Little River Continued Surface Water Quality Monitoring: Final Report and Data

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make every drop count

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TSSWCB Project 23-50

Cover: Little River at Old Sugarloaf Bridge. Photo by Cameron Castilaw

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List of Acronyms

AU	Assessment Unit
CWA	Clean Water Act
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
DO	Dissolved Oxygen
FDC	Flow Duration Curve
LDC	Load Duration Curve
MPN	Most Probable Number
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
OSSFs	On-site Sewage Facilities
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QPR	Quarterly Progress Report
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TNI	The NELAC Institute
TSSWCB	Texas State Soil and Water Conservation Board
TWRI	Texas Water Resources Institute
USGS	United States Geological Survey
WWTFs	Wastewater Treatment Facilities

Introduction

The Texas Commission on Environmental Quality (TCEQ) conducts statewide water body assessments on a biennial basis to satisfy requirements of the federal Clean Water Act (CWA) Sections 305(b) and 303(d). The resulting *Texas Integrated Report of Surface Water Quality (Texas Integrated Report)* characterizes the water quality, biological communities, and habitat of water bodies and whether they support their designated uses as defined in the state's Water Quality Standards (TCEQ, 2022a). Waterbodies that are not supporting one or more of their designated uses are classified as "impaired" for those uses. Waterbodies that are near to exceeding their water quality criteria, or exceed screening levels, may be described as having a "concern" for particular pollutants. The most recent report, the *2022 Texas Integrated Report* (TCEQ, 2022b), includes an assessment of water quality data collected from December 1, 2013, to November 30, 2020.

TCEQ identifies portions of waterbodies that have relatively homogeneous chemical, physical, and hydrological characteristics as segments. Water quality criteria and designated uses are usually assigned to an entire segment. Segments are further divided into assessment units (AU) and are the smallest geographic areas assessed in the *Texas Integrated Report* (TCEQ, 2022c). Each AU is intended to have relatively homogeneous chemical, physical, and hydrological characteristics, which allows the assignment of site-specific standards (TCEQ, 2022a). A segment identification number and AU are combined and used to identify individual AUs in a segment.

Little River is located within the larger Brazos River Basin (Figure 1). Its primary tributaries, the Leon and Lampasas rivers below Belton Lake and Stillhouse Hollow Lake, respectively, transect the urban areas of Temple and Belton. These rivers merge just south of Temple to form Little River. Little River then flows southeast toward its confluence with the Brazos River, approximately midway between Gause and Hearne. Other major tributaries of Little River are the San Gabriel River and Big Elm Creek. Previously, the furthest upstream AU (1213_04) of Little River was impaired for excessive levels of bacteria, and the furthest downstream AU (1213_01) has concerns for elevated bacteria and chlorophyll-a (TCEQ, 2022b). Additionally, concerns about excessive amounts of nitrate exist along the length of the river. Potential sources of these contaminants are various agricultural nonpoint sources and municipal point source discharges.

Except for work conducted under this project, water quality monitoring in the Little River watershed typically occurs quarterly at three locations. However, the distribution of these sampling sites and the frequency of data collected may not adequately represent water quality conditions in the bulk of the watershed. For example, assessment unit 1213_01, which extends from the Brazos River upstream to Cameron, TX, is evaluated on samples collected at two sites very near the city of Cameron (Figure 1). These sites are influenced by wastewater inflows to the river and may not adequately represent instream water quality conditions farther downstream where more primary contact recreation is known to occur.

Under this project, a third site on AU 1213_01 located on the downstream end of the AU and spatially distant from Cameron, was monitored monthly. Monthly monitoring was also performed at an upstream site on AU 1213_04, which was previously considered impaired due to an insufficient data set. AU 1213_04, which was first listed in 2010, was delisted in the *2022 Texas Integrated Report* (TCEQ, 2010; TCEQ, 2022b). Additionally, the draft *2024 Texas Integrated Report* (TCEQ, 2024) lists both AUs 1213_01 and 1213_04 as fully supporting, or not impaired, for *E. coli.*

The goal of this project was to increase the spatial and temporal distribution of water quality monitoring in the Little River watershed to better define current instream water quality conditions and increase the quantity of water quality data available for future water body assessments. This has helped to build a more robust data set for future planning purposes should future remedial action be needed. Additionally, the expanded data set may aid in identifying potential causes and sources of pollution. It is through monitoring and evaluation of adequate data that watershed managers are able to assess water quality conditions and inhibitors.

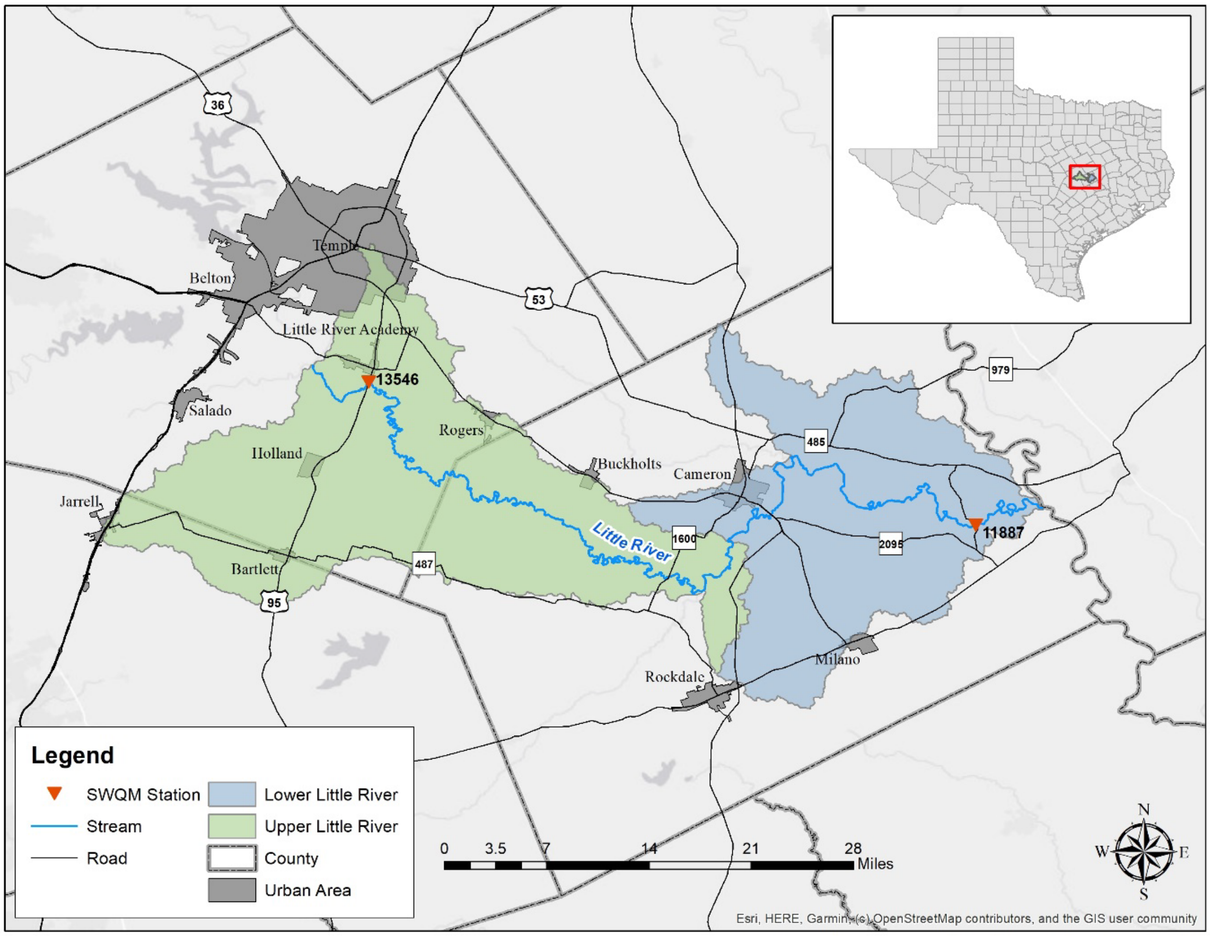

Figure 1. Overview of Little River watershed and TCEQ monitoring stations 13546 and 11887.

Project Description

Throughout this project, supplemental water quality monitoring was conducted with a focus on collecting paired flow rate and *E. coli* concentration data. Data were collected monthly for 18 months at TCEQ monitoring stations 11887 and 13546 (Figure 1). Both stations were located on AUs with impairments or concerns for bacteria at the time of project design. All sampling procedures, methods, sampling sites, and planned project activities are fully described in the quality assurance project plan (QAPP). Monthly sampling included streamflow measurements, *E. coli* grab samples, and field parameters including temperature, dissolved oxygen (DO), specific conductivity, and pH.

Water quality and quantity data were uploaded to the TCEQ surface water quality monitoring information system (SWQMIS) for use in future waterbody assessments. Water quality data collected as part of this project, findings, and trends are summarized in this final report to provide an informational basis for any future work conducted in the Little River watershed.

Station 11887, Little River Upstream of CR 264

This station is located on Little River at Sugarloaf Bridge, adjacent to CR 264 on AU 1213_01. It is north of the town of Gause and is the most downstream, publicly accessible point before the confluence with the Brazos River.

Station 13546, Little River Downstream of SH 95

Located on the upstream end of AU 1213_04 along Little River, this station is south of Little River Academy and immediately downstream of SH 95 at a United States Geological Survey (USGS) gage. It is the first accessible point downstream of the confluence of the Lampasas and Leon rivers, and Salado Creek.

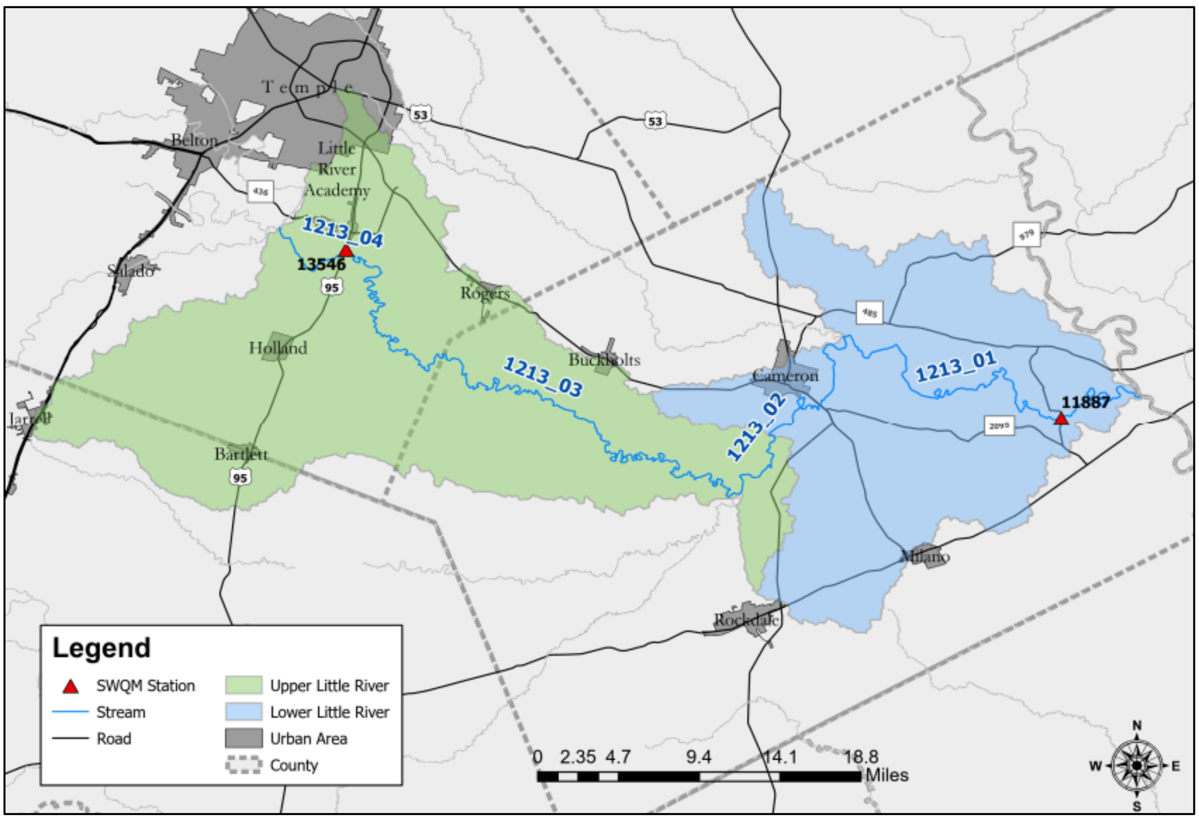

Figure 2. Little River AUs and project monitoring sites.

Task 1: Project Administration

The Texas Water Resources Institute (TWRI) has effectively administered, coordinated, and monitored all work performed under this project including technical and financial supervision and preparation of status reports.

Subtask 1.1: QPRs

To track project progress, TWRI submitted quarterly progress reports (QPRs) to the Texas State Soil and Water Conservation Board (TSSWCB). QPRs contained an overview of project activities completed during each quarter, an overview of activities to be completed in the next quarter, and highlighted related issues or problems associated with the project. The QPRs were submitted by the 1st of March, June, September, and December.

Subtask 1.2: Reimbursement Forms

TWRI provided financial supervision to ensure tasks and deliverables were acceptable and completed within budget. Financial supervision consisted of submitting appropriate reimbursement forms at least quarterly to TSSWCB and submitting necessary budget revisions.

Subtask 1.3: Project Coordination

TWRI hosted quarterly coordination meetings or conference calls with project partners to discuss project activities, the project schedule, communication needs, deliverables, and other requirements. TWRI developed lists of action items needed following each project coordination meeting and distributed them to project personnel.

Subtask 1.4: Final Report

TWRI developed a Final Report that summarizes activities completed during the duration of the project as well as the conclusions reached. The Final Report also discusses the extent to which the project goals and measures of success were achieved.

Task 2: Quality Assurance

TWRI developed data quality objectives and quality assurance/quality control (QA/QC) activities to ensure data generated through this project were of known and acceptable quality.

Subtask 2.1: QAPP Development

TWRI developed a QAPP for activities in Task 3, consistent with the most recent versions of *EPA Requirements for Quality Assurance Project Plans (QA/R-5)* (EPA, 2001) and the *TSSWCB Environmental Data Quality Management Plan*. All monitoring procedures and methods prescribed in the QAPP were to be consistent with the guidelines detailed in the *TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue (RG-415)* (TCEQ, 2012) and *Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data (RG-416)* (TCEQ, 2014). [Consistency with Title 30, Chapter 25 of the Texas Administrative Code, *Environmental Testing Laboratory Accreditation and Certification*, which describes Texas' approach to implementing the National Environmental Laboratory Accreditation Conference (NELAC) standards (TNI, 2016), were required where applicable.] After developing the QAPP, TWRI sent draft and final versions to TSSWCB, and a final document was approved.

Subtask 2.2: QAPP Implementation

TWRI implemented the approved QAPP. TWRI submitted revisions and amendments of the QAPP to TSSWCB as required.

Task 3: Continued Surface Water Quality Monitoring for Little River

TWRI collected water quality data and flow data, which were submitted to SWQMIS for use in future waterbody assessments.

Subtask 3.1: Water Quality Monitoring

TWRI conducted monthly water quality monitoring activities at two sites over a period of 18 months (36 total samples). Sampling included basic field parameters (temperature, pH, DO, conductivity, and streamflow where conditions allowed) and grab samples (analyzed for *E. coli*). Water samples were delivered to a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory within the appropriate holding time. Sampling events were documented in QPRs.

Subtask 3.2: Water Quality Data Submission

TWRI maintained a database of water quality data collected as part of this project. Collected data were submitted quarterly by TWRI to TSSWCB for submission to SWQMIS.

Appendix A: Data Summary Report

Bacteria

Concentrations of fecal indicator bacteria are evaluated to assess the risk of illness during contact recreation. In freshwater environments, concentrations of *Escherichia coli* (*E. coli)* are measured to evaluate the presence of fecal contamination in water bodies from warm-blooded animals and other sources. The presence of fecal indicator bacteria, like *E. coli*, suggests that associated pathogens from the intestinal tracts of warm-blooded animals could also be present in water bodies and may cause illness in people who recreate in them. Common sources that indicator bacteria originate from include wildlife, livestock, pets, malfunctioning on-site sewage facilities (OSSFs), urban and agricultural runoff, sewage system overflows, and direct discharges from wastewater treatment facilities (WWTFs). The criteria for *E. coli* in freshwater streams that is used for assessing support of the primary contact recreation use is a geometric mean of 126 most probable number (MPN) of *E. coli* per 100 mL of water from at least 20 samples (TCEQ, 2022c) collected over the most recent seven-year period.

As previously mentioned, AU 1213_01 and AU 1213_04 were previously listed as impaired for elevated bacteria. As of the *2022 Texas Integrated Report* (TCEQ, 2022b), AU 1213_01 had a use concern for *E. coli* and AU 1213_04 had just been delisted. Historically, the geomean of bacteria levels at several monitoring stations in each of the four Little River AUs is just below the criterion (Figure A-1). Data collected from this TWRI-led monitoring project indicate that both AUs have relatively stable bacteria levels with a geomean consistently below the maximum *E. coli* criteria of 126 MPN/100 mL (Figure A-1; Figure A-2). This indicates that the assessed water quality has improved from earlier monitoring conditions that resulted in listing Little River as impaired.

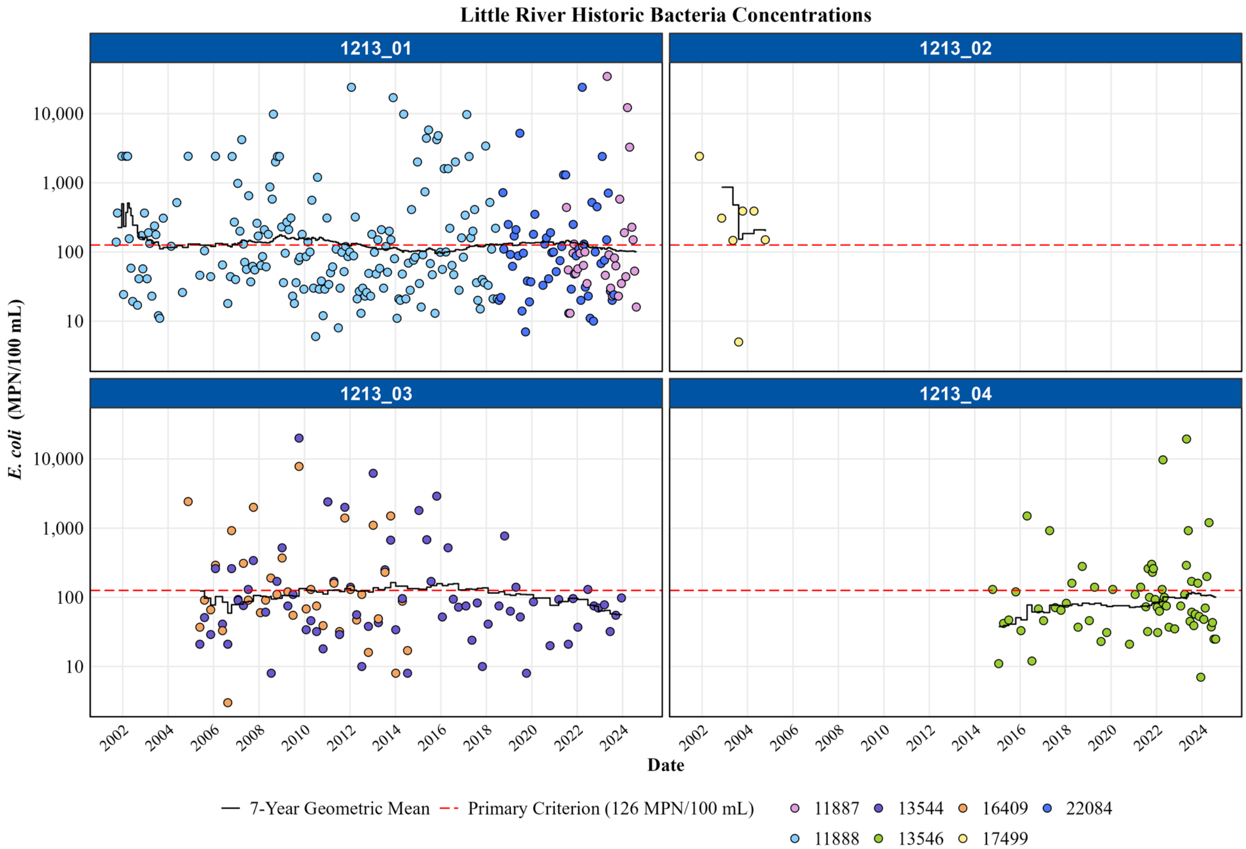

Figure A-1. Historical E. coli concentrations in Little River.

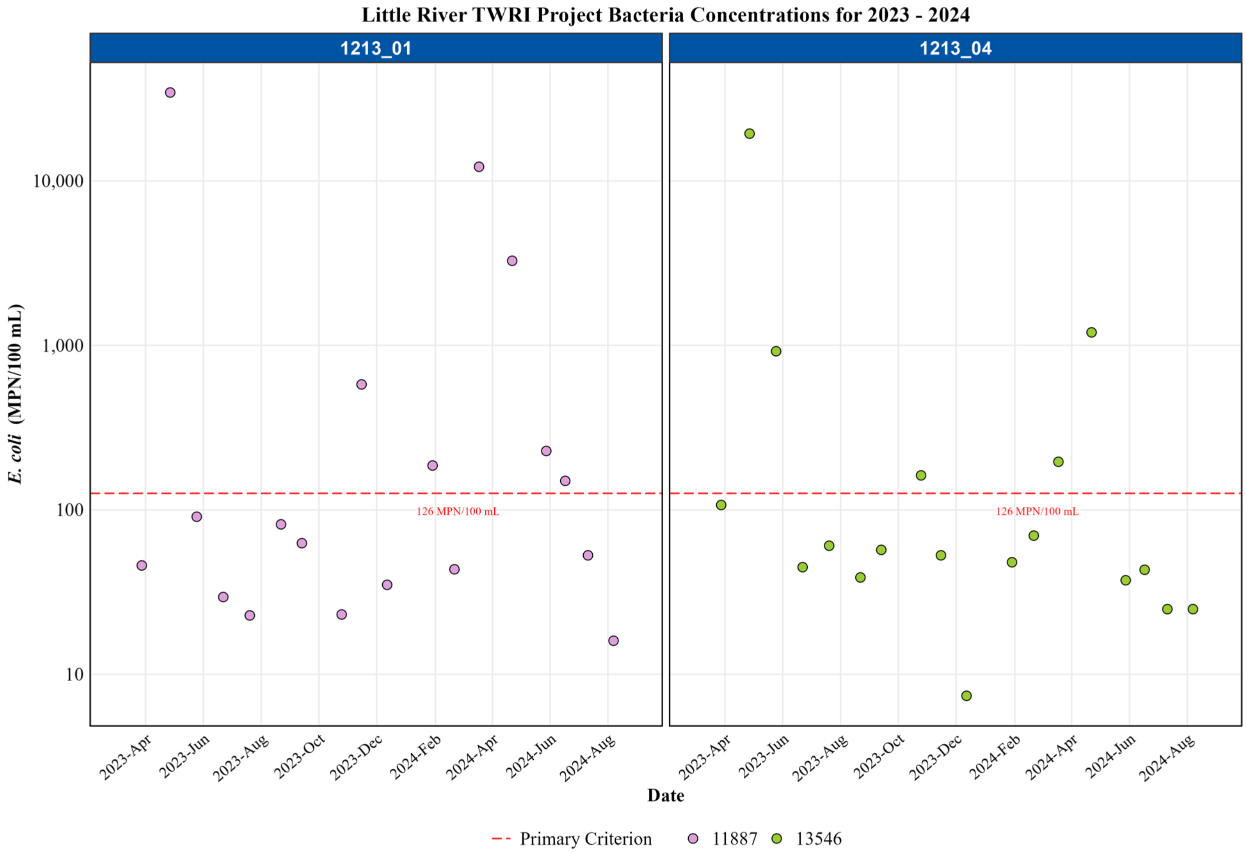

Figure A-2. E. coli concentrations of samples collected by TWRI.

Dissolved Oxygen

Dissolved oxygen (DO) is one indicator used to determine the level or category of aquatic life use assigned to a waterbody. DO concentrations can indicate whether a water body can support and maintain a healthy aquatic ecosystem. If DO levels drop too low, fish and other aquatic species will not survive. Typically, DO will fluctuate throughout the day, with the highest levels occurring in the mid to late afternoon due to photosynthesis. DO levels are usually at their lowest just before dawn as both plants and animals in the water consume oxygen through respiration. Furthermore, seasonal fluctuations in DO are common because of decreased oxygen solubility in water as temperature increases; therefore, DO levels are typically lower during the summer and higher in the winter months. While DO can fluctuate naturally, human activities can also cause abnormally low DO levels. Excessive organic matter (vegetative material, untreated wastewater, etc.) can result in depressed DO levels as bacteria break down the materials and consume oxygen. Excessive nutrients from fertilizers and manures can also depress DO as aquatic plant and algae growth increase in response. More respiration from plants and the decay of organic matter as plants die off can also decrease DO concentrations. In the *2022 Texas Integrated Report* (TCEQ, 2022b), the grab screening level and grab minimum criterion for Little River are 5 mg/L and 3 mg/L, respectively.

As of the *2022 Texas Integrated Report* (TCEQ, 2022b), Little River has no concerns for depressed DO. All historical data from ambient field monitoring is shown in Figure A-3. There are very few isolated points where DO drops below the criterion. The data collected by TWRI during this project are shown in Figure A-4. There are no violations of the criterion in AU 1213_01 and 1213_04. Figure A-4 demonstrates that

DO in both AUs along Little River have a normal pattern of increasing during the winter months and decreasing during summer months. However, AU 1213_04 may be more sensitive to warmer temperatures because dissolved oxygen levels are consistently lower throughout the summer. Table A-2 and Table A-4 summarize the data collected during this project which will be added to the historical dataset. Overall, the measured DO concentrations indicate healthy DO levels for aquatic ecosystems in the monitored AUs.

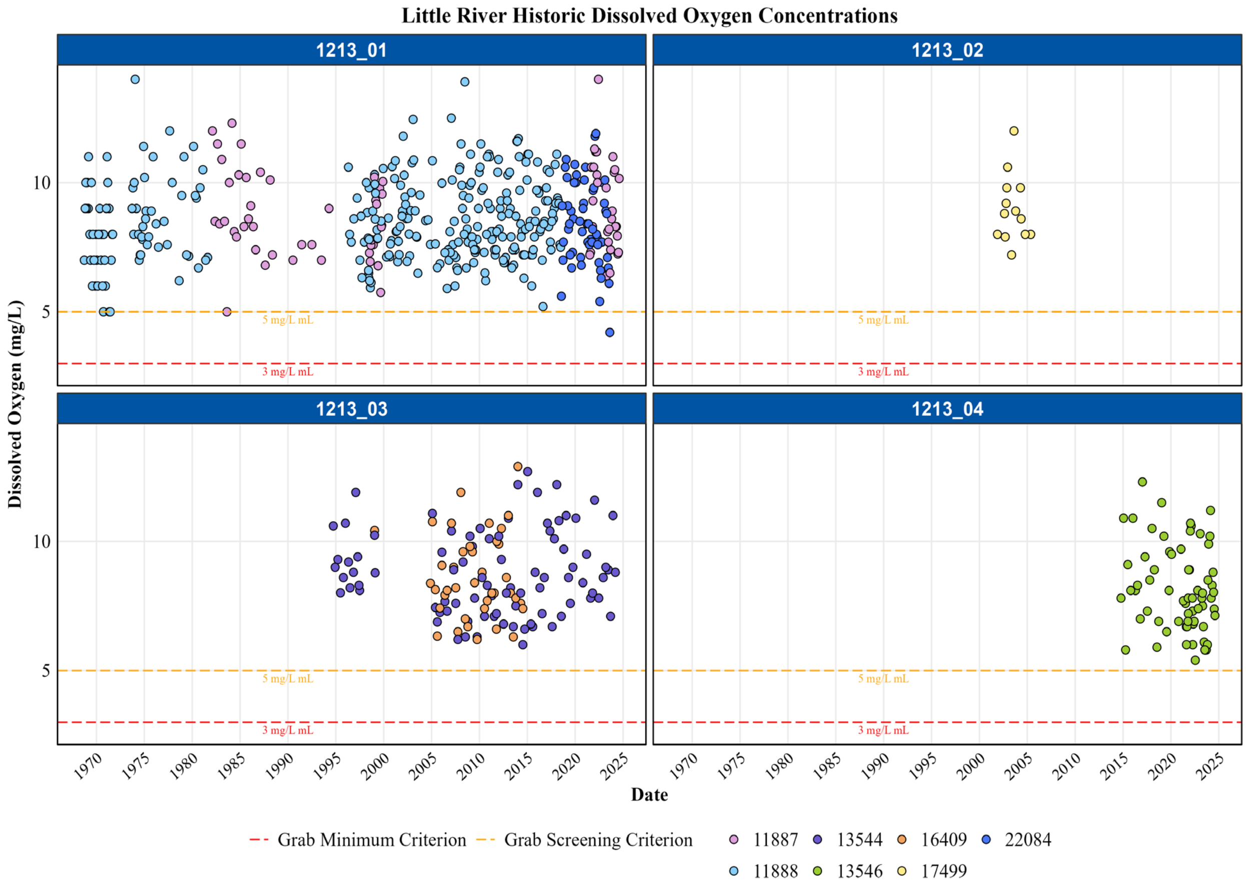

Figure A-3. Historical DO concentrations in Little River.

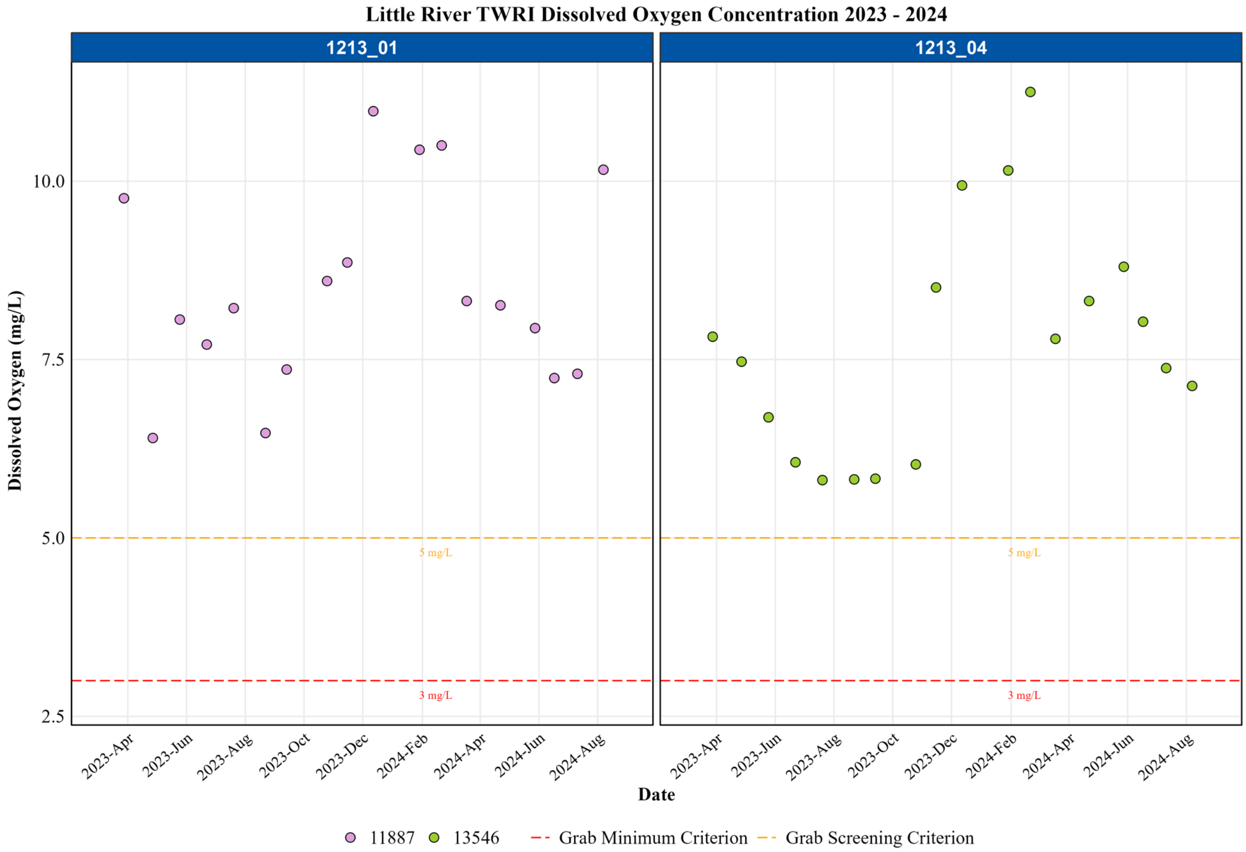

Figure A-4. DO concentrations collected by TWRI.

Flow

Generally, streamflow (the amount of water flowing in a river/creek at a given time) is dynamic and always changing in response to both natural (e.g. precipitation events) and anthropogenic (e.g. changes in land cover) factors. From a water quality perspective, streamflow is important because it influences the ability of a water body to assimilate pollutants.

Flow data is useful in creating flow duration curves (FDC) and load data curves (LDC). The LDC method is widely used to characterize water quality data across different flow conditions in a watershed. A LDC provides a visual display of streamflow, load capacity, and water quality exceedance by first developing a FDC using flow measurements. Instantaneous flow data collected by TWRI along AU 1213_01, in addition to USGS discharge data, can be analyzed to fill in data gaps (Figure A-6; Figure A-7). Once sufficient flow data has been collected, the data can be used to create a FDC and LDC for Little River.

Historical flow data indicates baseflow in Little River is approximately 100 cfs, but flow can fluctuate greatly as seen in Figure A-6 and Figure A-8. This influx of water is most likely due to rain events, the influence of wastewater inflows, and water releases from upstream reservoirs. Occasionally, high flow events prevented collection of flow measurement at site 11887 due to loss of bank access. Streamflow estimates were reported in place of flow under these conditions (Figure A-5).

Figure A-5. High flow at site 11887 on April 27, 2023

Elevated bacteria concentrations often coincided with high flow conditions for both AUs 1213_01 and 1213_04 (Table 2 and Table 4). However, in some cases, *E. coli* concentrations did not remain high after extended high flow periods. Large rain events in spring 2024 resulted in extended reservoir releases upstream of the watershed in May, June, and July. Both AUs 1213_01 and 1213_04 saw a reduction in elevated *E. coli* relative to flow while flows remained high in those months.

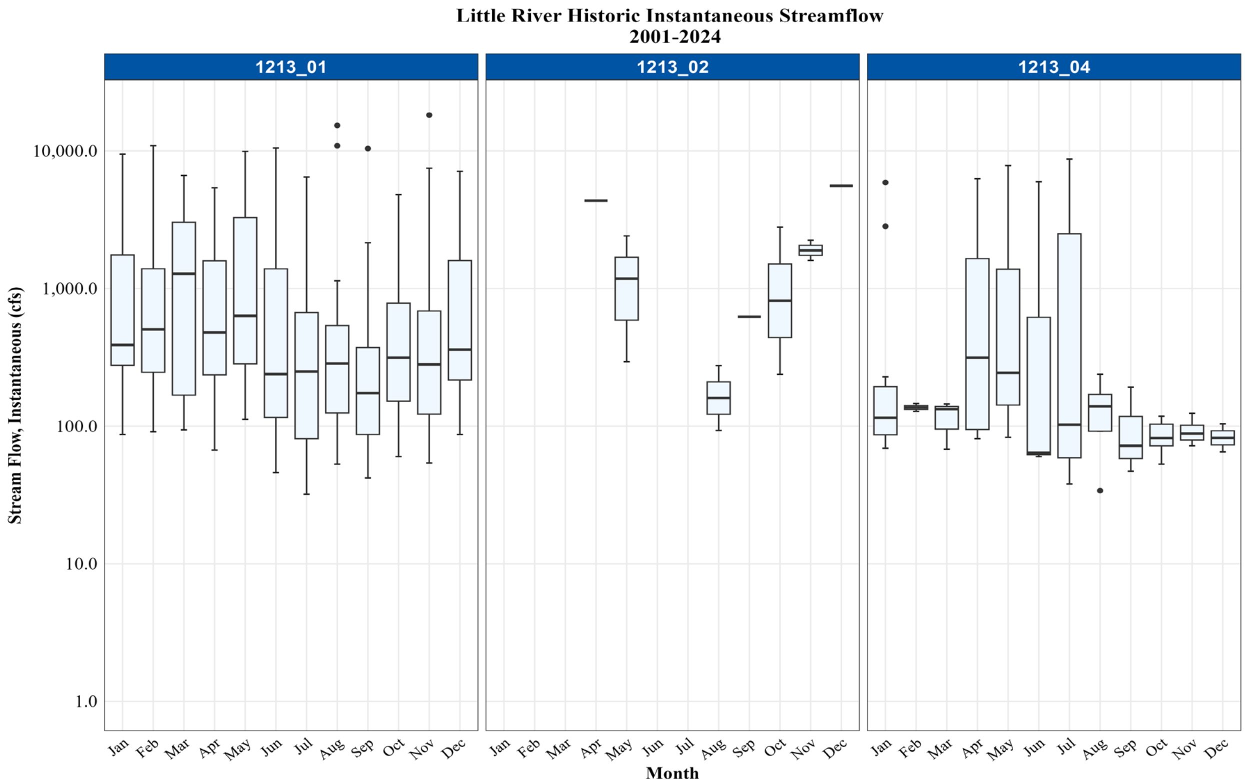

Figure A-6. Historical monthly instantaneous streamflow in Little River.

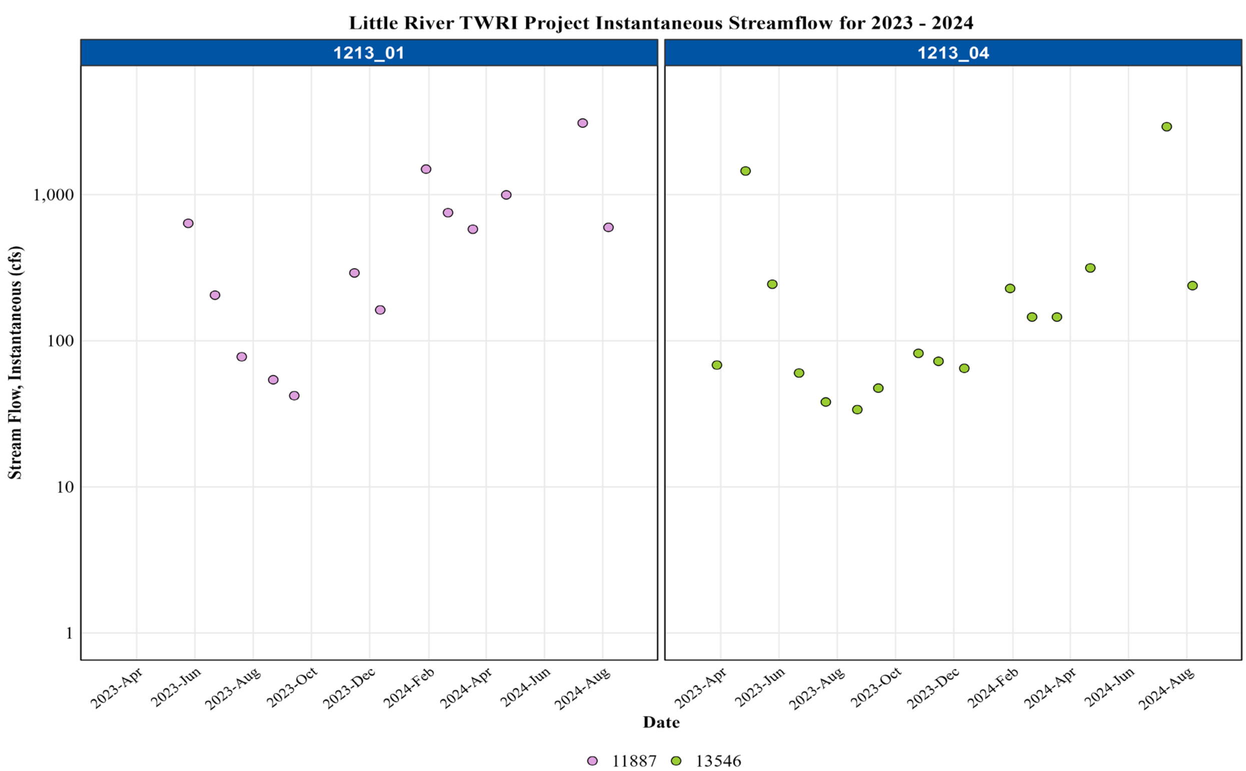

Figure A-7. Instantaneous streamflow in Little River during TWRI sampling events.

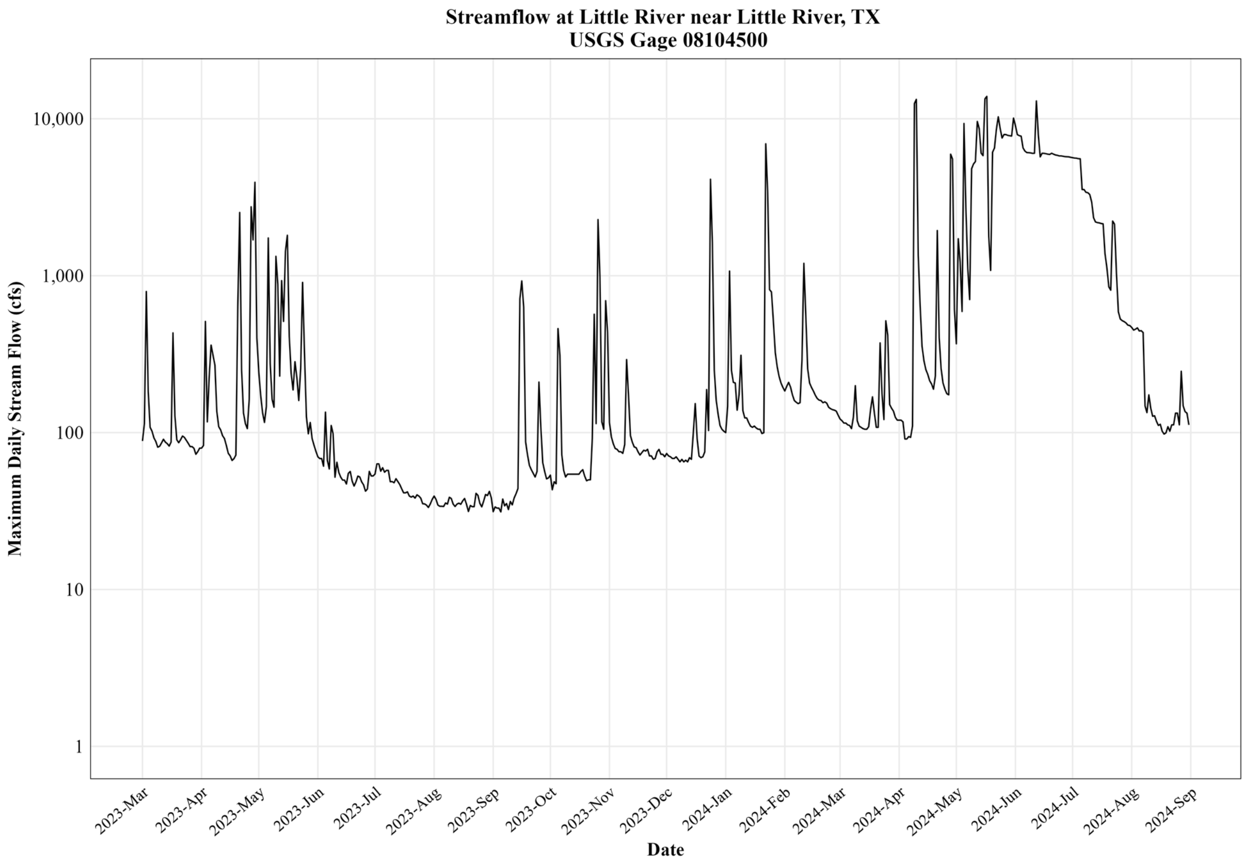

Figure A-8. Daily discharge at USGS gage for AU 1213_04 over the course of the Little River monitoring project.

Appendix B: Monitoring Data

The tables below summarize the data collected as part of this project at SWQM stations 11887 and 13546.

Station 11887

Table A-1. Sample event data for routine data collection at Station 11887.

Tag ID	Date	Time	End Depth	Collecting Agency	Submitting Agency
TX101616	2023-03-28	12:23:00 PM	0.30	WR (Texas Water Resource Institute)	TX (Texas State Soil and Water Conservation Board)
TX101618	2023-04-27	12:55:00 PM	0.30	WR	TX
TX101620	2023-05-25	12:12:00 PM	0.30	WR	TX
TX101622	2023-06-22	12:33:00 PM	0.30	WR	TX
TX101624	2023-07-20	12:02:00 PM	0.30	WR	TX
TX101625	2023-08-22	09:52:00 AM	0.30	WR	TX
TX101628	2023-09-13	13:04:00 PM	0.30	WR	TX
TX101630	2023-10-25	11:03:00 AM	0.30	WR	TX
TX101632	2023-11-15	12:38:00 PM	0.30	WR	TX
TX101634	2023-12-12	11:46:00 AM	0.30	WR	TX
TX101636	2024-01-29	12:38:00 PM	0.30	WR	TX
TX101638	2024-02-21	12:16:00 PM	0.30	WR	TX
TX101640	2024-03-18	12:16:00 PM	0.30	WR	TX
TX101642	2024-04-22	12:25:00 PM	0.30	WR	TX
TX101644	2024-05-28	11:20:00 AM	0.30	WR	TX
TX101646	2024-06-17	12:44:00 PM	0.30	WR	TX
TX101648	2024-07-11	12:00:00 PM	0.30	WR	TX
TX101650	2024-08-07	11:38:00 AM	0.30	WR	TX

Table A-2. Field measurements for Station 11887.

Parameter Code	**00010**	**00094**	**00400**	**00078**	**00300**	**31699**	**00061**	**72053**
Date	**Water Temperature (Celsius)**	**Specific Conductance (microS/cm)**	**pH**	**Secchi Depth (m)**	**Dissolved Oxygen (mg/L)**	***E. coli* (MPN/ 100mL)**	**Instantaneous Stream Flow (cfs)**	**Days Since Last Precipitation Event**
2023-03-28	20.9	742.0	8.3	0.15	9.76	46	*	**7**
2023-04-27	19.6	250.9	7.8	0.02	6.40	34500	Estimate[1]	**0**
2023-05-25	26.4	583.0	8.1	0.08	8.06	91	636.87	**1**
2023-06-22	31.7	741.0	8.1	0.16	7.71	30	205.34	**0**
2023-07-20	32.0	798.0	7.8	0.21	8.22	23	77.71	**13**
2023-08-22	31.3	948.0	7.3	0.15	6.47	82	54.08	**75**
2023-09-13	27.7	859.0	7.9	0.18	7.36	63	42.09	**0**

2023-10-25	23.1	800.0	7.9	0.35	8.60	23	Estimate[2]	**0**
2023-11-15	18.5	585.0	7.6	0.15	8.86	579	291.43	**2**
2023-12-12	12.5	814.0	8.0	0.75	10.98	35	162.57	**11**
2024-01-29	11.3	510.0	7.9	0.25	10.44	186	1494.39	**3**
2024-02-21	15.5	627.0	8.7	0.11	10.50	44	753.03	**10**
2024-03-18	19.6	654.0	8.0	0.08	8.32	12200	580.51	**1**
2024-04-22	20.6	563.0	8.1	0.05	8.26	3270	996.19	**1**
2024-05-28	23.3	416.7	7.9	0.02	7.94	228	Estimate[3]	**< 1**
2024-06-17	26.5	380.1	7.6	0.03	7.24	150	Estimate[4]	**5**
2024-07-11	26.7	393.9	7.8	0.06	7.30	53	3091.63	**3**
2024-08-07	31.1	475.2	8.1	0.56	10.16	16	596.96	**10**

[*]Instantaneous streamflow was not reported due to equipment issues in the field.
[1]High flow and inaccessible bank conditions were reported on 4/27/23. The reported streamflow estimate was >10,000 cfs.
[2]Instantaneous streamflow was not reported due to equipment issues in the field. The reported streamflow estimate was 151.99 cfs.
[3]High flow and inaccessible bank conditions were reported on 5/28/24. The reported streamflow estimate was 12,754.5 cfs.
[4]High flow and inaccessible bank conditions were reported on 6/17/24. The reported streamflow estimate was 7,436.7 cfs.

Station 13546

Table A-3. Sample event data for routine data collection at Station 13546.

Tag ID	Date	Time	End Depth	Collecting Agency	Submitting Agency
TX101615	2023-03-28	11:18:00 AM	0.18	WR	TX
TX101617	2023-04-27	11:53:00 AM	0.30	WR	TX
TX101619	2023-05-25	10:00:00 AM	0.30	WR	TX
TX101621	2023-06-22	10:13:00 AM	0.16	WR	TX
TX101623	2023-07-20	10:00:00 AM	0.15	WR	TX
TX101626	2023-08-22	11:05:00 AM	0.14	WR	TX
TX101627	2023-09-13	09:58:00 AM	0.15	WR	TX
TX101629	2023-10-25	09:50:00 AM	0.20	WR	TX
TX101631	2023-11-15	10:07:00 AM	0.20	WR	TX
TX101633	2023-12-12	10:04:00 AM	0.19	WR	TX
TX101635	2024-01-29	10:24:00 AM	0.30	WR	TX
TX101637	2024-02-21	10:07:00 AM	0.28	WR	TX
TX101639	2024-03-18	09:39:00 AM	0.28	WR	TX
TX101641	2024-04-22	09:55:00 AM	0.30	WR	TX
TX101643	2024-05-28	09:50:00 AM	0.30	WR	TX
TX101645	2024-06-17	10:41:00 AM	0.30	WR	TX
TX101647	2024-07-11	09:58:00 AM	0.30	WR	TX
TX101649	2024-08-07	09:44:00 AM	0.30	WR	TX

Table A-4. Field measurements for Station 13546.

Parameter Code	00010	00094	00400	00078	00300	31699	00061	72053
Date	**Water Temperature (Celsius)**	**Specific Conductance (microS/cm)**	**pH**	**Secchi Depth (m)**	**Dissolved Oxygen (mg/L)**	***E. coli* (MPN/100mL)**	**Instantaneous Stream Flow (cfs)**	**Days Since Last Precipitation Event**
2023-03-28	18.2	660.0	7.9	0.40	7.82	107	68.20	**4**
2023-04-27	19.5	*	7.8	0.04	7.47	19400	1453.00	**0**
2023-05-25	23.4	346.3	7.7	0.18	6.69	921	244.00	**1**
2023-06-22	30.3	671.0	8.0	0.40	6.06	45	60.20	**0**
2023-07-20	30.1	633.0	8.3	0.46	5.81	61	38.10	**40**
2023-08-22	30.5	703.0	8.1	0.28	5.82	39	33.80	**75**
2023-09-13	26.7	680.0	7.8	0.44	5.83	57	47.40	**0**
2023-10-25	23.0	413.6	7.4	0.50	6.03	162	82.10	**0**
2023-11-15	16.4	561.0	7.6	0.53	8.51	53	72.40	**2**
2023-12-12	10.4	660.0	7.6	>1.00	9.94	7	64.79	**11**
2024-01-29	11.2	579.0	7.8	0.35	10.15	48	228.00	**2**
2024-02-21	15.2	602.0	8.1	0.49	11.25	70	145.50	**10**
2024-03-18	17.9	658.0	7.9	0.26	7.79	196	145.40	**1**
2024-04-22	17.6	431.6	7.9	0.04	8.32	1200	315.33	**2**
2024-05-28	20.8	388.8	7.5	0.13	8.80	37.3	7813.00	**5**
2024-06-17	24.1	369.7	6.8	0.16	8.03	43.2	5960.00	**< 1**
2024-07-11	24.4	367.1	7.6	0.19	7.38	24.9	2920.00	**3**
2024-08-07	27.6	448.5	7.8	0.61	7.13	24.9	238.27	**3**

*Specific Conductance was not reported for this event.

Data Conclusions

Water quality data collected between March 2023 and August 2024 suggest that bacteria concentrations in Little River remain fairly stable and do not have a distinctive increasing or decreasing pattern. While both AUs 1213_01 and 1213_04 are not listed as impaired for primary contact recreation in the draft *2024 Texas Integrated Report* (TCEQ, 2024), the rolling geometric means for *E. coli* remain near the criterion of 126 MPN/100mL. DO concentrations measured during the project period remained largely above the minimum criterion and screening levels.

References

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