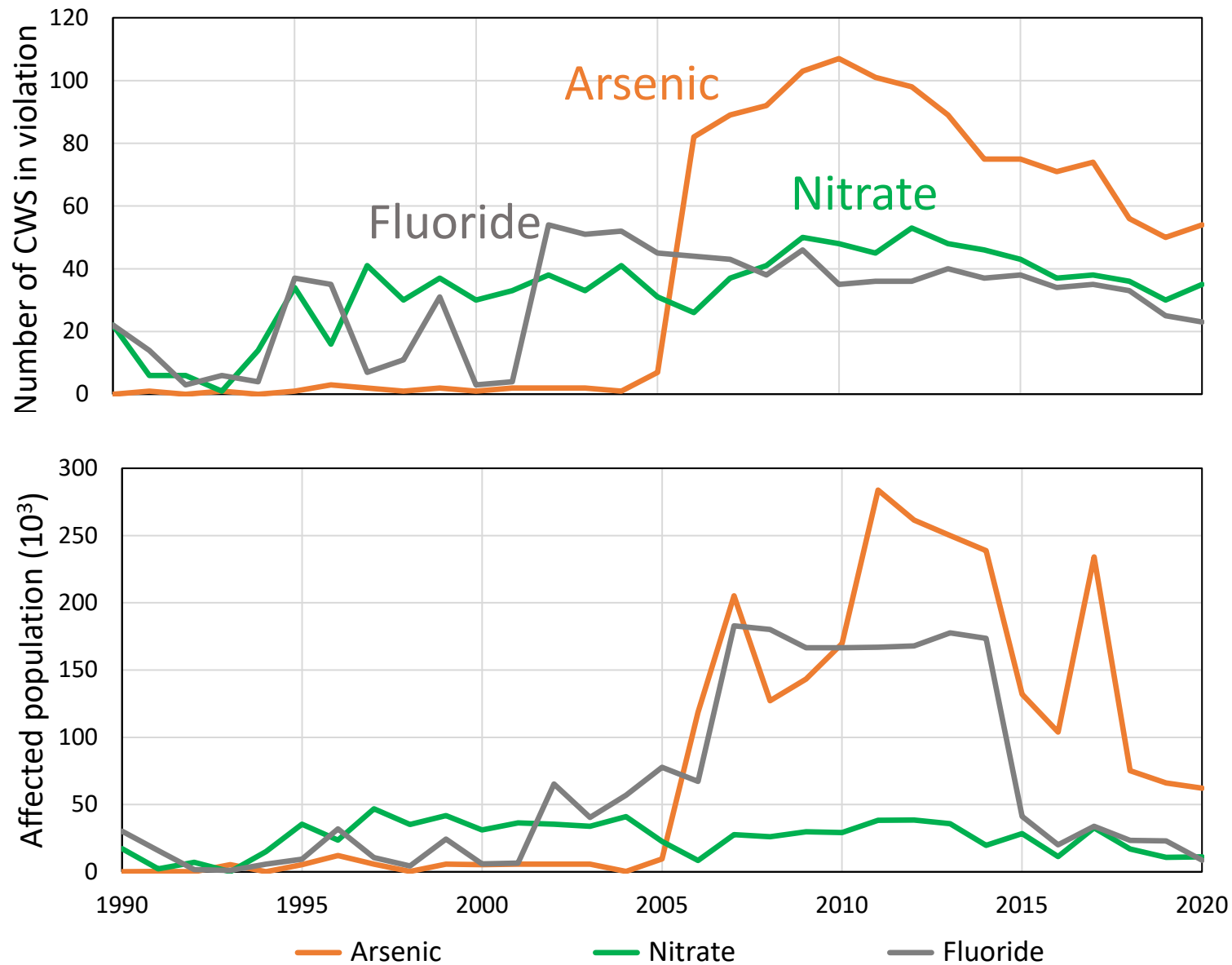


Texas ranks highly in the number of Inorganics Rule violations, including Nitrates

Rule / Rule Group	Texas Systems			Texas Populations			
	No. of CWS	National Rank	% of TX Systems	Affected	National Rank	Affected (%)	National Rank
Inorganics	37	1	0.80	46,659	3	0.16	8
Fluoride	34	1	0.73	37,683	3	0.13	5
Arsenic	71	2	1.53	110,363	2	0.38	10
Nitrates	33	1	0.71	11,139	2	0.04	10
Any inorganic	115	2	2.47	143,375	2	0.50	15
Radionuclides	170	1	3.65	195,657	3	0.68	18
DBPRs	242	1	5.20	940,425	3	3.27	20
SWTR	34	5	0.73	236,454	8	0.82	8
GWR	35	5	0.75	39,621	7	0.14	24
RTCR	53	2	1.14	137,166	7	0.48	23
Organics	3	3	0.06	5,089	6	0.02	6
LCR	68	1	1.46	100,283	8	0.35	11
Any HB Violation	545	1	11.71	2,690,600	2	9.36	21



Inorganics Rule Violations in Texas Community Water Systems





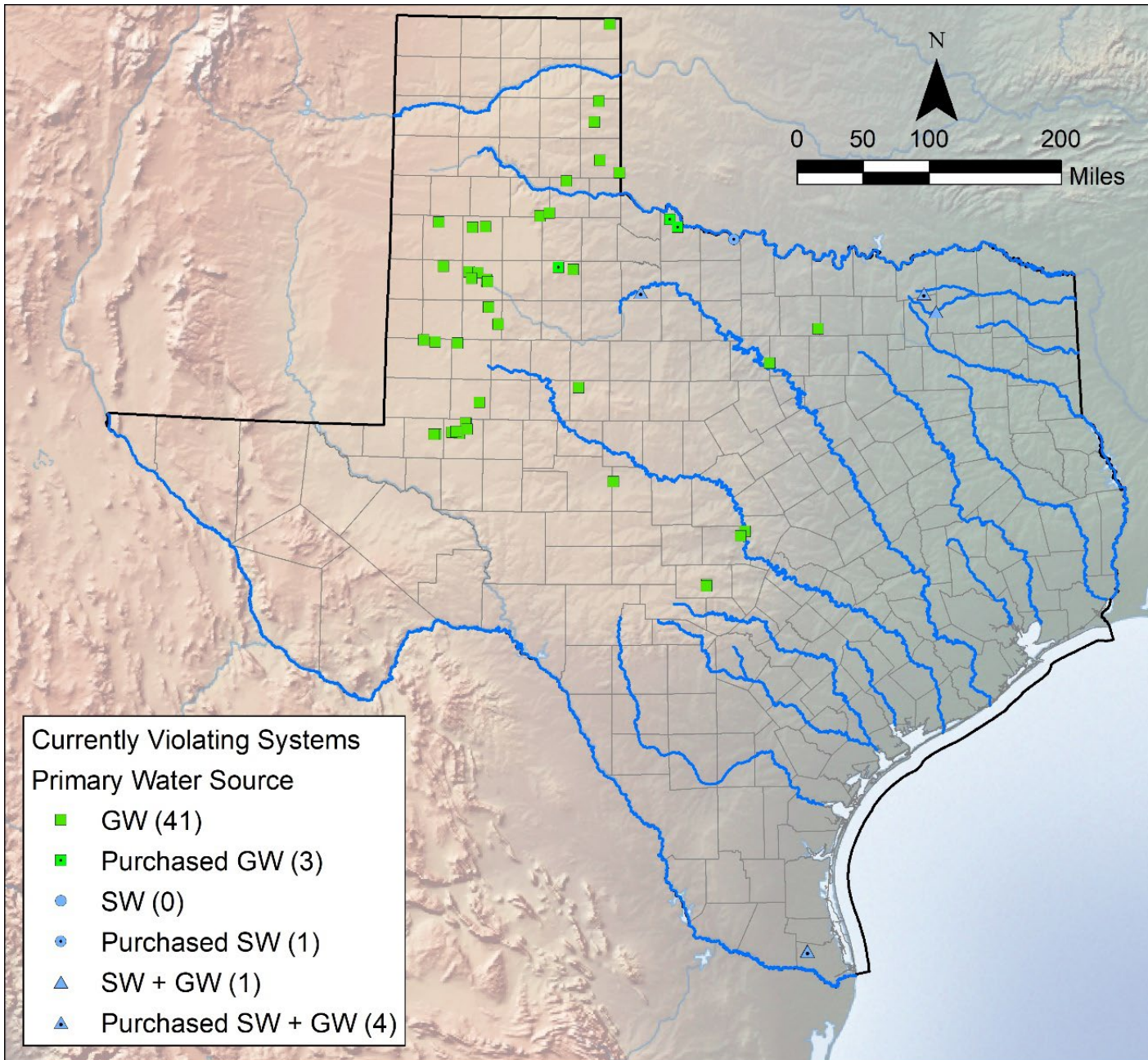
Nitrate Violations in Public Water Systems

Objective:

Assess linkages to public water systems and their populations

Method:

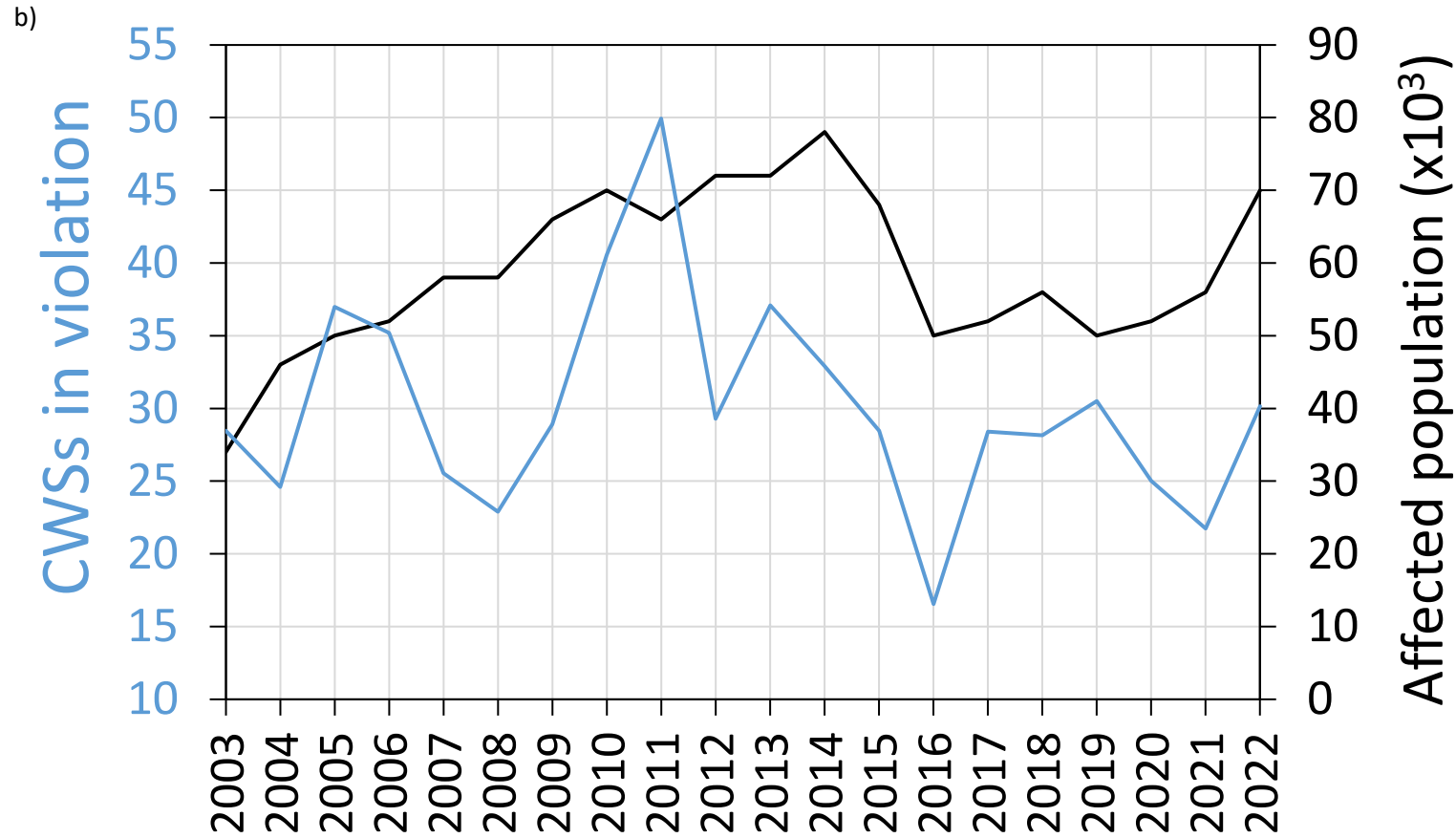
Analyze annual community water system data from 2003 to 2023, EPA nitrate rule violations



- Locations of CWSs with current Nitrates Rule violations during Jan 2022 – Jun 2023 symbolized by reported primary water source.
- Sources include
 - groundwater (GW)
 - surface water (SW)
 - water purchased water from another CWS system.
- There are many systems that indicate surface water as their primary source (purchased or not) that also include one or more active groundwater wells as a listed facility.



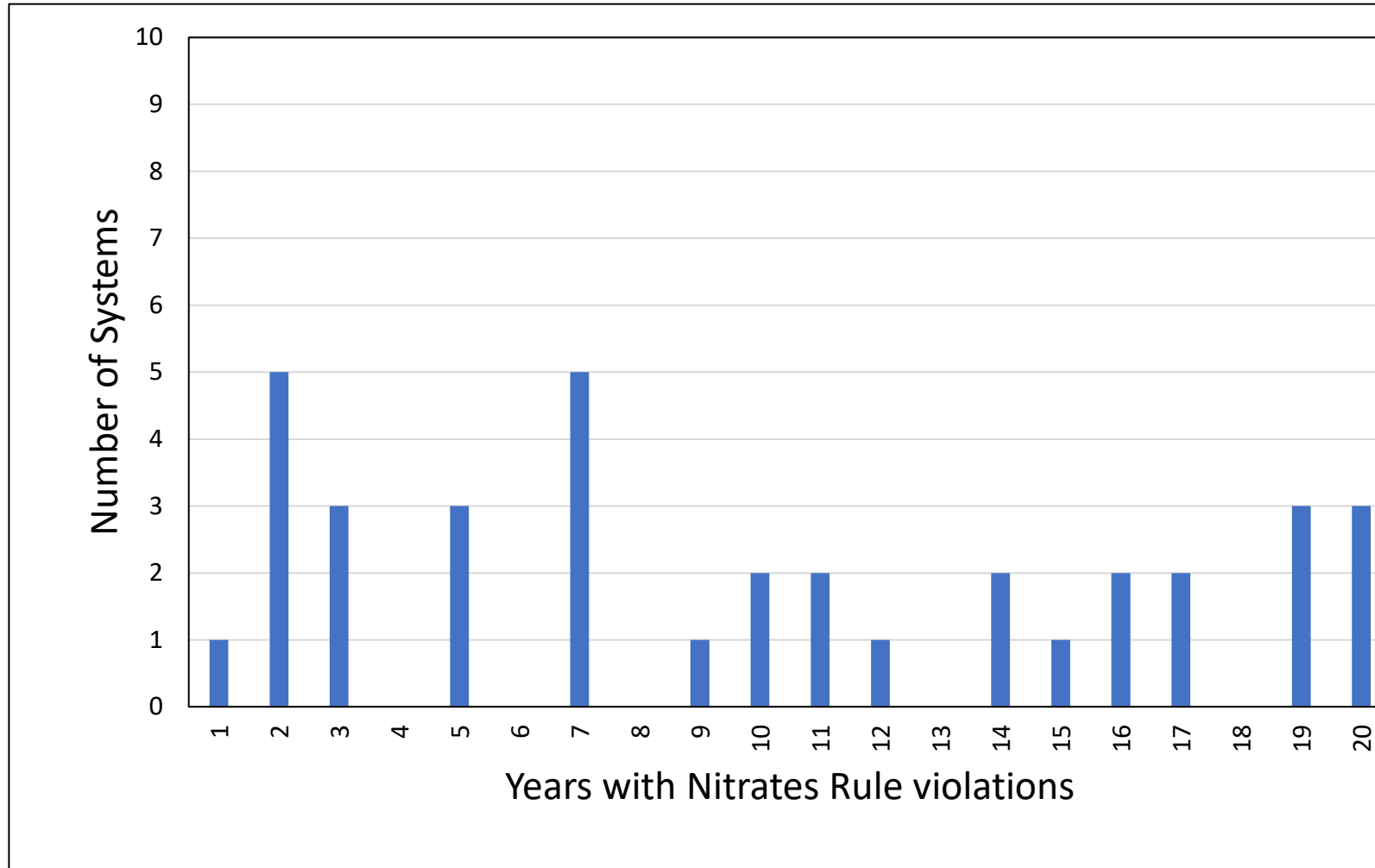
Variations in Nitrate Rule violations through time



Years of Nitrate Rule violations for CWSs in Texas and time series of violating systems and associated populations for currently active systems during 2003 – 2022.



Persistence of Violations: Years of Nitrate Rule violations during 2003 – 2023 for CWSs in Texas with current violations.





Persistence of Violations: Chronic Non-Compliance

PWS ID	PWS Name	Po. Served	Aquifer Name	No. of Quarters	2018				2019				2020			
					1	2	3	4	1	2	3	4	1	2	3	4
TX1650077	SOUTH MIDLAND COUNTY WSS	165	Ogallala	12	1	1	1	1	1	1	1	1	1	1	1	1
TX1530005	GRASSLAND WSC	55	Ogallala	10	1	1	1	1	1	1	1	1	1	1	1	1
TX1650111	COUNTRY VILLAGE MH ESTATES	138	Ogallala	10	1	1	1	1	1	1	1	1	1	1	1	1
TX1520080	FRANKLIN WSS 3	159	Ogallala	9	1	1	1	1	1	1	1	1	1	1	1	1
TX0580013	WELCH WSC	315	Ogallala	9	1	1	1	1	1	1	1	1	1	1	1	1
TX1100011	WHITHARRAL WSC	200	Ogallala	9	1	1	1	1	1	1	1	1	1	1	1	1
TX0680051	CANYON DAM MH PARK	108	Trinity	9	1	1	1	1	1	1	1	1	1	1	1	1
TX1650048	GREENWOOD TERRACE MH Sub.	120	Ogallala	9	1	1	1	1	1	1	1	1	1	1	1	1
TX1650057	TWIN OAKS MHP MIDLAND	234	Ogallala	8	1	1	1	1	1	1	1	1	1	1	1	1
TX1590002	MARTIN COUNTY FWSD 1	54	Ogallala	7	1	1	1	1	1	1	1	1	1	1	1	1
TX0990001	CITY OF CHILLICOTHE	707	Seymour	6	1	1	1	1	1	1	1	1	1	1	1	1
TX1380011	CITY OF BENJAMIN	258	Seymour	6	1	1	1	1	1	1	1	1	1	1	1	1
TX0580025	KLONDIKE ISD	264	Ogallala	4	1	1	1	1	1	1	1	1	1	1	1	1
TX0440002	CITY OF DODSON	109	Seymour	4	1	1	1	1	1	1	1	1	1	1	1	1
TX1520046	WILDWOOD MH VILLAGE	672	Ogallala	4	1	1	1	1	1	1	1	1	1	1	1	1
TX0860080	ROYAL OAKS APARTMENTS	57	Trinity	3	1	1	1	1	1	1	1	1	1	1	1	1

Summary of CWSs with a nitrate-rule violation between 2018-2020 with persistence of nitrate rule violations per quarter. No. of quarters refers to quarters that CWSs are noncompliant.

Many of these chronically non-compliant systems are from small-rural areas.

Infrastructure, funding, and personnel are key issues.



Nitrate Concentrations in Major & Minor Aquifers

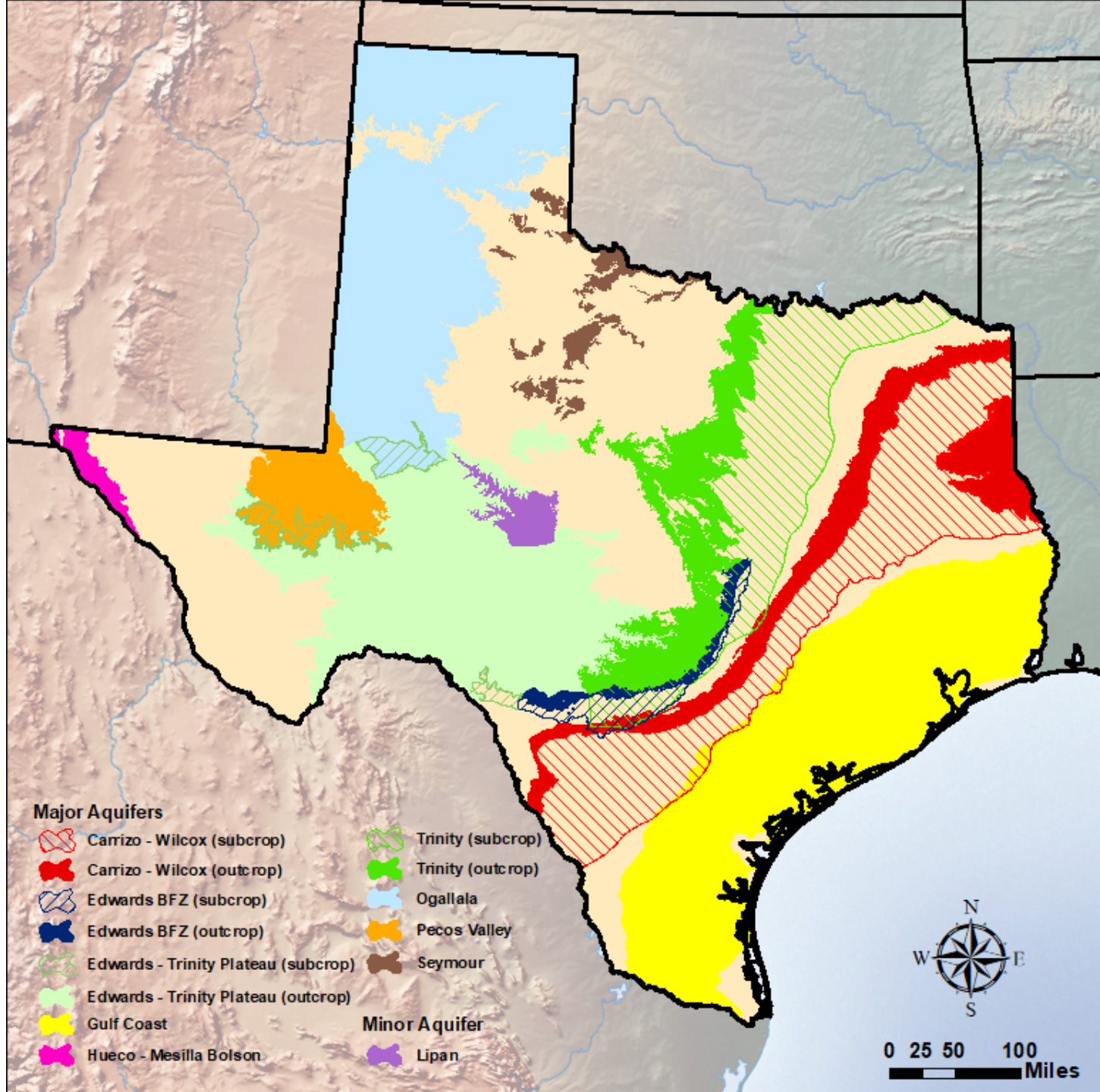
Objective:

Quantify the distribution of groundwater nitrate in major and minor aquifers

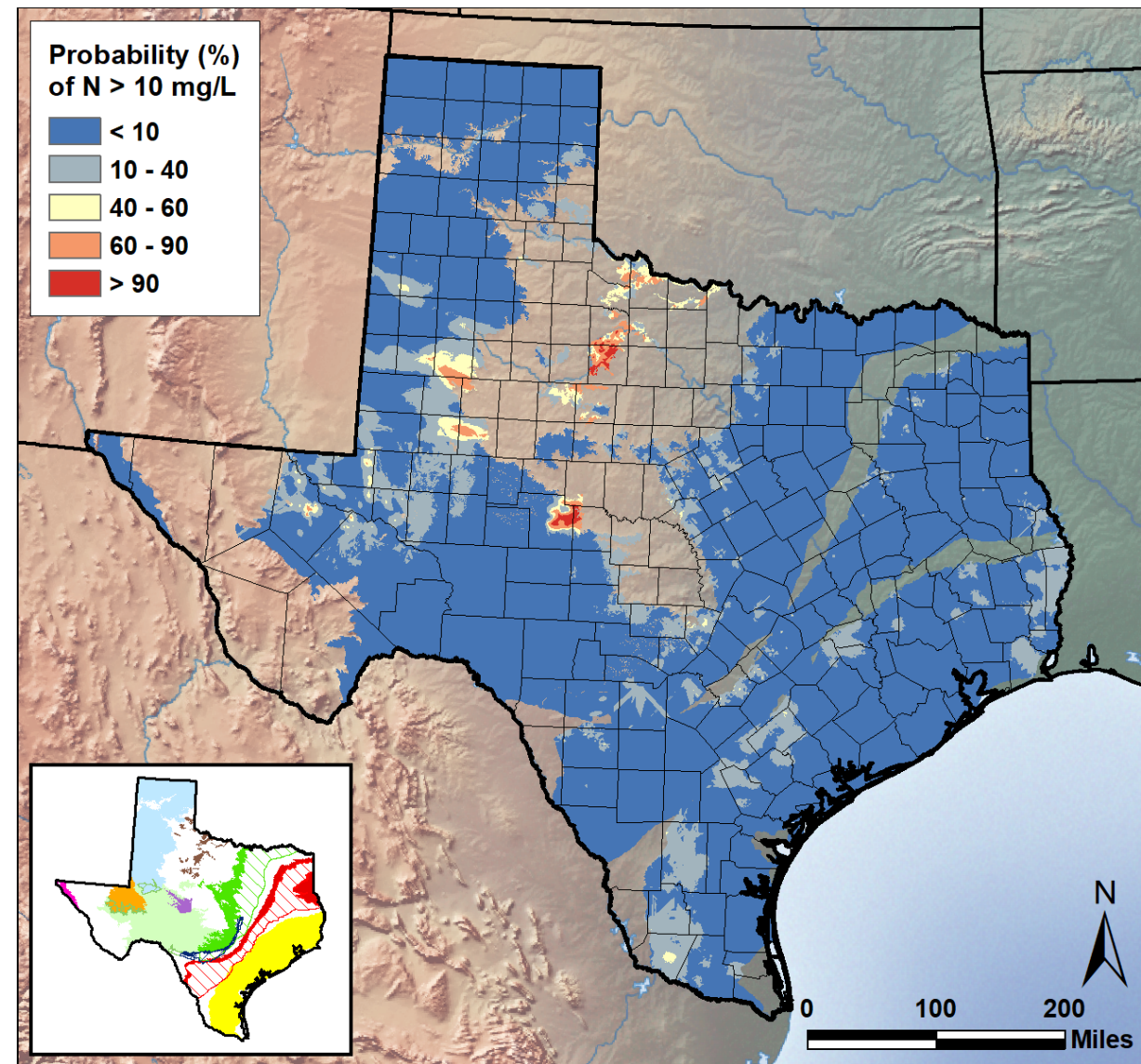
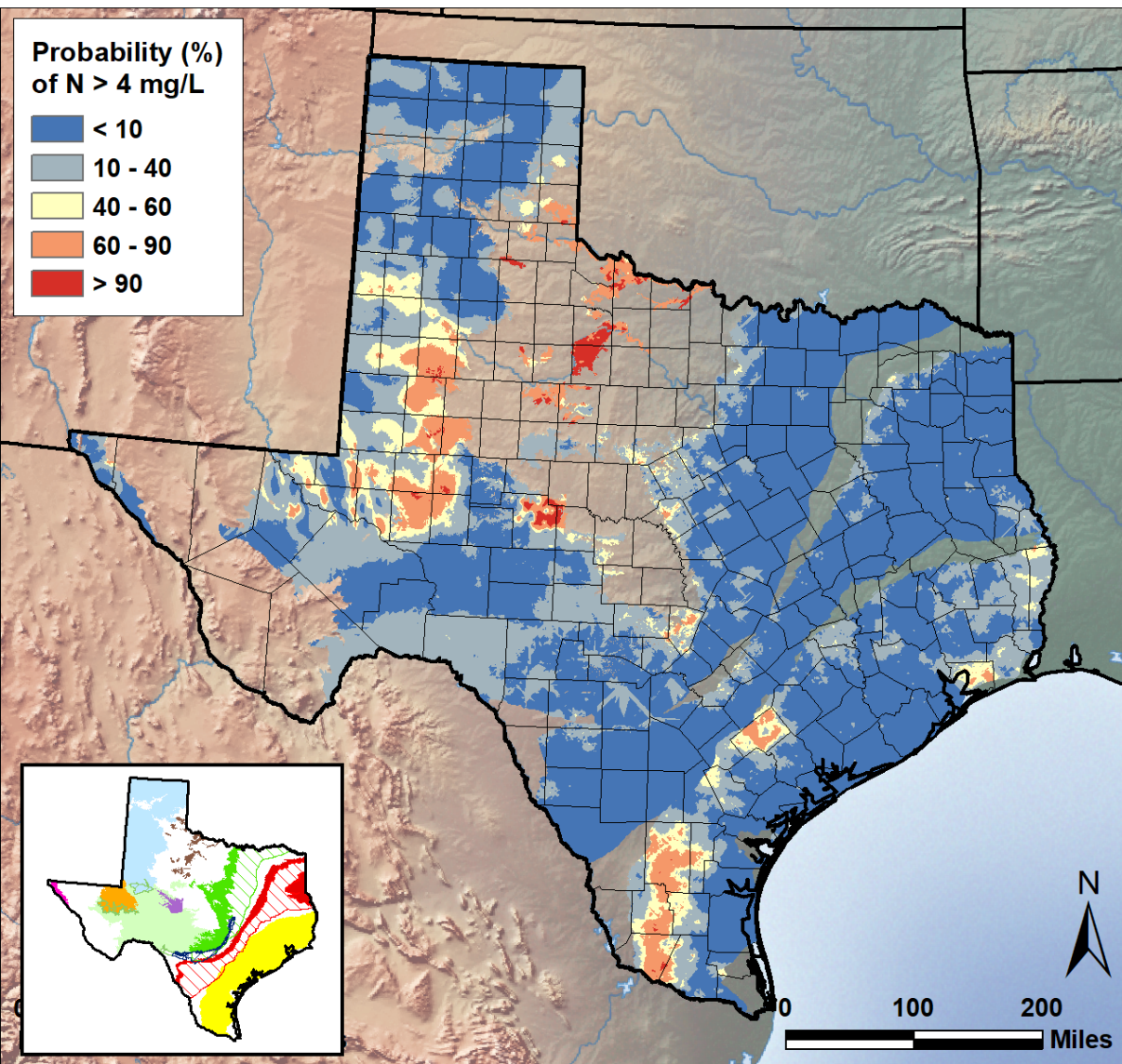
Method:

Conduct spatial analysis of nitrate concentrations from TWDB well database (33k samples)

Major Aquifers



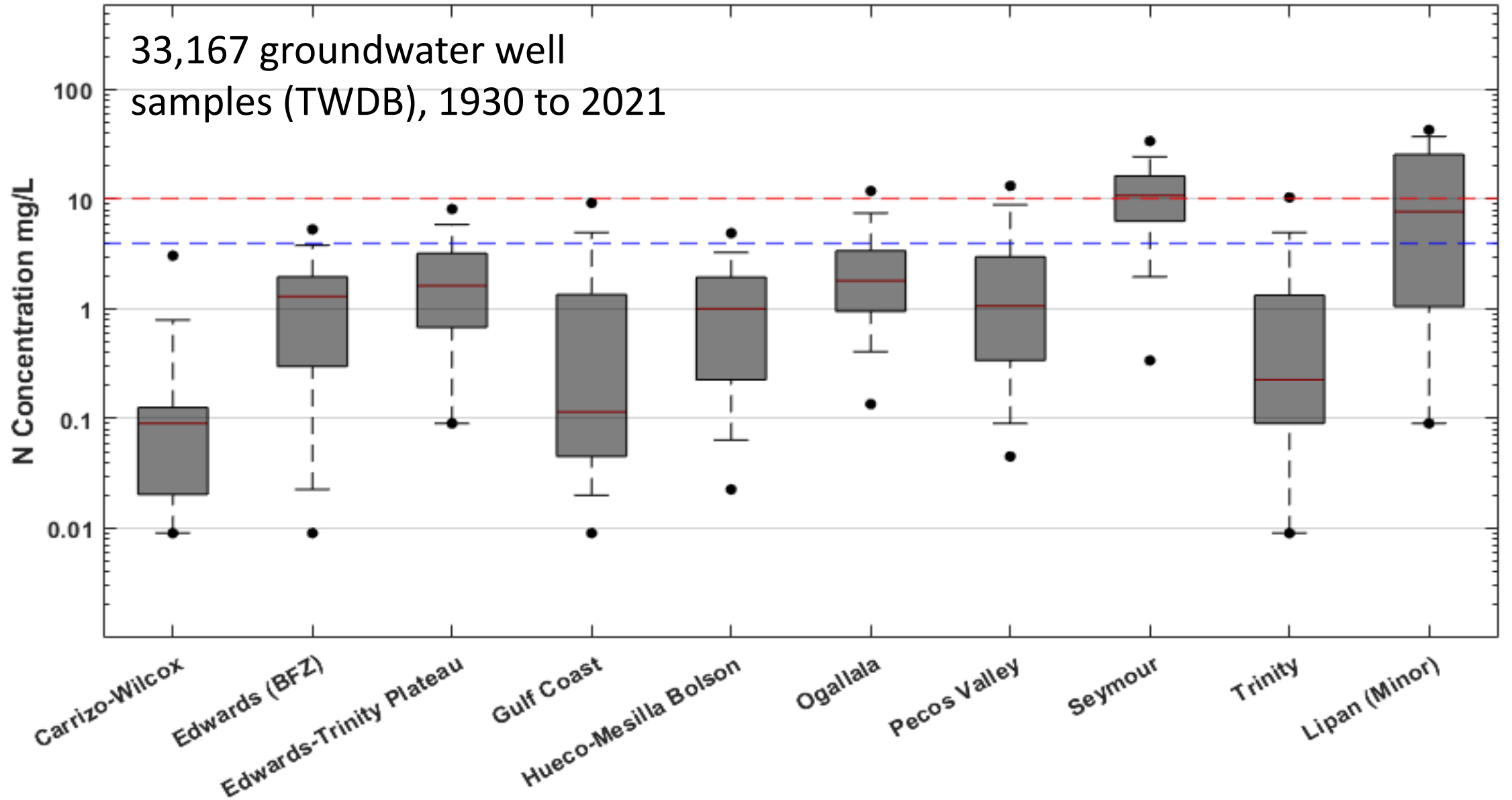
Major Aquifer Ambient Nitrate Levels



Probability of Nitrate Levels exceeding 4 mg/L and 10 mg/L [Nitrate-N MCL]



Major Aquifer Ambient Nitrate Levels





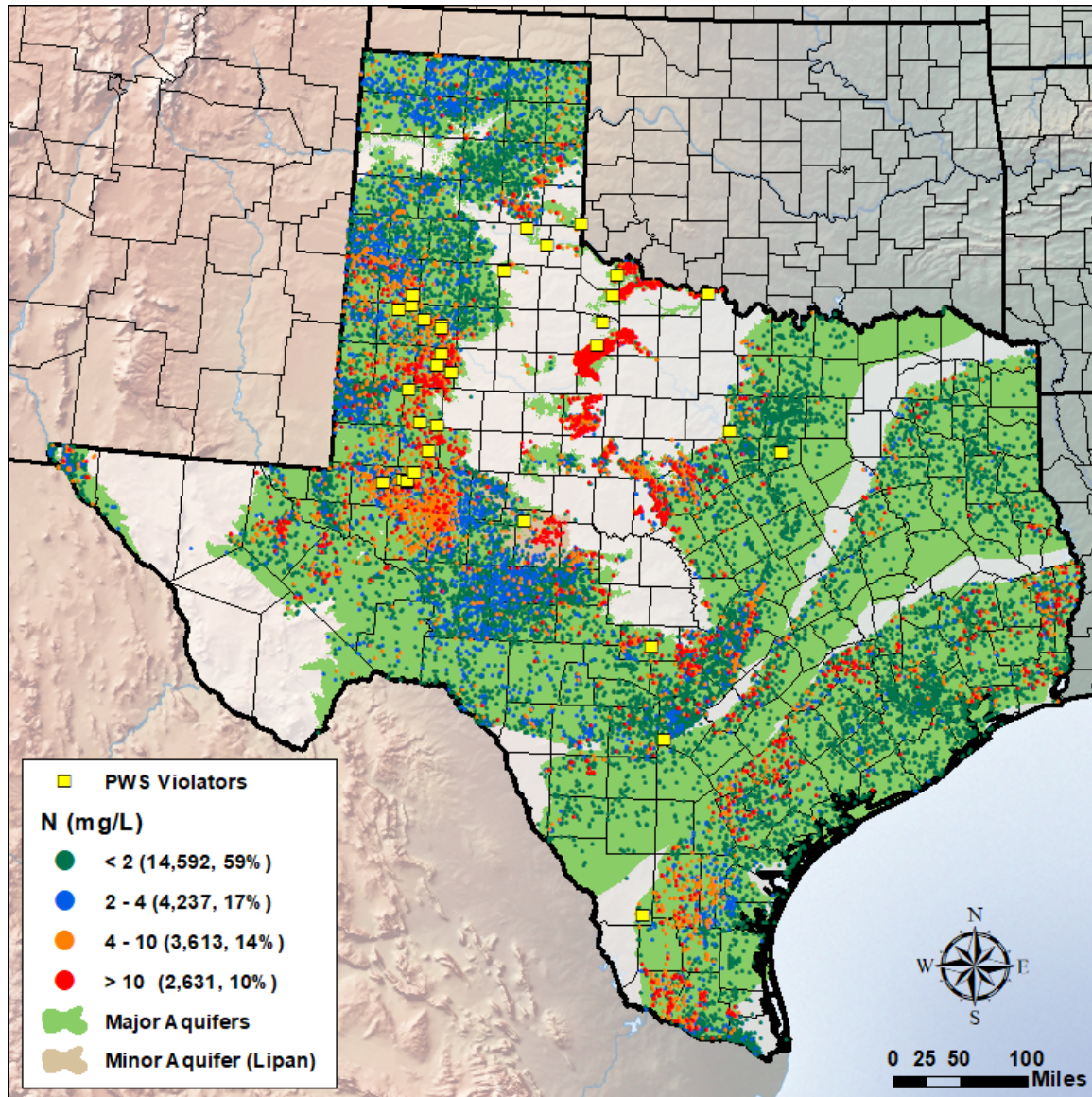
Major Aquifer Ambient Nitrate Levels

Aquifer	Aquifer Group	Total Number of Samples	Detects	Non-Detects	Nitrate-N >4 mg/L		Nitrate-N >10 mg/L	
					Samples	% of Total	Samples	% of Total
Carrizo-Wilcox	Major	3868	1619	2249	156	4.03	71	1.8
Edwards BFZ	Major	1465	1235	230	138	9.42	24	1.6
Edwards-Trinity Plateau	Major	5162	4482	680	1013	19.62	176	3.4
Gulf Coast	Major	6916	4641	2275	1030	14.89	315	4.6
Hueco-Mesilla Bolson	Major	547	479	68	45	8.23	7	1.3
Ogallala	Major	6439	6224	215	1326	20.59	419	6.5
Pecos Valley	Major	661	592	69	137	20.73	59	8.9
Seymour	Major	2199	2149	50	1840	83.67	1202	54.7
Trinity	Major	5763	3860	1903	779	13.52	294	5.1
Lipan	Minor	147	141	6	90	61.22	64	43.5
Total		33167	25422	7745	6554	19.76	2631	7.9

Major Aquifers Nitrate Rule Compliance (2018 – 2020)

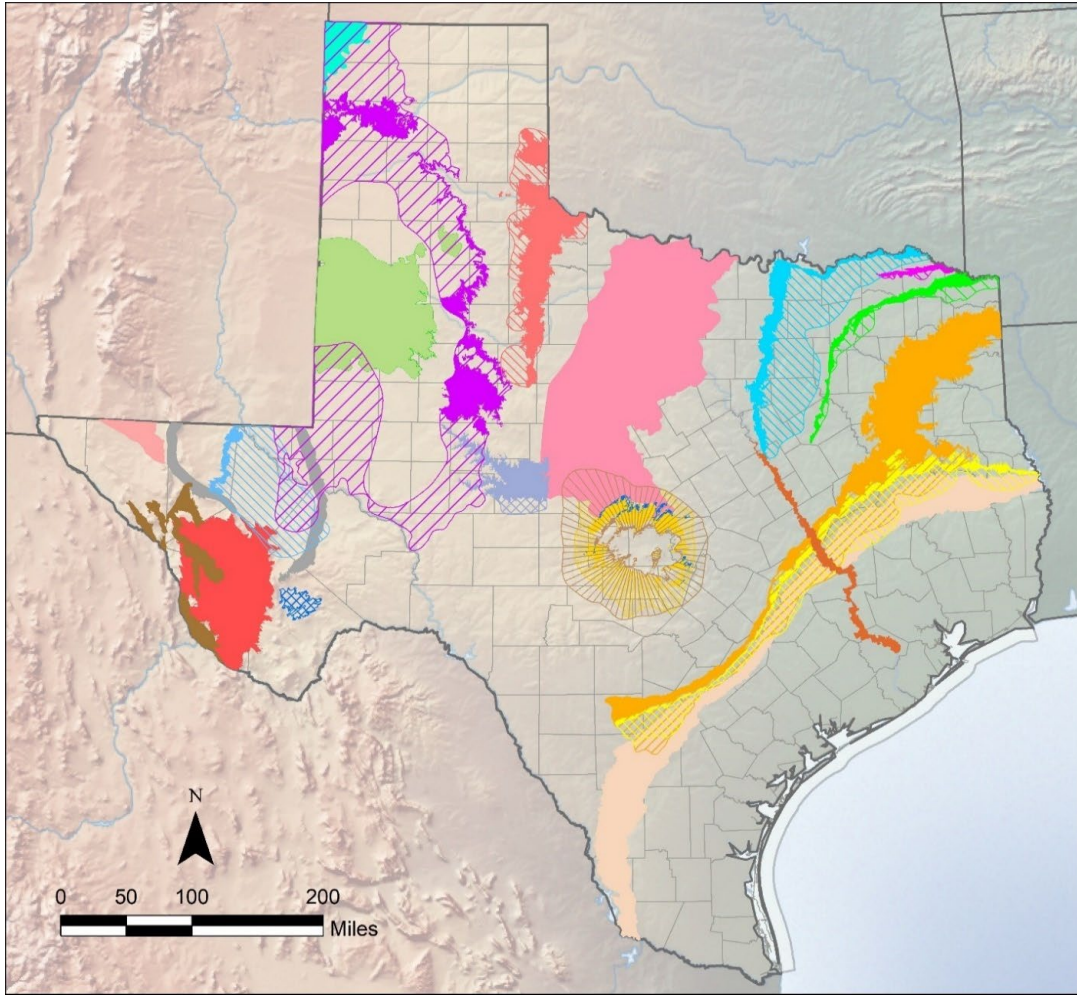
Aquifer	TCEQ Database			EPA Non-compliant	
	CWS Systems			CWS Systems	
	N >4 mg/L			N >10 mg/L	
	Number of NCWS	CWS	CWS At-risk Population	CWS	Population
Carrizo-Wilcox	2	5	42,506	-	-
Edwards BFZ	1	5	20,867	1	11,007
Edwards-Trinity Plateau	21	10	9,089	1	195
Gulf Coast	14	11	54,682	1	460
Hueco-Mesilla Bolson		3	6,109	-	-
Ogallala	71	81	64,670	18	7,017
Pecos Valley	1	-	-	-	-
Seymour	17	12	3,330	9	2,237
Trinity	8	22	70,107	4	6,631
Lipan (Minor)	4	4	16,158	1	4,569
Total		153	287,518	35	32,116
Percent of 2020 pop.			0.99		0.09

Major Aquifers Nitrate Rule Compliance

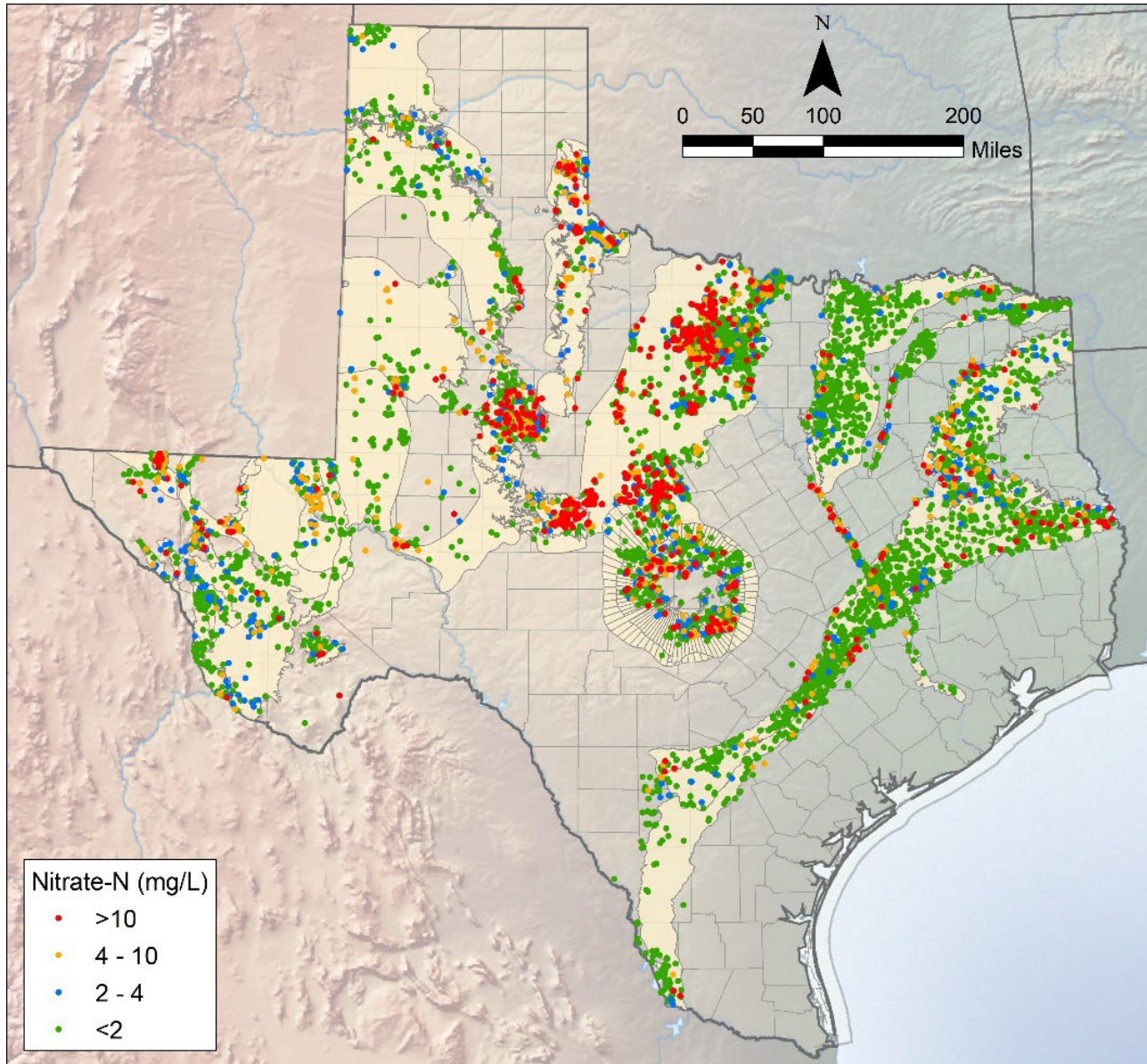


35 community water systems had health-based non-compliance violations for nitrate-N concentrations based on the EPA SDWIS database (12 quarters, Jan 2018 – Dec 2020).

Minor Aquifers



Minor Aquifers Ambient Nitrate Levels

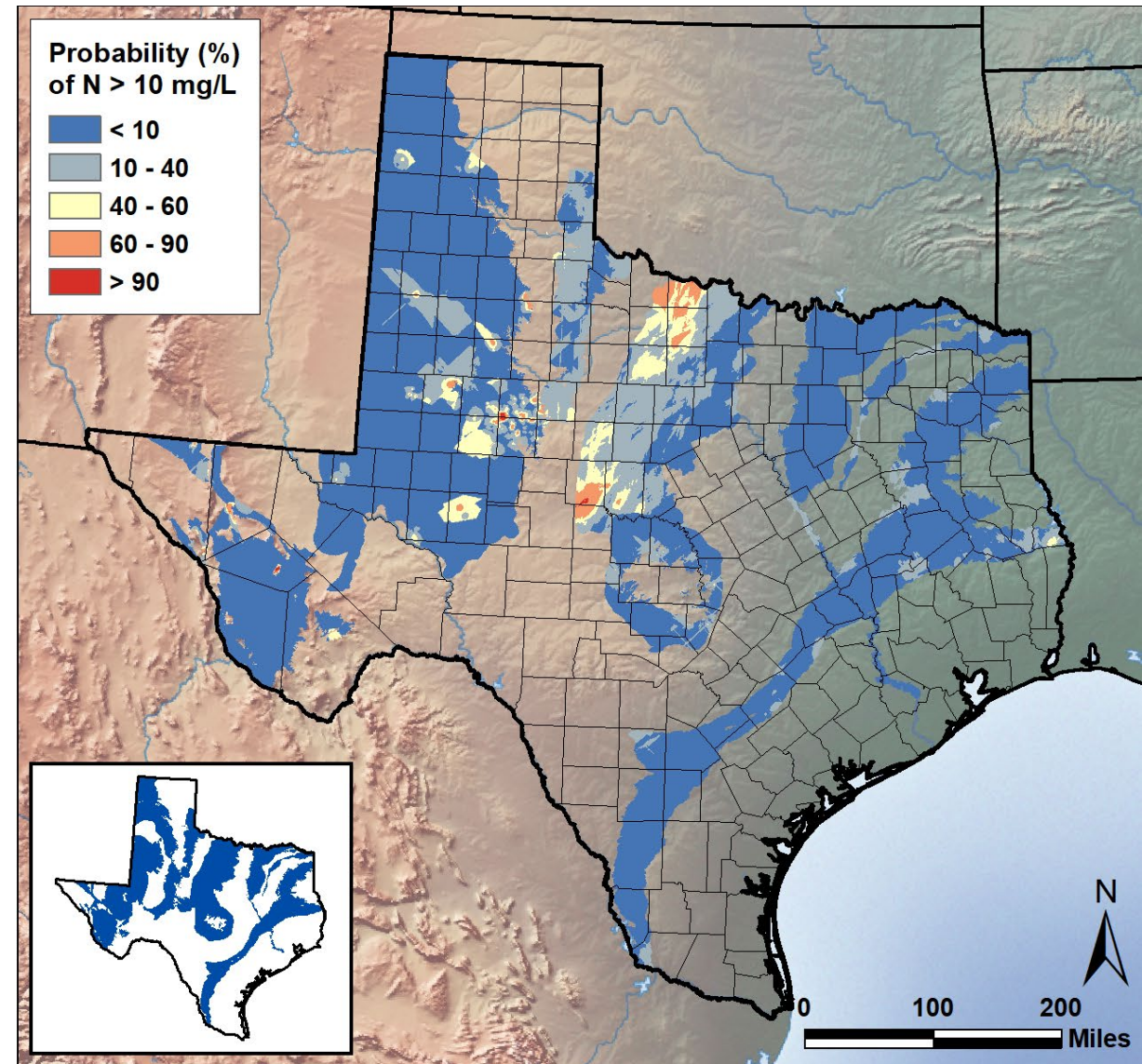
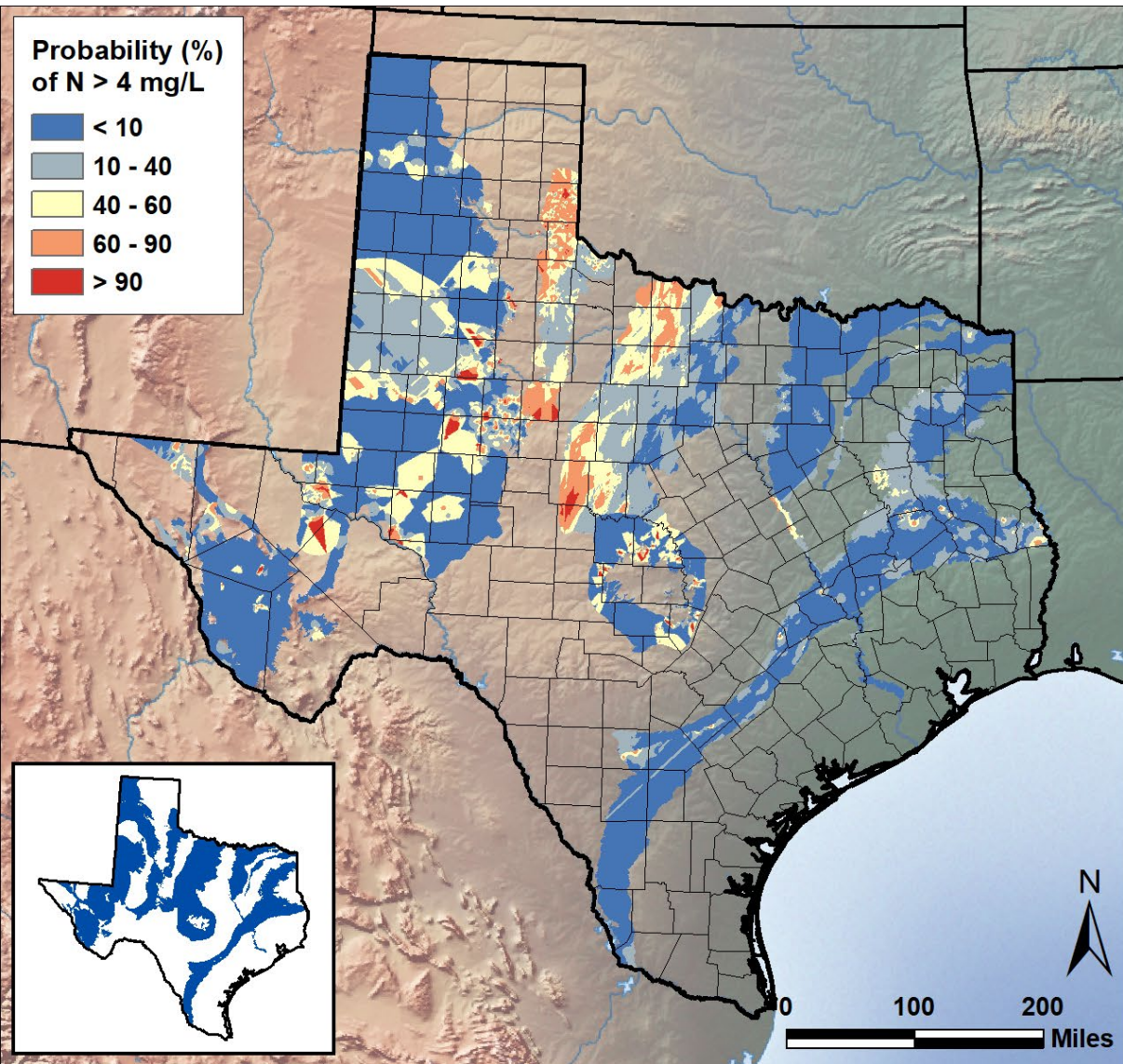


Spatial distribution of nitrate-N concentrations in the minor aquifers of Texas.

Values represent the latest sample for each location collected from 1930 – 2023. Samples from wells completed in more than one aquifer are not included.

Elevated N levels are located primarily in the Bone Spring, Cross-Timbers, and Blaine aquifers.

Minor Aquifers Ambient Nitrate Levels



Probability of Nitrate Levels exceeding 4 mg/L and 10 mg/L [Nitrate-N MCL]

Minor Aquifers Ambient Nitrate Levels

- Summary of nitrate-N analyses in the minor aquifers of Texas. Values represent the latest samples from the TWDB groundwater database for wells sampled between 1930 and 2023.

Aquifer	Total Number of Samples	Number of Detects	Number of Non-Detects	Nitrate-N > 4 mg/L		Nitrate-N > 10 mg/L	
				Samples	% of Total	Samples	% of Total
Blaine	282	208	74	100	35.5	37	13.1
Blossom	76	49	27	6	7.9	2	2.6
Bone Spring-Victorio Peak	161	145	16	74	46.0	30	18.6
Brazos River Alluvium	216	167	49	27	12.5	12	5.6
Capitan Reef Complex	64	46	18	5	7.8	1	1.6
Cross Timbers	2,252	1,588	664	530	23.5	336	14.9
Dockum	889	680	209	198	22.3	90	10.1
Edwards-Trinity (High Plains)	71	60	11	25	35.2	6	8.5
Ellenburger-San Saba	376	317	59	64	17.0	24	6.4
Hickory	476	390	86	110	23.1	42	8.8
Igneous	206	182	24	13	6.3	5	2.4
Lipan*	147	64	3	90	61.2	64	43.5
Marathon	44	40	4	4	9.1	2	4.5
Marble Falls	47	36	11	7	14.9	3	6.4
Nacatoch	204	113	91	9	4.4	7	3.4
Queen City	651	456	195	80	12.3	27	4.1
Rita Blanca	34	30	4	1	2.9	-	-
Rustler	53	39	14	18	34.0	6	11.3
Sparta	362	254	108	21	5.8	6	1.7
West Texas Bolson	260	246	14	26	10.0	9	3.5
Woodbine	685	410	275	15	2.2	4	0.6
Yegua-Jackson	664	409	255	51	7.7	34	5.1
Total	8,220	5,929	2,211	1,474	17.9	747	9.1

- The remaining minor aquifers (those NOT highlighted) had from 0.6% to 8.8% of samples above the MCL and the average for all minor aquifer samples was 9.1%. This is similar to but slightly larger than the exceedance rate of major aquifer samples (7.9%).

- *The Lipan aquifer was included in the major aquifers study.

Summary



- Texas has the largest number of active Community Water Systems in the country
 - Majority of the population has access to Community Water Systems
- 35 PWSs exceeded the nitrate-N MCL between 2018 and 2020
 - 32,116 people potentially affected
 - Violations tend to be persistent
 - Three of the major aquifers account for the majority of violations:
 - Seymour, Ogallala, and Trinity



Summary

- Ambient Nitrate Concentrations
 - Major Aquifers
 - 2,631 groundwater samples from the TWDB well database exceeded the nitrate-N MCL of 10 mg/L, representing 7.9% of the most recent nitrate analyses from wells
 - Minor Aquifers
 - 747 samples exceeded 10 mg/L, representing 9.1% of nitrate analyses from wells



Distribution of Fluoride Concentrations in Groundwater – 2021

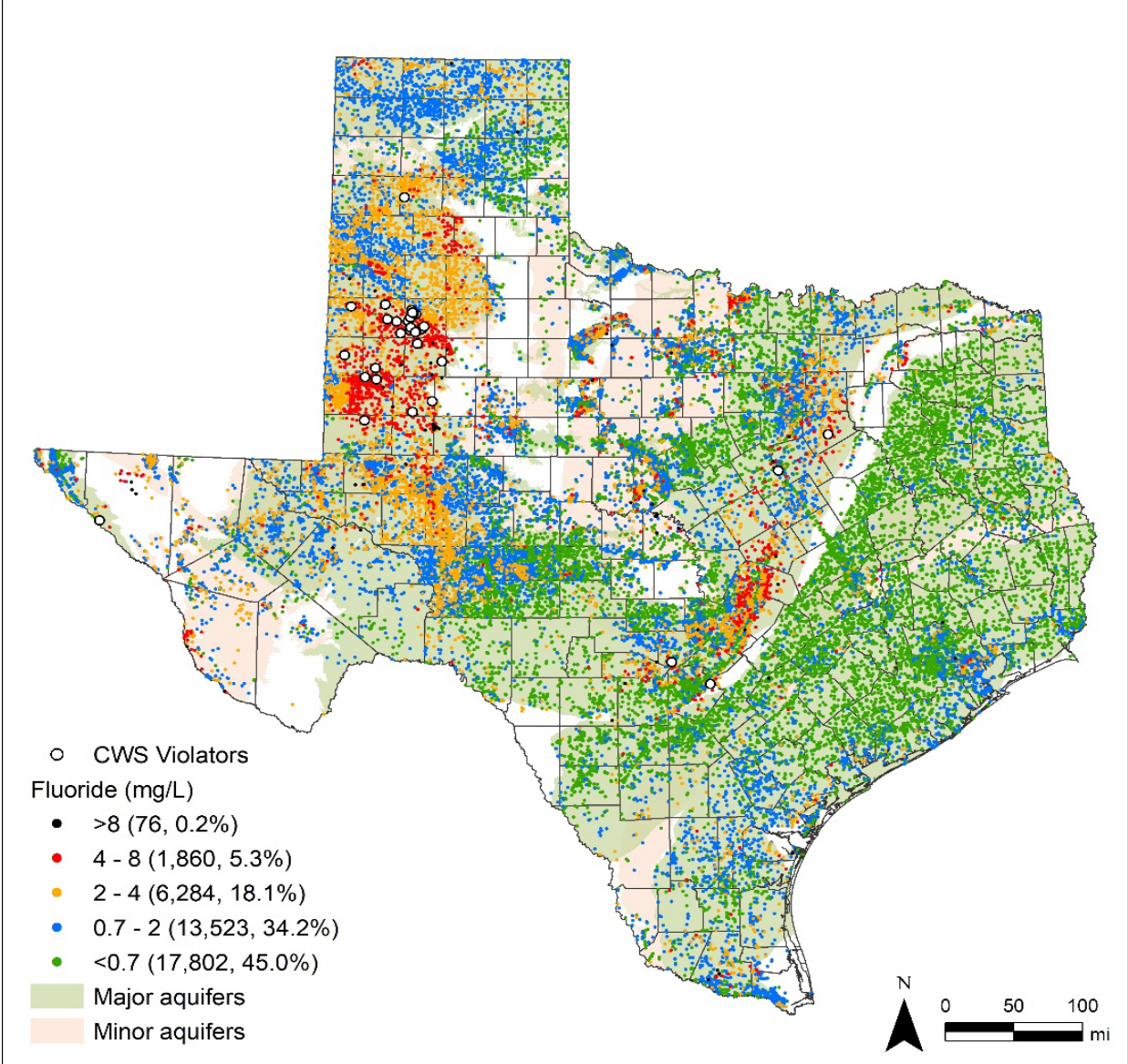
5% of samples \geq 4 mg/L (Primary MCL)

34 CWS exceeded 4 mg/L

Population impacted: ~38,000 people (0.1% of TX 2020 population)



Additional Work



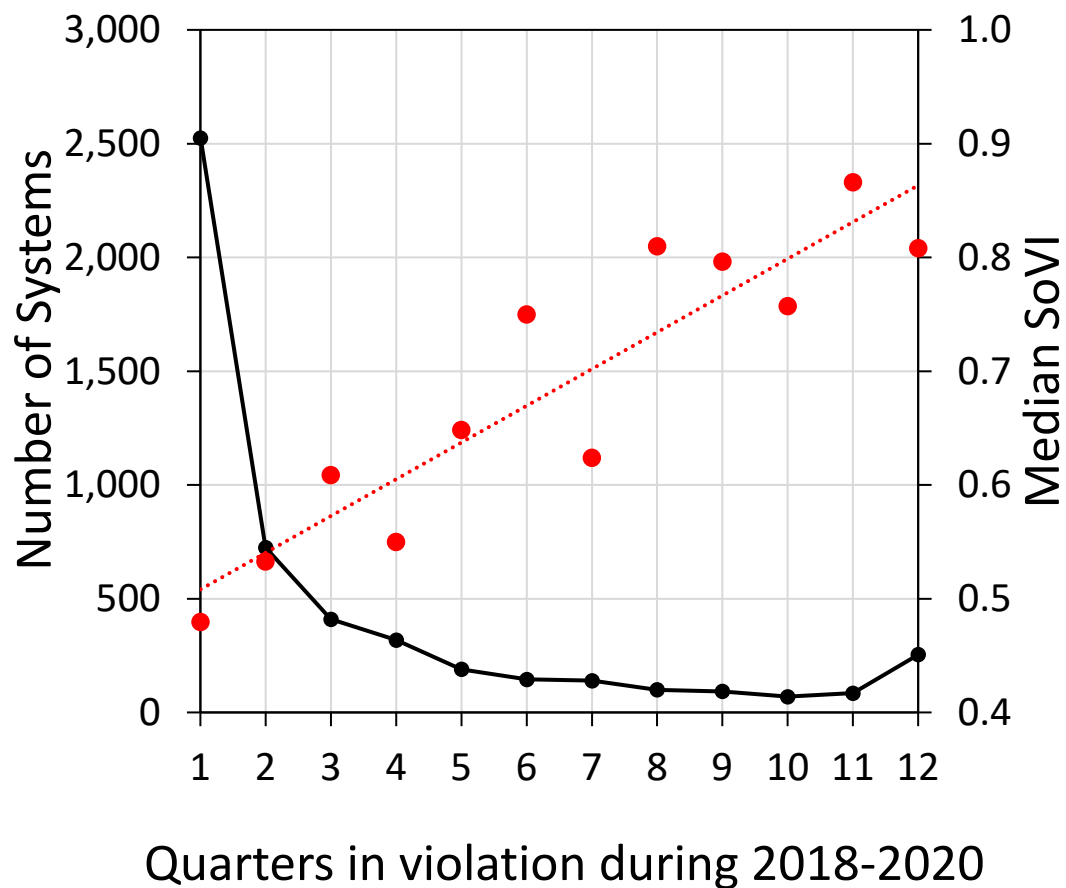


Persistence of U.S. Health Based Violations Correlated with **Social Vulnerability Index**

Violations of DBPR, inorganics, and arsenic are persistent and strongly linked to increasing SoVI (R2 0.63 – 0.82)



Additional Work





Thanks!

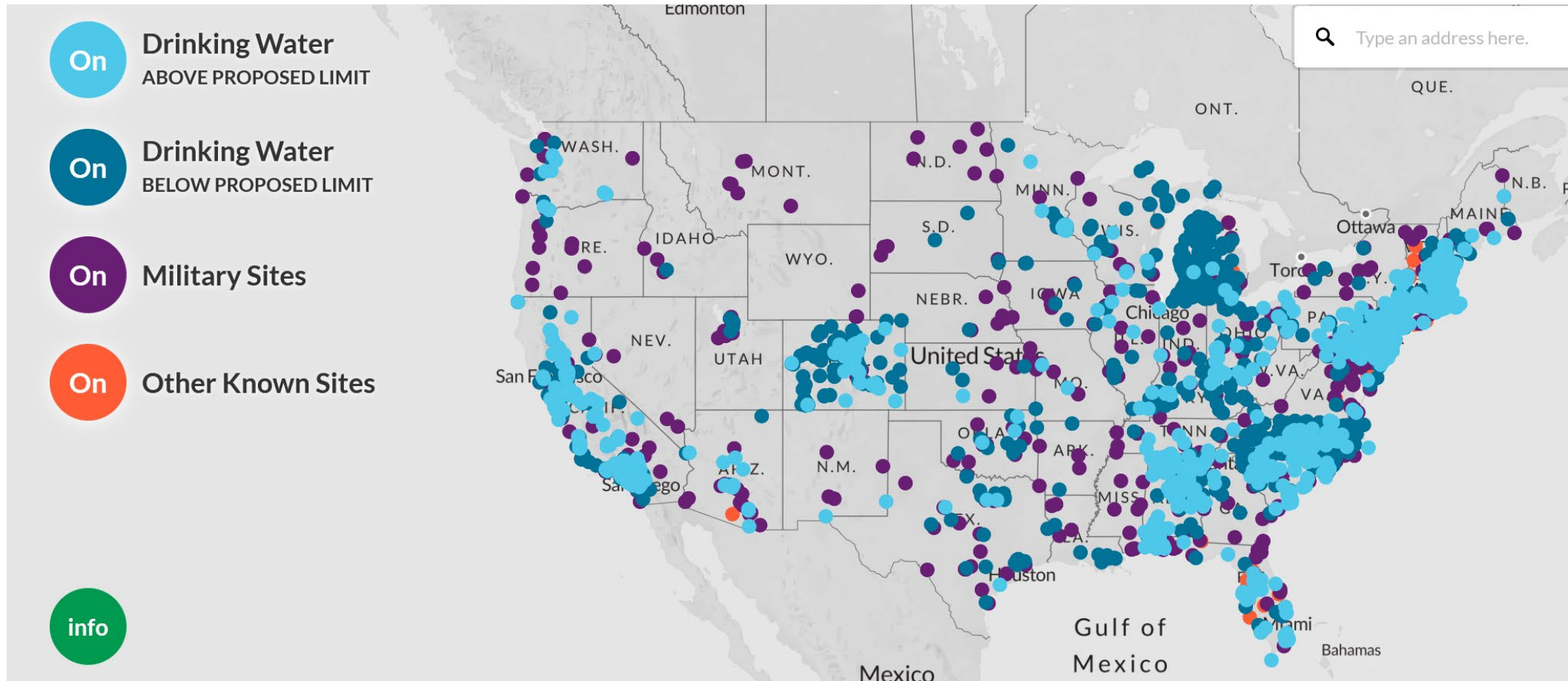


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Results for Unregulated Contaminant Monitoring Rule (UCMR)-5 PFAS



The MCLs announced are 4 parts per trillion, or ppt, for PFOA and 4 ppt for PFOS. For the other four PFAS, the agency proposes using a “hazard index,” a tool for addressing cumulative risks of mixtures of chemicals.

https://www.ewg.org/interactive-maps/pfas_contamination/



EPA Env. Finance Centers



NRWA

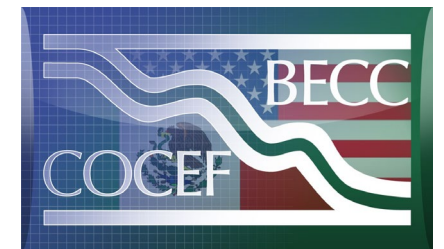


CADMUS

Texas Water Infrastructure Coordination Committee (TWICC)



COMMUNITIES Unlimited



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Future Implications for Compliance

- Changes in Federal regulations, key role (Contaminant Candidate List, e.g. PFAS, HABS)
- State specific regulatory issues
- Increase compliance: understand causes of non-compliance
- Consider non-treatment vs treatment options
- Infrastructure funding priorities:
 - High SoVI systems
 - Persistent violators
 - Very small (<500) to small (501 – 3,300) systems, rural/suburban
 - Climate impacts (floods/droughts, resilient infrastructure)
 - Workforce development