3.1 Texas Surface Water Quality Standards

Water quality standards are established by the state and approved by EPA to define a waterbody's ability to support its designated (beneficial) uses, which may include aquatic life use (fish, shellfish, and wildlife protection and propagation), primary contact recreation (swimming, wading, etc.), public water supply, and fish consumption. Water quality indicators for these uses include:

- dissolved oxygen (DO) for aquatic life use,
- *E. coli* for contact recreation,
- pH, temperature, total dissolved solids, sulfate, and chloride for general uses, and
- toxins for fish consumption and public water supply

The standards are set by TCEQ in Texas under the authority of the Clean Water Act (CWA). The most recent version of the Texas Surface Water Quality standards (TSWQS, TCEQ 2022) was adopted as a state rule on September 29, 2022, and serves as the reference for water quality assessment in this report. The standards set general and numerical criteria/limitations expressed as acceptable levels (constituent concentrations) or as narrative statements that are aimed at protecting beneficial uses. Numeric water quality criteria specify precise measurable levels of a particular water quality indicator allowable in a water body.

3.1.1 Recreation

The 2022 TSWQS include the following categories of recreational use:

- Primary contact recreation 1 (PCR1) – Activities that are presumed to involve a significant risk of ingestion of water.
- Primary Contact Recreation 2 (PCR2) - Water recreation activities that involve a significant risk of ingesting water, but that occur less frequently than for primary contact recreation 1 due to physical characteristics of the waterbody or limited public access.
- Secondary Contact Recreation 1 (SCR1) - Activities that commonly occur but have limited body contact incidental to shoreline activity,

- Secondary Contact Recreation 2 (SCR2) - Activities with limited body contact incidental to shoreline activity that are presumed to pose a less significant risk of ingesting water than secondary contact recreation 1, and
- Noncontact Recreation - Activities that do not involve a significant risk of water ingestion, such as those with limited body contact incidental to shoreline activity.

TCEQ conducts a Recreational Use-Attainability Analysis (RUAA) to evaluate and determine what category of recreational use is appropriate for a particular water body. The RUAA for Cottonwood Branch characterized the waterbody as a SCR1 segment (TCEQ 2022c). For waterbodies without a RUAA, PCR1 is presumed as the appropriate recreation use category. Recreation use categories and corresponding *E. coli* criteria for waterbodies in the watershed are listed in Table 3-1.

Table 3-1. Recreation use categories and indicator bacteria criteria for water bodies in the Thompsons Creek watershed.

Water body	Use Category	Geometric Mean Colonies/100 mL Criterion	Indicator Bacteria
Cottonwood Branch	Secondary contact recreation 1	630	*E. coli*
Still Creek	Primary contact recreation 1	126	*E. coli*
Thompsons Creek	Primary contact recreation 1	126	*E. coli*

3.1.2 Aquatic Life

The establishment of numerical criteria for aquatic life is highly dependent on desired use, sensitivities of aquatic communities, and local physical and chemical characteristics. Six subcategories of aquatic life use are established. They include minimal, limited, intermediate, high, and exceptional aquatic life and oyster waters. The categories and associated DO criteria for waterbodies in the watershed are listed in Table 3-2.

Table 3-2. Aquatic life use categories and dissolved oxygen criteria for water bodies in the Thompsons Creek watershed

Water body	Use Category	Dissolved Oxygen Criterion - Mean (mg/L)
Cottonwood Branch	Intermediate	4.0
Still Creek	High	5.0
Thompsons Creek (AU 1242D_01)	High	5.0

Thompsons Creek (AU 1242D_02)	Intermediate	4.0
Unnamed tributary of Cottonwood Branch	Intermediate	4.0

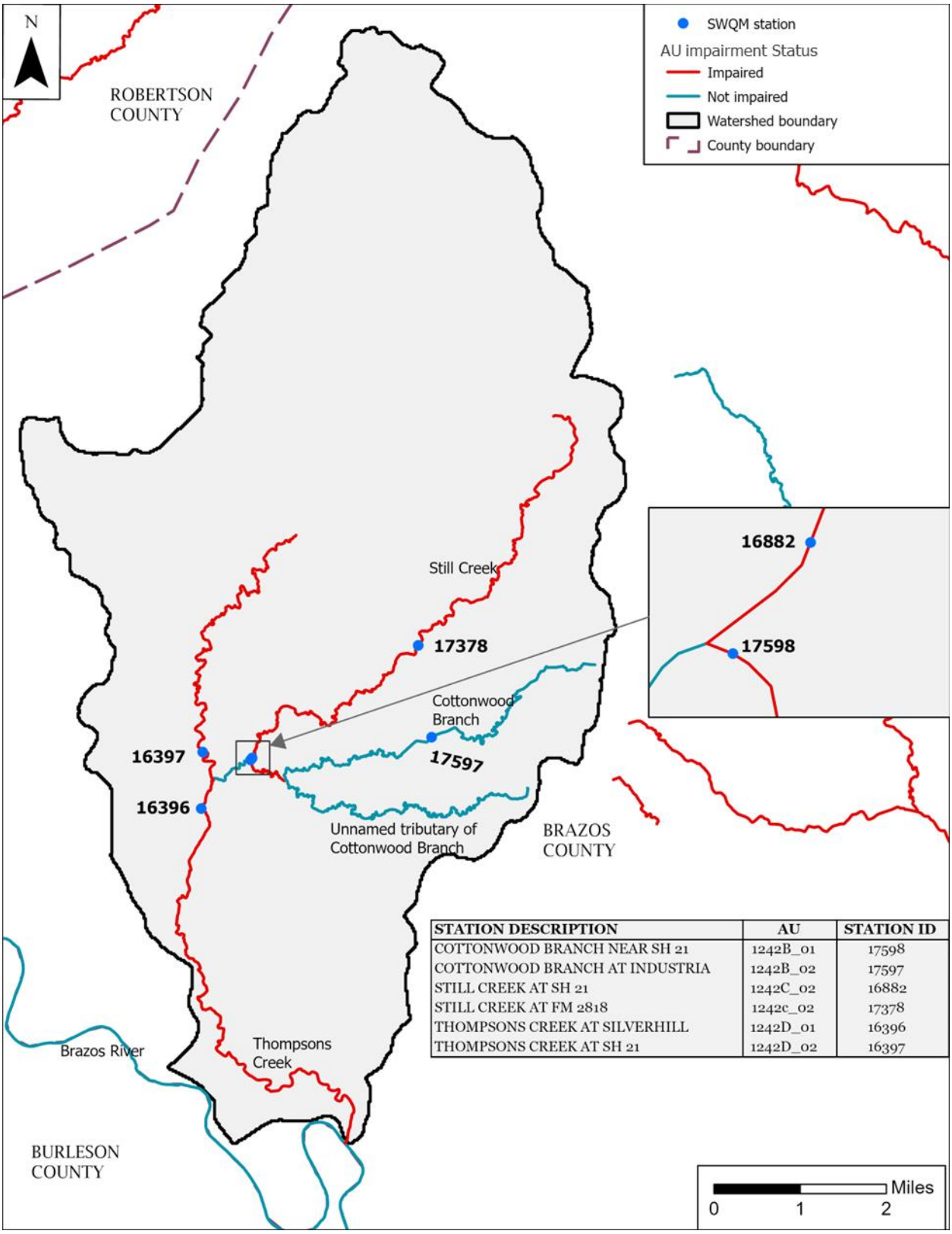
3.1.3 Additional Criteria

Waterbody quality can also be evaluated based on whether water quality conditions meet standards criteria for:

- Chemical parameters – criteria for chloride, sulfate, and total dissolved solids are established as averages over an annual period for either a single sampling point or multiple sampling points,
- pH – Site specific numerical criteria for pH are established as absolute minima and maxima,
- Temperature - Criteria are established as absolute maxima,
- Nutrient criteria - Numeric and narrative criteria to preclude excessive growth of aquatic vegetation are intended to protect multiple uses such as primary, secondary, and noncontact recreation, aquatic life, and public water supplies, and
- Toxic materials - Surface waters utilized for domestic water supply must not exceed toxic material concentrations that prevent them from being treated by conventional surface water treatment to meet drinking water standards.

3.2 Surface Water Quality Monitoring in the Watershed

The federal CWA gives states the primary responsibility for implementing programs to protect and restore water quality, including monitoring and assessing the nation's waters and reporting on their quality. The TCEQ Surface Water Quality Monitoring (SWQM) program coordinates the collection of physical, chemical, and biological samples throughout the State. TCEQ partners with regional water authorities through the Texas Clean Rivers Program (CRP) to coordinate and conduct water quality monitoring. The regional state agency that manages water resources of the Brazos River basin, the Brazos River Authority, collects water quality monitoring data in the watershed at six SWQM stations in the watershed (Figure 3-1).



STATION DESCRIPTION	AU	STATION ID
COTTONWOOD BRANCH NEAR SH 21	1242B_01	17598
COTTONWOOD BRANCH AT INDUSTRIA	1242B_02	17597
STILL CREEK AT SH 21	1242C_02	16882
STILL CREEK AT FM 2818	1242c_02	17378
THOMPSONS CREEK AT SILVERHILL	1242D_01	16396
THOMPSONS CREEK AT SH 21	1242D_02	16397

Figure 3-1. SWQM stations and Assessment Unit (AU) boundaries in the Thompsons Creek watershed.

3.3 Water Body Assessments

TCEQ conducts biennial waterbody assessments and publishes an assessment report that lists all impaired waterbodies not supporting their beneficial uses and those having use concerns. The most recent assessment, the 2022 Texas Integrated Report (TCEQ 2022a) includes water quality assessment data collected from December 1, 2013 – November 30, 2020. Table 3-3 shows the impairments and concerns for water quality listed on the 2022 Texas Integrated Report.

Table 3-3. Impairments and concerns listed on the *2022 Texas Integrated Report of Surface Water Quality*

Parameter	Assessment unit	Category
Bacteria	1242B_01, 1242C_02	5c
	1242D_01, 1242D_02	5b
Nitrate Nitrogen	1242B_01, 1242C_02, 1242D_01	CS
Ammonia	1242D_02	CS
Total Phosphorus	1242B_01, 1242C_02, 1242D_01	CS
Chlorophyll-a	1242D_02	CS
Dissolved Oxygen Grab	1242C_02	CS
Dissolved oxygen 24-hour average	1242D_02	5b
Dissolved oxygen 24-hour minimum	1242D_02	5b
Fish Community	1242D_01	CN
Macro benthic community	1242D_02	CN
Category 5c - Additional data and information will be collected or evaluated before a management strategy is selected; Category 5b - A review of the standards for parameter(s) will be conducted before a management strategy is selected; CS - Concern for water quality based on screening levels; CN - Concern for water quality based on use.		

3.3.1 Bacteria

To assess the potential risk of illness from contact recreation, concentrations of fecal indicator bacteria such as *E. coli* in water bodies are measured. The presence of these bacteria can indicate increased potential for related pathogens present in the intestinal tract of warm-blooded animals to also be in surface waters. Common sources of *E. coli* include wildlife, livestock, pets, failing on-site sewage facilities (OSSFs), urban/agricultural runoff, sanitary sewage overflows, and WWTPs.

Four of the five assessed AUs in the watershed have *E. coli* concentrations above their respective recreation use type standards criteria (Table 3-4, Figure 3-2). *E. coli* concentrations are highest in the downstream portion of Thompsons Creek.

Table 3-4. Bacteria Water quality monitoring station summary from December 2013 – November 2020

Water body	Segment ID	Assessment unit	Station	Assessment results from the Texas 2022 Integrated Report		
				# of samples	7-year *E. coli* geomean (cfu/100 mL)	*E. coli* geomean criteria (cfu/100 mL)
Cottonwood Branch	1242B	1242B_01	17598	26	1,659	630
		1242B_02	17597	27	93	630
Still Creek	1242C	1242C_02	16882	47	234	126
Thompsons Creek	1242D	1242D_01	16396	36	1150	126
		1242D_02	16397	10	381	126

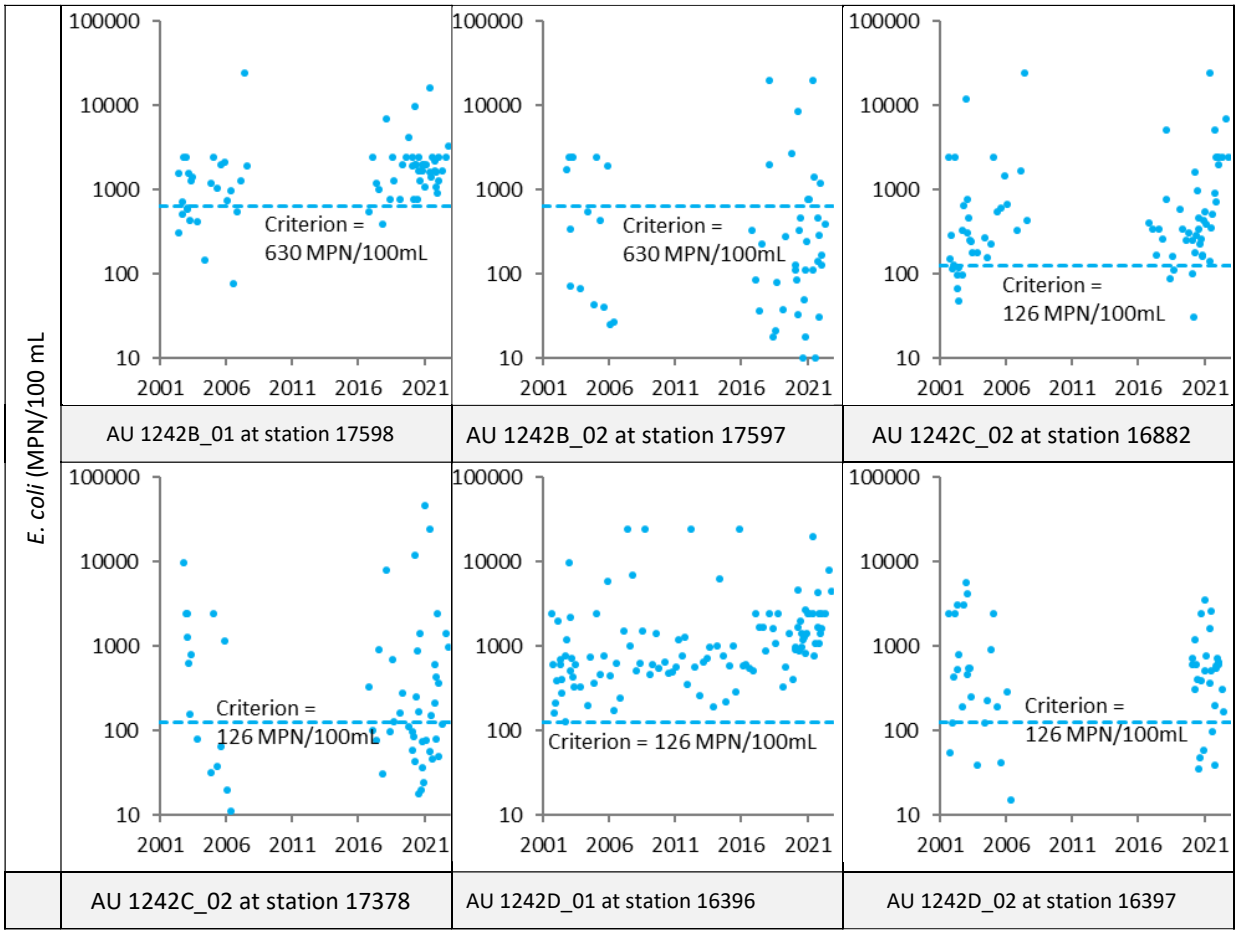


Figure 3-1. *E. coli* measurements in the Thompsons Creek watershed, January 2001 – December 2022.

3.3.2 Nutrients

Both nitrogen and total phosphorus are used by aquatic plants and algae to grow, and excessive concentrations can lead to algae blooms which reduce DO instream and can affect fish respiration. The main nutrient sources in watersheds are typically WWTP effluent and fertilizer application in urban yards or agricultural fields that is then introduced into the surface water as runoff. Runoff can also carry newly eroded sediment particles that have nutrients bound to them, further increasing the nutrient concentrations in streams.

Although Texas does not currently have numeric nutrient criteria set for surface water, screening concentrations have been developed to evaluate nutrient loading. Screening concentrations for nutrient parameters are based on the 85th percentile values of a similar water body type. A concern for water quality is identified if the screening level is exceeded more than 20% of the time. Elevated nutrient

concentrations, specifically nitrate nitrogen, ammonia, total phosphorus, and chlorophyll-*a* were found in several waterbodies in the watershed (Table 3-5, Figure 3-3).

Table 3-1. TCEQ nutrient screening levels and assessment results for water bodies in the Thompsons Creek watershed

Parameter	Screening Level	Assessment results from the Texas 2022 Integrated Report				
		Assessment Unit	Number of Data assessed	Assessed data exceeding criteria	Mean Exceedances	Category
Nitrate (mg/L)	1.95	1242B_01	16	16	73.78	CS
		1242B_02	15	0	-	NC
		1242C_02	32	16	16.74	CS
		1242D_01	27	25	31.06	CS
Ammonia (mg/L)	0.33	1242D_01	27	4	0.6	CS
		1242D_02	0	-	-	CS
Total Phosphorus (mg/L)	0.69	1241B_01	0	-	-	CS
		1241C_02	69	0	-	CS
		1241D_01	27	25	5.25	CS
Chlorophyll-*a* (µg/L)	14.1	1242D_01	27	7	21.3	NC
		1242D_02	0	-	-	CS

Figure 2-3. Nutrient concentrations in impaired water bodies in the Thompsons Creek watershed.

3.4.3 Dissolved Oxygen

Dissolved oxygen (DO) is the primary measurement used to determine a water body's ability to support and maintain aquatic life and related activities. If DO levels in a water body drop too low (or are "depressed"), fish and other aquatic species will not have enough oxygen to survive.

Dissolved oxygen concentrations fluctuate throughout the day depending on environmental factors. The lowest levels of DO occur just before dawn as both plants and animals in the water consume oxygen through respiration, while the highest levels of DO occur in mid to late afternoon, due to increased photosynthesis. Similarly, seasonal fluctuations in DO are common due to decreased oxygen solubility in water as temperature increases and it is common to see lower DO levels during the summer.

While DO does fluctuate naturally, human activities can also impact levels. Excess fertilizers and manure in the water can lower DO as aquatic plants and algae increase growth in response to the greater nutrient levels, which causes increased respiration and consumption of DO. In addition, decaying organic matter from plant die-off can also reduce DO concentrations as bacteria break down the materials and,

subsequently, consume oxygen. Thompsons Creek (AU 1242D_02) is listed as impaired for depressed DO in the 2022 Texas Integrated Report (Table 3-6 and Figure 3-4).

Table 3-2. Dissolved oxygen assessment results for water bodies in the Thompsons Creek watershed

Parameter	Criteria (mg/L)	Assessment results from the Texas 2022 Integrated Report			
		Assessment unit	Number of data assessed	Assessed data exceeding criteria	Level of support
Dissolved Oxygen – grab minimum	3	1242B_01	27	0	FS (Fully supporting)
	1.5	1242B_02	27	1	FS
	3	1242C_02	48	3	FS
	3	1242D_01	38	0	FS
Dissolved Oxygen – grab screening level	4	1242B_01	27	0	NC (No concern)
	2	1242B_02	27	1	NC
	5	1242C_02	48	8	CS (Screening level concern)
	5	1242D_01	38	0	NC
	5	1242D_01	38	0	NC
Dissolved Oxygen – 24hr average	4	1242D_02	0	-	NS (Not supporting)
Dissolved Oxygen – 24hr minimum	3	1242D_02	0	-	NS

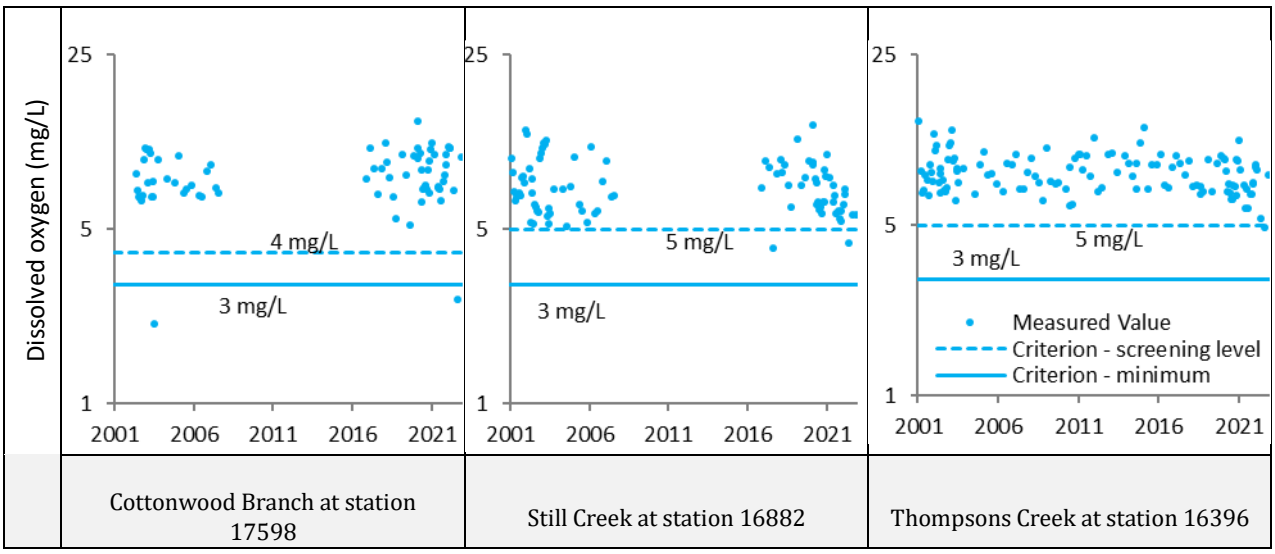


Figure 3-3. Dissolved oxygen concentrations in impaired water bodies in the Thompsons Creek watershed.

3.4.4 Biological/ Habitat Assessments

The health of aquatic systems can also be assessed by evaluating the biological community present. Along with physical habitat information, fish and benthic macroinvertebrates are collected and identified in a manner that permits an assessment of the composition and integrity of the aquatic community. Previous assessments conducted in the watershed identified use concerns for fish communities in AU 1242D_01 and macrobenthic communities in AU 1242D_02.

3.4.5 Chloride and Sulphate in Water

Total dissolved solids are a measure of all constituents dissolved in water. The inorganic anions dissolved in water include carbonates, chlorides, sulfates, and nitrates. The inorganic cations include sodium, potassium, calcium, and magnesium. Anions can form salts with the cations in water. Concentrations of anions are therefore indicative of water salinity. The Texas water quality standards require that concentrations and the relative ratios of dissolved minerals such as chlorides, sulfates, and total dissolved solids must be maintained such that existing, designated, presumed, and attainable uses are not impaired.

The water bodies in the Thompsons Creek watershed do not have water quality standards criteria for dissolved solids. Limits for chloride and sulphate in the Brazos River Above Navasota River (Segment 1242), which is downstream of Thompsons Creek, are used as a benchmark for analyzing chloride and sulphate levels in the Thompsons Creek watershed. In all water bodies, concentrations are below the 350 mg/L and 200 mg/L thresholds for chloride and sulphate thresholds respectively (Figure 3-5).

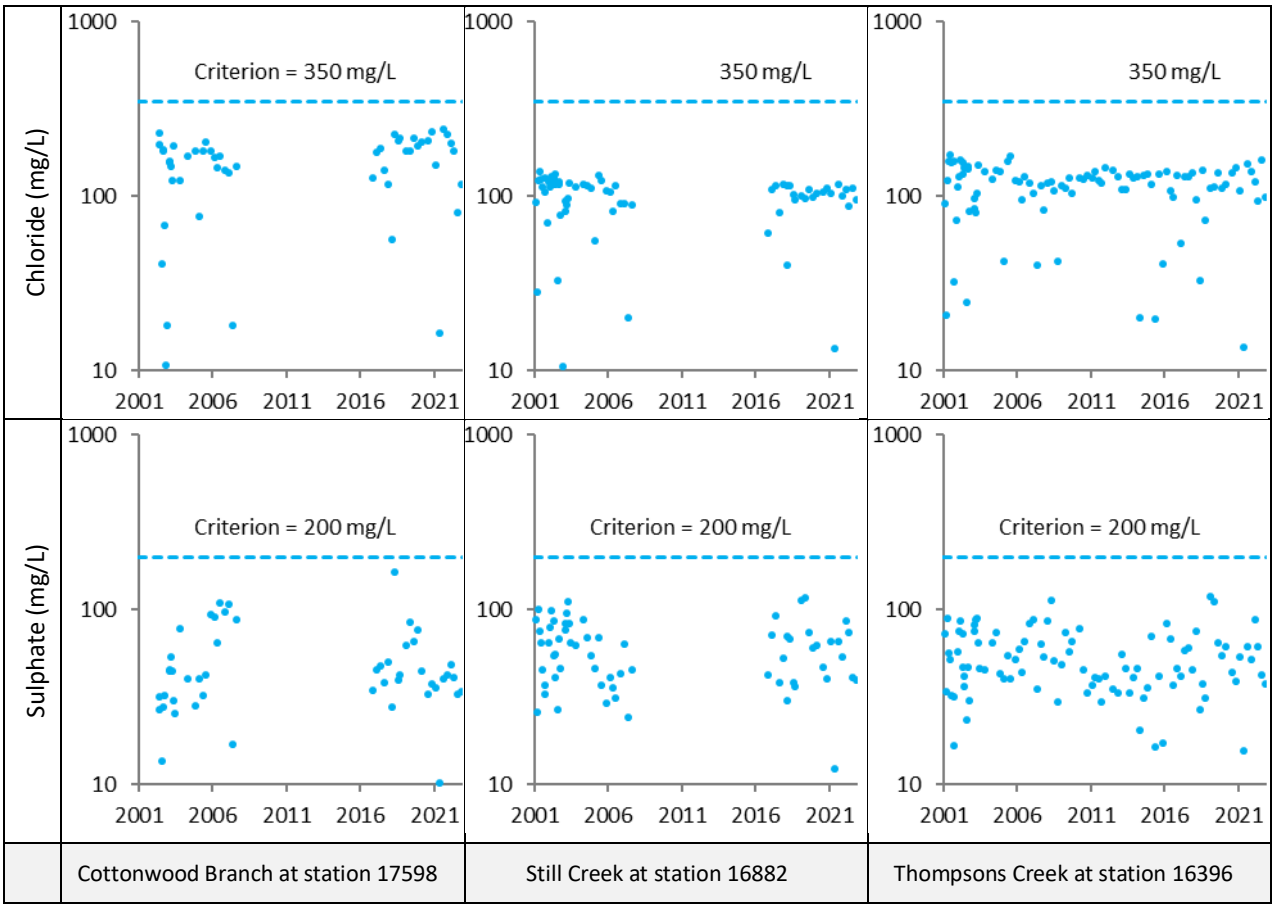


Figure 3-4. Chloride and sulphate concentrations in water bodies in the Thompsons Creek watershed.

3.4 Streamflow

Continuous stream discharge data are essential to watershed projects that focus on pollutant load analysis. Streamflow records are required for estimating loads of constituents of concern, and for determining the variability of constituents based on seasonal or daily variations in flow, point-source discharges, or other variables.

3.4.1 USGS Streamflow Monitoring in the Watershed

Recorded data is published in the National Water Information System (NWIS) (USGS 2023).

USGS gage in the Thompsons Creek watershed and no records of long-term stream flow data are available in the NWIS.

The nationwide streamflow-gaging network operated by the USGS in cooperation with State agencies and other cooperators provides stream flow data that are valuable for developing flow duration curves (FDC)s. There is no active

3.4.2 Stream flow Estimation

To better understand the hydrology of Thompsons Creek and its tributaries, TWRI, in cooperation with TCEQ, measured continuous streamflow data from March 2020 to March 2021 at three SWQM stations (16396, 16397, and 16882). Using measured data, long-term daily flows for the 2003–2021 period for the three stations were estimated using a calibrated and validated daily lumped catchment water balance model. Flows at two additional SWQM stations (17597 and 17598) on Cottonwood Branch were estimated using the drainage-area ratio method. The methodology and results of the flow estimation tasks are described in Schramm et al. (2022).

3.4.4 Flow Duration Curves

FDCs for impaired assessment units were constructed using estimated discharge data for the 2003-2021 period. FDCs were divided into three flow regimes to assist in determining streamflow conditions under which exceedances occur. For more information on FDCs, EPA has extensive guidance on the development and application of FDCs for water quality analysis. The methodology for constructing FDCs is described in Appendix A.

References

Texas Commission on Environmental Quality (TCEQ). 2022a. 2022 Texas Integrated Report of Surface Water Quality. https://www.tceq.texas.gov/waterquality/assessment/22twqi

TCEQ. 2022b. 2022 Texas Surface Water Quality Standards. https://www.tceq.texas.gov/waterquality/standards

TCEQ. 2023. Surface water quality web reporting tool (database). Available online. Retrieved on 10/18/2023. https://www80.tceq.texas.gov/SwqmisPublic/index.htm

Texas Water Development Board. 2021. Regional Water Plan County Population Projections. https://www3.twdb.texas.gov/apps/reports/Projections/2022%20Reports/pop_county

USCB (United States Census Bureau). 2020a. 2020 TIGER/Line Shapefiles. Available online. Downloaded on 10/20/2023. https://www.census.gov/geographies/mapping-files.html

USCB. 2020b. Decennial Census of Population and Housing Data. Available online. Retrieved on 10/16/2023. https://data.census.gov/

United States Department of Agriculture (USDA). 2017. Census of Agriculture. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Texas/.