



Baseline Groundwater Quality Survey of Panola County, Texas

Prepared by:
Panola County Groundwater
Conservation District

Prepared by:
Wade A. Oliver, P.G.
INTERA Inc.

September 2019

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Introduction

The data collection efforts and series of maps documented here reflect a baseline groundwater quality survey in Panola County, Texas. Groundwater use in Panola County is managed by Panola County Groundwater Conservation District (GCD or the "District"), which funded this survey. Panola County is in eastern Texas on the Texas/Louisiana border. Groundwater in Panola County exists primarily in the Wilcox unit of the Carrizo-Wilcox Aquifer. Figure 1 below shows the location of Panola County and a cross section of the aquifer. Panola County is in the Sabine uplift area where the aquifer is exposed at land surface. For additional information

on the hydrogeologic characteristics of the Carrizo-Wilcox Aquifer in Panola County, refer to previous studies such as Kelley and others (2004), Fryar and others (2003), Oliver and Lupton (2013) and Lupton and others (2015).

The purpose of the current study is to assemble and synthesize available groundwater quality data for Panola County. This will be used by Panola County GCD to better understand the availability and usability of groundwater and incorporate the data collected into the District's water quality database.

Data Sources

This study represents a desktop evaluation and compilation of data from available sources and studies. We reviewed numerous studies and data sources with the potential to provide reliable information on groundwater quality in Panola County. The study focused on compilation of data representing natural groundwater conditions as opposed to local-scale groundwater contamination. While local-scale groundwater contamination

can be important at certain sites, they do not help characterize groundwater availability and usability across the county.

The primary source of data for this study is the Texas Water Development Board Groundwater Database (TWDB, 2019). TWDB maintains the Groundwater Database as a central location for water level and water quality data on certain wells in Texas. Data is submitted to TWDB from many sources including groundwater conservation districts, the US Geological Survey, raw water from public utilities, and data collected directly by TWDB staff. The compilation here includes 5,809 water quality analyses across 97 wells in Panola County from the TWDB Groundwater Database.

Another source of data for the study is the sampling results documented in Nicot and others (2017). That study focused on evaluating the sources of dissolved methane in groundwater in and around Panola County. The study included sampling of 70 wells, 43 of which were in the county. Nicot and others (2017) found that the dissolved methane was of mixed microbial (biogenic) and thermogenic origins. The findings "... strongly suggest that dissolved methane in the Panola County cluster is due to natural processes" (Nicot and others, 2017). With the development of hydrocarbons in Panola County, there was some concern that the presence of dissolved methane in groundwater was due to contamination. Nicot and others (2017) conclude that the methane is likely due to natural processes due to 1) lack of correlation between the presence of methane and distance to gas wells, 2) the dry chemical composition of the gas, unlike the natural gas produced in the county, 3) the correlation of the

presence of methane with the location of shallow lignite coal, and 4) the presence of faults in areas with dissolved methane, providing a plausible pathway for upward migration of thermogenic gas.

Darvari and others (2018) is a follow up study to Nicot and others (2017) focused on the geochemical impact of dissolved methane in wells in Panola County. We confirmed with the author that Darvari and others (2018) used the same wells as were used in the Nicot and others (2017) study. Darvari and others (2018) notes that the presence of methane in Panola County is typically a sign of reducing groundwater conditions. The study included tests for many trace elements such as lithium, boron, aluminum, titanium, vanadium, chromium, arsenic, selenium, lead, and uranium among others. Darvari and others (2018) conclude that the concentrations of trace elements are generally lower where dissolved methane is present in groundwater. The author proposes a mechanism for this observation by which the presence of methane increases the pH of groundwater, which leads to the formation of clays and other precipitates, which scavengers dissolved trace elements taking them out of solution. We obtained the source data for the 42 wells sampled in the study and the concentrations of the 41 constituents evaluated in each well.

Other studies relating to ground water quality in Panola County were reviewed, but were determined to not contain additional information that could or should be included in Panola County GCD's groundwater database. For example, O'Rourke and others (2011) is a statewide survey of groundwater contamination in Texas. However, the study is limited to

contamination by anthropogenic sources and therefore is not representative of natural groundwater conditions. Reedy and others (2012) is a statewide survey of naturally occurring groundwater contamination in Texas. While the topic is relevant to this study, we confirmed with TWDB – the entity which funded and published the study – that source water quality data was not delivered or preserved beyond what is already included in the TWDB groundwater database.

Kreitler and others (2013) is an evaluation of the hydrochemical and isotopic data in Groundwater Management Areas 11, 12 and 13. Panola County GCD is in Groundwater Management Area 11 and is addressed in the study. However, after obtaining the source geodatabase for the study from TWDB, we determined that the new isotopic data collected for the study does not extend into Panola County and the other data evaluated as for the study was from the TWDB Groundwater Database.

Summary of Data Compiled

We compiled available information from the data sources described above into a format suitable for inclusion into the Panola County GCD water quality database. We have indicated in the data delivered to the District the source of the information, an identifier for each well, the well location, the date of collection (where available), the constituent evaluated, any quality flags associated with the analysis, and whether the value is below the detection limit of the instrument. We removed wells from the data set with issues flagged that could compromise data reliability such as unbalanced results and results where the sample was noted to not be representative of natural groundwater conditions. Table

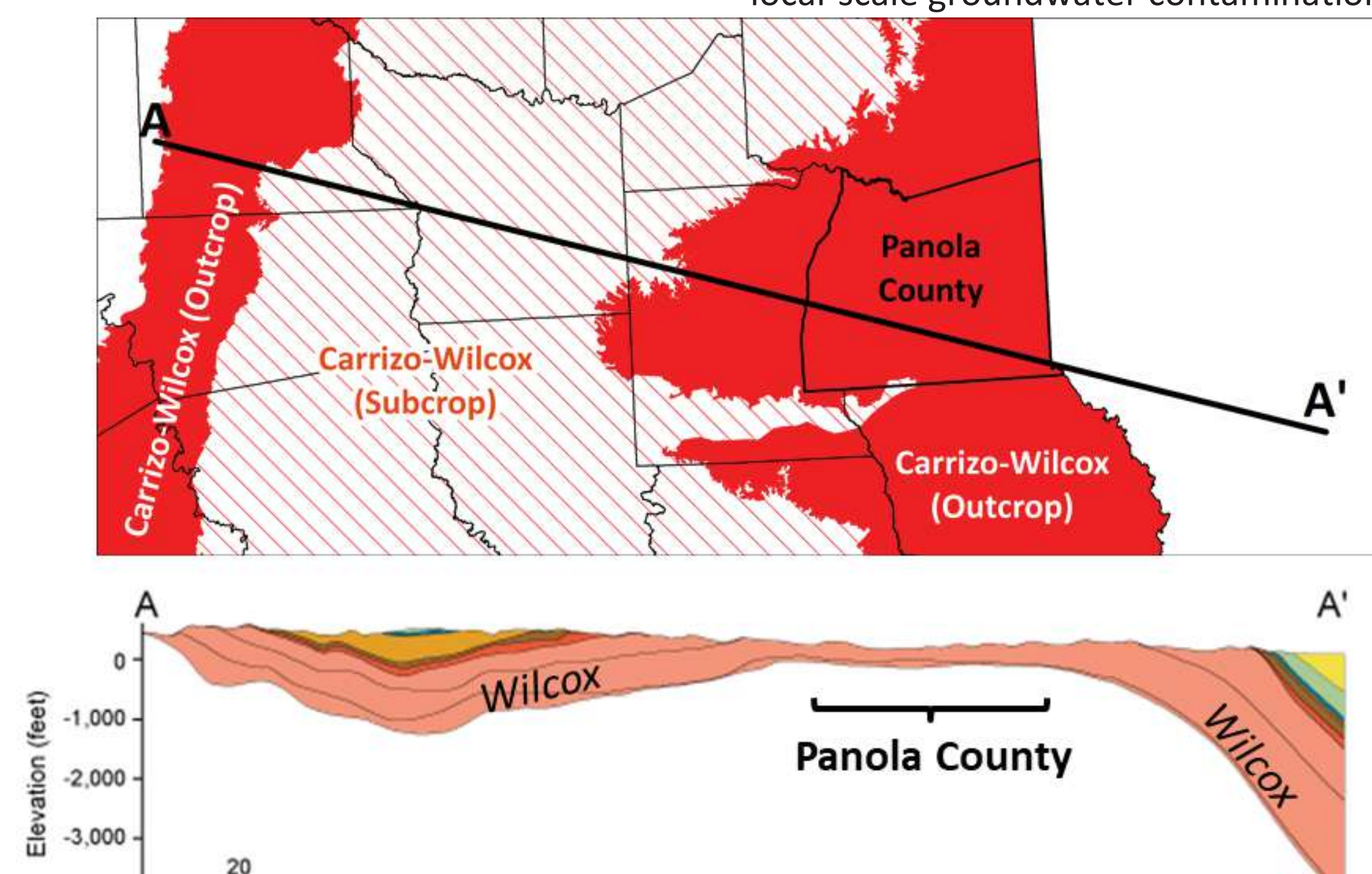


Figure 1. Cross-Section of the Carrizo-Wilcox Aquifer through Panola County. Modified from Kelley and others (2004).

1 on the following page summarizes the groundwater quality available for wells in Panola County for each constituent. In addition to the number of samples and number of wells with data available for each constituent, we have included the range of values, the average value and relevant primary and secondary drinking water standards.

The Environmental Protection Agency (EPA) maintains national drinking water regulations including maximum contaminant levels (MCLs). Primary MCLs relate to contaminants with known health impacts to humans related to exposure above a certain concentration. Secondary MCLs are not federally enforceable water quality regulations but are guidelines that can affect the cosmetic or aesthetic character of water such as taste, odor, or color.

As shown in Table 1, 28 of the 99 constituents in the dataset have primary MCLs. Of these 28, only one constituent (fluoride) has any sample results exceeding the primary federal drinking water standard. For fluoride, 2 of the 251 samples available from 136 wells in Panola County have results exceeding the primary MCL of 4 milligrams per liter (mg/L).

Also shown in Table 1, 19 of the 99 constituents have secondary MCLs relating to cosmetic or aesthetic characteristics of the water for drinking purposes. Of the 1,197 samples for the 19 constituents with secondary MCLs, 253 exceeded the secondary MCLs. The water quality parameters most commonly exceeding the secondary MCL were iron, total dissolved solids (TDS), and pH.

After Table 1 in this report is a series of plates showing the distribution of select water quality parameters in Panola County. Table 2 below lists the

parameters included in the plates, which we selected out of the 99 constituents listed in Table 1 based on the number of wells and samples available and the relevance to understanding groundwater availability and usability in Panola County.

Table 2. Water quality parameters mapped on plates in the current study

Mapped Parameters	
Arsenic	Manganese
Barium	Methane
Bicarbonate	pH
Boron	Phosphorus
Calcium	Silica
Chloride	Sodium
Copper	Strontium
Fluoride	Sulfate
Iron	Titanium
Magnesium	Zinc
Total Dissolved Solids	

The plates for parameters shown in Table 2 use a consistent approach to well selection and symbology. The wells shown represent the most recent sample in a given well for the specified parameter. The coloring of the wells, as reflected in the legend, indicates the concentration of the parameter or constituent and whether it is above or below the applicable MCL.

Also shown on the plates are counts for the number of wells that exceed the MCL and the average value for the wells shown. Note that these averages will not agree exactly with the averages shown in Table 2. The values shown in Table 2 represent the average of all samples for a given constituent, including multiple samples for an

individual well. The values shown in the plates represent the average of the most recent sample for wells shown on the map.

The secondary MCL for total dissolved solids is 500 mg/L. Fifty-seven (57) of the 140 wells displayed on the plate for total dissolved solids exceeded this standard. Elevated total dissolved solids are generally found in the south-central part of Panola County and correlate with the presence of the Lower Wilcox (Lupton and others, 2015). Higher total dissolved solids concentrations are also common in the northwestern portion of the county between Beckville and Tatum. Water is generally fresh (low total dissolved solids) east of the Sabine River.

Iron concentrations vary over short distances, but the higher values are generally found east of the Sabine River in areas with otherwise high-quality water. Of the 91 wells displayed on the plate, 26 have iron concentrations exceeding the secondary MCL of 300 micrograms per liter (ug/L).

pH is a characteristic of water typically evaluated in the field that indicates the concentration of hydrogen ions. A pH of 7 is considered neutral. A pH below 7 is considered acidic while a pH above 7 is considered alkaline (also called basic). The secondary MCL for pH is the range of 6.5 to 8.5. As shown on the plate, many more wells have pH values above 8.5 (41 wells) than below 6.5 (16 wells). Darvari and others (2018) contains a detailed discussion on the interrelationship among pH, dissolved methane and trace element concentrations.

One of the more significant contributions of Nicot and others (2017) to the data available to the District is the sampling for dissolved methane. The Texas Water

Development Board Groundwater Database only contains one datapoint in Panola County for dissolved methane. Nicot and others (2017) added 43 additional samples in the county. As shown in the plate, the areas of higher dissolved methane are clustered in the south-central portion of the county.

Conclusions

The purpose of this study was to compile baseline water quality information in Panola County. This information can be used to better understand the availability and usability of groundwater in the county as well as guide future sampling efforts. While there are some factors that may limit the usability of groundwater in certain areas (namely high total dissolved solids), the survey confirms that groundwater quality in Panola County is generally suitable in most areas for most purposes.

References

Darvari, R, Nicot, JP, Scanlon, BR, Mickler, P, and Uhlman, K, 2018, Trace element behavior in methane-rich and methane-free groundwater in north and east Texas, *Groundwater*, vol. 56, no. 5, pages 705-718

Fryar, DG, Senger, R, Deeds, NE, Pickens, J, and Jones, T, 2003, Groundwater availability model of for the northern portion of the Carrizo-Wilcox Aquifer, Final Report for the Texas Water Development Board, 529 p.

Kelley, VA, Deeds, NE, Fryar, DG, and Nicot, JP, 2004, Groundwater availability models for the Queen City and Sparta Aquifers, Final Report for the Texas Water Development Board, 867 p.

Kreitler, CW, Bassett, R, Beach, JA, Symank, L, O'Rourke, C, Papafotiou, A, Ewing, J, and Kelley, V, 2013, Evaluation of hydrochemical and isotopic data in groundwater management areas 11, 12 and 13, Final report prepared for the Texas Water Development Board, 488 p.

Lupton, DM, Dale, TF, and Oliver, WA, 2015, Characterization of Wilcox Aquifer structure, composition and hydraulic properties in Panola County, Texas, Final Report for Panola County Groundwater Conservation District, 158 p.

Nicot, JP, Larson, T, Darvari, R, Mickler, P, Sloten M, Aldridge J, Uhlman, K, and Costley, R, 2017, Controls on methane occurrences in shallow aquifers overlying the Haynesville Shale gas field, east Texas, *Groundwater*, vol. 55, no. 4, pages 443-454

Oliver, WA, and Lupton, DM, 2013, Wilcox structure, water levels and water quality in Panola County Groundwater Conservation District, 32 p.

O'Rourke, DO, Cross, and B, Symank, L, 2011, Anthropogenic groundwater contamination in Texas aquifers – Volume 1, Final report prepared for the Texas Water Development Board, 119 p.

Reedy, RC, Scanlon, BR, Walden S, and Strassberg, G, 2012, Naturally occurring groundwater contamination in Texas, Final contract report prepared for the Texas Water Development Board, 213 p.

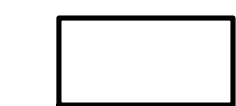
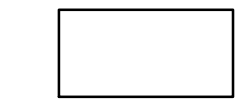



Texas Water Development Board, 2019, Texas Water Development Board Groundwater Database, <http://www.twdb.texas.gov/>

Table 1. Summary of Water Quality in Data in Panola County






PARAMETER							MAXIMUM CONTAMINANT LEVELS (MCL)				
	NUMBER OF WELLS	NUMBER OF SAMPLES		BELOW DETECTION LIMIT (BDL)	MINIMUM VALUE	MAXIMUM VALUE	AVERAGE VALUE	PRIMARY MCL	SECONDARY MCL	SAMPLES EXCEEDING	SAMPLES EXCEEDING
		SAMPLES								PRIMARY MCL	SECONDARY MCL
ALKALINITY FIELD DISSOLVED AS CaCO3	17	44			132	660	336.82				
ALKALINITY PHENOLPHTHALEIN FIELD DATA (MG/L)	10	21			0.5	26	15.79				
ALKALINITY, BICARBONATE DISSOLVED (MG/L), LAB	4	4			158	528	261				
ALKALINITY, CARBONATE DISSOLVED (MG/L), LAB	4	4	2		3.76	4	3.88				
ALKALINITY, HYDROXIDE DISSOLVED (MG/L), LAB	4	4	4		BDL	BDL	BDL				
ALKALINITY, PHENOLPHTHALEIN (MG/L)	97	219	128		1	45	15.391				
ALKALINITY, TOTAL (MG/L AS CaCO3)	97	219			5	662	284.962				
ALPHA, DISSOLVED (PC/L)	12	12	12		BDL	BDL	BDL	15			
ALUMINUM, DISSOLVED (UG/L AS AL)	15	41	27		1	8.94	4.576		200		
ALUMINUM, TOTAL (UG/L AS AL)	2	2	2		BDL	BDL	BDL		200		
ANION/CATION CHG BAL, PERCENT	9	20			-3.03	3.77	1.199				
ANTIMONY, DISSOLVED (UG/L AS SB)	15	41	41		BDL	BDL	BDL	6			
ANTIMONY, TOTAL (UG/L AS SB)	2	2	2		BDL	BDL	BDL	6			
ARSENIC, DISSOLVED (UG/L AS AS)	59	89	70		0.0679	4	1.57	10			
ARSENIC, TOTAL (UG/L AS AS)	4	4	4		BDL	BDL	BDL	10			
ATRAZINE, TOTAL, UG/L	8	8	3		0.05	0.05	0.05	3			
BARIIUM, DISSOLVED (UG/L AS BA)	59	89	1		10	345	65.66	2000			
BARIIUM, TOTAL (UG/L AS BA)	4	4	1		16	110	75.33	2000			
BERYLLIUM, DISSOLVED (UG/L AS BE)	15	41	41		BDL	BDL	BDL	4			
BERYLLIUM, TOTAL (UG/L AS BE)	2	2	2		BDL	BDL	BDL	4			
BETA, DISSOLVED (PC/L)	6	6	5		31	31	31				
BICARBONATE ION, CALCULATED (MG/L AS HCO3)	138	260			6.1	860.2	343.60				
BORON, DISSOLVED (UG/L AS B)	58	84	2		10	2841.9	523.13				
BROMIDE, DISSOLVED, (MG/L AS BR)	15	41	12		0.07	4.37	0.42				
CADMIUM, DISSOLVED (UG/L AS CD)	17	47	47		BDL	BDL	BDL	5			
CADMIUM, TOTAL (UG/L)	4	4	3		2.5	2.5	2.5	5			
CALCIUM (MG/L)	172	246			0.15	157	10.317				
CALCIUM, DISSOLVED (MG/L AS CA)	22	57	4		0.7	39.8	7.055				
CARBONATE ION, CALCULATED (MG/L AS CO3)	97	219	130		1.2	54	18.560				
CESIUM, DISSOLVED (UG/L AS CS)	42	42	16		0.02	0.573	0.080				
CHLORIDE, DISSOLVED (MG/L AS CL)	22	57			14	293	99.30		250		3
CHLORIDE, TOTAL (MG/L AS CL)	130	204			2.3	1664.5	100.52		250		12
CHROMIUM, DISSOLVED (UG/L AS CR)	59	89	38		0.0125	16.1	2.51	100			
CHROMIUM, TOTAL (UG/L AS CR)	4	4	4		BDL	BDL	BDL	100			
COBALT, DISSOLVED (UG/L AS CO)	57	83	63		0.01	2.1257	0.4418				
COPPER, DISSOLVED (UG/L AS CU)	59	89	31		0.32	74.41	9.185	1300	1000		
COPPER, TOTAL (UG/L AS CU)	4	4	4		BDL	BDL	BDL	1300	1000		
DELTA CARBON 13 CORRECTED, PER MIL	20	20			-75.9	-46.9	-58.044				
ETHANE, DISSOLVED IN WATER (UG/L)	44	44	23		0.4	717.3	110.919				
FLUORIDE, DISSOLVED (MG/L AS F)	136	251	14		0.1	11.1	0.603	4	2	2	9
HARDNESS, TOTAL, CALCULATED (MG/L AS CaCO3)	97	219			1	712	40.69				
IODIDE (MG/L AS I)	1	1			0.1	0.1	0.1				
IRON, DISSOLVED (UG/L AS FE)	24	59	22		6.3	1100	202.11		300		8
IRON, TOTAL (UG/L AS FE)	91	108	3		2.2	21000	1174.93		300		30
LEAD, DISSOLVED (UG/L AS PB)	17	47	47		BDL	BDL	BDL	15			
LEAD, TOTAL (UG/L AS PB)	4	4	3		2.5	2.5	2.5	15			
LITHIUM, DISSOLVED (UG/L AS LI)	57	83			1.84	80	20.35				
MAGNESIUM (MG/L)	88	162	18		0.02	78	4.28				
MAGNESIUM, DISSOLVED (MG/L AS MG)	106	141	9		0.02	14.1	2.14				
MANGANESE, DISSOLVED (UG/L AS MN)	63	98	6		0.3	584	27.73		50		12
MANGANESE, TOTAL (UG/L AS MN)	18	24	18		10	150	68.33		50		4
MERCURY, DISSOLVED (UG/L AS HG)	12	26	26		BDL	BDL	BDL	2			
MERCURY, TOTAL (UG/L AS HG)	4	4	3		0.14	0.14	0.14	2			
METHANE, DISSOLVED (UG/L)	44	44			4	33047	6995.12				
METOLACHLOR, WHOLE WATER, TOTAL RECOVERABLE, UG/L	3	3	3		BDL	BDL	BDL				
MOLYBDENUM, DISSOLVED (UG/L AS MO)	57	83	74		0.15	3	1.45				
NICKEL, DISSOLVED (UG/L AS NI)	51	55	28		0.04	5.3	0.89				
NICKEL, TOTAL (UG/L AS NI)	2	2	2		BDL	BDL	BDL				
NITRATE NITROGEN, DISSOLVED (MG/L AS N)	9	9	5		0.01	0.05	0.035	10			
NITRATE NITROGEN, DISSOLVED, CALCULATED (MG/L AS NO3)	136	248	162		0.04	54.6	2.24				
NITRITE NITROGEN, DISSOLVED (MG/L AS N)	7	7	6		0.76	0.76	0.76	1			
NITRITE PLUS NITRATE, DISSOLVED (MG/L AS N)	15	41	34		0.0204	2.52	0.460				
NITROGEN, AMMONIA, DISSOLVED (MG/L AS N)	10	13			0.16	1.24	0.696				
NITROGEN, KJELDAHL, DISSOLVED (MG/L AS N)	10	13			0.32	1.43	0.925				
OXIDATION REDUCTION POTENTIAL (ORP), MILLIVOLTS	10	13			-271	132.2	-100.792				
OXYGEN, DISSOLVED (MG/L)	7	7			0.19	5	1.299				
PH (STANDARD UNITS), FIELD	138	258			5.4	9	7.922		6.5-8.5		71
PHOSPHORUS, DISSOLVED (MG/L AS P)	53	61	4		0.0022	1.266	0.346				
PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE (MG/L AS P)	1	1			1.2	1.2	1.2				
POTASSIUM, DISSOLVED (MG/L AS K)	106	141			0.5	7.27	1.653				
POTASSIUM, TOTAL (MG/L AS K)	63	69	1		1	5.6	1.715				
PROPANE, DISSOLVED (UG/L)	43	43	41		0.2	1.6	0.9				
RADIUM 226, DISSOLVED, PC/L	6	6	6		BDL	BDL	BDL				
RADIUM 228, DISSOLVED (PC/L AS RA-228)	6	6	5		1.2	1.2	1.2				
RESIDUAL SODIUM CARBONATE, CALCULATED	97	219	18		0.02	13.1	5.422				
RUBIDIUM, DISSOLVED (UG/L AS RB)	42	42			0.23	4.82	1.406				
SELENIUM, DISSOLVED (UG/L AS SE)	60	90	80		0.063	2	1.076	50			
SELENIUM, TOTAL (UG/L)	3	3	3		BDL	BDL	BDL	50			
SILICA, DISSOLVED (MG/L AS SiO2)	92	200			8	86	24.116				
SILVER, DISSOLVED (UG/L AS AG)	12	26	26		BDL	BDL	BDL		100		
SILVER, TOTAL (UG/L AS AG)	3	3	3		BDL	BDL	BDL		100		
SODIUM ADSORPTION RATIO, CALCULATED (SAR)	97	219			0.24	108.45	28.259				
SODIUM, CALCULATED, PERCENT	97	219			14	100	82.593				
SODIUM, DISSOLVED (MG/L AS NA)	106	141			5.3	1275.5	224.667				
SODIUM, TOTAL (MG/L AS NA)	88	162			3.9	482	164.287				
SPECIFIC CONDUCTANCE, FIELD (UMHOS/CM AT 25C)	133	241			48	5650	929.4809				
STRONTIUM, DISSOLVED (UG/L AS SR)	59	89	1		10	2040	303.1965				
SULFATE, DISSOLVED (MG/L AS SO4)	22	57	24		1.02	64.9	13.0921		250		
SULFATE, TOTAL (MG/L AS SO4)	129	203	25		0.2	284	16.0084		250		1
SULFIDE, DISSOLVED (MG/L AS S)	6	6			0.02	0.08	0.0467				
TEMPERATURE, WATER (CELSIUS)	104	181			14	28	21.174				
THALLIUM, DISSOLVED (UG/L AS TL)	15	41	41		BDL	BDL	BDL	2			
THALLIUM, TOTAL (UG/L AS TL)	2	2	2		BDL	BDL	BDL	2			
TITANIUM (MG/L)	42	42			0.0005	0.3081	0.0096				
TOTAL DISSOLVED SOLIDS, SUM OF CONSTITUENTS (MG/L)	140	262			25	4345	561.610		500		103
URANIUM, NATURAL, DISSOLVED (UG/L AS U)	9	20	20		BDL	BDL	BDL	30			
VANADIUM, DISSOLVED (UG/L AS V)	57	83	38		0.02	8.8761	1.181				
ZINC, DISSOLVED (UG/L AS ZN)	59	89	38		0.44	561	33.605		5000		
ZINC, TOTAL (UG/L AS ZN)	4	4			14	580	186		5000		
TOTALS (WHERE APPLICABLE)	140	7464	1581							2	253

Arsenic (Dissolved, ug/L)

Legend

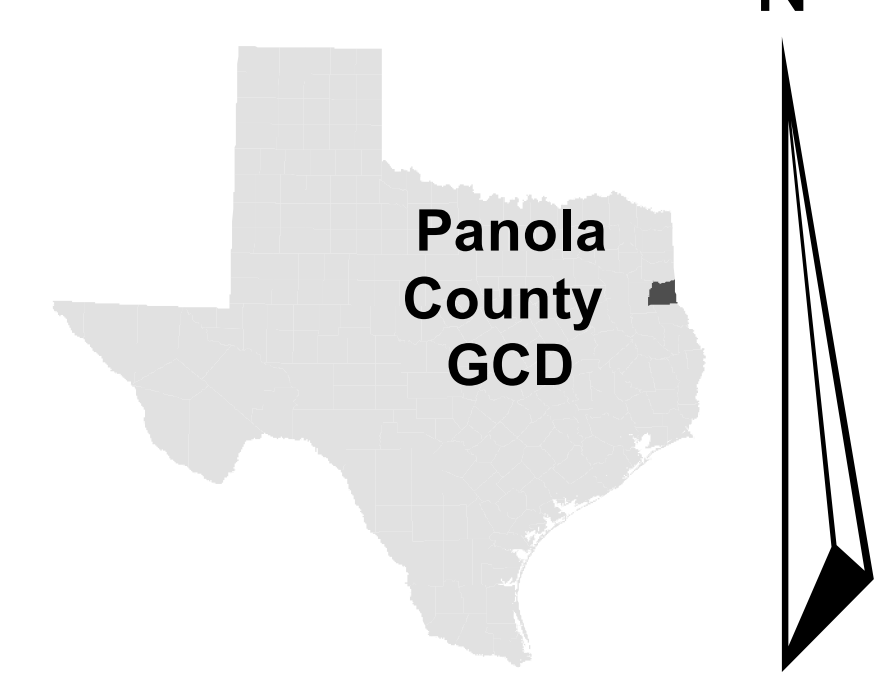
-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Arsenic Concentration (Dissolved, ug/L)

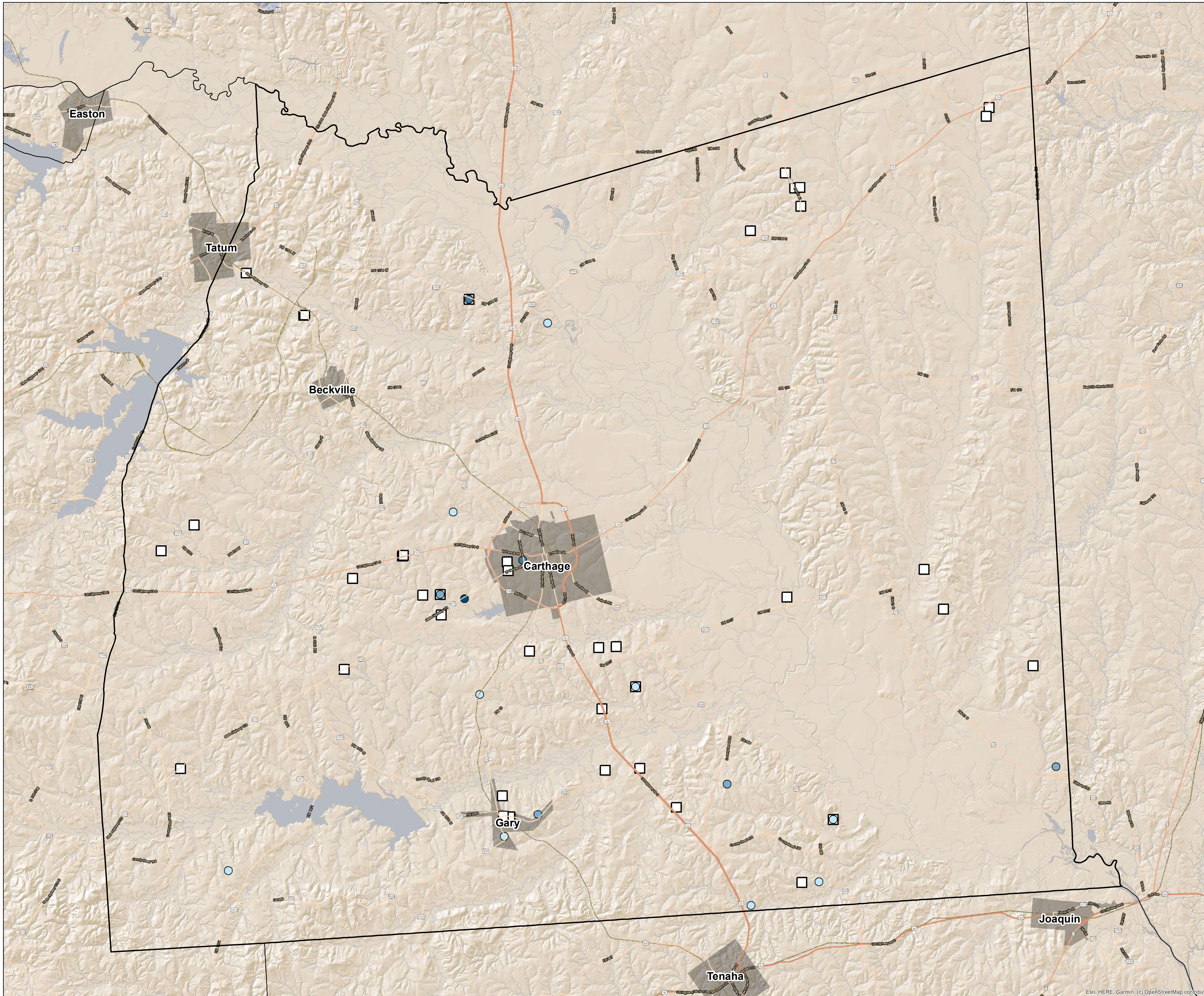
-  <1 (min 0.07 ug/L)
-  1-2
-  2-3
-  3-4 (max 4 ug/L)
-  Below Detection Limit

Maximum Contaminant Level (Primary): 10 ug/L
 Total Wells Displayed: 59
 Wells with Non-Detect: 43
 Wells with Values: 16
 Wells Exceeding MCL: 0
 Average Value: 1.2 ug/L

Location Map

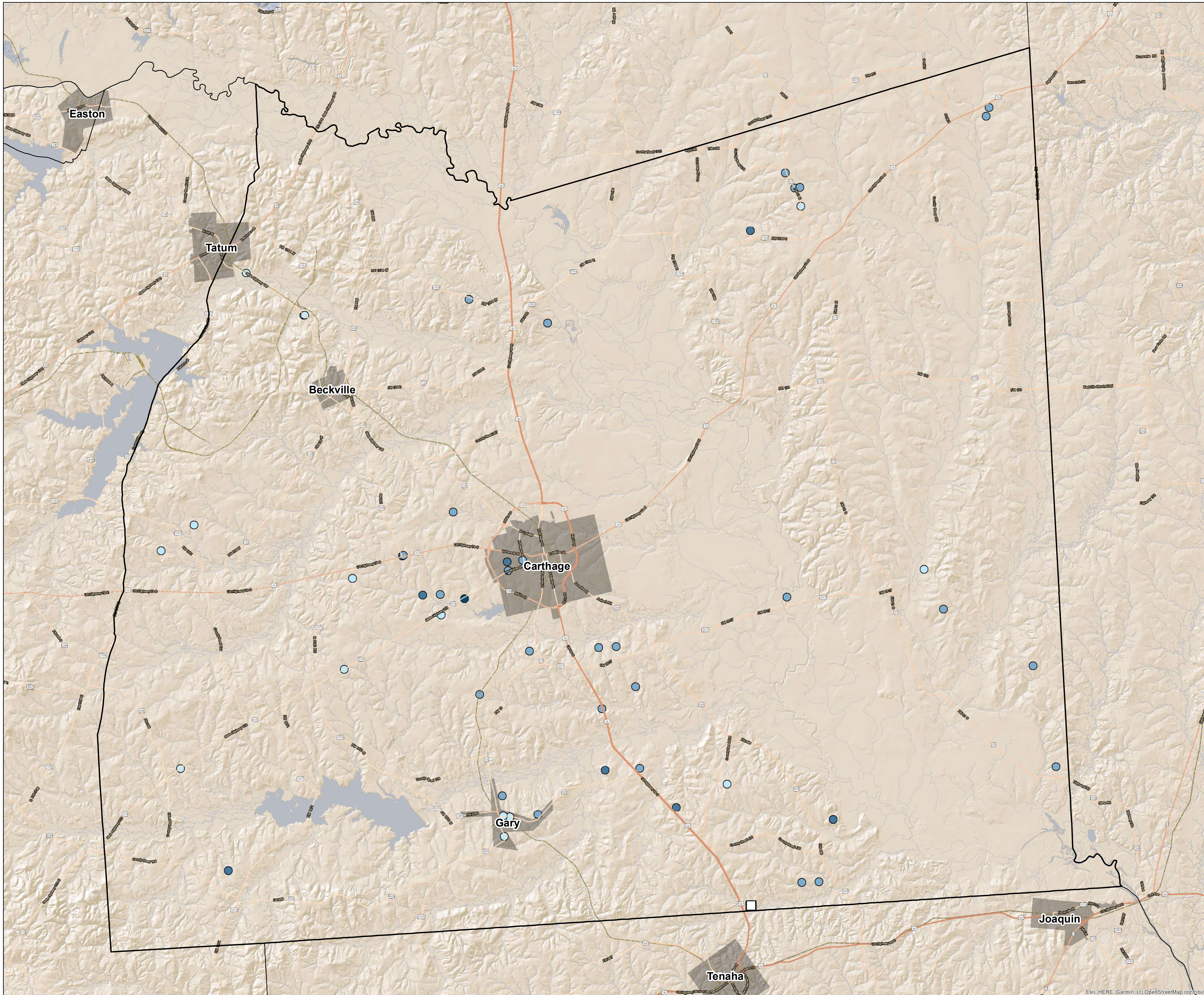


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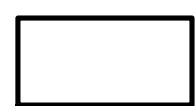
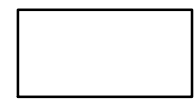





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Barium (Dissolved, ug/L)



Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Barium Concentration (Dissolved, ug/L)

-  <30 (min 10 ug/L)
-  30 - 100
-  100-300
-  >300 (max 345 ug/L)
-  Below Detection Limit

Maximum Contaminant Level (Primary): 2,000 ug/L
 Total Wells Displayed: 59
 Wells with Non-Detect: 1
 Wells with Values: 58
 Wells Exceeding MCL: 0
 Average Value: 72.9 ug/L

Location Map

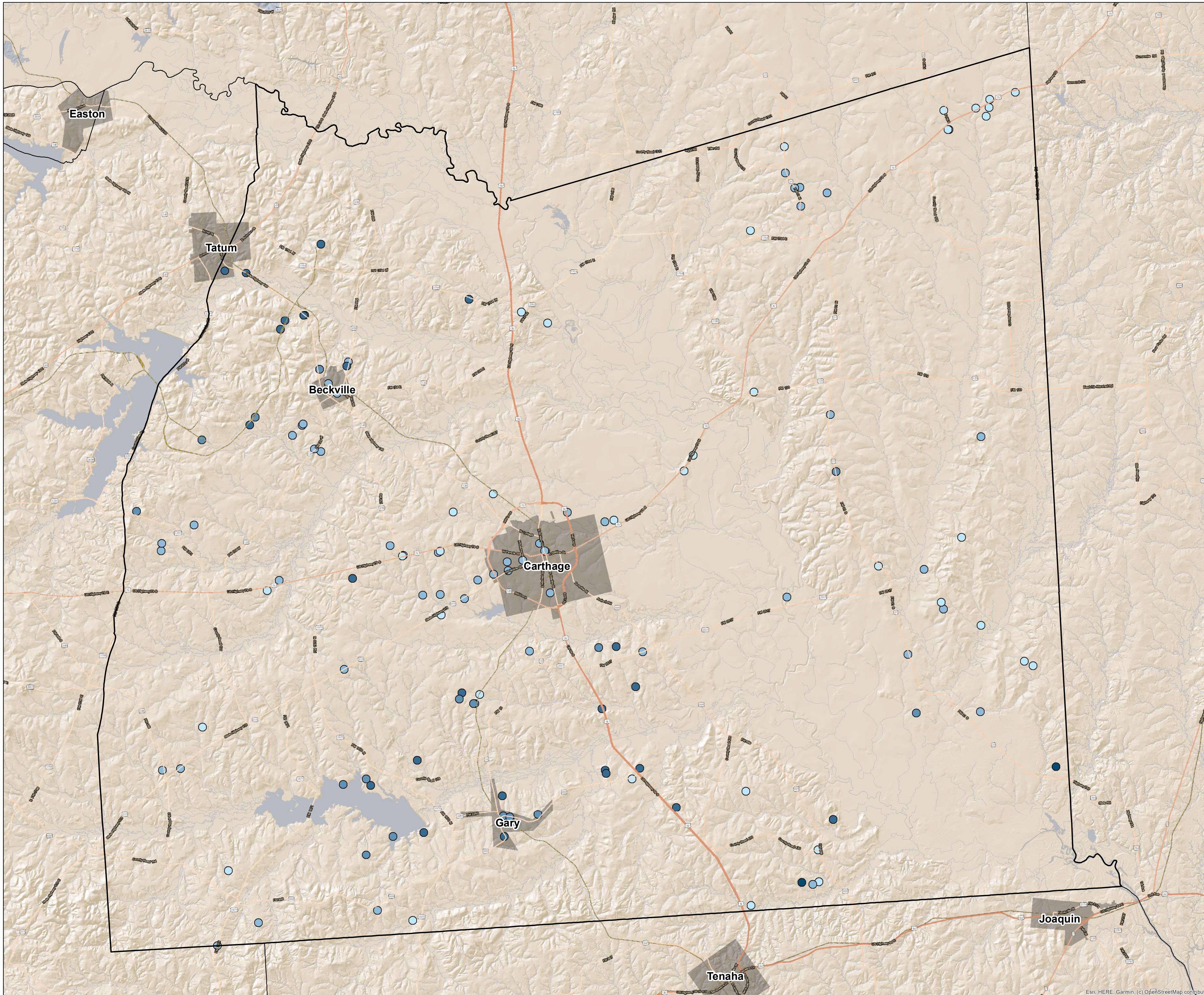


Prepared by:



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Bicarbonate (mg/L)



Legend

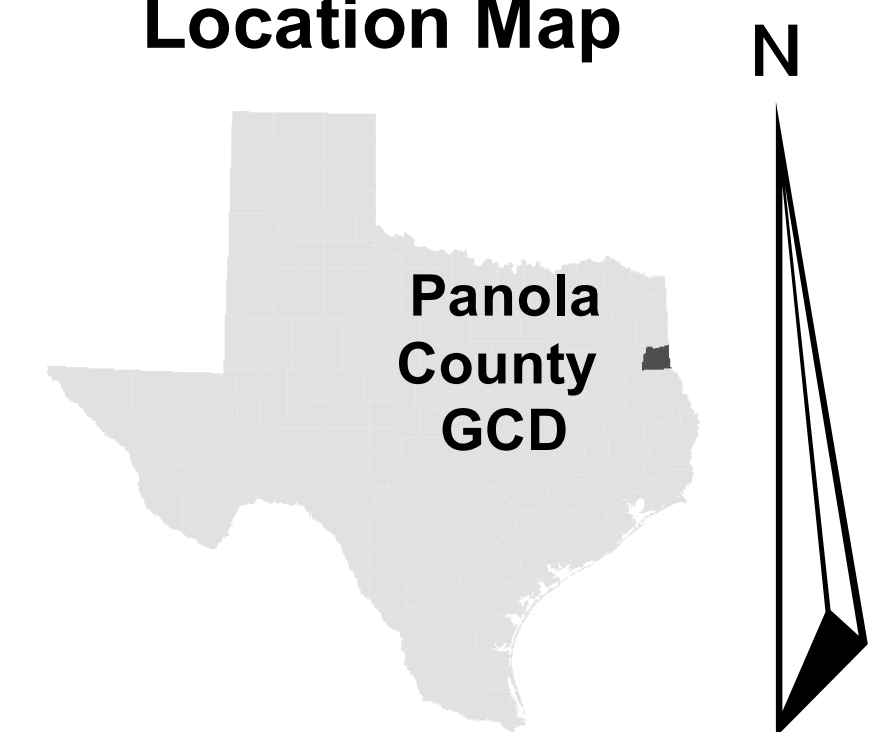
- Panola County
- Counties
- Cities
- Rivers and Streams
- Lakes and Reservoirs

Bicarbonate (mg/L)

- < 200 (min 6 mg/L)
- 200-400
- 400-600
- 600-800
- >800 (max 860 mg/L)
- Below Detection Limit

Maximum Contaminant Level: Not Applicable
Total Wells Displayed: 138
Wells with Non-Detect: 0
Wells with Values: 138
Wells Exceeding MCL: Not Applicable
Average Value: 346 mg/L

Location Map

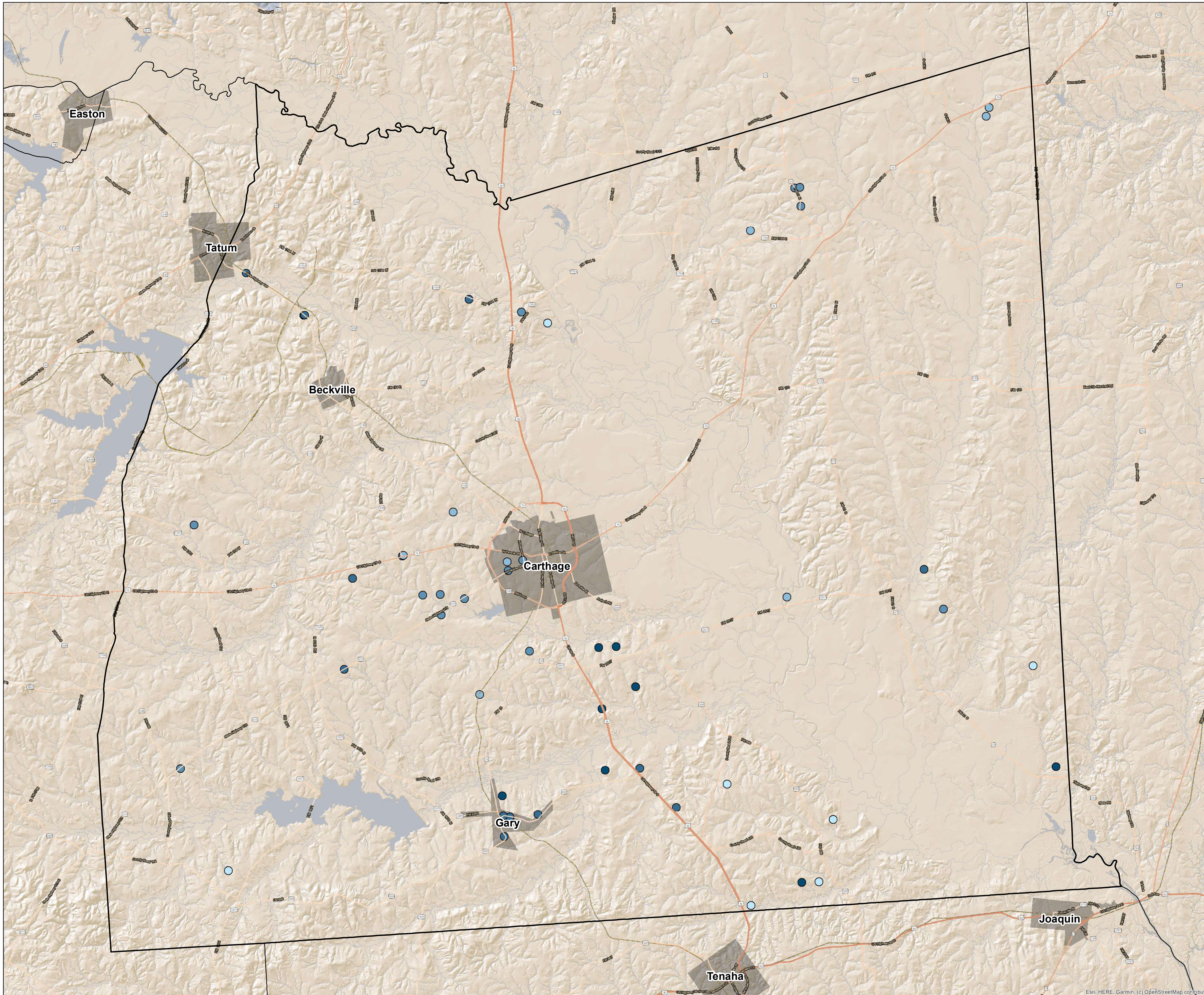


Prepared by:


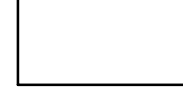


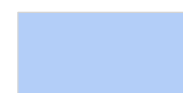


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Boron (Dissolved, ug/L)



Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Boron Concentration (Dissolved, ug/L)

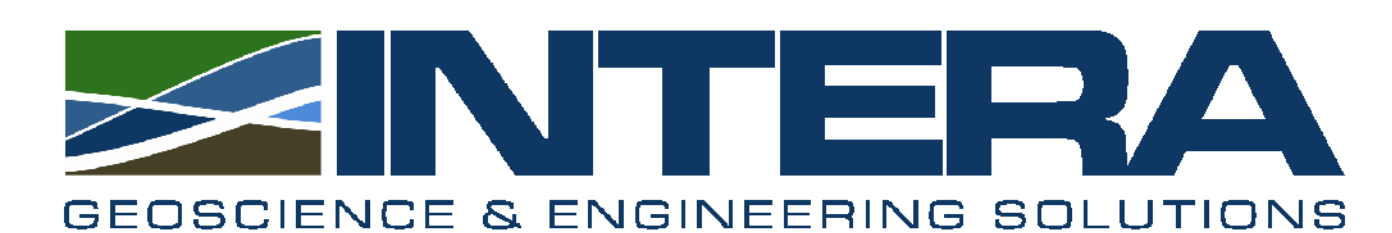
-  < 30 (min 10 ug/L)
-  30-100
-  100-300
-  300-1,000
-  >1,000 (max 2,842 ug/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
 Total Wells Displayed: 58
 Wells with Non-Detect: 0
 Wells with Values: 58
 Wells Exceeding MCL: Not Applicable
 Average Value: 575 ug/L

Location Map

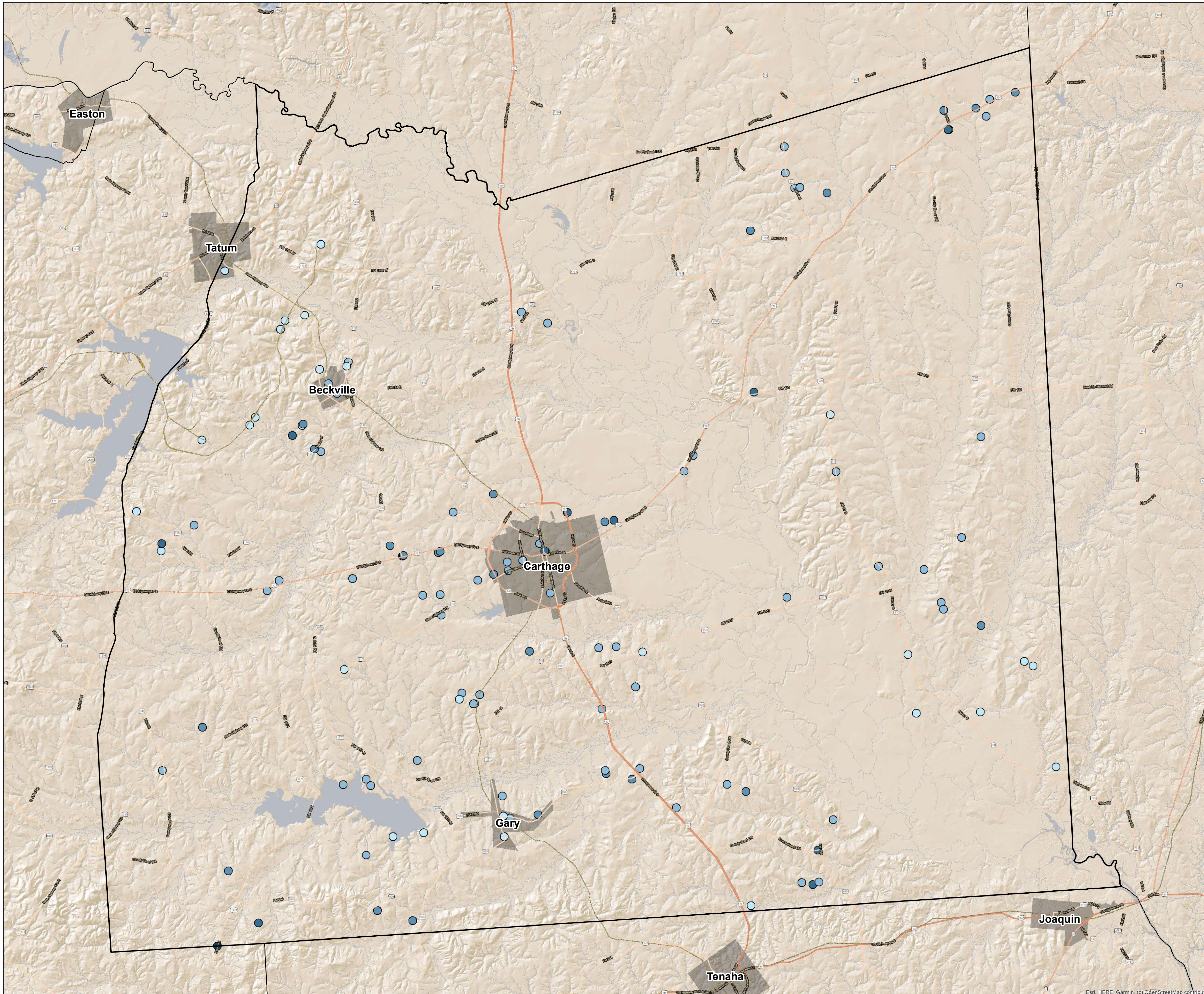


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Calcium (mg/L)



Legend

Panola County

Counties

Cities

Rivers and Streams

Lakes and Reservoirs

Calcium Concentration (mg/L)

<1 (min 0.15 mg/L)

1-10

10-30

30-100

>100 (max 157 mg/L)

Below Detection Limit

Maximum Contaminant Level: Not Applicable

Total Wells Displayed: 130

Wells with Non-Detect: 0

Wells with Values: 130

Wells Exceeding MCL: Not Applicable

Average Value: 11.6 mg/L

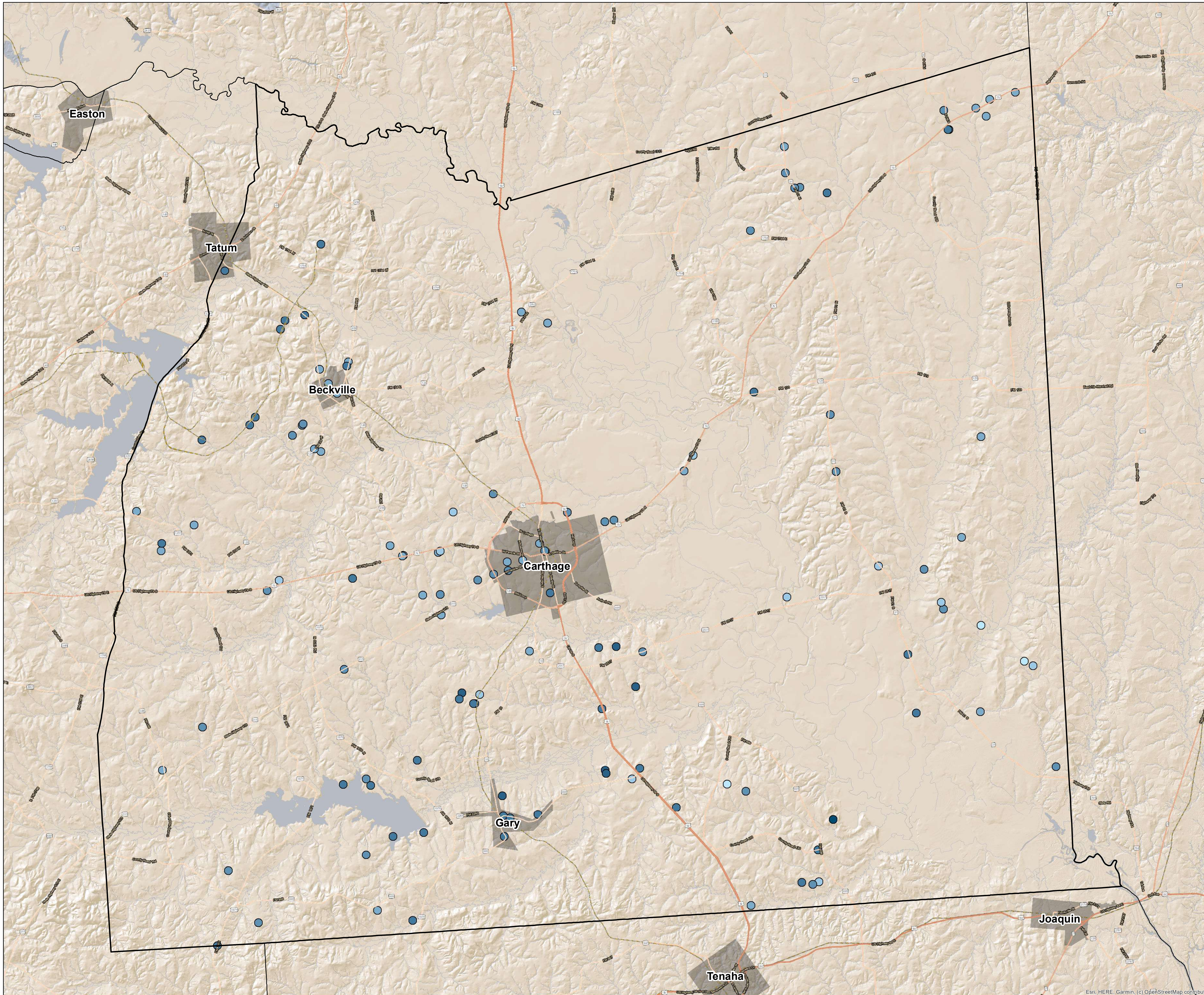
Location Map



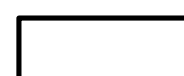
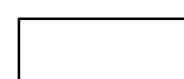



Prepared by:











Chloride (Total, mg/L)



Legend

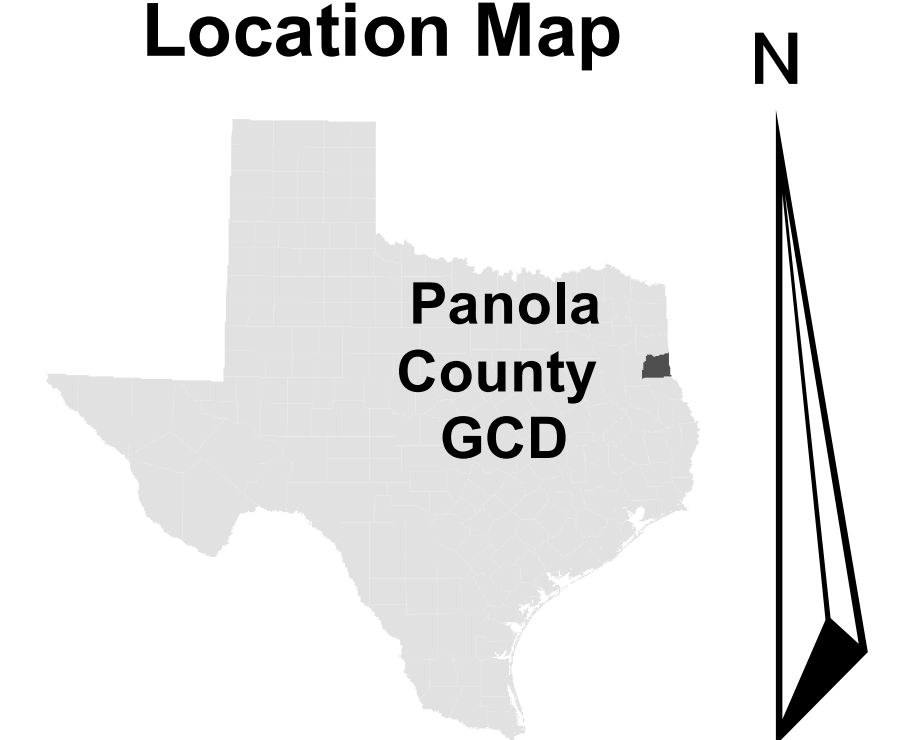
-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Chloride Concentration (Total, mg/L)

-  <3 (min 2.3 mg/L)
-  3-10
-  10-30
-  30-100
-  100-300
-  300-1,000
-  >1,000 (max 1,664 mg/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
 Total Wells Displayed: 130
 Wells with Non-Detect: 0
 Wells with Values: 130
 Wells Exceeding MCL: Not Applicable
 Average Value: 109 mg/L

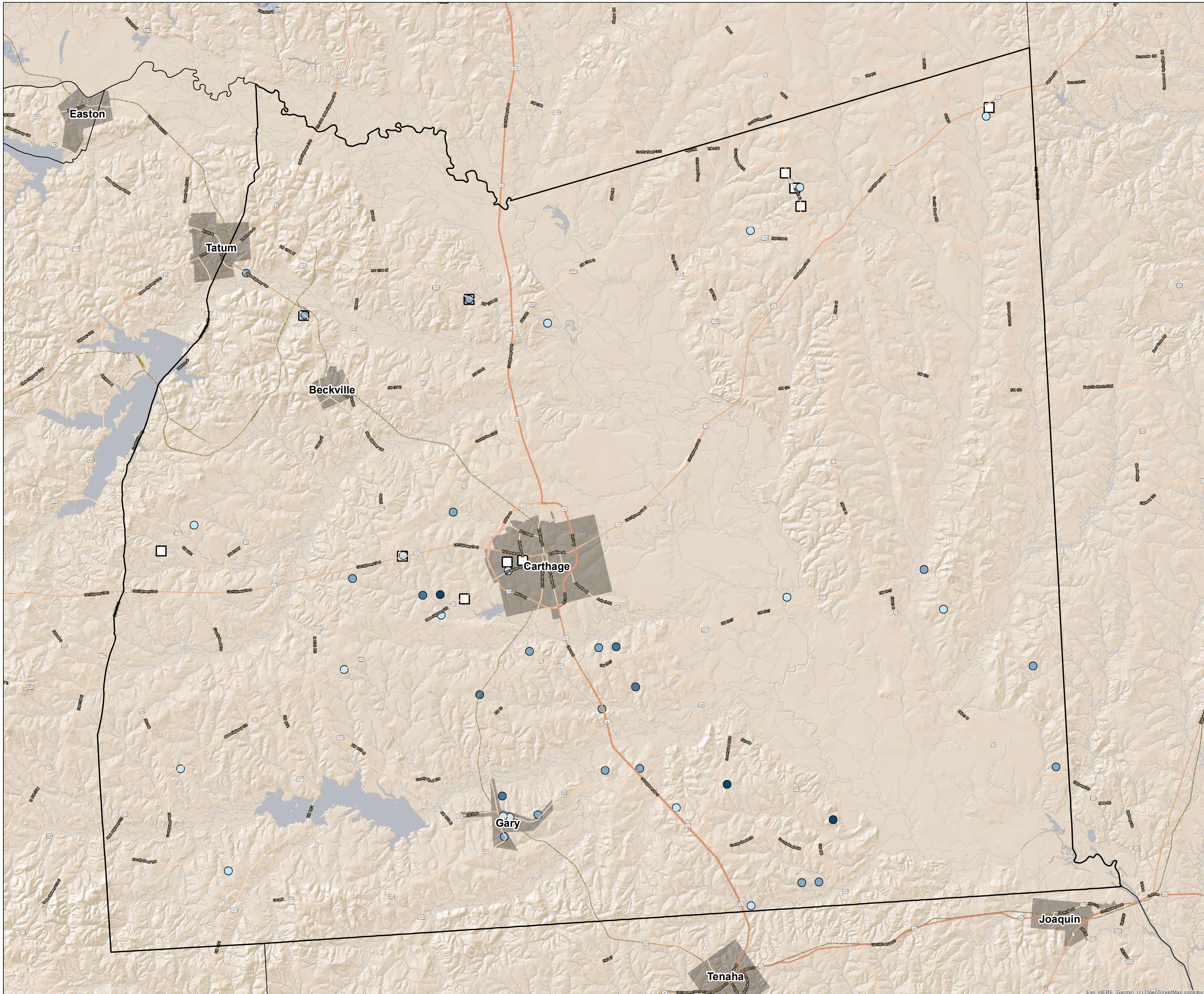
Location Map



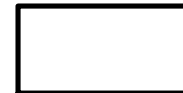
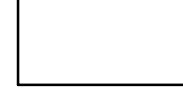


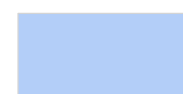
Prepared by:








Copper (Dissolved, ug/L)



Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Copper Concentration (Dissolved, ug/L)

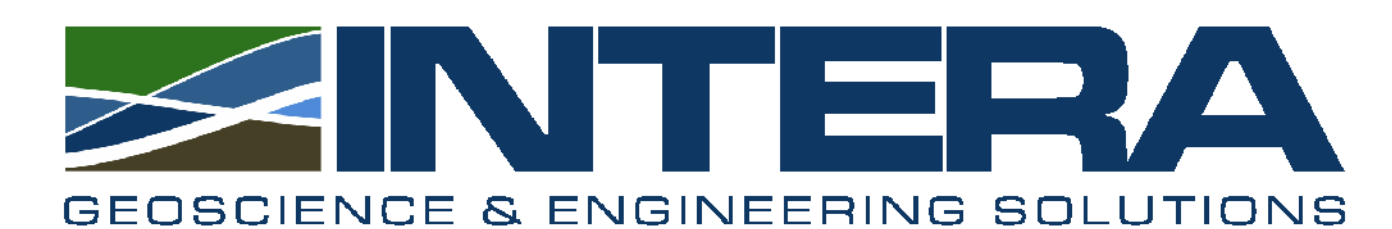
-  <3 (min 0.32 ug/L)
-  3-10
-  10-30
-  >30 (max 74.4 ug/L)
-  Below Detection Limit

Maximum Contaminant Level (Secondary): 1,000 ug/L
 Total Wells Displayed: 59
 Wells with Non-Detect: 11
 Wells with Values: 48
 Wells Outside MCL: 0
 Average Value: 9.6 ug/L

Location Map


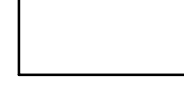





Prepared by:

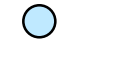
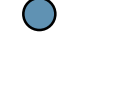





Fluoride (Dissolved, mg/L)

Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Fluoride Concentration (Dissolved, mg/L)

-  <0.5 (min 0.1 mg/L)
-  0.5-1
-  1-2
-  >2 (max 4.5 mg/L)
-  Below Detection Limit

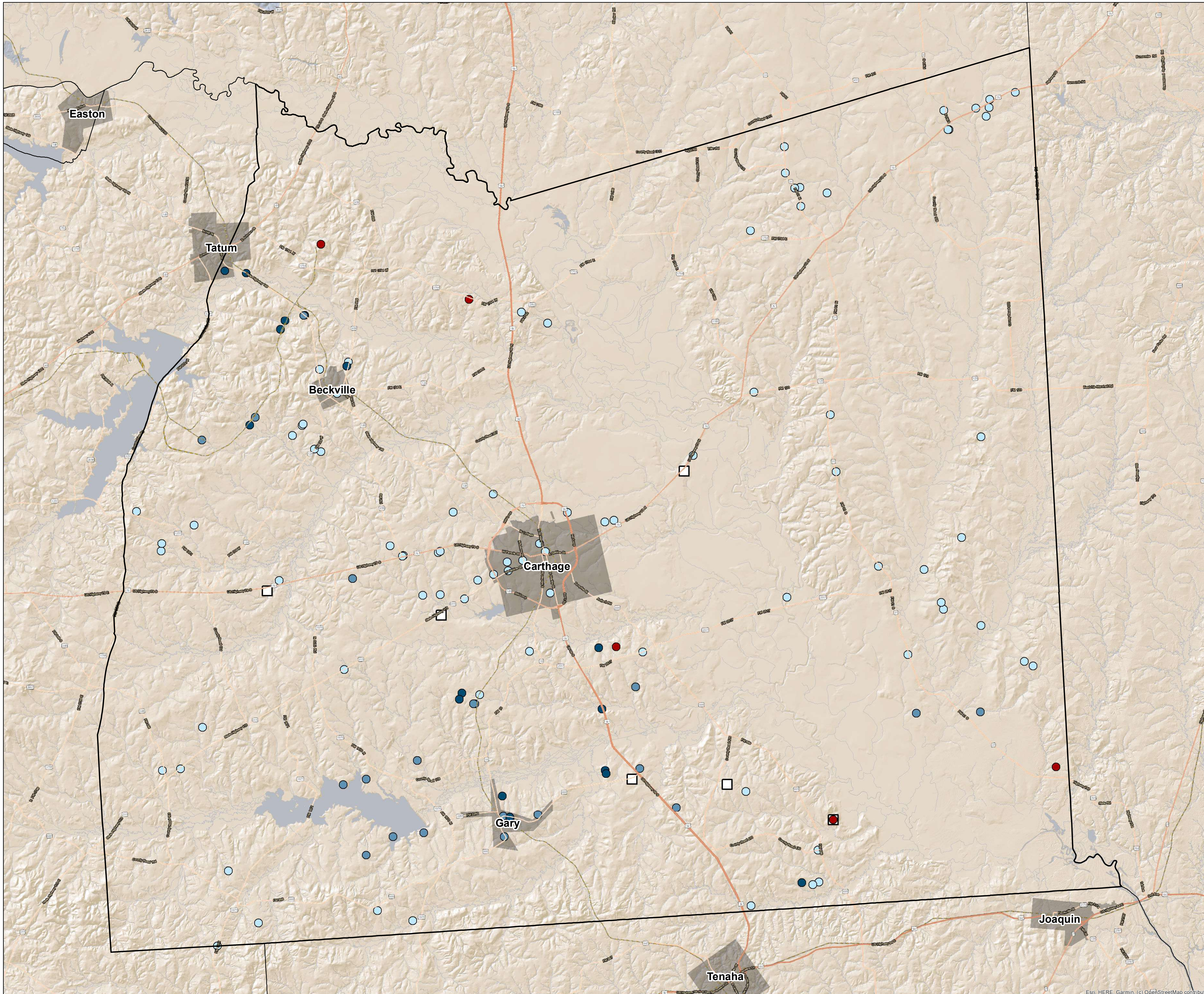
Above MCL | Below MCL

Maximum Contaminant Level (Secondary): 2 mg/L
 Total Wells Displayed: 136
 Wells with Non-Detect: 6
 Wells with Values: 130
 Wells Exceeding MCL: 6
 Average Value: 0.56 mg/L

Location Map

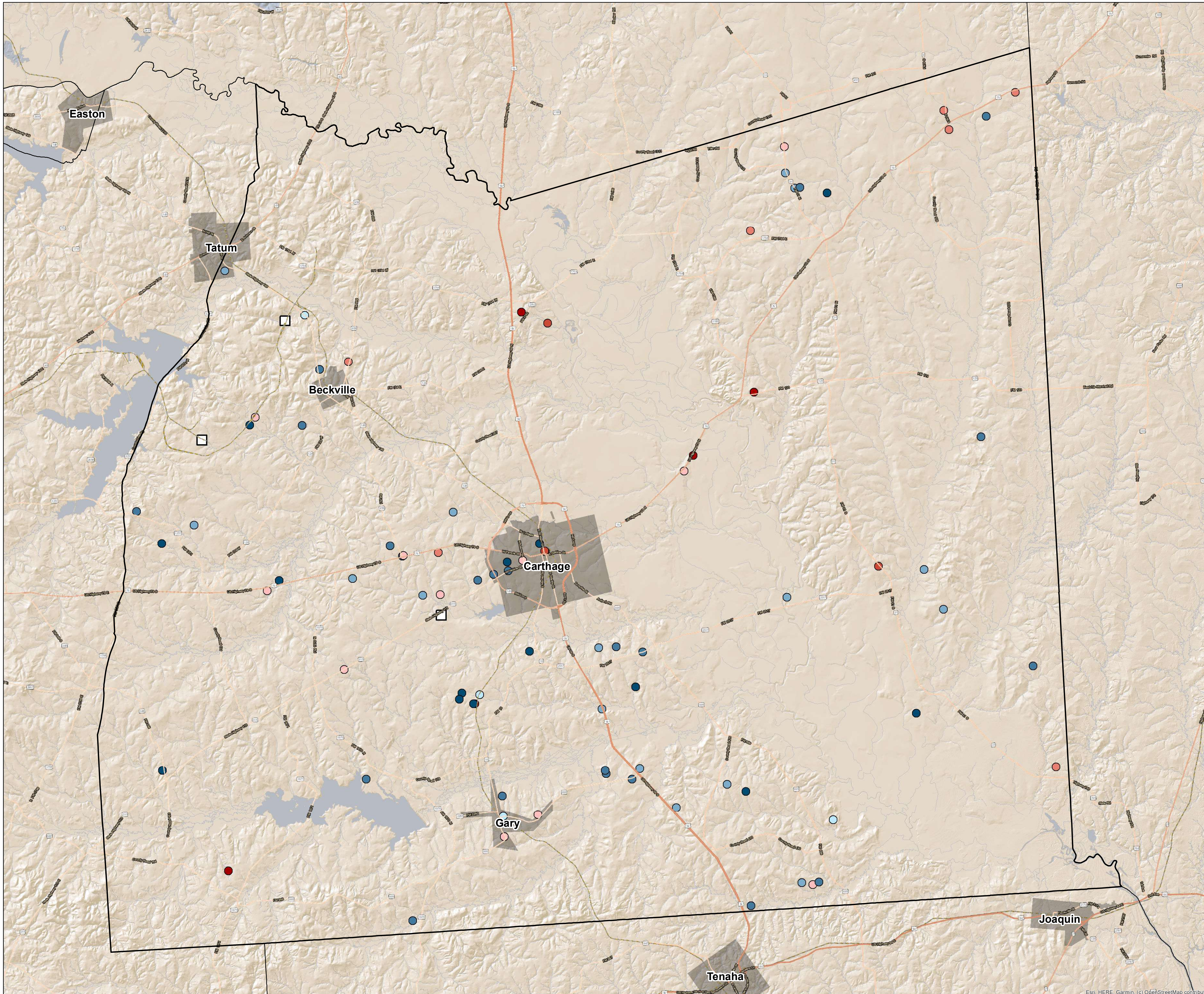


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Iron (Total, ug/L)



Legend

- Panola County
- Counties
- Cities
- Rivers and Streams
- Lakes and Reservoirs

Iron Concentration (Total, ug/L)

- <10 (min 2.1 ug/L)
- 10-30
- 30-100
- 100-300
- 300-1,000
- 1,000-3,000
- 3,000-10,000
- >10,000 (max 21,000 ug/L)
- Below Detection Limit

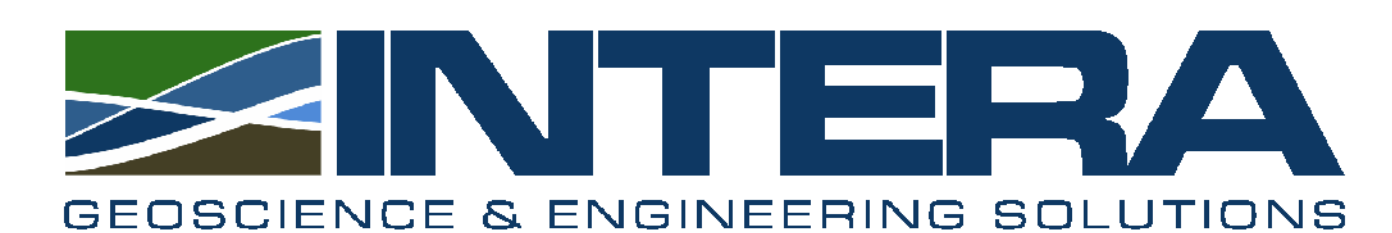
Above MCL | Below MCL

Maximum Contaminant Level (Secondary): 300 ug/L
 Total Wells Displayed: 91
 Wells with Non-Detect: 3
 Wells with Values: 88
 Wells Exceeding MCL: 26
 Average Value: 1,362 ug/L

Location Map

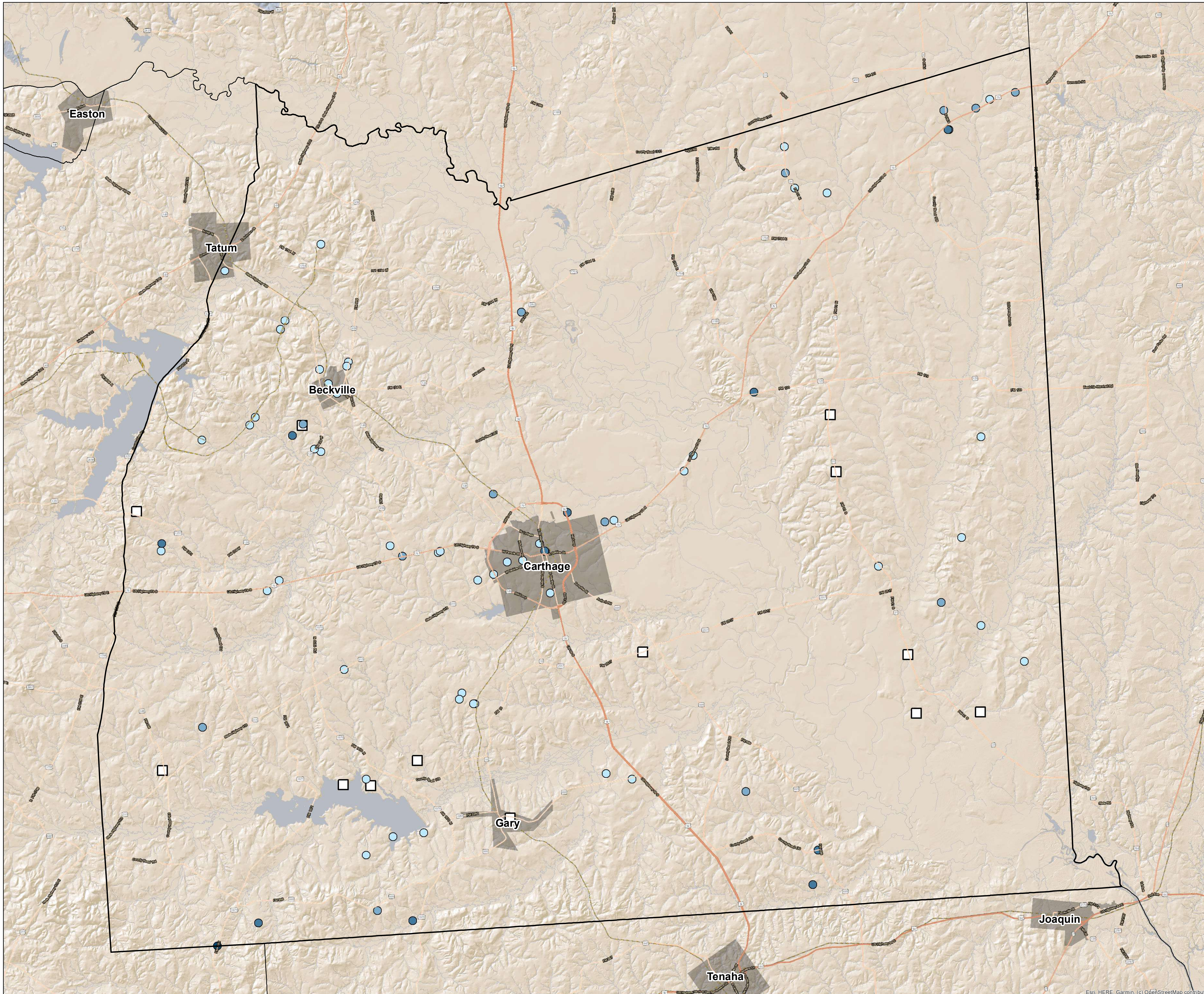


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Magnesium (mg/L)



Legend

- Panola County
- Counties
- Cities
- Rivers and Streams
- Lakes and Reservoirs

Magnesium Concentration (mg/L)

- <3 (min 0.1 mg/L)
- 3-10
- 10-30
- >30 (max 78 mg/L)
- Below Detection Limit

Maximum Contaminant Level: Not Applicable
Total Wells Displayed: 88
Wells with Non-Detect: 13
Wells with Values: 75
Wells Exceeding MCL: Not Applicable
Average Value: 5.0 mg/L

Location Map


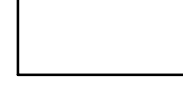





Prepared by:

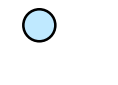
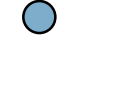







Manganese (Dissolved, ug/L)

Legend

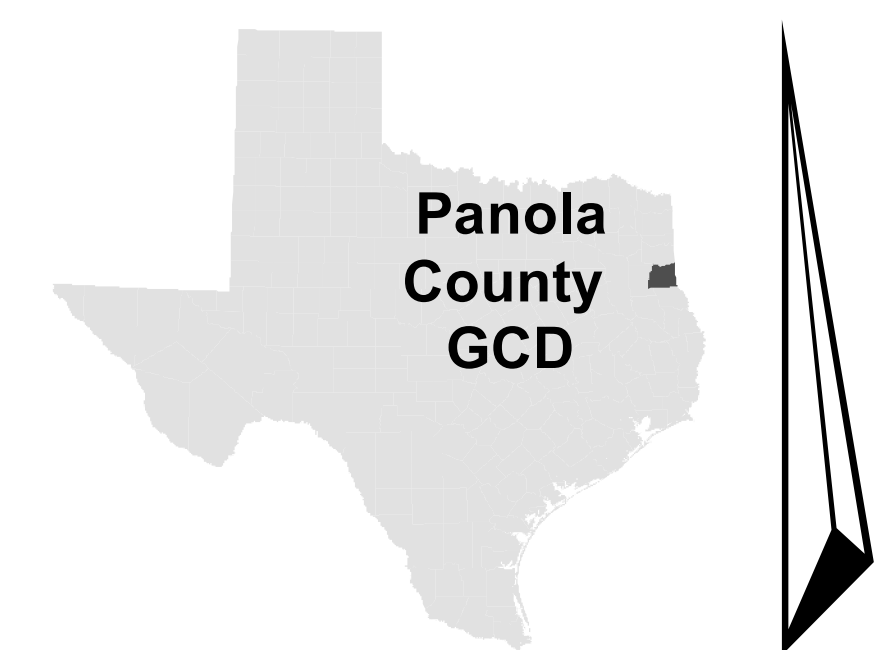
-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Manganese Concentration (Dissolved, ug/L)

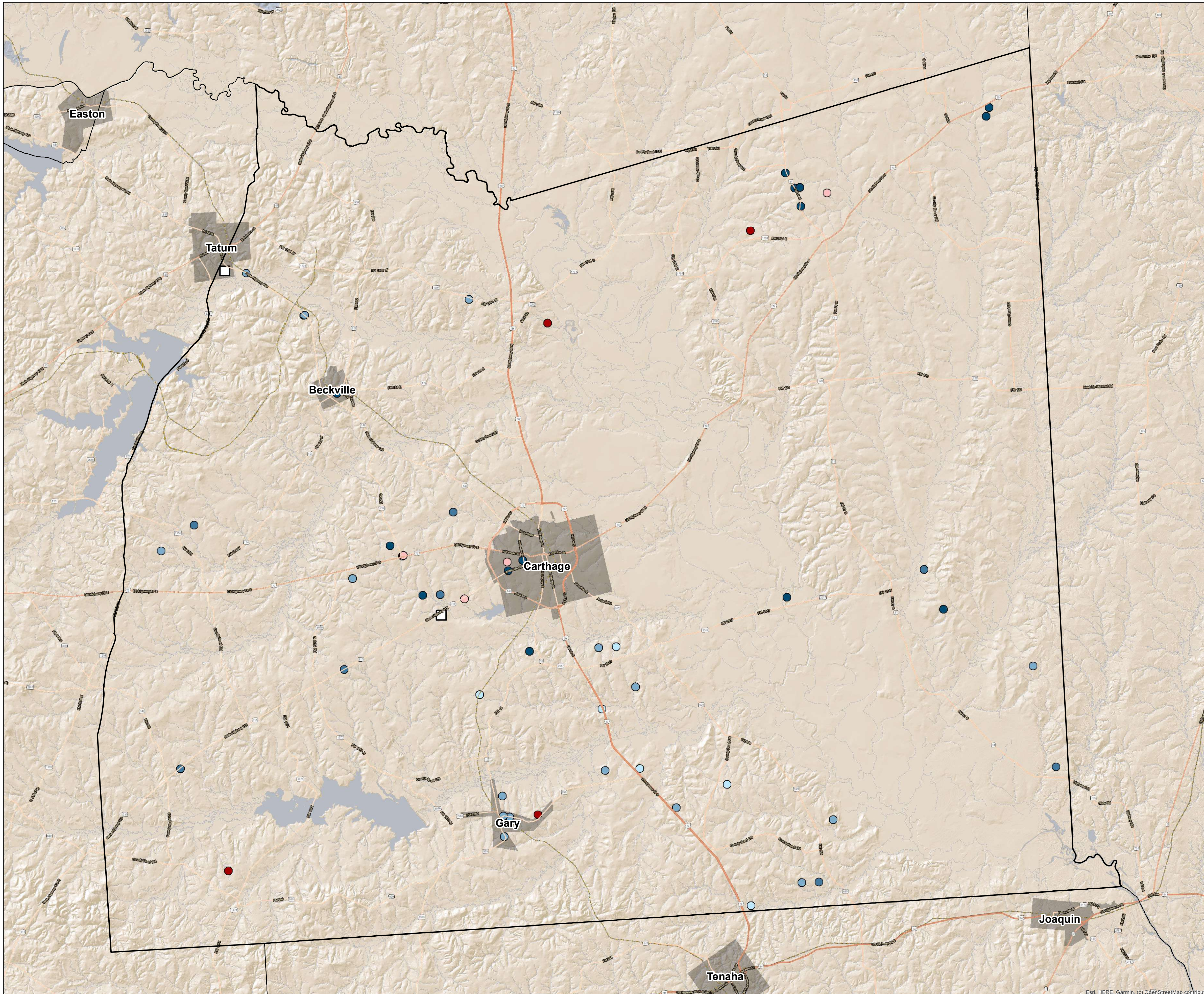
-  <1 (min 0.3 ug/L)
 -  1-5
 -  5-10
 -  10-50
 -  50-100
 -  >100 (max 584 ug/L)
 -  Below Detection Limit
- Above MCL | Below MCL

Maximum Contaminant Level (Secondary): 50 ug/L
 Total Wells Displayed: 63
 Wells with Non-Detect: 2
 Wells with Values: 61
 Wells Exceeding MCL: 9
 Average Value: 30.2 mg/L

Location Map

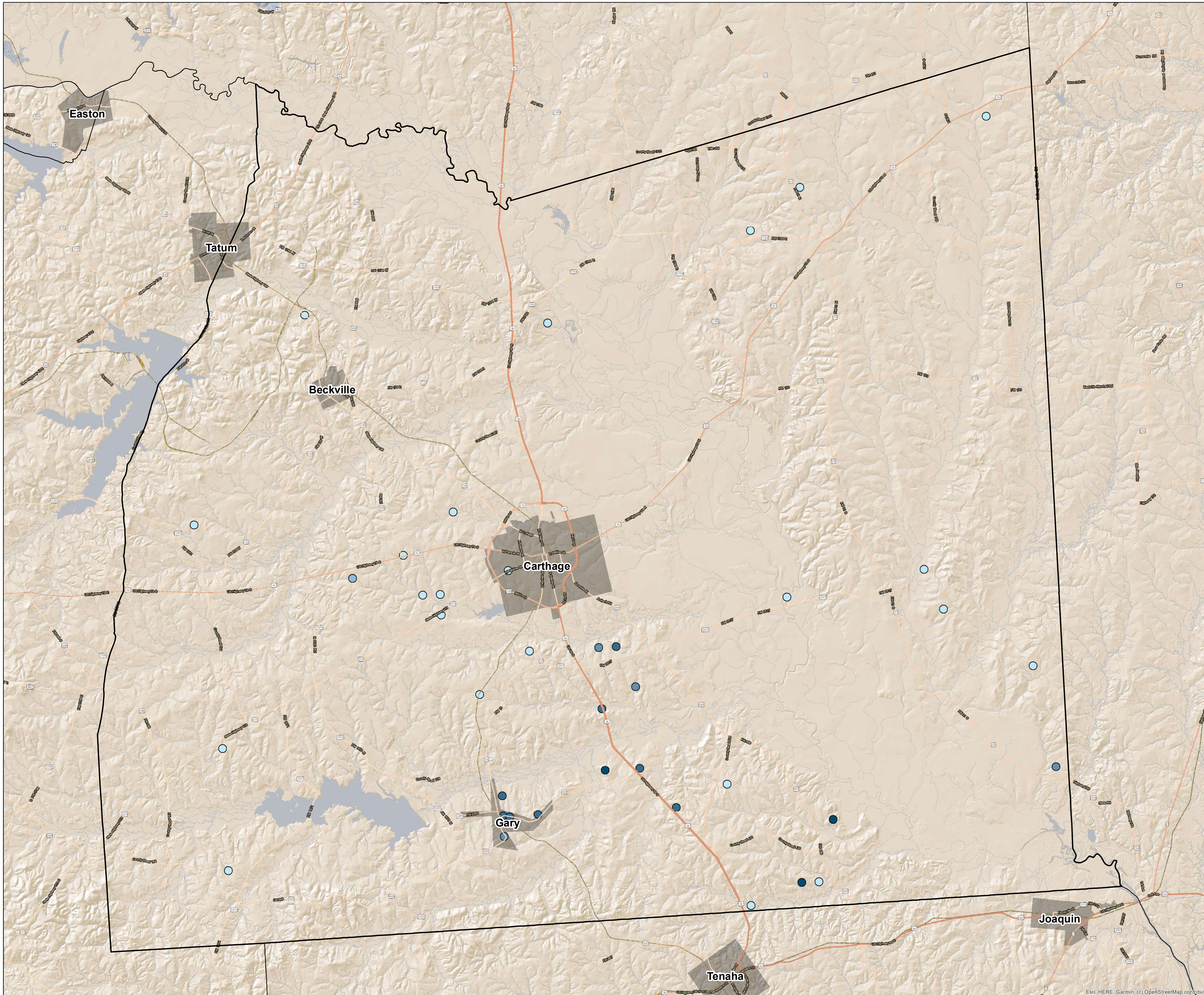


Prepared by:








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Methane (Dissolved, ug/L)



Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Methane Concentration (Dissolved, ug/L)

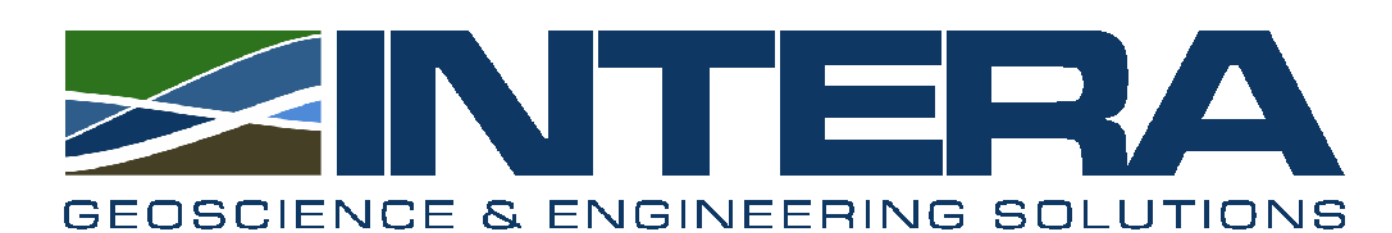
-  <1,000 (min 4 ug/L)
-  1,000-3,000
-  3,000-10,000
-  10,000-30,000
-  >30,000 (max 33,047 ug/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
 Total Wells Displayed: 44
 Wells with Non-Detect: 0
 Wells with Values: 44
 Wells Exceeding MCL: Not Applicable
 Average Value: 6,995 ug/L

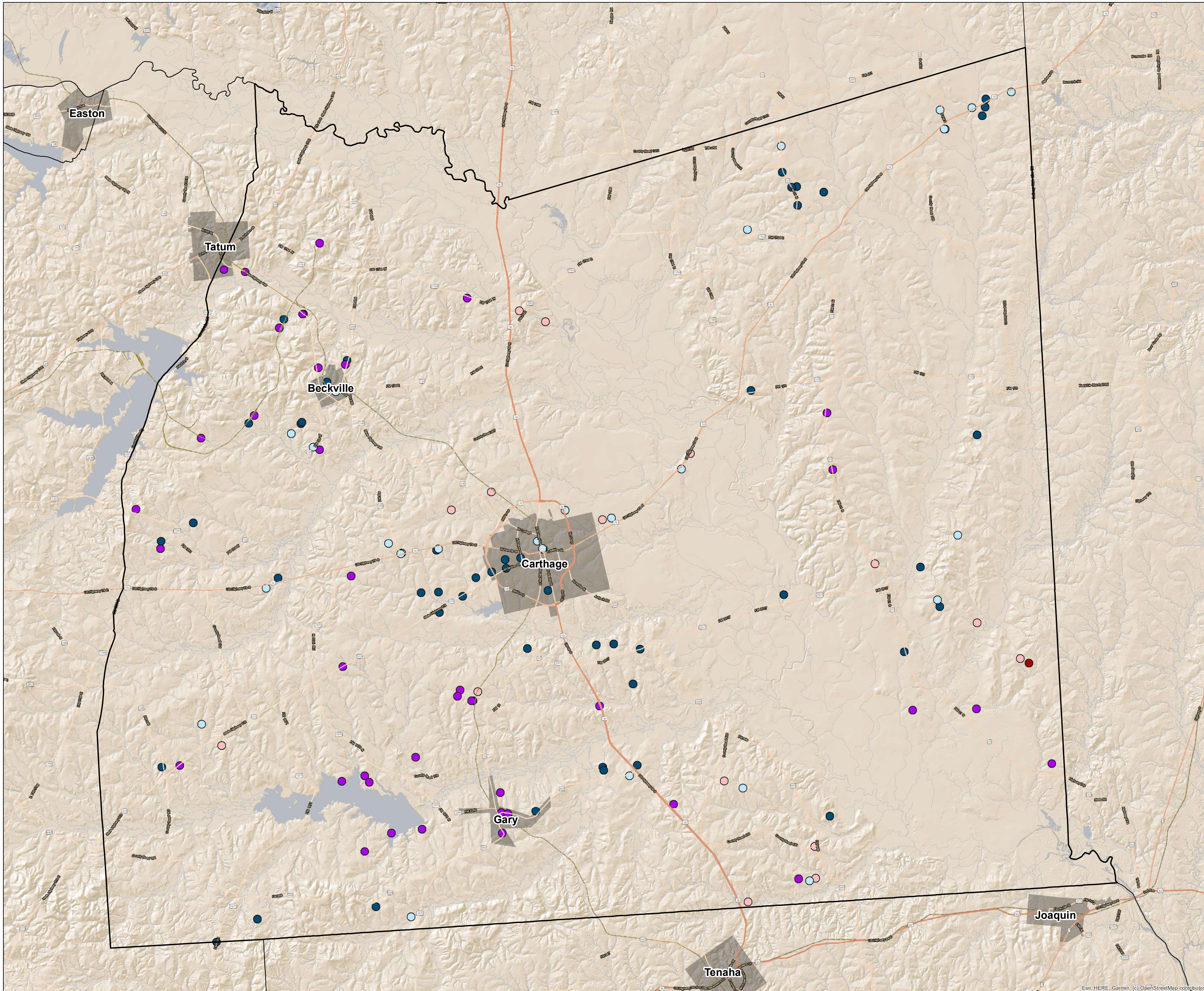
Location Map



Prepared by:



pH



Legend

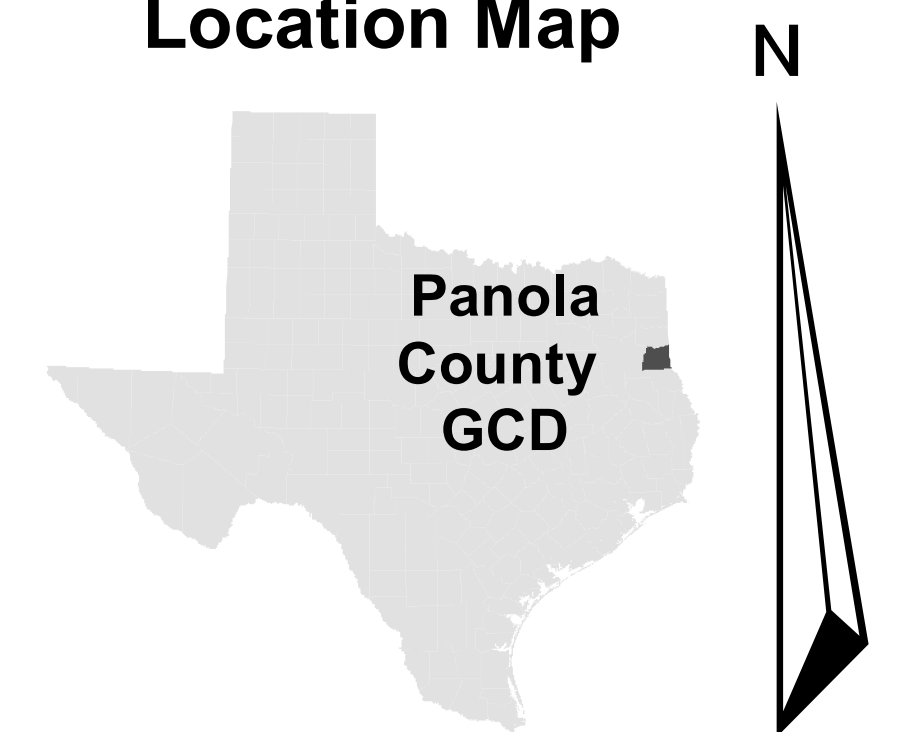
- Panola County
- Counties
- Cities
- Rivers and Streams
- Lakes and Reservoirs

pH (Field, Standard Units)

- <math>< 5.5</math> (min 5.4, outside MCL range)
- 5.5-6.5 (outside MCL range)
- 6.5-7.5
- 7.5-8.5
- 8.5 (max 8.9, outside MCL range)

Maximum Contaminant Level (Secondary): 6.5 - 8.5
Total Wells Displayed: 138
Wells with Non-Detect: 0
Wells with Values: 138
Wells Outside MCL: 16 below 6.5, 41 above 8.5
Average Value: 7.8

Location Map


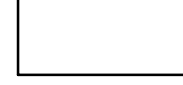





Prepared by:








Phosphorus (Dissolved, mg/L)

Legend

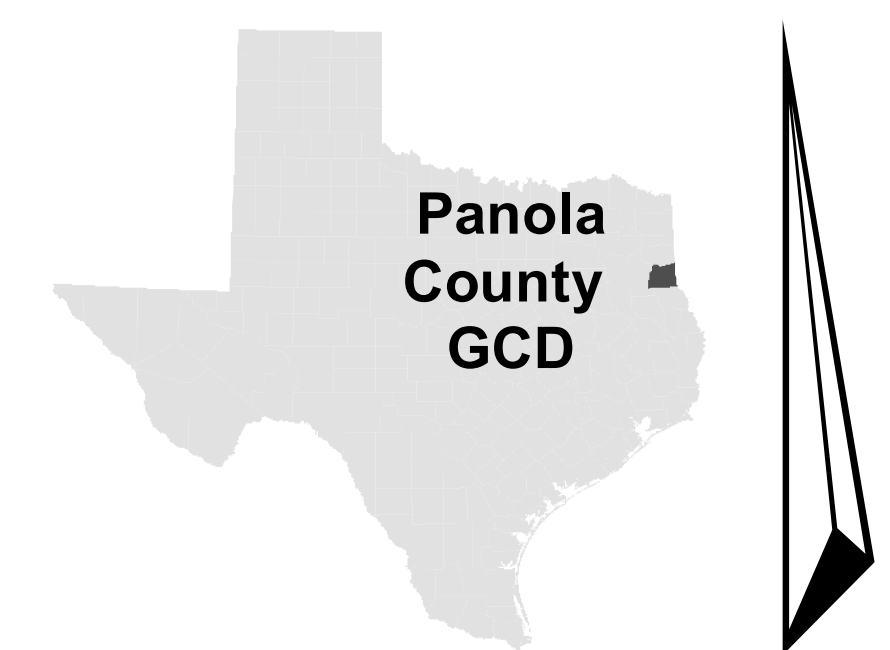
-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Phosphorus Concentration (Dissolved, mg/L)

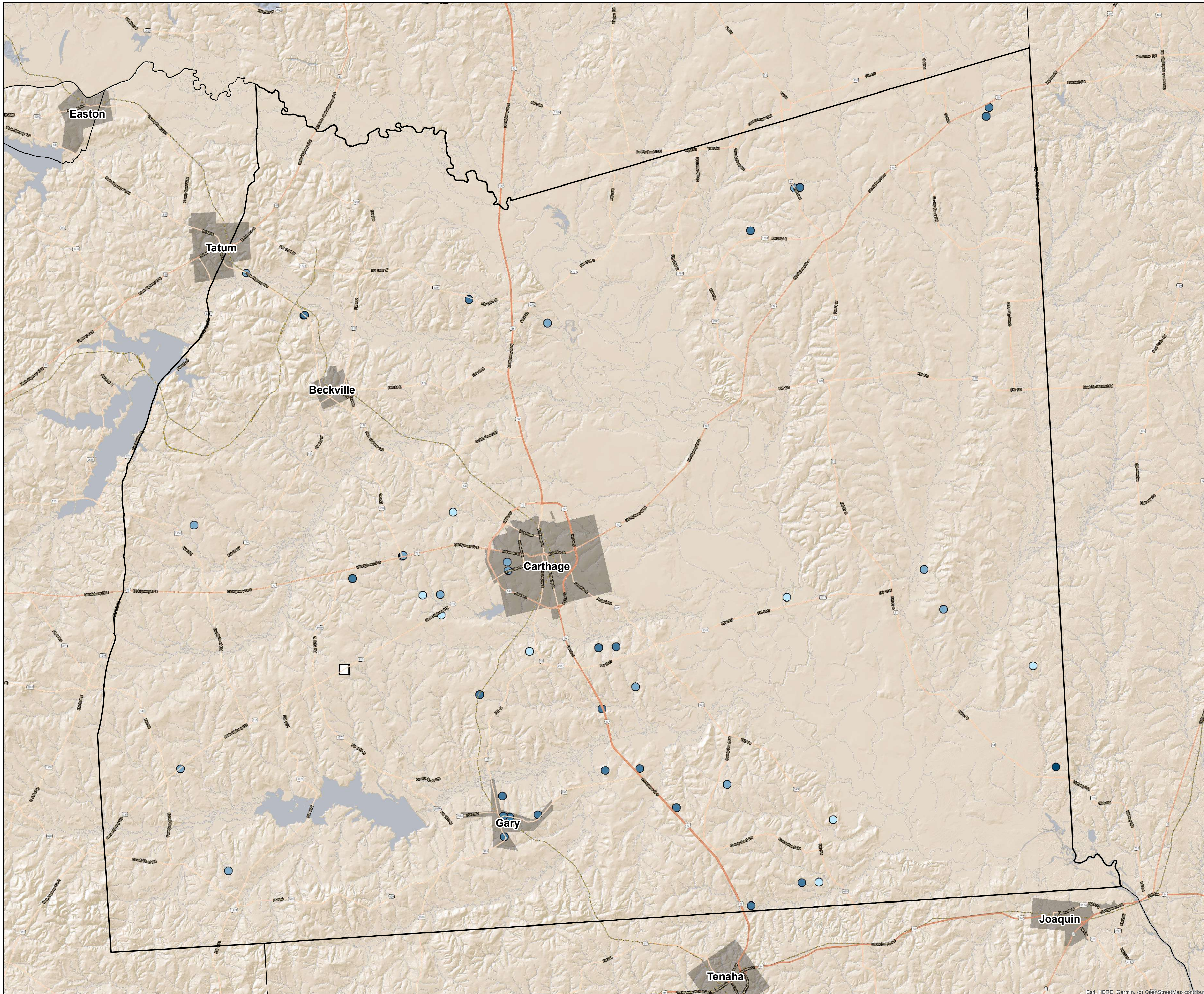
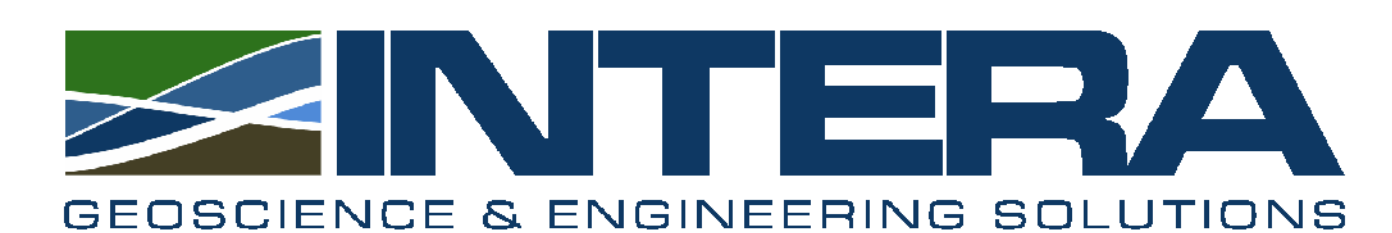
-  <0.1 (min 0.002 mg/L)
-  0.1-0.3
-  0.3-1
-  >1 (max 1.3 mg/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
 Total Wells Displayed: 53
 Wells with Non-Detect: 1
 Wells with Values: 52
 Wells Outside MCL: Not Applicable
 Average Value: 0.34 mg/L

Location Map




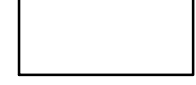



Prepared by:








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Silica (Dissolved, mg/L)

Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Silica Concentration (Dissolved, mg/L)

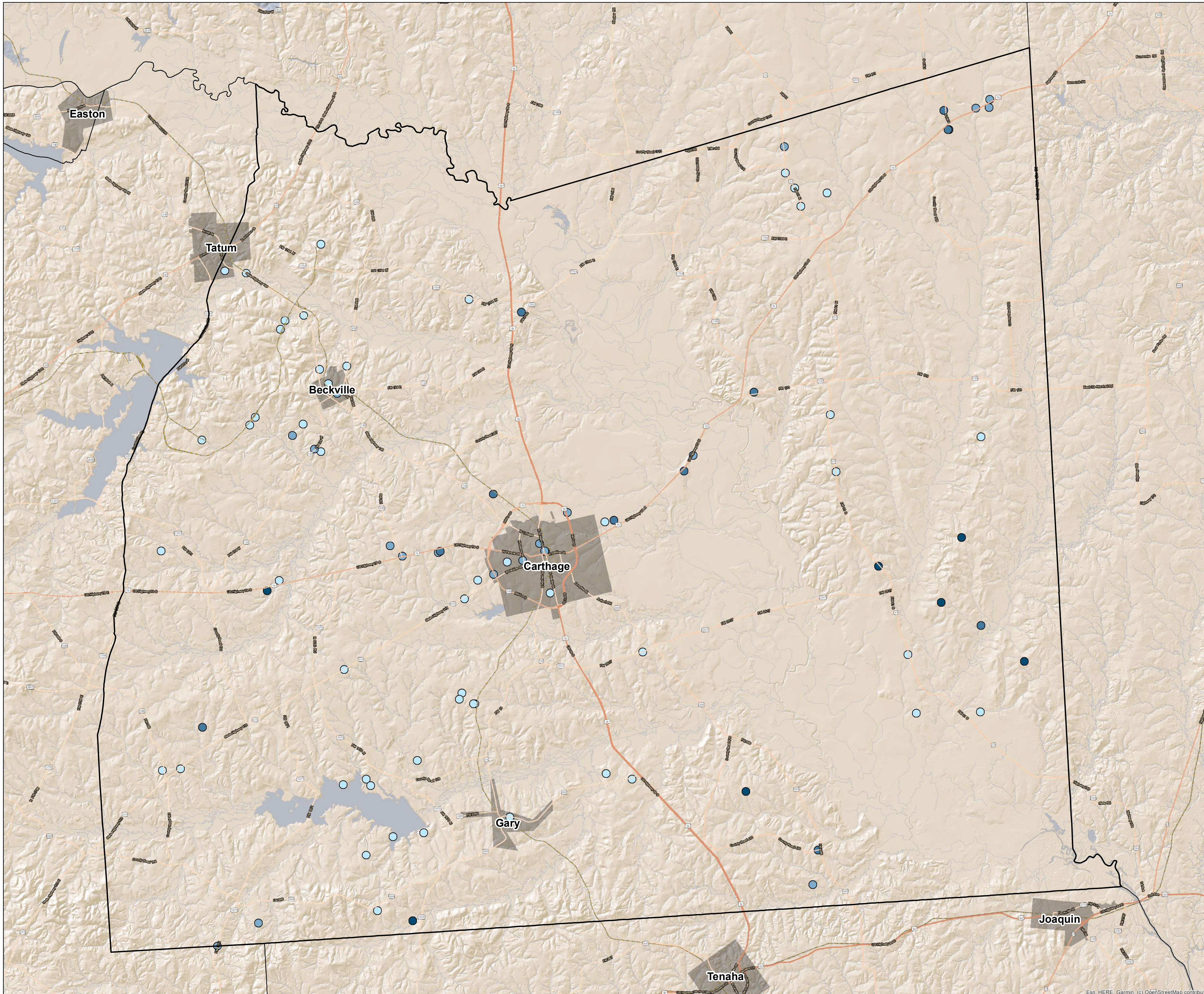
-  <20 (min 8 mg/L)
-  20-40
-  40-60
-  >60 (max 79 mg/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
 Total Wells Displayed: 92
 Wells with Non-Detect: 0
 Wells with Values: 92
 Wells Outside MCL: Not Applicable
 Average Value: 25.2 mg/L

Location Map

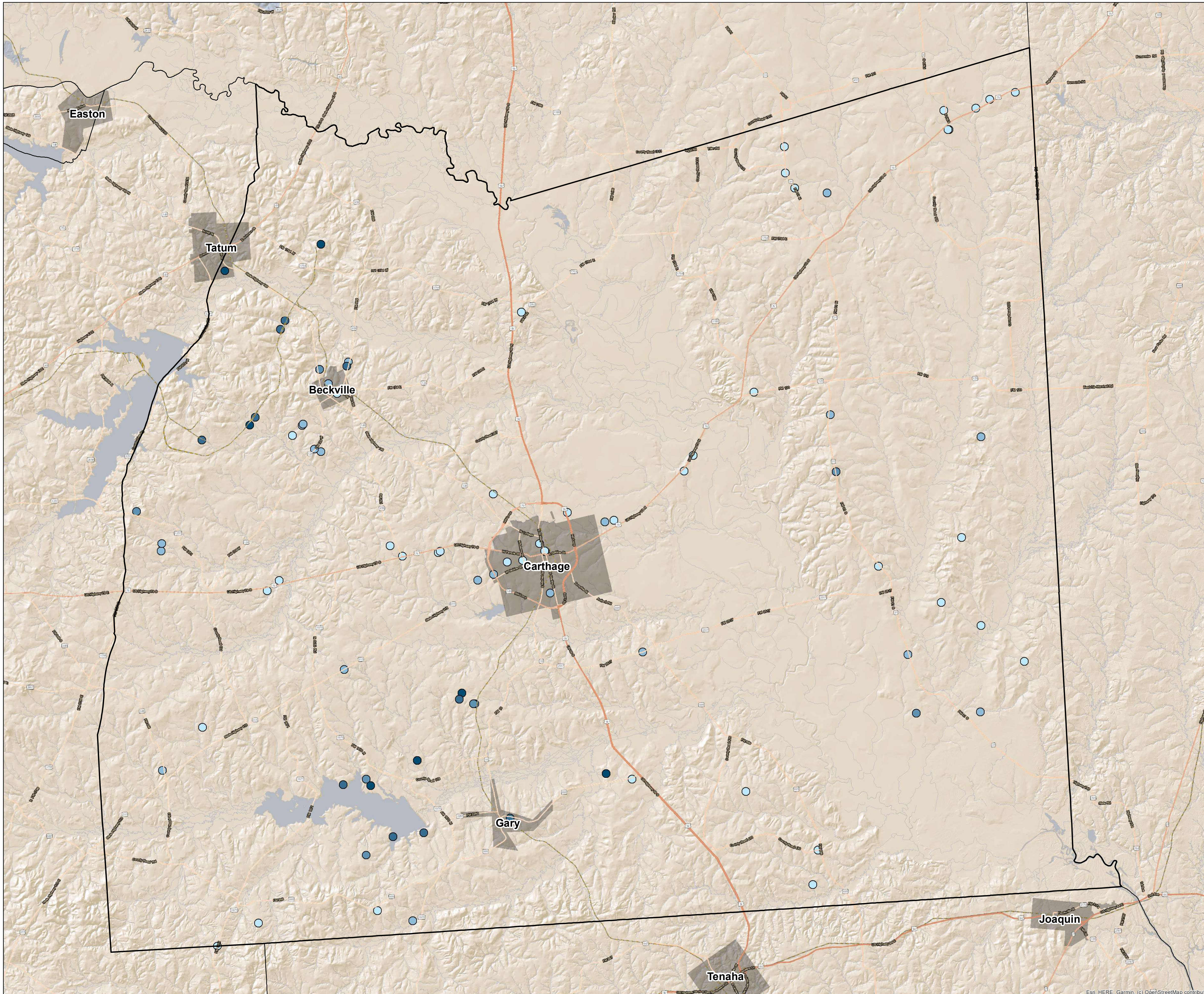


Prepared by:


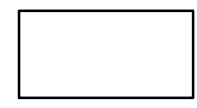





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





Sodium (Total, mg/L)



Legend

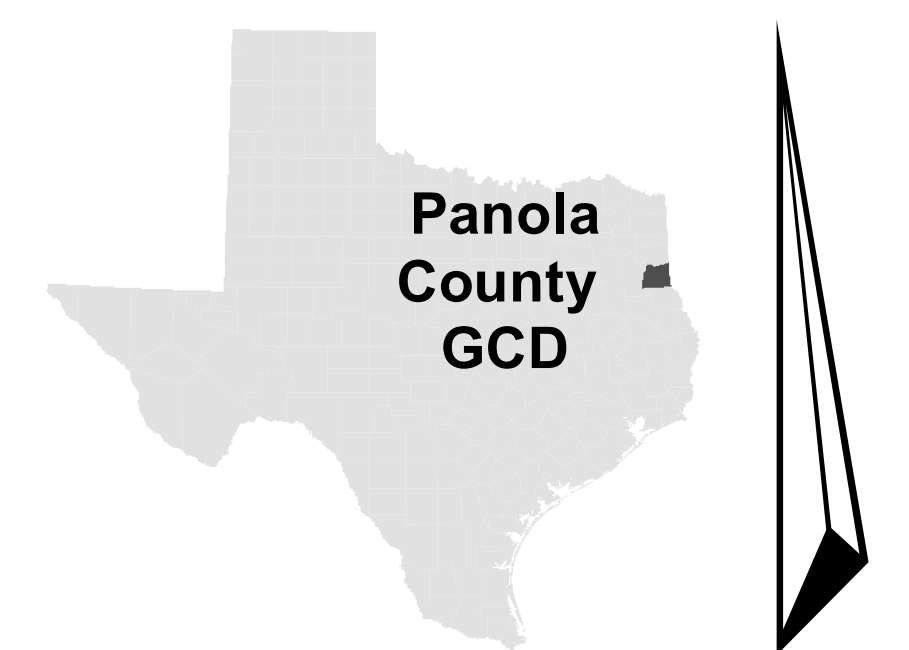
-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Sodium Concentration (Total, mg/L)

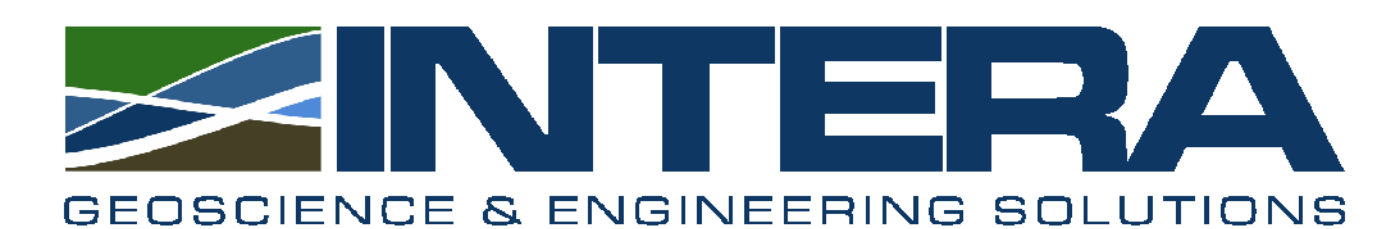
-  <100 (min 3.9 mg/L)
-  100-200
-  200-300
-  300-400
-  >400 (max 468 mg/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
 Total Wells Displayed: 88
 Wells with Non-Detect: 0
 Wells with Values: 88
 Wells Outside MCL: Not Applicable
 Average Value: 154 mg/L

Location Map


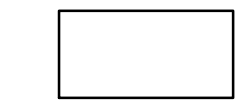





Prepared by:

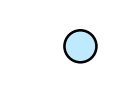
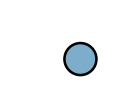
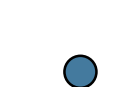




Strontium (Dissolved, ug/L)

Legend

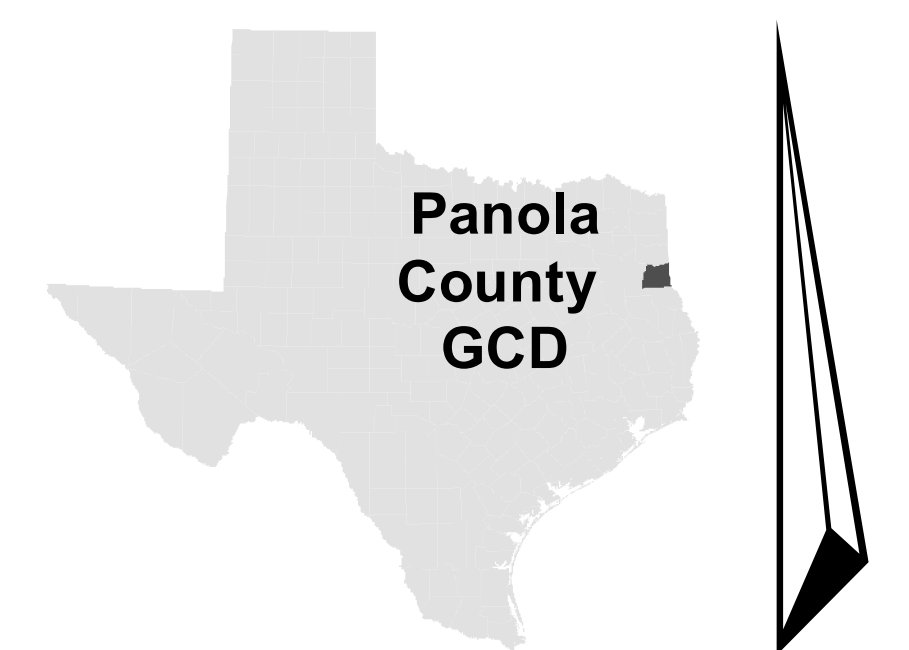
-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Strontium Concentration (Dissolved, ug/L)

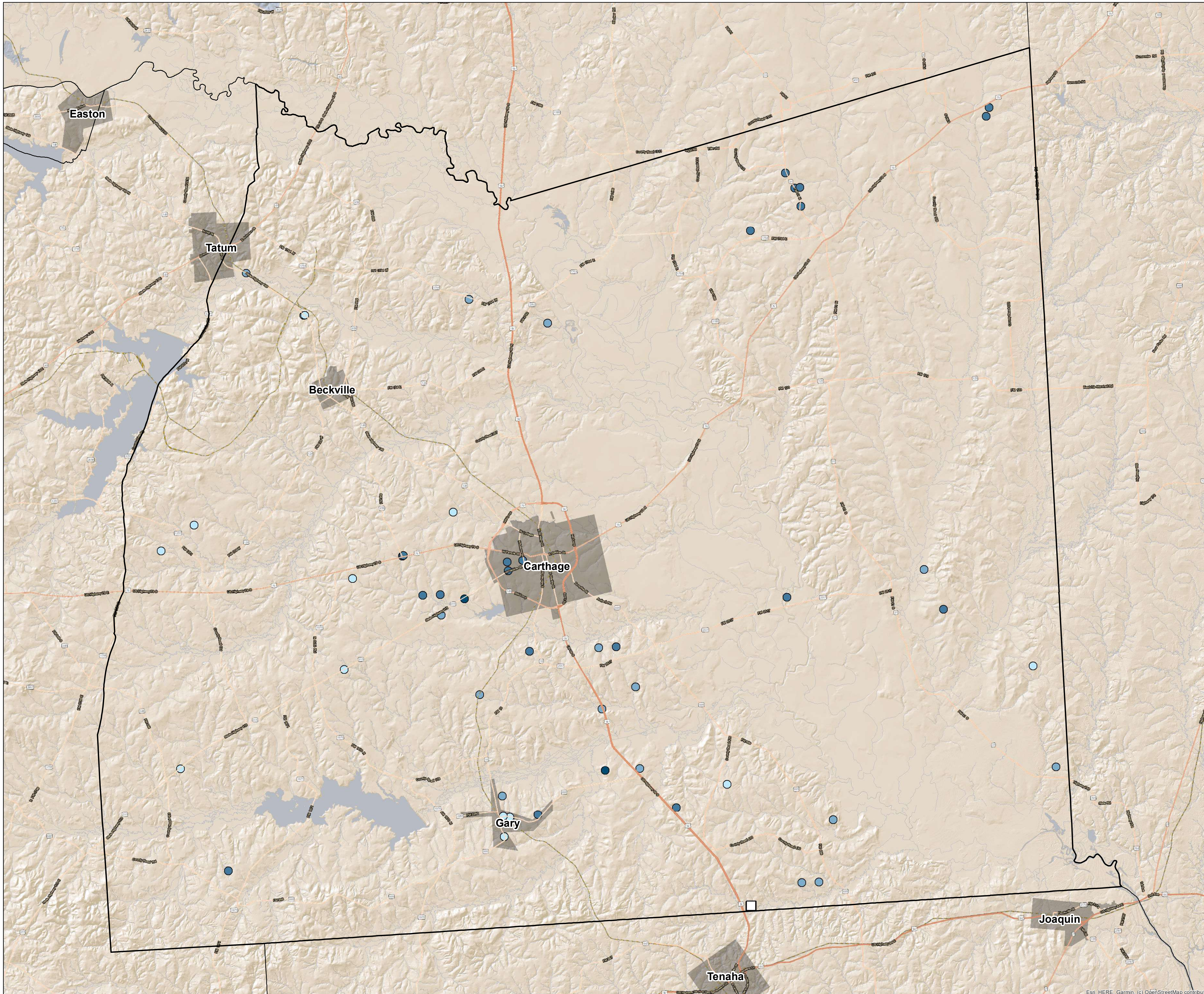
-  <100 (min 10 ug/L)
-  100-300
-  300-1,000
-  >1,000 (max 2,040 ug/L)
-  Below Detection Limit

Maximum Contaminant Level: Not Applicable
Total Wells Displayed: 59
Wells with Non-Detect: 1
Wells with Values: 58
Wells Outside MCL: Not Applicable
Average Value: 325 ug/L

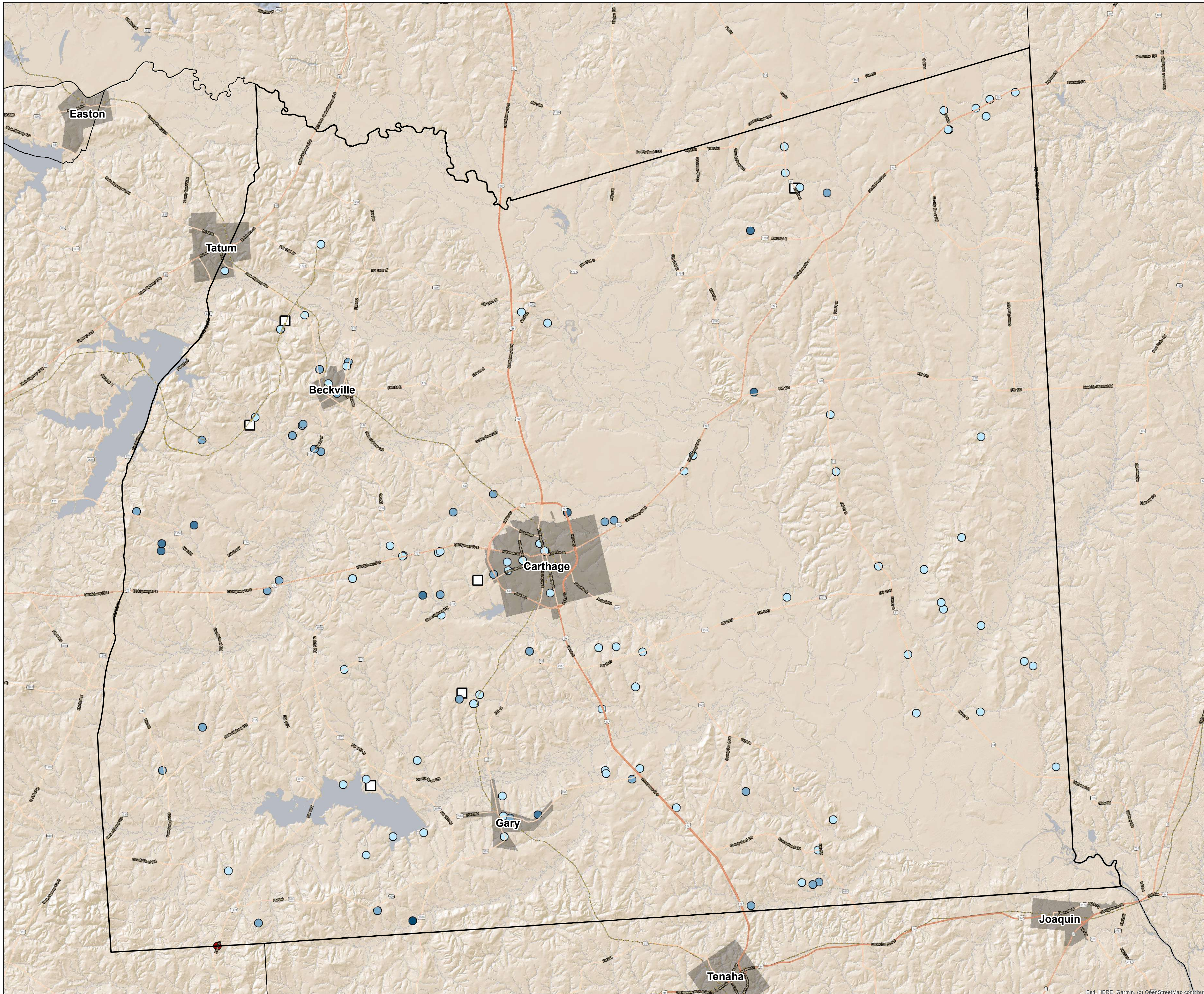
Location Map




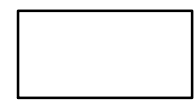



Prepared by:









Sulfate (Total, mg/L)



Legend

-  Panola County
 -  Counties
 -  Cities
 -  Rivers and Streams
 -  Lakes and Reservoirs
- Sulfate Concentration (Total, mg/L)**

-  <10 (min 0.2 mg/L)
-  10-50
-  50-100
-  100-250
-  >250 (max 284 mg/L)
-  Below Detection Limit

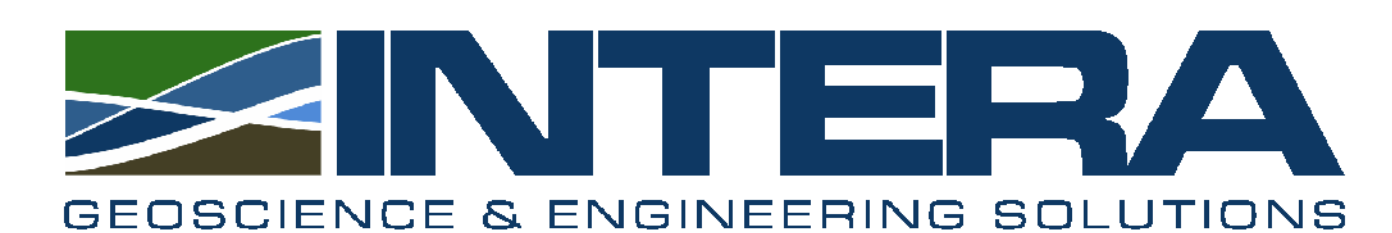
Above MCL | Below MCL

Maximum Contaminant Level (Secondary): 250 mg/L
 Total Wells Displayed: 129
 Wells with Non-Detect: 6
 Wells with Values: 123
 Wells Outside MCL: 1
 Average Value: 15.7 mg/L

Location Map

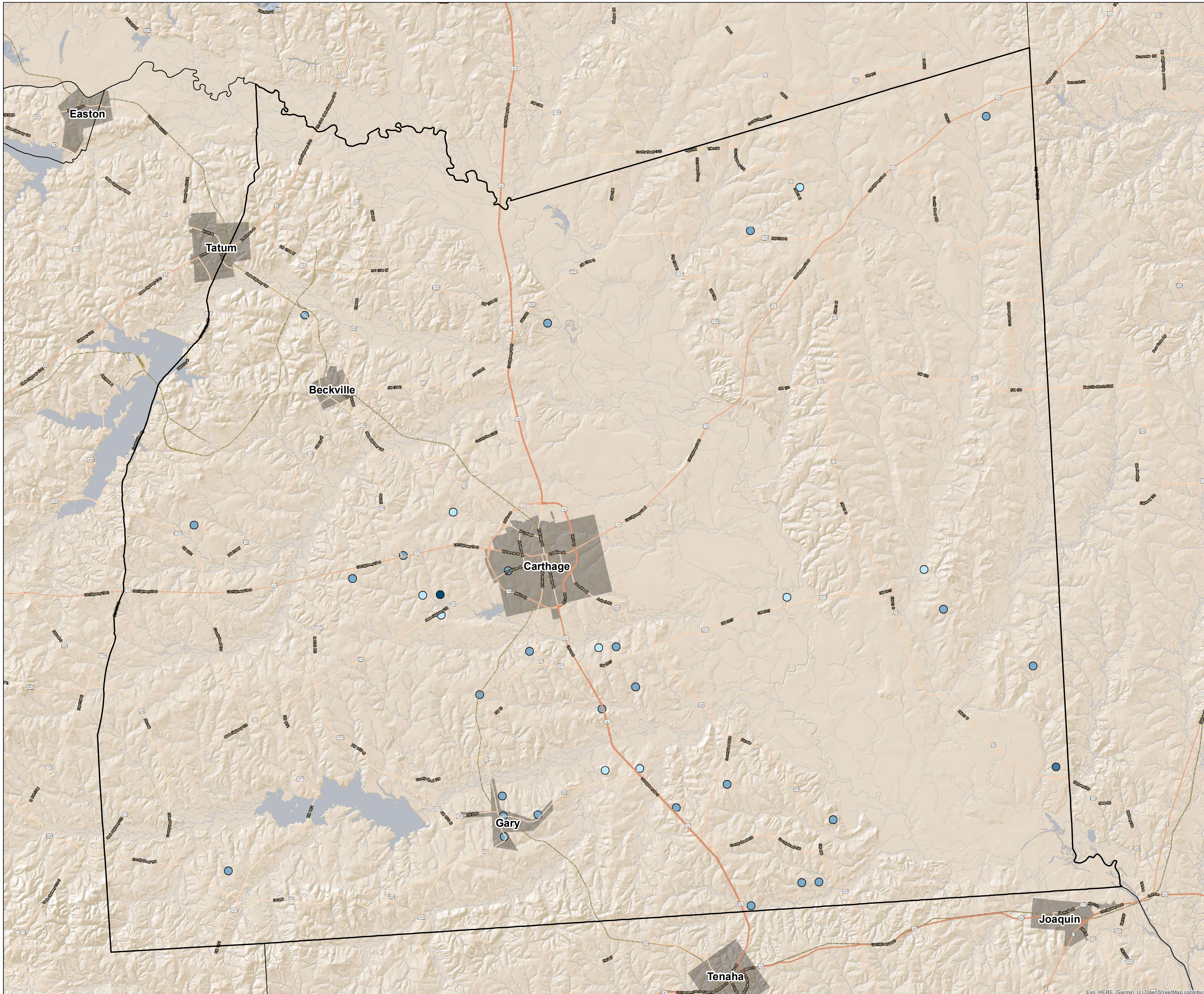


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Titanium (mg/L)



Legend

Panola County

Counties

Cities

Rivers and Streams

Lakes and Reservoirs

Titanium Concentration (mg/L)

<0.001 (min 0.0005 mg/L)

0.001 - 0.01

0.01 - 0.1

>0.1 (max 0.31 mg/L)

Below Detection Limit

Maximum Contaminant Level: Not Applicable

Total Wells Displayed: 42

Wells with Non-Detect: 0

Wells with Values: 42

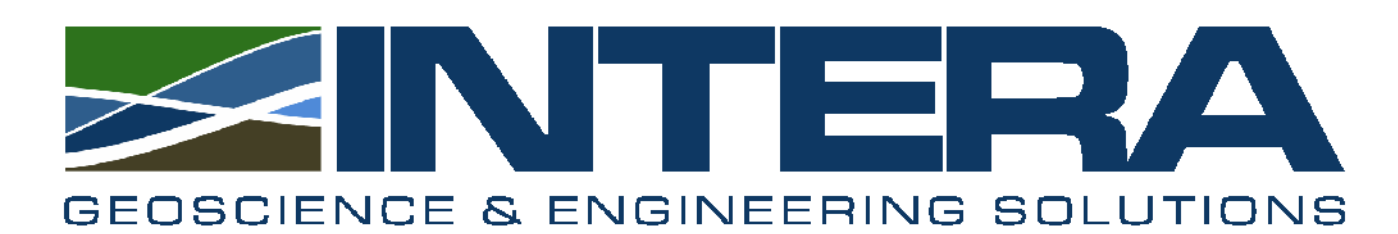
Wells Outside MCL: Not Applicable

Average Value: 0.0096 mg/L

Location Map




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Zinc (Dissolved, ug/L)

Legend

 Panola County

 Counties

 Cities


 Rivers and Streams


 Lakes and Reservoirs

Zinc Concentration (Dissolved, ug/L)

 <10 (min 0.44 ug/L)

 10-30

 30-100

 >100 (max 184 ug/L)

 Below Detection Limit

Maximum Contaminant Level (Secondary): 5,000 ug/L

Total Wells Displayed: 59

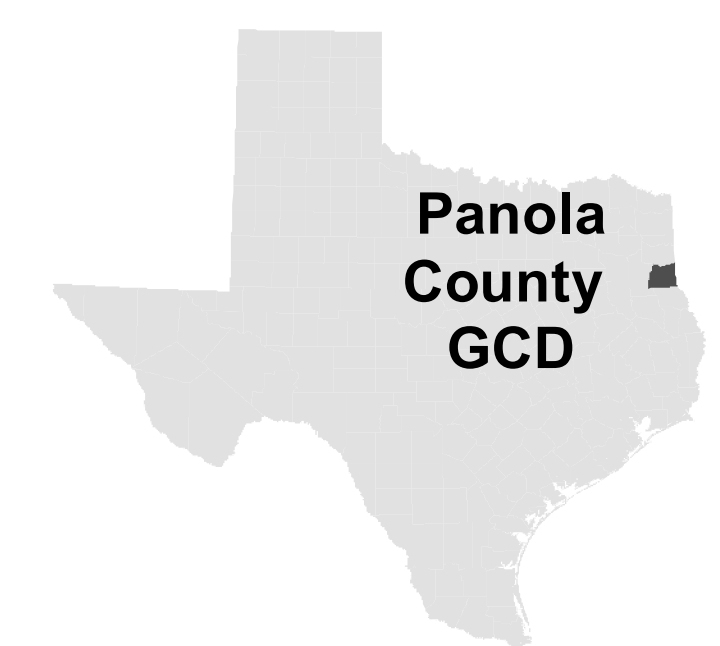
Wells with Non-Detect: 17

Wells with Values: 42

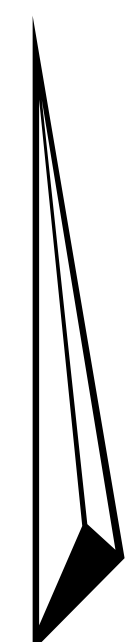
Wells Outside MCL: 0

Average Value: 21.0 mg/L

Location Map



N

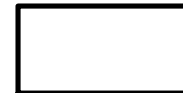
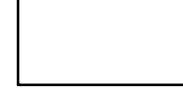


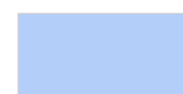


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Total Dissolved Solids (mg/L)

Legend

-  Panola County
-  Counties
-  Cities
-  Rivers and Streams
-  Lakes and Reservoirs

Total Dissolved Solids Concentration (mg/L)

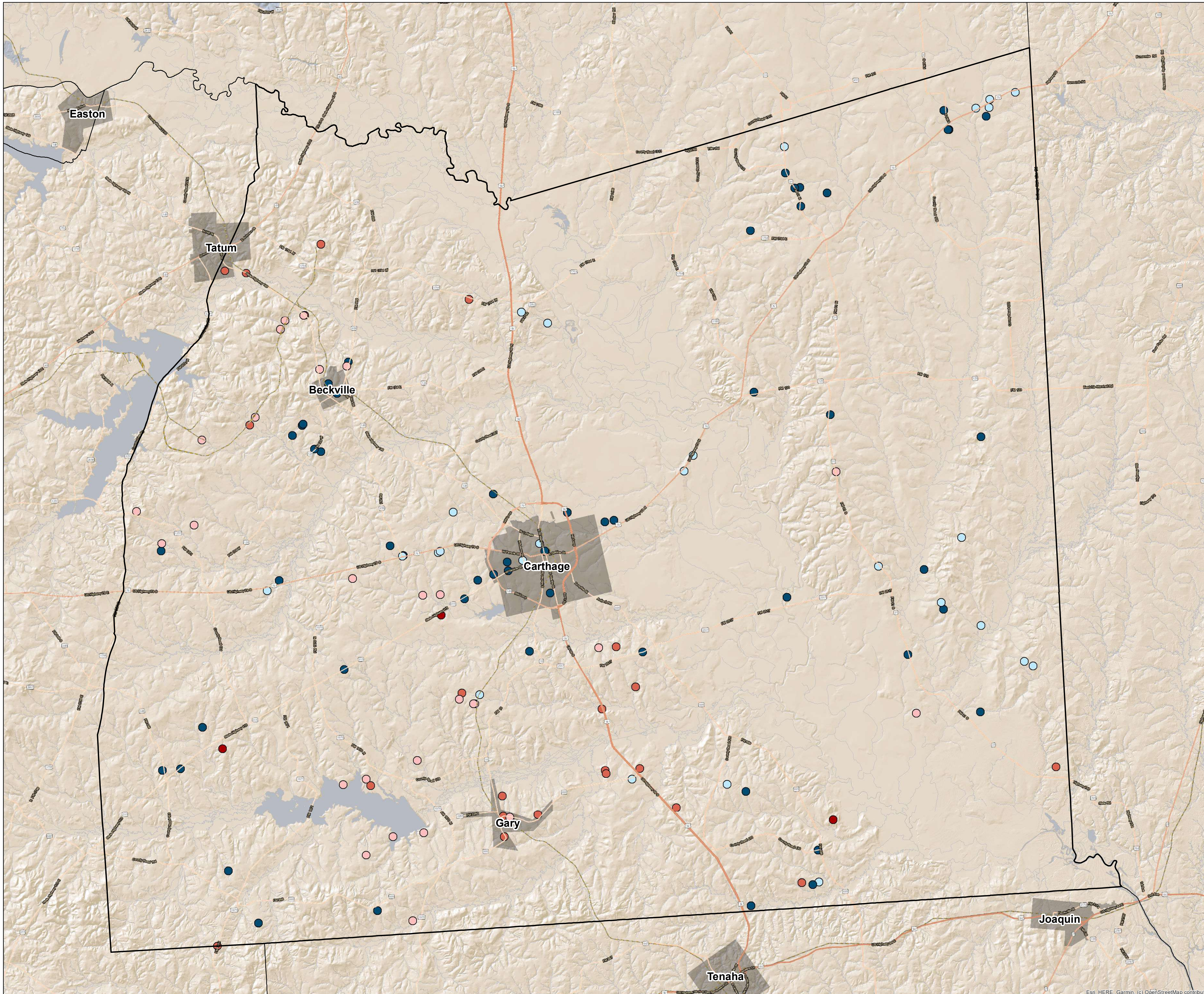
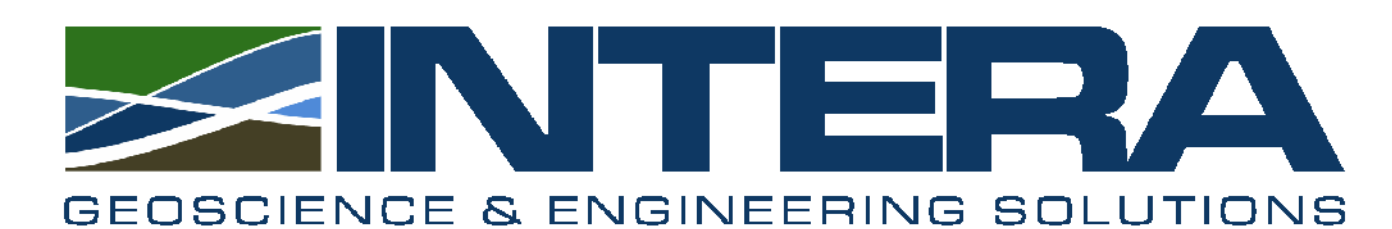
-  <250 (min 25 mg/L)
-  250-500 Below MCL
-  500-1,000 Above MCL
-  1,000-3,000
-  >3,000 (max 4,345 mg/L)

Maximum Contaminant Level (Secondary): 500 mg/L
 Total Wells Displayed: 140
 Wells with Non-Detect: Not Applicable
 Wells with Values: 140
 Wells Outside MCL: 57
 Average Value: 626 mg/L
 Median Value: 395 mg/L
 (Note average impacted by high values.
 Median value represents midpoint of dataset)

Location Map



Prepared by:



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