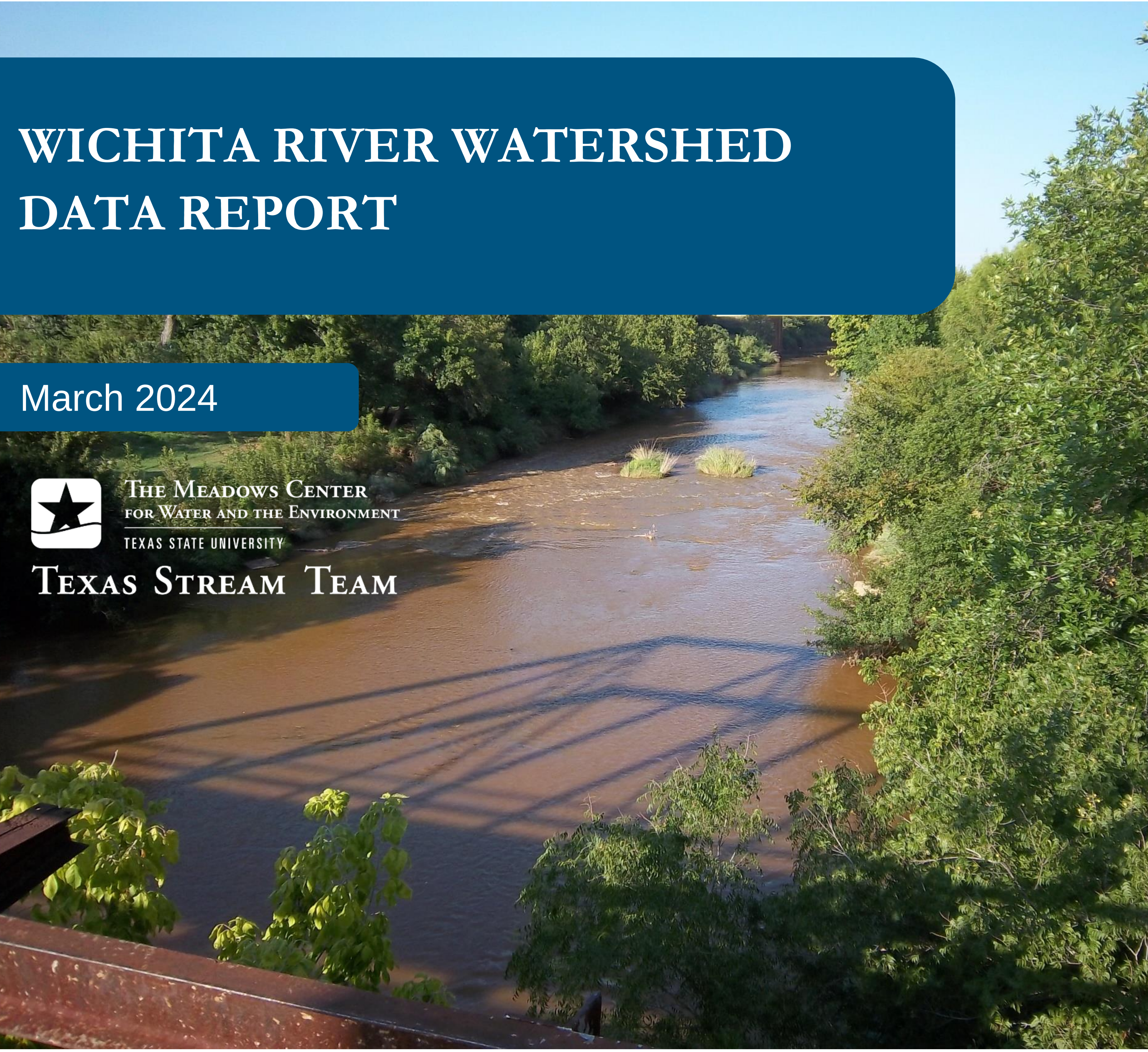
WICHITA RIVER WATERSHED DATA REPORT

March 2024

The Meadows Center for Water and the Environment
Texas State University
Texas Stream Team



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United States Environmental Protection Agency

Texas Commission on Environmental Quality

Texas State University
The rising STAR of Texas

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ACKNOWLEDGEMENTS

The Texas Stream Team encourages life-long learning about the environment and people's relationship to the environment through its multidisciplinary community science programs. We also provide hands-on opportunities for Texas State University students and inspire future careers and studies in natural resource related fields. Preparation of this report fulfills a contract deliverable for the granting entity, but it also serves as a valuable educational experience for the students that assisted in preparing the report. The Texas Stream Team staff values the student contributions and recognizes each individual for their role. The following staff and student workers assisted in the preparation of this report and are acknowledged for their contributions:

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INTRODUCTION

Texas Stream Team

Texas Stream Team is a volunteer community science water quality monitoring program. Community scientist water quality monitoring occurs at predetermined monitoring sites, at approximately the same time of day each month. Information collected by Texas Stream Team community scientists is covered by a Texas Commission on Environmental Quality-approved Quality Assurance Project Plan to ensure a standard set of methods is used. Community scientist data may be used to identify surface water quality trends, target additional data collection needs, identify potential pollution events and sources of pollution, and to test the effectiveness of water quality management measures. Texas Stream Team community scientist data are not used by the state to assess whether water bodies are meeting the designated surface water quality uses and standards. Data collected by Texas Stream Team provide valuable information, often collected in water bodies professionals are not able to monitor frequently or monitor at all.

For additional information about water quality monitoring methods and procedures, including the differences between professional and volunteer community science monitoring, please refer to the following sources:

- Texas Stream Team Core Water Quality Community Scientist Manual
- Texas Stream Team Advanced Water Quality Community Scientist Manual
- Texas Stream Team Program Volunteer Water Quality Monitoring Program Quality Assurance Project Plan
- Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures

The purpose of this report is to provide a summary of the data collected by Texas Stream Team community scientists. The data presented in this report should be considered in conjunction with other relevant water quality reports for a holistic view of water quality in the Wichita River watershed within the Red River Basin. Such sources may include, but are not limited to, the following:

- Texas Surface Water Quality Standards
- Texas Water Quality Inventory and 303(d) List (Integrated Report)
- Texas Clean Rivers Program partner reports, such as Basin Summary and Highlight Reports
- Texas Commission on Environmental Quality Total Maximum Daily Load reports
- Texas Commission on Environmental Quality and Texas State Soil and Water Conservation Board Nonpoint Source Program funded reports, including watershed protection plans

To get involved with Texas Stream Team or for questions regarding this watershed data report contact us at TxStreamTeam@txstate.edu or at (512) 245-1346. Visit our website for more information on our programs at www.TexasStreamTeam.org.

WATERSHED DESCRIPTION

Location and Climate

The watershed spans approximately 3,440 square miles (8909 km^2) and is located within the Red River Basin. The watershed lies within Archer, Baylor, Clay, Knox, Wichita, and Wilbarger Counties (Figure 1). The Wichita River rises in Dickinson County and branches off into three forks, flowing northeast through Baylor, Archer, Wichita, then Clay County until it joins the Red River (Texas State Historical Association, 1996). This area is important locally for recreational parks/hiking trails as well as the environment it sustains (City of Wichita Falls).

Wichita River got its name from the Wichita Indians who inhabited the area until they were removed from the land in the mid-late 19th century (Texas State Historical Association, 1996). Ranching and farming would initially contribute to the county population and economic growth in the mid-18th century until the oil industry took over in the early 19th century. This oil boom brought a multitude of businesses and families to the area and created a prosperous retail-based economy which the county still relies on for economic stability today (Hart, 2019).

The Texas Commission on Environmental Quality designates classifications for streams, rivers, lakes, and bays throughout Texas including the watershed (Table 1). One classified and four unclassified streams within the watershed were monitored by Texas Stream Team community scientists and are included in the study area for this summary report. Wichita River Below Diversion Lake Dam (Segment 0214) is a classified stream and begins from the confluence with the Red River in Clay County to Diversion Dam in Archer County. As such, Wichita River Below Diversion Lake Dam is the focus of this report and is recognized as a classified segment and a freshwater stream. Buffalo Creek (Segment 0214B), unnamed tributary of Buffalo Creek (Segment 0214F), Wichita Valley Irrigation Project (Segment 0214E), and Holiday Creek above Lake Wichita (Segment 0219A) are all unclassified streams in the watershed.

The climate in this area is described as semi-humid subtropical with hot summers and cool winters (Koppen-Geiger climate classification). National Oceanic and Atmospheric Administration climate data from one weather station in Wichita Falls, Texas, was acquired from the National Data Center (National Oceanic and Atmospheric Administration, 2021). Average annual precipitation is 27.9 inches and typically occurs year-round (Figure 2). Long-term monthly average precipitation has a bimodal distribution with peaks occurring in May and September. Average rainfall during these months is 3.6 inches. The least amount of rainfall (1.2 inches) occurs in January. The warmest and coldest months of the year are July (29.3°C) and January (5.8°C), respectively.

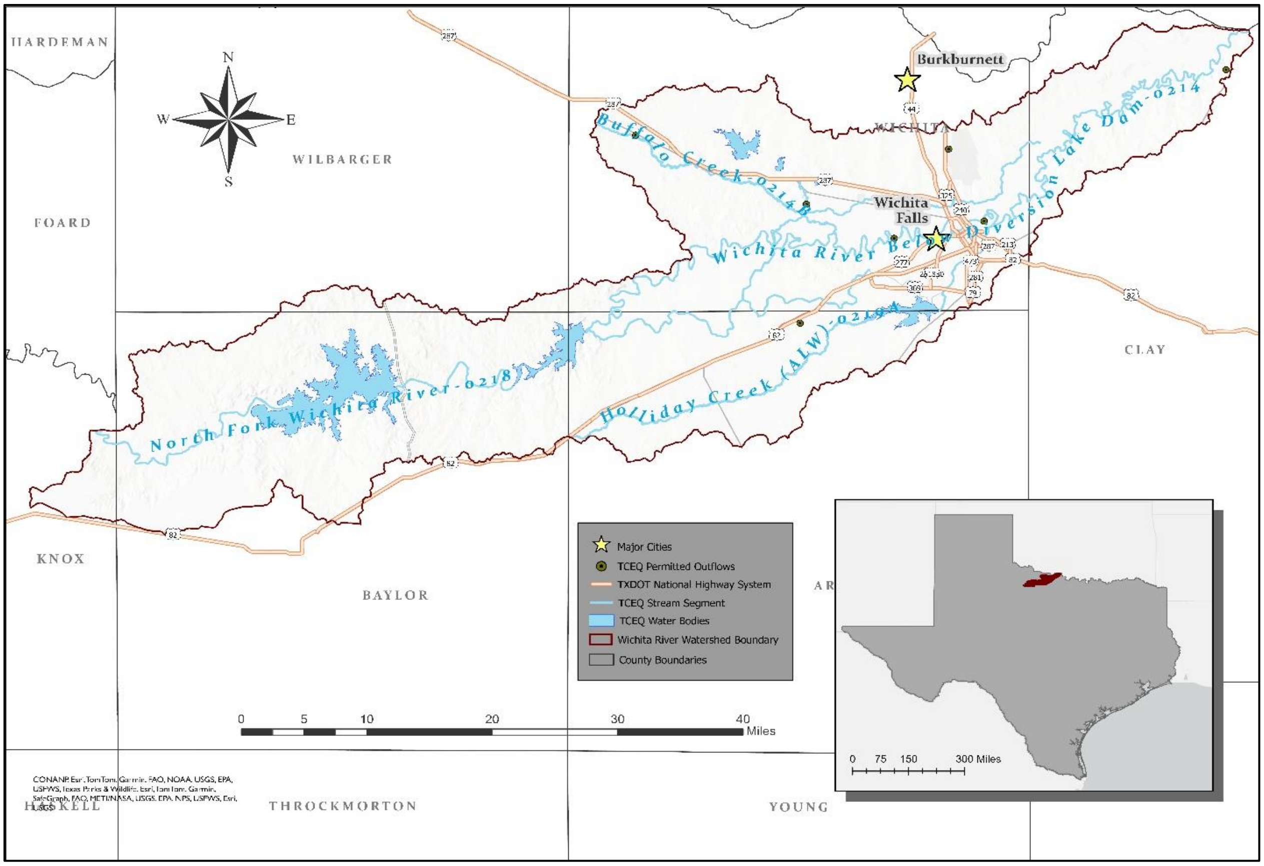

Figure 1. Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas.

Table 1. Texas Commission on Environmental Quality segment classifications (Texas Commission on Environmental Quality, 2002).

Segment Number	**Segment Name**	**Segment Description**
0214	Wichita River Below Diversion Lake Dam	From the confluence with the Red River in Clay County to Diversion Dam in Archer County
0214B	Buffalo Creek	From the confluence of the Wichita River upstream to the headwater east of Electra
0214E	Wichita Valley Irrigation Project	From northeast of Wichita Falls (North Side Canal) upstream to Lake Diversion Dam
0214F	Unnamed tributary of Buffalo Creek	From the confluence of Buffalo Creek upstream to the headwaters at eastbound frontage road of US 287 in Iowa Park
0219A	Holiday Creek above Lake Wichita	From the headwaters of Lake Wichita upstream to the headwater near the intersection of US 277 and an unnamed road southwest of Dundee

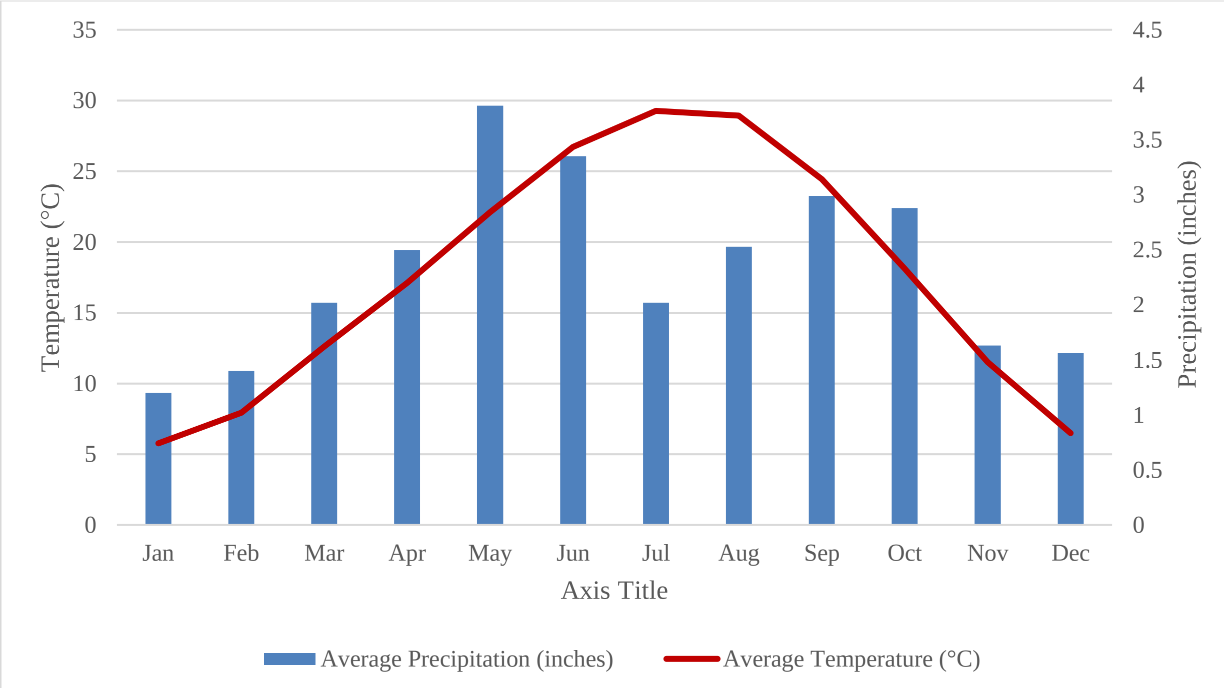

Figure 2. Long-term (1991-2020) monthly average precipitation (inches) and air temperature (°C) from Wichita Falls, Texas (National Oceanic and Atmospheric Administration Climate Data, 2021).

Physical Description

The watershed is contained within Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties. Located along the Oklahoma border, the landscape is described as having low rolling hills and grassland prairies. The Rolling Plains vegetation in the central portion of the watershed is comprised of juniper, cottonwood, mesquite, legumes and grasses (Texas Parks and Wildlife Department, 2023). The Central Rolling Red Prairie vegetation in the central portion of the watershed is comprised mostly of grazing pasture for cattle but is also home to woody trees, shrubs, switchgrass, little bluestem, and Indiangrass (U.S. Department of Agriculture, 1981). The prominent mineral found within the Wichita River watershed is limestone while the soil types include fine sand, clay, and clay loams. This area is home to a wide range of diverse wildlife such as white-tailed deer, Rio Grande turkeys, bobwhites, songbirds, waterfowl, reptiles, amphibians, and more (Texas Parks and Wildlife Department, 2023).

Land Use

Land cover types were determined from spatial data sets processed in geographic information systems for the watershed (Figure 3). Eighty-five percent of the land cover in the area consists of herbaceous (48%), hay/pasture (20%), and shrub/scrub (17%) (Table 2). The remaining fifteen percent is comprised of land use types including developed (7%), open water (4%), forest (2%), barren land (1%), and wetlands (1%).

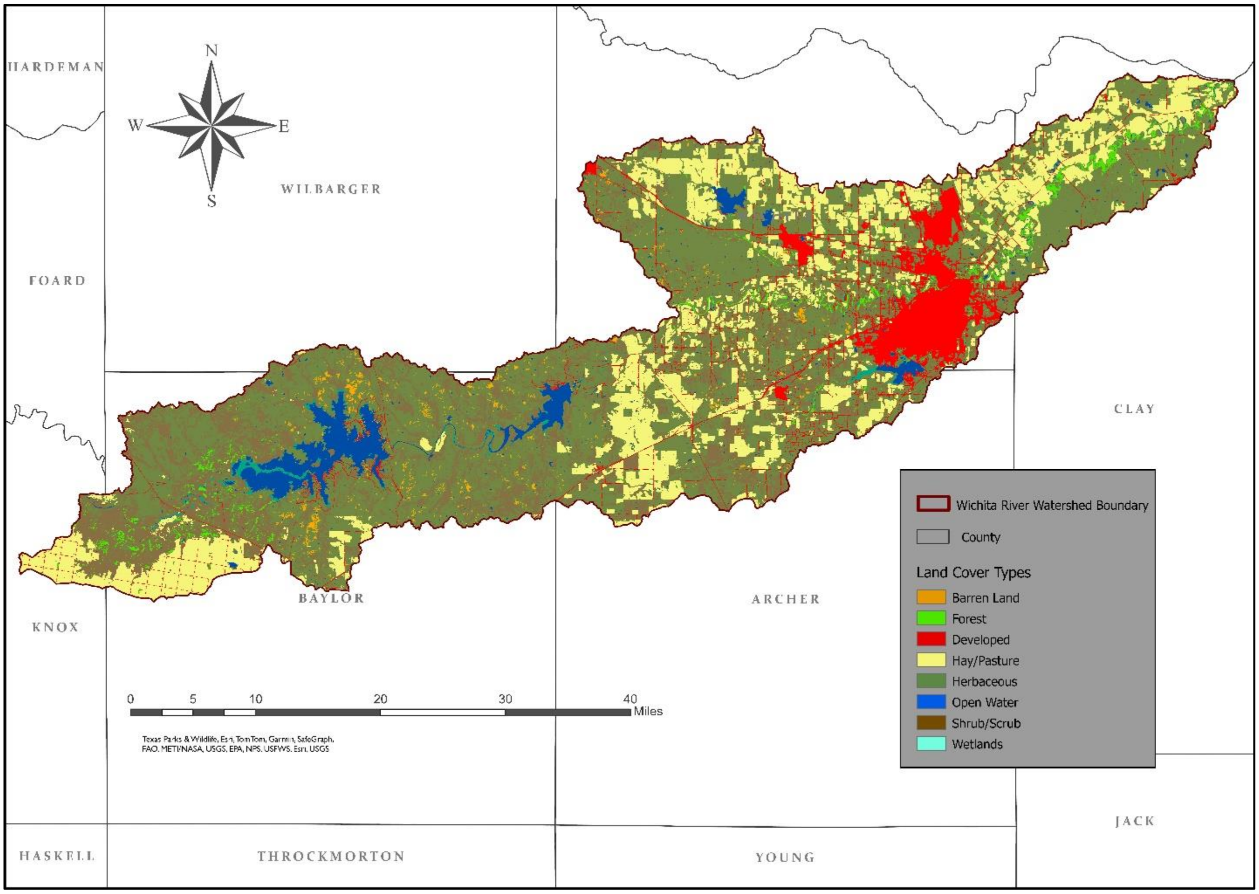

Figure 3. Land cover for the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (National Land Cover Data, 2019).

Table 2. Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (National Land Cover Data, 2016).

Land Use	Total Acarage	Total Hectares	Percentage
Open **Water**	25320.50	10246.86	4%
Developed	48452.42	19608.03	7%
Barren Land	6430.09	2602.17	1%
Forest	9931.69	4019.22	2%
Shrub/Scrub	110618.58	44765.82	17%
Herbaceous	316585.02	128117.61	48%
Hay/Pasture	132438.37	53595.99	20%
Wetlands	4243.95	1717.47	1%
	654020.64	**264673.17**	**100%**

History

The land where Wichita Falls is located was first inhabited by the Caddoan peoples, mostly the Wichita and Taovayas tribes, but in the mid-19th century, they were moved off their land onto a reservation north of the Red River for Anglo settlers to settle the area (Hart, 2019).

Wichita Falls was founded on that land shortly after and became known for the agriculture and cattle industries. In the early 20th century, the Texas oil boom struck Wichita Falls and ignited the town's economic and population growth. Today, most of Wichita Falls' modern population and economic development has come from retail despite the town's long history of agriculture and oil industries (Hendrickson, 1996).

Endangered Species and Conservation Needs

The common names of 12 species listed as threatened or endangered (under the authority of Texas state law and/or under the United States Endangered Species Act) within the watershed are included in Appendix A. A summary of the number of species per taxonomic group listed as state or federally endangered, threatened, G1 or G2 (critically imperiled or imperiled), species of greatest conservation need, and/or endemic are provided in Table 3.

Table 3. State and federally listed species in the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas.

Taxon	**Endangered (Federal or State)**	**Threatened (Federal or State)**	**G1 or G2 (Critically Imperiled/ Imperiled)**	**Species of Greatest Conservation Need (TPWD) (S1 or S2)**	**Endemic Total Count**
Amphibians	0	0	0	0	0
Birds	1	3	1	6	0
Fish	2	4	1	6	2
Mammals	0	1	1	6	0
Reptiles	0	1	0	2	1
Insects	0	0	1	1	0
Plants	0	0	1	1	3
Total	**3**	**9**	**5**	**22**	**6**

Texas Water Quality Standards

The Texas Surface Water Quality Standards establish explicit goals for the quality of streams, rivers, lakes, and bays throughout the state. The standards are developed to maintain the quality of surface waters in Texas to support public health and protect aquatic life, consistent with the sustainable economic development of the state. Water quality standards identify appropriate uses for the state's surface waters, including aquatic life, recreation, and sources of public water supply as drinking water. The criteria for evaluating support of those uses at monitoring sites on the Wichita River Below Diversion Lake Dam (Segment 0214) included in this report are provided in Table 4. Unclassified water bodies are not defined in the state's standards but are associated with a classified water body because they are in the same watershed. The dissolved oxygen criteria are for dissolved oxygen means at any site within the segment, the minimum and maximum values for pH apply to any site within the segment, the *E. coli* indicator bacteria for freshwater is a geometric mean, and the temperature criteria is a maximum value at any site within the segment.

The Texas Surface Water Quality Standards also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor-producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated by using screening levels, if they are available, and other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference to indicate when water quality parameters may be approaching levels of concern.

Water Quality Impairments

The *Draft 2024 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Integrated Report) includes an index of water quality impairments. Of the one classified and four unclassified segments which are the focus of this report, the classified segment, Wichita River Below Diversion Lake Dam (Segment 0214), and the unnamed tributary of Buffalo Creek (Segment 0214F) have impairments for bacteria in water (Recreation Use). The Wichita River is listed as a Category 5c, additional data and information will be collected or evaluated before a management strategy is selected, while the unnamed tributary of Buffalo Creek is listed as a Category 5b, a review of the standards for the water body will be conducted before a management strategy is selected.

Table 4. State water quality criteria for the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (Texas Commission on Environmental Quality, 2022).

Segment	Dissolved Oxygen (mg/L)	pH Range (s.u.)	Total Dissolved Solids (mg/L)	*E. coli* Bacteria (#/100 mL)	Temperature (°C)
Wichita River Below Diversion Lake Dam (0214)	Grab screening level: 5.0 Grab min.: 4.0	6.5-9.0	5,000	Primary Contact Recreation 1: 126 geometric mean, 399 single sample	32.2

WATER QUALITY PARAMETERS

Water Temperature

Water temperature influences the physiological processes of aquatic organisms, and each species has an optimum temperature for survival. High water temperatures increase oxygen-demand for aquatic communities and can become stressful for fish and aquatic insects. Water temperature variations are most detrimental when they occur rapidly, leaving the aquatic community no time to adjust. Additionally, the ability of water to hold oxygen in solution (solubility) decreases as temperature increases. This effect is exacerbated in coastal water bodies influenced by tidal, saline waters.

Warm water temperatures occur naturally with seasonal variation, as water temperatures tend to increase during summer and decrease in winter in the Northern Hemisphere. Daily (diurnal) water temperature changes occur during normal heating and cooling patterns. Man-made sources of warm water include power plant effluent after it has been used for cooling or hydroelectric plants that discharge warm water. Community scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases because of the monthly sampling frequency. While community scientist data may not show diurnal temperature fluctuations, they could demonstrate the fluctuations over seasons and years when collected consistently at predetermined monitoring sites and monthly frequencies.

Specific Conductance and Salinity

Specific conductance is a measure of the ability of a body of water to conduct electricity. It is measured in microsiemens per centimeter (µS/cm). A body of water is more conductive if it has more total dissolved solids such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lead to eutrophication, which results in lower levels of dissolved oxygen. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, leading to an abundance of more drought tolerant plants, and can cause dehydration of fish and amphibians. Sources of total dissolved solids can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants.

Salinity is a measure of saltiness or the dissolved inorganic salt concentration in water. Salinity is often measured in ocean, estuarine, or tidal influenced waters, but in Texas there are some inland streams that have a high salt content due to the local geology and require salinity measurements. Some common ions measured as salinity include sodium, chloride, magnesium, sulfate, calcium, and potassium. Seawater typically has a salt content of 35 parts per thousand (ppt or ‰). Like other water quality parameters, salinity affects the homeostasis or the balance of water and solutes within both plants and animals. Too much or too little salt can affect plant and animal cell survival and growth, therefore salinity is an important measurement.

Dissolved Oxygen

Oxygen is necessary for the survival of organisms like fish and aquatic insects. The amount of oxygen needed for survival and reproduction of aquatic communities varies according to species composition and adaptations to watershed characteristics like stream gradient, habitat, and available streamflow.

The dissolved oxygen concentrations can be influenced by other water quality parameters such as nutrients and temperature. High concentrations of nutrients can lead to excessive surface vegetation and algae growth, which may starve subsurface vegetation of sunlight and, therefore, reduce the amount of oxygen they produce via photosynthesis. This process is known as eutrophication. Low dissolved oxygen can also result from high groundwater inflows (which have low dissolved oxygen due to minimal aeration), high temperatures, or water releases from deeper portions of dams where dissolved oxygen stratification occurs. Supersaturation typically occurs underneath waterfalls or dams with water flowing over the top where aeration is abundant.

pH

The pH scale measures the concentration of hydrogen ions in a range from zero to 14 and is reported in standard units (s.u.). The pH of water can provide information regarding acidity or alkalinity. The range is logarithmic; therefore, every one-unit change is representative of a 10-fold increase or decrease in acidity or alkalinity. Acidic sources, indicated by a low pH level, can include acid rain and runoff from acid-laden soils. Acid rain is predominantly caused by coal powered plants with minimal contributions from the burning of other fossil fuels and other natural processes, such as volcanic emissions. Soil-acidity can be caused by excessive rainfall leaching alkaline materials out of soils, acidic parent material, crop decomposition creating hydrogen ions, or high-yielding fields that have drained the soil of all alkalinity. Sources of high pH (alkaline) include geologic composition, as in the case of limestone increasing alkalinity and the dissolving of carbon dioxide in water. Carbon dioxide is water soluble, and as it dissolves it forms carbonic acid. A suitable pH range for healthy organisms is between 6.5 and 9.0 s.u.

Water Transparency and Total Depth

Two instruments can be used by Texas Stream Team community scientists to measure water transparency, a Secchi disc or a transparency tube. Both instruments are used to measure water transparency or to determine the clarity of the water, a condition known as turbidity. The Secchi disc is lowered into the water until it is no longer visible, then raised until it becomes visible, and the average of the two depth measurements is recorded. A transparency tube is filled with sample water and water is released until the Secchi pattern at the bottom of the tube can be seen. The tube is marked with two-millimeter increments and is used to measure water transparency. Transparency measurements less than the total depth of the monitoring site are indicative of turbid water. Readings that are equal to total depth indicate clear water. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow less light to penetrate deep into the water, which, in turn, decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the dissolved oxygen in the water due to reduced photosynthesis. Contaminants are mostly transported in sediment rather than in the water. Turbid waters can result from sediment runoff from construction sites, erosion of farms, or mining operations.

E. coli and Enterococci Bacteria

E. coli bacteria originate in the digestive tract of endothermic organisms. The United States Environmental Protection Agency has determined *E. coli* to be the best indicator of the degree of pathogens in a freshwater system. A pathogen is a biological agent that causes disease.

Enterococci bacteria are a subgroup of fecal streptococci bacteria (mainly *Streptococcus faecalis* and *Streptococcus faecium*) that are present in the intestinal tracts and feces of warm-blooded animals. It is used by the Texas Commission on Environmental Quality as an indicator of the potential presence of pathogens in tidally-influenced saltwater along the Texas Gulf Coast.

The Wichita River below diversion lake dam (segment 0214) is designated a primary contact recreation 1 use. This means that recreation activities are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, hand fishing as defined by Texas Parks and Wildlife Code, §66.115, and the following whitewater activities: kayaking, canoeing, and rafting).

The standard for a bacteria impairment is based on the geometric mean (geomean) of the bacteria measurements collected. A geometric mean is a type of average that incorporates the high variability found in parameters such as *E. coli* and enterococci which can vary from zero to tens of thousands of colony forming units per 100 milliliters (CFU/100 mL). The standard for contact recreational use of a water body is 126 CFU/100 mL for *E. coli* in freshwater or 35 CFU/100 mL for enterococci in saltwater. A water body is considered impaired if the geometric mean is higher than the corresponding water quality standard.

Texas Stream Team does not currently monitor water quality for enterococci in coastal waters. Instead, community scientists can get certified in *E. coli* bacteria monitoring, the indicator used by the Texas Commission on Environmental Quality for freshwater streams.

Nitrate-Nitrogen

Nitrogen is present in terrestrial or aquatic environments as nitrate-nitrogen, nitrites, and ammonia. Nitrate-nitrogen tests are conducted for maximum data compatibility with the Texas Commission on Environmental Quality and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most living organisms. Nitrogen inputs into a water body may be from livestock and pet waste, excessive fertilizer use, failing septic systems, and industrial discharges that contain corrosion inhibitors. The effect excess nitrogen has on a water body is known as eutrophication and is described previously in the “Dissolved Oxygen” section. Nitrate-nitrogen dissolves more readily than orthophosphate, which attach to sediment, and, therefore, can serve as a better indicator of possible sewage or manure pollution during dry weather.

Phosphate

Phosphorus almost always exists in the natural environment as phosphate and continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for phosphate in the water excludes the phosphate bound up in plant and animal tissue. There are other methods to retrieve phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by community scientists. Testing for phosphate provides an idea of the degree of phosphorus in a water body. It can be used for problem identification, which can be followed up with more detailed professional monitoring, if necessary. Phosphorus inputs into a water body may be caused by the weathering of soils and rocks, discharge from wastewater treatment plants, excessive fertilizer use, failing septic systems, livestock and pet waste, disturbed land areas, drained wetlands, water treatment, and some commercial cleaning products. The effect excess phosphate has on a water body is known as eutrophication and is described above in the “Dissolved Oxygen” section.

DATA COLLECTION, MANAGEMENT, AND ANALYSIS

Data Collection

The field sampling procedures implemented by trained community scientists are documented in the Texas Stream Team Core Water Quality Community Scientist Manual and the Texas Stream Team Advanced Water Quality Community Scientist Manual. The sampling protocols in the manuals adhere closely to the Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to Texas Stream Team's Texas Commission on Environmental Quality-approved Quality Assurance Project Plan.

Procedures documented in Texas Stream Team Water Quality Community Scientist Manuals or the Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012) outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field quality control samples are collected and analyzed to detect whether contamination has occurred and to ensure data accuracy and precision.

Field sampling activities are documented on Environmental Monitoring Forms. The following items are recorded for each field sampling event: station ID, location, sampling time, date, depth, sample collector's name/signature, group name, meter calibration information, and reagent expiration dates. Specific conductance values are converted to total dissolved solids using a conversion factor of 0.65 and are reported as mg/L.

Values for measured parameters are recorded. If reagents or media are expired, it is noted, and data are flagged and communicated to Texas Stream Team staff. Sampling is not permitted with expired reagents or bacteria media; the corresponding values will be flagged in the database and excluded from data reports. Detailed observational data recorded include water appearance, weather, field observations (biological activity and stream uses), algae cover, unusual odors, days since last significant rainfall, and flow severity. Comments related to field measurements, number of participants, total time spent sampling, and total round-trip distance traveled to the sampling site are also recorded for grant reporting and administrative purposes.

Data Management

The community scientists collect field data and report the measurement results to Texas Stream Team, by submitting a hard copy of the Environmental Monitoring Form, entering the data directly into the online Waterways Dataviewer database, or by using the electronic Environmental Monitoring Form. All data are reviewed to ensure they are representative of the samples analyzed and locations where measurements were made. The measurements and associated quality control data are also reviewed to ensure they conform to specified monitoring procedures and project specifications as stated in the approved Quality Assurance Project Plan.

Data review and verification is performed using a quality control checklist and self-assessments, as appropriate to the project task, followed by automated database functions that validate data as the information is entered into the database. The data are verified and evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential errors are identified by examination of documentation and by manual and computer-assisted examination of corollary or unreasonable data. Issues that can be corrected are corrected and documented. Once entered, the data can be accessed publicly through the online Texas Stream Team Datamap.

Data Analysis

Data were compiled, analyzed, summarized, and compared to state water quality standards and/or criteria to provide readers with a reference point for parameters that may be of concern. The statewide, biennial assessment performed by the Texas Commission on Environmental Quality involves more stringent monitoring methods and oversight than those used by community scientists and staff in this report. The Texas Stream Team community scientist water quality monitoring data are not currently used in the Texas Commission on Environmental Quality assessments mentioned above. However, the Texas Stream Team data is intended to inform stakeholders about general characteristics and assist professionals in identifying areas of potential concern to plan future monitoring efforts.

All data collected by community scientists in the study watersheds were exported from the Texas Stream Team database and grouped by site. Sites with 10 or more monitoring events were maintained in the dataset for analysis. Sites with fewer than 10 monitoring events were excluded from the analysis for this report but may be used in future data summary reports. Once compiled, data were sorted, summary statistics were generated and reviewed, and results were graphed in JMP Pro 14.0.0 (SAS Institute Inc., 2018) using standard methods. Best professional judgement was used to verify outliers. Outlier box or scatter plots were prepared to provide a compact view of the distribution of the data for each parameter and site(s). The horizontal line within the box plot represents the median sample value, while the ends of the box represent the 25^{th} and 75^{th} quantiles or the interquartile range. The lines extending from each end of the box, or whiskers, are computed using the $25^{th}/75^{th}$ quartiles ± 1.5 x (interquartile range). Outliers are plotted as points outside the box plot.

DATA RESULTS

Water quality data from six Texas Stream Team monitoring sites in the watershed were acquired for this report (Figure 4). Four of the six sites had 10 or more monitoring events and were monitored sporadically from April 2017 through January 2024 (Table 5). Trained community scientists conducted between 6 and 49 monitoring events at each site, for a total of 145 events. The period of record for the sampling events ranged from April 2017 through January 2024, with most sites experiencing temporal intermittent sampling.

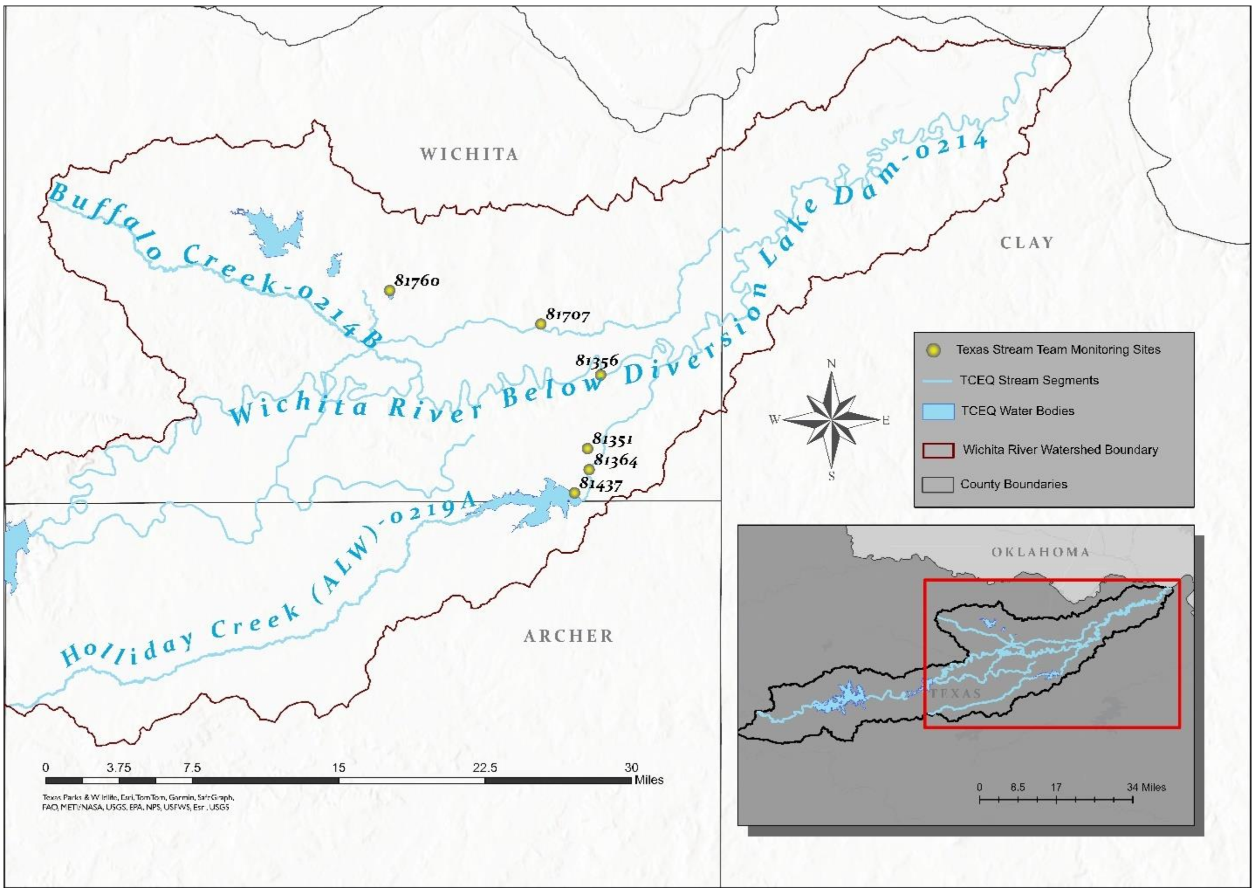

Figure 4. Texas Stream Team monitoring sites in Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger Counties, Texas.

Table 5. Texas Stream Team monitoring sites in Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas.

Site ID	Description	Number of Events	Period of Record
81707	LARGE POND WEST OF CITY VIEW DR. PARKING LOT, ADJACENT TO FOOTBALL STADIUM	24	Nov 2022 – Jan 2024
81437	LAKE WICHITA BOAT RAMP	45	Apr 2018 – Feb 2019, Mar 2021 – Aug 2023
81351	SIKES LAKE @ SIKES LAKE CENTER	12	Mar 2018 – Apr 2019
81356	WICHITA RIVER @ LUCY PARK	49	Apr 2017 – Feb 2019, Mar 2021 – Jan 2024
81364	HOLIDAY CREEK @ LAKE PARK DRIVE	9	Mar – Nov 2018
81760	BRIDGE @ LAKE GORDON, DIRECTLY BELOW SW ACCESS RD OF TX HWY 287	6	Aug 2023 – Jan 2024
	TOTAL	**145**	

Site Analysis

Water quality monitoring data from sites with 10 or more sampling events were analyzed and summarized including the number of samples, mean, standard deviation, and range of values (Table 6). Community scientists monitored the sites for standard core parameters, including air and water temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, Secchi disc transparency, transparency tube, and total depth. Three sites on the Wichita Valley Irrigation Project (site 81707), Holiday Creek (site 81437), and Wichita River (site 81356) were monitored for nitrate-nitrogen beginning in 2023.

Air and Water Temperature

Average air temperature for all sites ranged from 20.5 to 22.8°C (Table 6). The lowest mean air temperature (20.5°C) was observed at the Lake Wichita Boat Ramp (site 81437), while the highest mean air temperature (22.8°C) was observed at the Football Stadium Pond (site 81707).

Average water temperature for all sites ranged from 17.8 to 19.1°C (Table 6). The lowest mean water temperature (17.8°C) was observed at the Lake Wichita Boat Ramp (site 81437), while the highest mean water temperature (19.1°C) was observed at the Football Stadium Pond (site 81707). Discreet water temperature measurements from all sites met the water quality standard (32.2°C) throughout the period of record of this report except for three occurrences (Figure 5). Two of the three occurrences occurred on the same day (June 13, 2021) at Wichita River (site 81356) and Lake Wichita (site 81437), while the third occurrence (August 25, 2023) was at the Football Stadium Pond (site 81707).

Table 6. Texas Stream Team data summary for sites in the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas. (April 2017 to January 2024).

Parameter	81707	81437	81351	81356
	Football Stadium Pond	Lake Wichita Boat Ramp	Sikes Lake	Wichita River
Number of events	n = 24	n = 45	n = 12	n = 49
Air Temperature (°C)	22.8±7.7 (30.5)	20.5±8.6 (31.3)	21.7±6.3 (20.3)	21.2±8.7 (33)
Water Temperature (°C)	19.1±8.5 (28.0)	17.8±7.8 (28.0)	18.6±5.0 (16.1)	18.9±8.1 (26.5)
Specific Conductance (µS/cm)	2,189±821 (2,268)	3,249±2,542 (9,488)	435±243 (660)	5,705±1,947 (7,588)
*Total Dissolved Solids (mg/L)	1,423±533 (1,474)	2,112±1,653 (6,167)	283±158 (429)	3,708±1,266 (4,932)
Dissolved Oxygen (mg/L)	8.0±2.2 (7.5)	7.7±2.1 (8.5)	7.0±1.2 (6.3)	7.1±2.3 (10.1)
pH (s.u.)	8.9±0.3 (1.5)	8.5±0.5 (1.8)	7.8±1.1 (4.9)	8.3±0.6 (3.0)
Secchi Disk Transparency (m)	ND	0.2±0.3 (1.4)	0.9±0.0 (0)	0.3±0.1 (0.8)
Transparency Tube (m)	0.3±0.1 (0.5)	0.6±2.7 (15.5)	0.9±0.0 (0.1)	0.2±0.1 (0.6)
Total Depth (m)	0.2±0.1 (0.2)	0.5±0.5 (2.1)	1±0 (0)	0.7±0.3 (1.7)
Nitrate-nitrogen (mg/L)	1	1	ND	1

*Total dissolved solids were calculated from specific conductance (TDS = specific conductance * 0.65).
ND = no data available.

Specific Conductance and Total Dissolved Solids

Total dissolved solid values were calculated from specific conductance measurements. The average total dissolved solids from all sites ranged from 283 mg/L to 5,705 mg/L (Table 6). The lowest mean total dissolved solids value (283 mg/L) was observed at Sikes Lake (site 81351) on Holiday Creek. The highest mean total dissolved solids value (5,705 mg/L) was observed on the Wichita River (site 81356) and this value exceeded the water quality standard. Discreet measurements exceeded the water quality standard (5,000 mg/L) at sites on Lake Wichita (site 81437) and Wichita River (site 81356) (Figure 6).

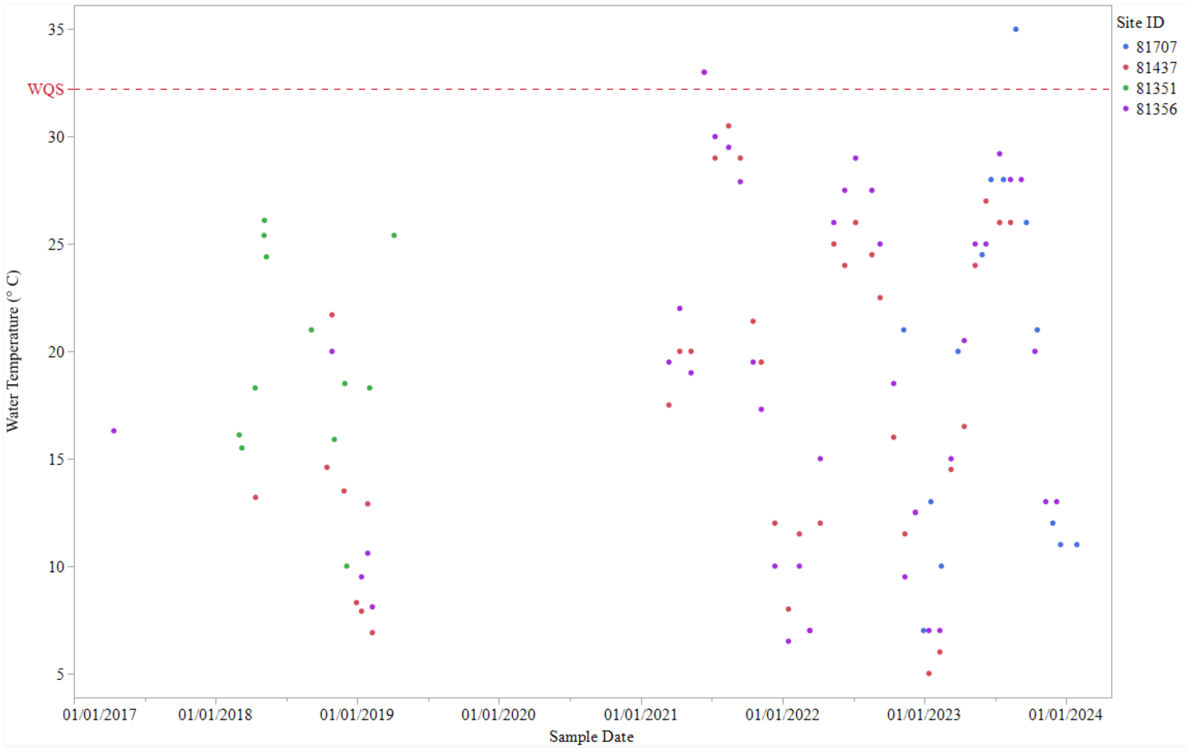

Figure 5. Water temperature for Texas Stream Team sites in the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (April 2017 to January 2024). WQS = Water Quality Standard.

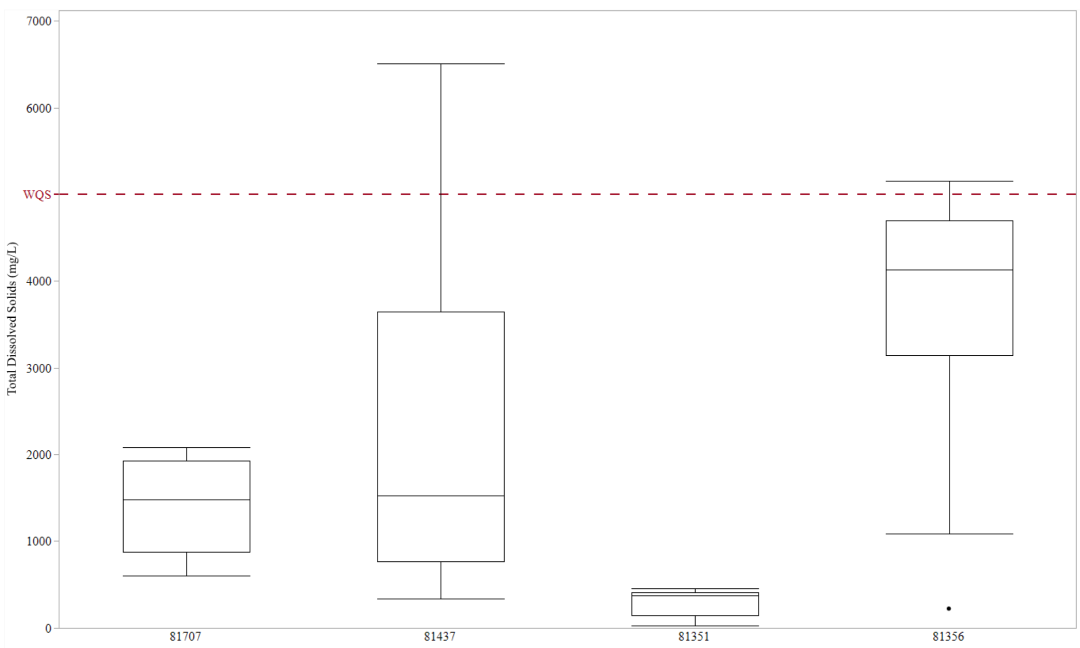

Figure 6. Total dissolved solids (mg/L) for Texas Stream Team sites in the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas. (April 2017 to January 2024). WQS = Water Quality Standard.

Dissolved Oxygen

The range of average dissolved oxygen values for all sites spanned from 7.0 to 8.0 mg/L (Table 6). The average dissolved oxygen value at each site was above the average water quality standard of 5.0 mg/L. Although the average water quality standard was maintained at all sites, there were discreet measurements recorded below the standard at all sites during the period of record of this report (Figure 7).

Discreet dissolved oxygen measurements fell below the minimum standard of 4.0 mg/L at most sites except for the Lake Wichita Boat Ramp (site 81437) (Figure 7).

pH

The average range of values at all sites was between 7.8 and 8.9 s.u. (Table 6). Average pH values at all sites were within the range of the minimum and maximum WQS (6.5 to 9.0 s.u.) (Figure 8). However, discreet measurements above and below the range were measured at all sites except for the Lake Wichita Boat Ramp (site 81437).

Transparency and Total Depth

Secchi discs and tubes were used to measure transparency at the sites monitored in the watershed. The average Secchi disc transparency values measured at three of four sites (81437, 81351 and 81356) ranged from 0.2 to 0.9 meters, while the average tube values measured at all four sites ranged from 0.2 to 0.9 meters (Table 6). The largest variability in Secchi disc and transparency tube measurements were observed at the Lake Wichita Boat Ramp (site 81437) (Figure 9).

Total depth was measured at all sites monitored (Table 6). The average range of depths for all sites was 0.2 to 1.0 meters.

Nitrate-Nitrogen

Nutrients, including nitrate-nitrogen and phosphate, are measured as parameters for the advanced monitoring type. Nitrate-nitrogen was monitored in the watershed at three sites (site 81707, 81437, and 81356) beginning in 2023. All measurements at all three sites were reported as a value of 1 (Table 6).

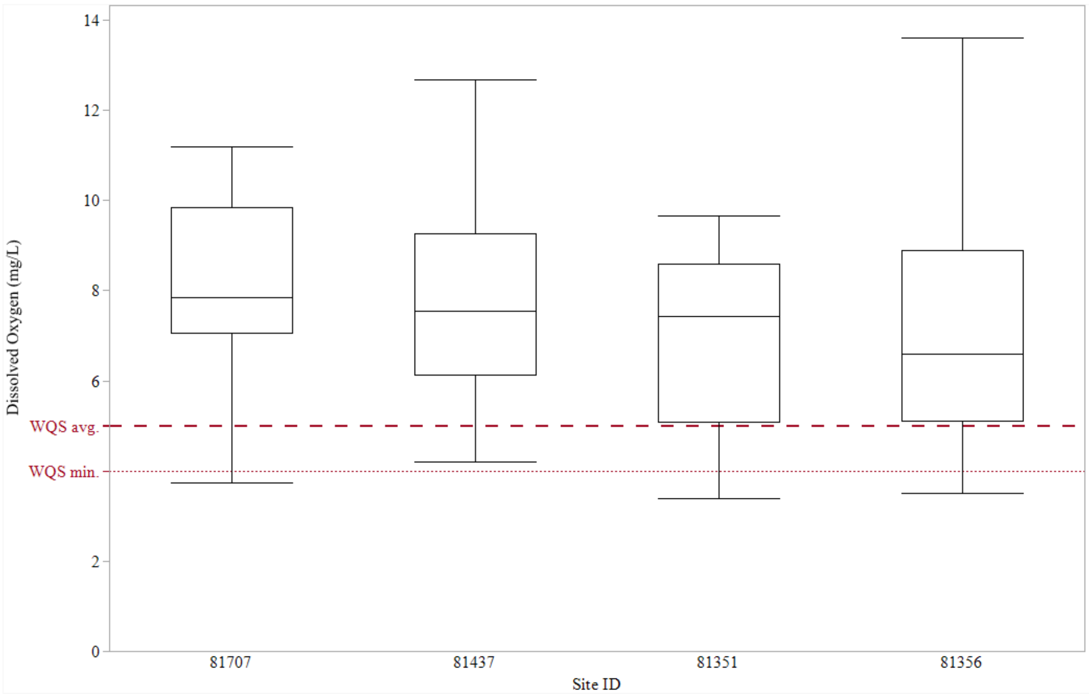

Figure 7. Dissolved oxygen in water for Texas Stream Team sites in Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (April 2017 to January 2024). WQS avg = average water quality standard; WQS min = minimum water quality standard.

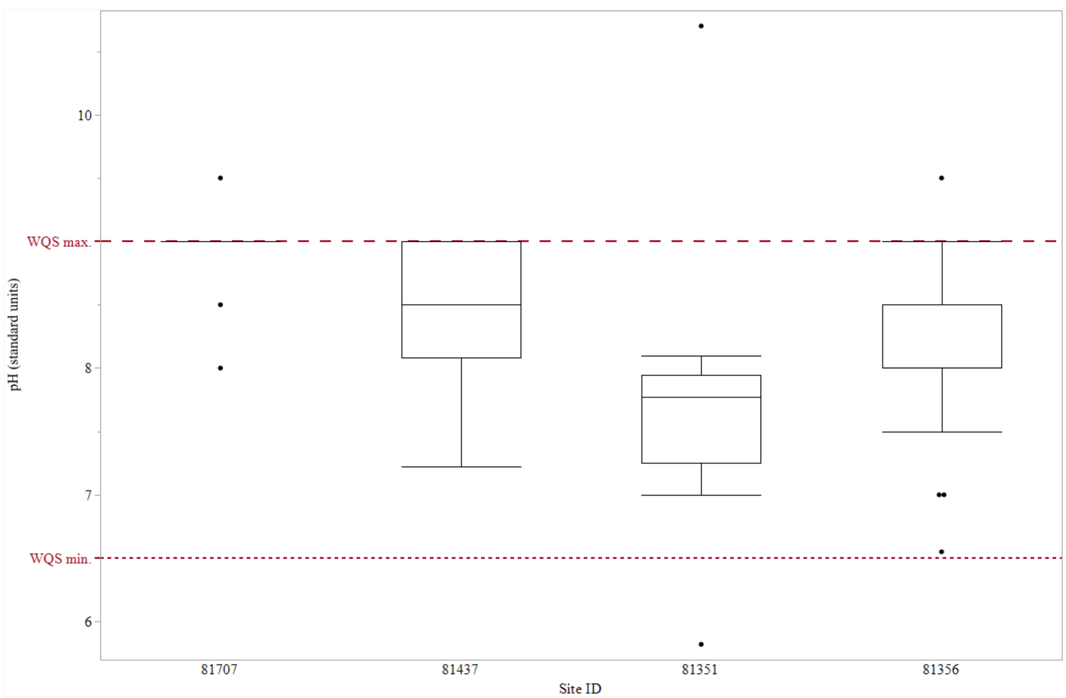

Figure 8. pH (s.u.) for Texas Stream Team sites in the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (April 2017 to January 2024). WQS max= maximum pH water quality standard; WQS min = minimum pH water quality standard.

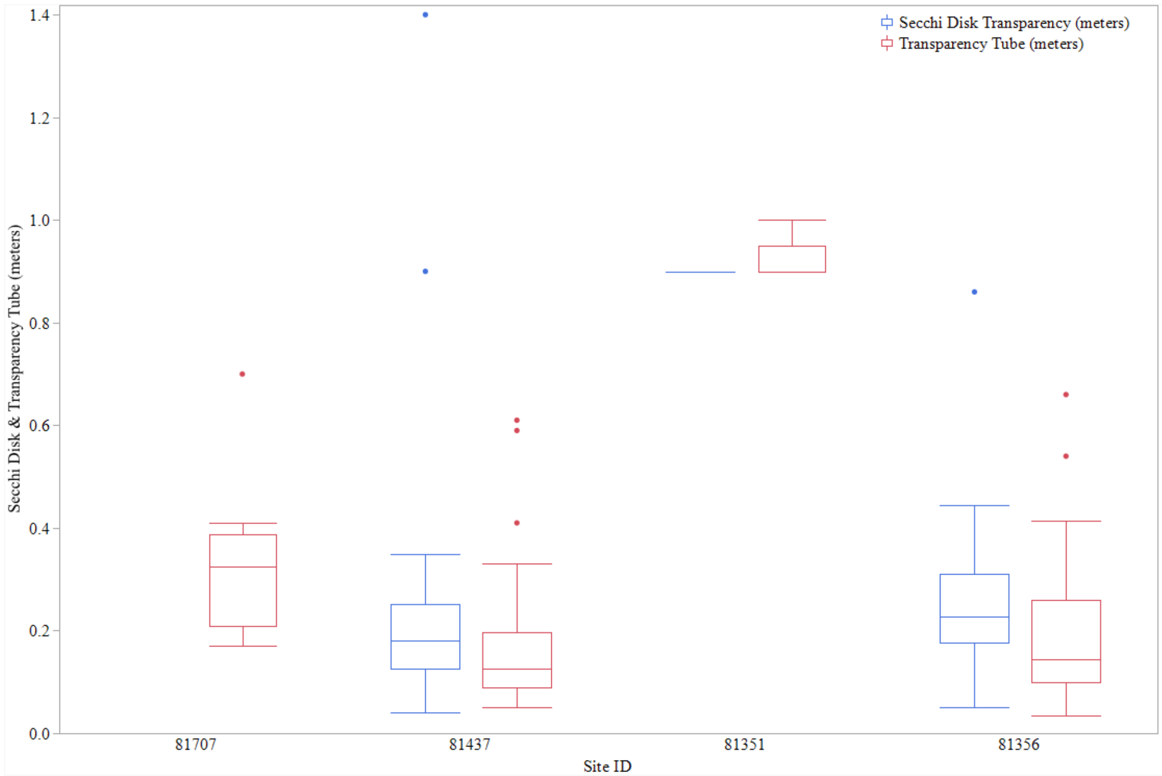

Figure 9. Secchi disk transparency measurements for Texas Stream Team sites in the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas (April 2017 to January 2024).

WATERSHED SUMMARY

Texas Stream Team community scientists monitored standard core and *E. coli* bacteria parameters intermittently at six sites in the watershed from April 2017 to January 2024. A total of 145 monitoring events were conducted during that period of record with four of the six sites having 10 or more monitoring events. Of the four sites monitored with 10 or more monitoring events, one (Football Stadium Pond, site 81707) was on the Wichita Valley Irrigation Project (segment 0214E), two (Lake Wichita Boat Ramp, site 81437, and Sikes Lake, site 81351) were on Holiday Creek (segment 0219A), and one (Wichita River, site 81356) was on the Wichita River (segment 0214). The watershed has diverse land uses with 85% of the land cover in the area consisting of herbaceous (48%), hay/pasture (20%), and shrub/scrub (17%), while 7% of the developed, urbanized area predominantly surrounds the city of Wichita Falls in the lower reach of the watershed. Collectively, all sites included in this report were monitored by Texas Stream Team trained community scientists.

Parameters monitored by community scientists included water and air temperature, specific conductance, total dissolved solids, dissolved oxygen, pH, transparency, total depth, and nitrate-nitrogen.

The Draft 2024 Integrated Report prepared by the Texas Commission on Environmental Quality identified impairments in the classified segment, Wichita River Below Diversion Lake Dam (Segment 0214), and the unnamed tributary of Buffalo Creek (Segment 0214F) for bacteria in water (Recreation Use). However, *E. coli* bacteria were not monitored by community scientists, therefore no bacteria data was available for this summary report.

Water quality standards associated with designated uses in the watershed were compared to the results of this analysis to evaluate water quality. One major finding from this comparison was that the mean water quality standard for total dissolved solids (5,000 mg/L) was not met at the site on the Wichita River at Lucy Park (site 81356) in the urbanized area of Wichita Falls. In addition, discreet measurements at the Lake Wichita Boat Ramp (site 81437) also exceeded the standard for total dissolved solids. Although the Wichita River is not impaired for the aquatic life use associated with total dissolved solids, these findings are of concern.

Discreet measurements from select sites evaluated did not meet the water quality standard for temperature (32.2°C), total dissolved solids (5,000 mg/L), dissolved oxygen (5.0 and 4.0 mg/L), and pH (6.5 and 9.0 s.u.) during the period of record for this report. For water temperature, three of the four sites evaluated (sites 81707, 81437, and 81356) had discreet measurements exceeding the standard at some point during the period of record. For total dissolved solids, two sites (81437 and 81356) exceeded the standard. For dissolved oxygen, all four sites had discreet measurements that exceeded the average standard (5.0 mg/L) and three sites (81707, 81351, and 81356) exceeded the minimum standard (4.0 mg/L). And for pH, three sites (81707, 81351, and 81356) exceeded the upper (9.0 s.u.) and/or the lower (6.5 s.u.) range of the standard. Although the average water quality standards were met, these periodic exceedances may be cause for concern if they continue to occur.

The Wichita River is impaired for contact recreation using the freshwater indicator bacteria *E. coli*, therefore it is imperative to monitor bacteria to better understand the sources of bacteria over time and to address those sources to prevent further degradation. Nitrate-nitrogen was monitored at three sites during the period of record, and we commend those efforts. However, it is prudent to continue the nitrate-nitrogen monitoring and add phosphate monitoring to assess nutrient loadings to area surface waters. With the growing human population and increased development in Texas and throughout the area, these findings should be of concern to residents and decision-makers alike.

The Texas Stream Team community scientists monitoring standard core water quality parameters in the watershed are encouraged to continue monitoring and consider adding the advanced parameters of nutrients (both nitrate-nitrogen and phosphate) and bacteria at all sites to their current monitoring efforts. Continuation of the ongoing monitoring is crucial due to the results presented here and the potential for increased development in the watershed and the surrounding area. Continued water quality monitoring is important for the development of long-term data sets that describe current water quality conditions and for historical and future trends to capture changes in water quality as the area grows. Texas Stream Team will continue to support community scientists by providing technical support, creating new monitoring sites, and re-activating existing sites. We look forward to training new community scientists to expand, grow, and sustain the water quality monitoring efforts in this area and beyond. For more information about Texas Stream Team and upcoming trainings contact us at TxStreamTeam@txstate.edu or visit the calendar of events on our website at www.TexasStreamTeam.org.

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Appendix A.

Table 7. Endangered species located within the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas.

Species Type	Common Name	Federal/State Listing
Birds	Whooping Crane	Federally Listed as Endangered, State Listed as Endangered
Fish	Smalleye Shiner	State Listed as Endangered
	Sharpnose Shiner	Federally Listed as Endangered, State Listed as Endangered

Table 8. Threatened species located within the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas.

Species Type	Common Name	Federal/State Listing
Birds	White-faced Ibis	State Listed as Threatened
	Black Rail	State Listed as Threatened
	Piping Plover	State Listed as Threatened Federally Listed as Threatened
Fish	Shovelnose Sturgeon	State Listed as Threatened
	Chub Shiner	State Listed as Threatened
	Prairie Chub	State Listed as Threatened
	Red River Pupfish	State Listed as Threatened
Mammals	Texas Kangaroo Rat	State Listed as Threatened
Reptiles	Texas Horned Lizard	State Listed as Threatened

Table 8. State and federally listed species located within the Wichita River watershed in Archer, Baylor, Clay, Knox, Wichita, and Wilbarger counties, Texas.

Taxon	**Endangered (Federal or State)**	**Threatened (Federal or State)**	**G1 or G2 (Critically Imperiled or Imperiled)**	**Species of Greatest Conservation Need (TPWD) (S1 or S2)**	**Endemic Total Count**
Amphibians	0	0	0	0	0
Birds	1	3	1	6	0
Fish	2	4	1	6	2
Mammals	0	1	1	6	0
Reptiles	0	1	0	2	1
Insects	0	0	1	1?	0
Plants	0	0	1	1	3
Total Count	**3**	**9**	**5**	**22**	**6**