Trinity River Authority Clean Rivers Program 2021 Basin Highlights Report

Acknowledgments

The preparation of this report was financed through funding from the Texas Commission on Environmental Quality under Agreement No. 582-18-80164.

Cover photo: Mid-Trinity River waterfall at high flow, May 2013

Table of Contents

The Texas Clean Rivers Program

The Texas Clean Rivers Program (CRP) was created in 1991 by Texas Senate Bill 818 and is administered by the Texas Commission on Environmental Quality (TCEQ) which contracts with local planning agencies such as the Trinity River Authority (TRA) to conduct the program in each river basin. The program is tasked with protecting the water quality resources of the state and improving water quality. Data collected by the TRA CRP and other river authorities are used for regulatory purposes, such as setting water quality standards, modeling for permit limits, and water quality assessments.

Annual Reports

Each year, local planning agencies produce a water quality report. The content and breadth of these reports vary each year. Most years, a Basin Highlights Report is produced which can include discussion of water quality issues, activities within the basin, and watershed characterizations. Every third biennium, a Basin Summary Report is generated and discusses water quality data, issues, and potential sources in detail. TRA completed a Basin Summary Report in 2020. A program update report is generated the year following the Basin Summary Report. The 2021 Basin Highlights Report will follow this program update format and provide an overview of the activities of the past year.

Public Involvement

The TRA CRP participates in several public involvement activities which range from trash clean-ups to public education events. Public interest in the welfare of local water bodies is vital to improving water quality in the Trinity Basin.

The TRA Clean Rivers Program Steering Committee is made up of basin stakeholders and other interested parties, including city officials and the general public. The steering committee provides input and information that is used to guide the program. Annual public meetings are held to update committee members on the activities of the program and to provide a forum to share ideas. If you are interested in participating in the Steering Committee, contact the TRA CRP at tra@trinityra.org.

Trash clean-ups are public events that are organized by cities and counties. TRA staff participates in several of these events. Volunteers at these events remove many tons of debris from water bodies and water ways. In addition to the immediate benefit of the waste removal, volunteers become more aware of their impact on local water bodies.

The Texas Stream Team utilizes a network of trained volunteers to monitor the quality of water bodies in Texas. The Meadows Center at Texas State University administers this program in cooperation with the Texas Commission on Environmental Quality (TCEQ) and the Environmental Protection Agency (EPA). The TRA CRP supports this program through funding for replacement supplies for existing TRA kits. For more information about this program, visit the Texas Stream Team website hosted by the Texas State University Meadows Center for Water and the Environment.

In addition to the activities discussed above, the TRA CRP participates in several organized public outreach and education events each year. These range from local Earth Day events to educational field trips for large school groups. At these events, information is presented on the Trinity River Basin as well as the Trinity River Authority. Educational materials are supplied to teach the public about how they can take a personal role in reducing and preventing water pollution. Due to COVID protocols, the opportunities were limited in 2020 however, TRA CRP staff participated in three events. A Girl Scout Career Day was held in February and focused on women in STEM careers. A booth was set up and information about the Authority and the CRP tasks that we conduct were presented. Girl Scouts were encouraged to ask questions and engage with presenters at this event. In July, staff participated in a virtual classroom setting for students participating in an extracurricular summer program to learn about all the careers available at TRA. In October, two staff members lead a field lab in White Rock Creek for SMU students to teach them about various aspects of field sampling including field parameter and flow measurements and aquatic life monitoring.

2020 Texas Integrated Report

Every two years the TCEQ releases an assessment of surface water bodies. Current and past reports can be found on the TCEQ Texas Integrated Report of Surface Water Quality webpage. **Table 1** presents a brief summary of the findings of the 2020 Texas Integrated Report as it was discussed in detail in the TRA 2020 Basin Summary Report. The summary table lists the impairments or concerns that were identified in any portion of the water body. Some of the impairments or concerns may apply to the entire water body while others apply only to portions of the water body. These details can be found in the TRA 2020 Basin Summary Report.

Table 1: 2020 Texas Integrated Report Summary

Segment	Segment Name	Impairment	Concern
0801	Trinity River Tidal	No Impairments	Chlorophyll-a
0801A	Lost River	Not Assessed	Not Assessed
0801B	Old River	No Impairments	Chlorophyll-a
0801C	Cotton Bayou	Bacteria, Depressed dissolved oxygen	Chlorophyll-a, Depressed dissolved oxygen, Nitrate, Total Phosphorus
0801D	Lynchburg Canal	No Impairments	Chlorophyll-a

Segment	Segment Name	Impairment	Concern
0802	Trinity River Below Lake Livingston	Dioxin & PCBs in edible tissue	Chlorophyll-a
0802A	Choates Creek	Not Assessed	Not Assessed
0802B	Long King Creek	No Impairments	Bacteria
0802C	Unnamed Tributary of Coley Creek	Not Assessed	Not Assessed
0802D	Menard Creek	No Impairments	Bacteria
0802E	Big Creek	No Impairments	Bacteria
0803	Lake Livingston	Dioxin & PCBs in edible tissue, Sulfate	Depressed dissolved oxygen
0803A	Harmon Creek	No Impairments	Nitrate, Total Phosphorus
0803B	White Rock Creek	No Impairments	Chlorophyll-a
0803C	Turkey Creek	Not Assessed	Not Assessed
0803D	Parker Creek	Not Assessed	Not Assessed
0803E	Nelson Creek	No Impairments	No Concerns
0803F	Bedias Creek	No Impairments	Bacteria, Chlorophyll-a, Zinc
0803G	Lake Madisonville	Mercury in edible tissue	No Concerns
0804	Trinity River Above Lake Livingston	Dioxin & PCBs in edible tissue	Chlorophyll-a, Nitrate, Total Phosphorus
0804A	Box Creek	Not Assessed	Not Assessed
0804B	Keechi Creek	Not Assessed	Not Assessed
0804C	Mims Creek	Not Assessed	Not Assessed
0804D	Toms Creek	Not Assessed	Not Assessed
0804E	Northwest Branch	Not Assessed	Not Assessed
0804F	Tehuacana Creek	No Impairments	Bacteria, Chlorophyll-a
0804G	Catfish Creek	Bacteria, Depressed dissolved oxygen	Depressed dissolved oxygen
0804H	Upper Keechi Creek	Depressed dissolved oxygen	Bacteria
0804I	Big Brown Creek	Not Assessed	Not Assessed
0804J	Fairfield Lake	No Impairments	Fish kill
0804K	Lower Keechi Creek	Bacteria	Depressed dissolved oxygen
0804L	Town Creek	Bacteria	Nitrate, Total Phosphorus
0804M	Bassett Creek	Impaired fish community, Impaired macrobenthic community	Impaired macrobenthic community
0805	Upper Trinity River	Dioxin & PCBs in edible tissue, Bacteria	Chlorophyll-a, Nitrate, Total Phosphorus
0805A	Red Oak Creek	No Impairments	No Concerns
0805B	Parsons Slough	Not Assessed	Not Assessed
0805C	White Rock Creek below White Rock Lake	Not Assessed	Not Assessed
0805D	Fivemile Creek	Not Assessed	Not Assessed
0806	West Fork Trinity River Below Lake Worth	Dioxin & PCBs in edible tissue	Bacteria, Chlorophyll-a
0806A	Fosdic Lake	PCBs in edible tissue	Arsenic in edible tissue
0806B	Echo Lake	Dieldrin, Dioxin, & PCBs in edible tissue	No Concerns
0806C	Big Fossil Creek	Not Assessed	Not Assessed
0806D	Marine Creek	Bacteria	No Concerns
0806E	Sycamore Creek	Bacteria	No Concerns
0806F	Little Fossil Creek	No Impairments	Bacteria
0806G	Marine Creek Reservoir	Not Assessed	Not Assessed
0807	Lake Worth	Dioxin & PCBs in edible tissue	No Concerns
0808	West Fork Trinity River Below Eagle Mountain Reservoir	PCBs in edible tissue	No Concerns

Segment	Segment Name	Impairment	Concern
0809	Eagle Mountain Reservoir	No Impairments	Depressed dissolved oxygen
0809A	Walnut Creek	No Impairments	Bacteria
0809B	Ash Creek	Bacteria	Nitrate
0809C	Dosier Creek	Bacteria	No Concerns
0809D	Derrett Creek	Bacteria	No Concerns
0810	West Fork Trinity River Below Bridgeport Reservoir	Bacteria	Chlorophyll-a
0810A	Big Sandy Creek	No Impairments	No Concerns
0810B	Garrett Creek	No Impairments	No Concerns
0810C	Martin Branch	Bacteria	No Concerns
0810D	Salt Creek	No Impairments	No Concerns
0811	Bridgeport Reservoir	No Impairments	No Concerns
0811A	Big Creek	No Impairments	Bacteria
0811B	Beans Creek	Bacteria	No Concerns
0812	West Fork Trinity River Above Bridgeport Reservoir	Bacteria, Total dissolved solids	No Concerns
0813	Houston County Lake	No Impairments	No Concerns
0814	Chambers Creek Above Richland-Chambers Reservoir	Bacteria	Nitrate, Total Phosphorus
0814A	Mill Creek	Not Assessed	Not Assessed
0814B	South Fork Chambers Creek	Not Assessed	Not Assessed
0815	Bardwell Reservoir	Sulfate	No Concerns
0815A	Waxahachie Creek	No Impairments	Bacteria, Nitrate
0816	Lake Waxahachie	No Impairments	No Concerns
0816A	South Prong Creek	Not Assessed	Not Assessed
0817	Navarro Mills Lake	No Impairments	No Concerns
0817A	Richland Creek	Not Assessed	Not Assessed
0818	Cedar Creek Reservoir	pH	Depressed dissolved oxygen
0818A	One Mile Creek	Not Assessed	Not Assessed
0818B	Cedar Creek above Cedar Creek Reservoir	Bacteria	No Concerns
0818C	Kings Creek	Bacteria	Nitrate, Total Phosphorus
0818D	Lacy Fork	No Impairments	Bacteria
0818E	Prairie Creek	Not Assessed	Not Assessed
0818F	Clear Creek	No Impairments	Bacteria
0818G	North Twin Creek	No Impairments	Bacteria
0818H	South Twin Creek	No Impairments	Bacteria
0818I	Caney Creek	No Impairments	Bacteria
0819	East Fork Trinity River	Bacteria, Sulfate	Chlorophyll-a, Nitrate, Total Phosphorus
0819A	Duck Creek	Not Assessed	Not Assessed
0819B	Buffalo Creek	No Impairments	Nitrate, Total Phosphorus
0820	Lake Ray Hubbard	No Impairments	No Concerns
0820A	Cottonwood Creek	Not Assessed	Not Assessed
0820B	Rowlett Creek	Bacteria	Nitrate
0820C	Muddy Creek	No Impairments	Nitrate
0821	Lake Lavon	No Impairments	No Concerns
0821A	Pilot Grove Creek	No Impairments	Bacteria
0821B	Sister Grove Creek	No Impairments	Bacteria, Depressed dissolved oxygen
0821C	Wilson Creek	Bacteria	No Concerns
0821D	East Fork Trinity River above Lake Lavon	Bacteria	No Concerns

Segment	Segment Name	Impairment	Concern
0822	Elm Fork Trinity River Below Lewisville Lake	No Impairments	Cadmium, Chlorophyll-a
0822A	Cottonwood Branch	Bacteria	Chlorophyll-a
0822B	Grapevine Creek	Bacteria	No Concerns
0822C	Hackberry Creek	No Impairments	Chlorophyll-a
0822D	Ski Lake	No Impairments	No Concerns
0823	Lewisville Lake	No Impairments	No Concerns
0823A	Little Elm Creek	No Impairments	No Concerns
0823B	Stewart Creek	No Impairments	Nitrate, Total Phosphorus
0823C	Clear Creek	Bacteria	No Concerns
0823D	Doe Branch	No Impairments	No Concerns
0824	Elm Fork Trinity River Above Ray Roberts Lake	Bacteria	Chlorophyll-a, Nitrate
0825	Denton Creek	No Impairments	Bacteria
0826	Grapevine Lake	pH	No Concerns
0826A	Denton Creek	No Impairments	Nitrate, Zinc
0826B	Trail Creek	Not Assessed	Not Assessed
0826C	Henrietta Creek	Not Assessed	Not Assessed
0827	White Rock Lake	No Impairments	No Concerns
0827A	White Rock Creek above White Rock Lake	Bacteria	No Concerns
0827B	Cottonwood Creek	Not Assessed	Not Assessed
0828	Lake Arlington	No Impairments	No Concerns
0828A	Village Creek	Bacteria	No Concerns
0829	Clear Fork Trinity River Below Benbrook Lake	Dioxin & PCBs in edible tissue, Bacteria	Chlorophyll-a
0829A	Lake Como	Dieldrin, Dioxin, & PCBs in edible tissue	Arsenic in edible tissue
0830	Benbrook Lake	No Impairments	No Concerns
0830A	Rock Creek	No Impairments	No Concerns
0830B	Bear Creek	No Impairments	No Concerns
0831	Clear Fork Trinity River Below Lake Weatherford	Bacteria, Depressed dissolved oxygen	Depressed dissolved oxygen, Nitrate, Total Phosphorus
0831A	South Fork Trinity River	No Impairments	Bacteria, Nitrate, Total Phosphorus
0831B	Unnamed Tributary of South Fork Trinity River	No Impairments	No Concerns
0831C	Town Creek	Not Assessed	Not Assessed
0832	Lake Weatherford	No Impairments	No Concerns
0833	Clear Fork Trinity River Above Lake Weatherford	Depressed dissolved oxygen	Depressed dissolved oxygen
0833A	Clear Fork Trinity River Above Strickland Creek	Depressed dissolved oxygen	Chlorophyll-a, Depressed dissolved oxygen
0834	Lake Amon G. Carter	No Impairments	No Concerns
0835	Richland Creek Below Richland-Chambers Reservoir	Not Assessed	Not Assessed
0836	Richland-Chambers Reservoir	Bacteria	Depressed dissolved oxygen
0836A	Pin Oak Creek	Not Assessed	Not Assessed
0836B	Cedar Creek	Depressed dissolved oxygen	Depressed dissolved oxygen
0836C	Grape Creek	No Impairments	Depressed dissolved oxygen
0836D	Post Oak Creek	No Impairments	Bacteria
0837	Richland Creek Above Richland-Chambers	Bacteria	Chlorophyll-a, Depressed dissolved oxygen
0838	Joe Pool Lake	Not Assessed	Not Assessed

Segment	Segment Name	Impairment	Concern
0838A	Mountain Creek	Not Assessed	Not Assessed
0838B	Sugar Creek	No Impairments	No Concerns
0838C	Walnut Creek	No Impairments	No Concerns
0838D	Hollings Branch	No Impairments	No Concerns
0838E	Soap Creek	No Impairments	No Concerns
0838F	Unnamed tributary of Mountain Creek	No Impairments	No Concerns
0839	Elm Fork Trinity River Below Ray Roberts Lake	No Impairments	No Concerns
0840	Ray Roberts Lake	No Impairments	Depressed dissolved oxygen
0840A	Unnamed Tributary of Jordan Creek	Not Assessed	Not Assessed
0841	Lower West Fork Trinity River	Dioxin & PCBs in edible tissue, Bacteria	Nitrate, Total Phosphorus
0841A	Mountain Creek Lake	Dioxin & PCBs in edible tissue	No Concerns
0841B	Bear Creek	No Impairments	No Concerns
0841C	Arbor Creek	Not Assessed	Not Assessed
0841D	Big Bear Creek	No Impairments	No Concerns
0841E	Copart Branch Mountain Creek	No Impairments	No Concerns
0841F	Cottonwood Creek	Bacteria	Depressed dissolved oxygen
0841G	Dalworth Creek	Bacteria	No Concerns
0841H	Delaware Creek	No Impairments	No Concerns
0841I	Dry Branch Creek	Bacteria	No Concerns
0841J	Estelle Creek	No Impairments	No Concerns
0841K	Fish Creek	Bacteria	Depressed dissolved oxygen, Impaired habitat, Impaired macrobenthic community
0841L	Johnson Creek	Bacteria	No Concerns
0841M	Kee Branch	Bacteria	Depressed dissolved oxygen
0841N	Kirby Creek	Bacteria	Depressed dissolved oxygen
0841O	Mountain Creek	No Impairments	Ammonia, Bacteria, Chlorophyll-a
0841P	North Fork Cottonwood Creek	Bacteria	No Concerns
0841Q	North Fork Fish Creek	Bacteria	No Concerns
0841R	Rush Creek	No Impairments	No Concerns
0841S	Vilbig Lakes	No Impairments	No Concerns
0841T	Village Creek	No Impairments	Bacteria
0841U	West Irving Creek	Bacteria	No Concerns
0841V	Crockett Branch	Bacteria	No Concerns
0841W	Mountain Creek above Mountain Creek Lake	No Impairments	No Concerns

Trinity River Basin Monitoring

The TRA Clean Rivers Program has built an extensive network of monitoring stations by leveraging the activities of cities and regional agencies within the basin that are also conducting water quality monitoring. This network currently monitors more than 220 stations throughout the basin. In addition, TRA staff are working to expand the Clean Rivers Program in the Trinity River Basin. An amendment to add one new partner, Upper Trinity Regional Water

District, is currently in development. Two other entities, the cities of Plano and Denton, have expressed interest in joining the Clean Rivers Program and are expected to be added by the end of the year.

The number of sites monitored by each partner entity and the types of parameters to be sampled in Fiscal Year 2021 is shown in **Table 2**. Parameters typically included in each group include those listed below.

- Field – the standard four water quality parameters (Dissolved Oxygen, Specific Conductivity, pH, and Temperature) as well as parameters describing any contact recreation activities and drought conditions
- Diurnal – summary information for the standard four parameters noted above that are collected over a 24-hour period
- Flow – instantaneous flow measurements, method of measurement, and flow severity category
- Bacteria – *E. coli*
- Conventionals – nutrients such as Nitrogen and Phosphorus species, Hardness, Chlorophyll-a, Alkalinity, Chloride, Sulfate, and suspended and dissolved solids
- Metals – total and/or dissolved metals
- Organics – petroleum hydrocarbons
- Biological – habitat, benthic macroinvertebrate, and nekton data

Figure 1 shows the locations of current monitoring within the basin. This map is not intended to show detailed location information for each monitoring station. Rather, it is intended only to show the abundance and focus of monitoring throughout the basin. Monitoring schedules and maps of stations within the Trinity River Basin, as well as other basins within the state, are hosted on the Lower Colorado River Authority Coordinated Monitoring Schedule webpage.

Table 2: Fiscal Year 2021 Monitoring Summary

Entity	Number of Sites	24-Hour Dissolved Oxygen	Aquatic Habitat	Benthics	Nekton	Metals in Water	Organics in Water	Conventionals	Bacteria	Flow	Field
City of Arlington (AR)	8	None	None	None	None	X	None	X	X	X	X
City of Dallas (DA)	30	None	None	None	None	X	None	None	None	None	X
DFW Airport Environmental Affairs Department (DF)	6	None	None	None	None	X	X	X	X	X	X
City of Dallas (DT)	3	None	None	None	None	None	None	None	X	X	X
City of Fort Worth (FW)	7	None	None	None	None	None	None	None	X	X	X
City of Grand Prairie (GP)	7	None	None	None	None	X	None	X	X	X	X
City of Irving (IR)	9	None	None	None	None	X	None	X	X	X	X
TRA Lake Livingston Project (LL)	23	X	None	None	None	X	None	X	X	X	X
North Texas Municipal Water District (NM)	16	None	None	None	None	X	None	X	X	X	X
Tarrant Regional Water District (TD)	71	X	None	None	None	X	None	X	X	X	X
Trinity River Authority (TR)	39	X	X	X	X	X	None	X	X	X	X

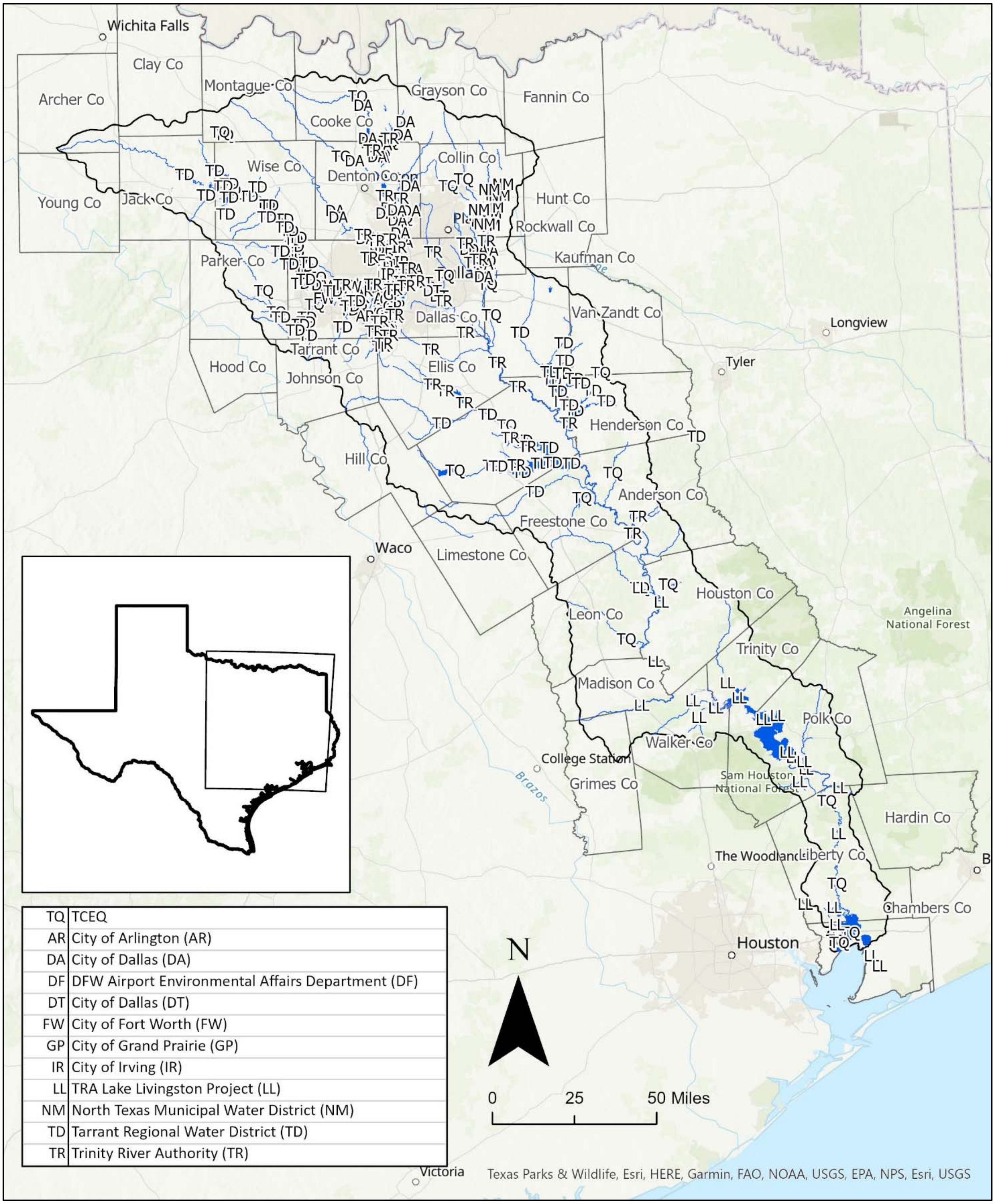

Figure 1: Map of Fiscal Year 2021 Monitoring Stations

Climate

The drought of record in Texas has generally been accepted as being a period between October 1950 and February 1957[1] based on the Palmer Drought Severity Index. This drought is used for water planning in the state. The most recent drought extended from August 2010 to October 2014. Based on NOAA data from a continuously operating weather station currently located at DFW International Airport, the 2010's drought was hotter than the drought of record. However, there was slightly more precipitation during the most recent drought. Figure 1**Figure 3** shows a gradient scale comparison of climate data from the Dallas weather station. For temperatures, blue shades are years that were cooler than the average temperature during the drought of record and red shades are warmer years; darker blue and darker red shades being the coolest and warmest years, respectively. For precipitation totals, brown shades were drier than the drought of record and green shades were wetter with the darkest brown and darkest green being the driest and wettest years, respectively. As shown in **Figure 3**, the last 17 years have been consistently warmer than the 1950s drought. Although, precipitation totals have generally been higher than those seen during the 1950s drought, the most recent drought was observed to have effects on water quality as discussed in the TRA 2020 Basin Summary Report. Decreased precipitation, along with warmer temperatures and its associated increase in evaporation, increased concentrations of pollutants in water bodies. The effects of drought are compounded by ever-increasing populations and their demands on existing water supplies. In response to the recent drought, the Texas Water Development Board has required that all state water planning regions provide drought response plans. Additionally, water providers must now notify TCEQ when they have less than 180 days of water supply available[1].

Figure 2: Benbrook Lake during drought at 62.4% capacity on August 23, 2006

[1] Texas Water Development Board, '2017 State Water Plan', *Texas Water Development Board*, Texas, Texas Water Development Board, 2017, Chapter 3, https://www.twdb.texas.gov/waterplanning/swp/2017/doc/SWP17-Water-for-Texas.pdf?d=27271.284999966156, (accessed 14 January 2021)

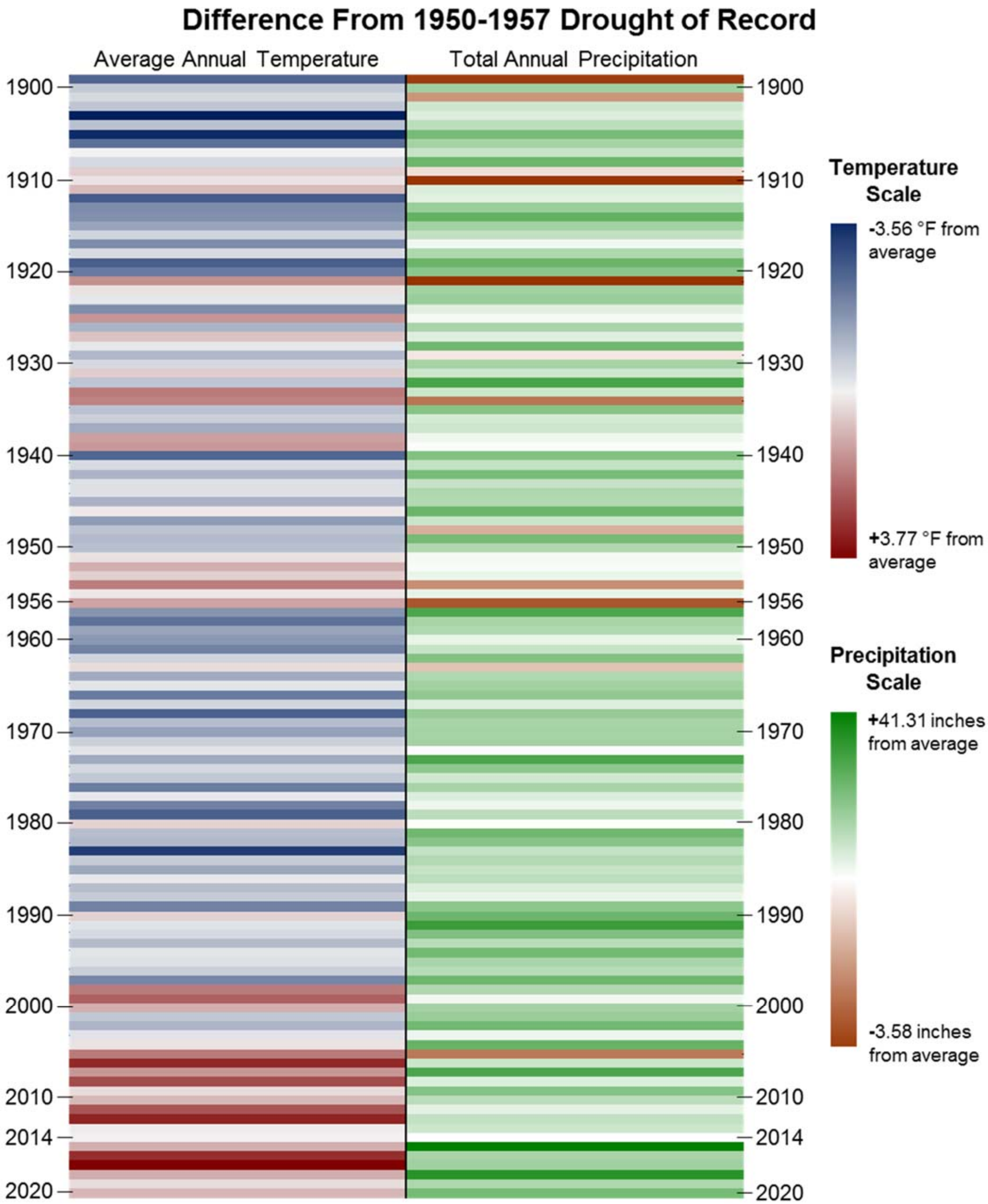

Figure 3: Temperature and Precipitation Differences from 1950-1957 Drought of Record

Joe Pool Lake Watershed Protection Plan

In 2015, TRA personnel were approached by staff from the City of Mansfield regarding a potential restoration effort for Walnut Creek, which was listed by the Texas Commission on Environmental Quality (TCEQ) in the 2014 Texas Integrated Report as impaired for bacteria, pending the results of an ongoing Recreational Use Attainability Analysis (RUAA). Waters contaminated with elevated levels of bacteria can be linked to increased risk for illnesses amongst recreational users of the water body. Local communities can take steps to address water-related concerns on their own. One such community-driven approach is the Watershed Protection Plan (WPP). WPPs are broad, stakeholder-driven, voluntary, and rely on local knowledge to address both impairments and other water quality concerns deemed important, like stream bank erosion, nutrient loadings, etc. In 2017, the TCEQ accepted TRA's proposal for a Joe Pool Lake WPP but recommended that the proposed three-year data collection and planning phase be divided into two separate projects: a two-year water quality monitoring project (Phase I), and a two-year data analysis, and stakeholder participation project (Phase II). These two projects will overlap but will be completed within a three-year timeframe. TCEQ approved the work plan for the Phase I grant in January 2019 and approved the Phase II work plan in November 2019. After completion of the planning projects, stakeholders will be eligible to apply for funds to implement best management practices (BMPs) identified in the WPP. These BMPs are recommendations made by local stakeholder groups to mitigate water quality concerns on a case-by-case basis. Recommendations will be based on targeted water quality sampling, analysis, and modeling for several water quality constituents including those related to bacteria (*E. coli*), nutrients (nitrogen and phosphorus), algal growth, and sediments.

Analysis of historical data was finalized in October 2019. Data collection to support this effort commenced in June 2019 and continued monthly through May 2020. A Data Collection Report was completed in December 2020. Both reports are available online at the TRA Joe Pool Lake Watershed Protection Plan webpage. Phase I of this project has been completed as of January 2021. Stakeholder meetings have commenced as part of Phase II and will continue until the Watershed Protection Plan has been developed. Development of a water quality model for the Joe Pool Lake watershed commenced in January 2021 and will continue through September 2021. The objective of this watershed modeling is to assist with pollutant source identification, quantification of load reduction targets, and the strategic application of best management practices. The implementation phase would use these recommendations to propose and construct projects aimed at addressing the water quality issues identified in the planning phase, usually with assistance from federal grant programs. Assuming that the WPP is approved by Summer 2022, implementation projects could begin construction in 2023.

Lake Arlington Zebra Mussel Monitoring

The zebra mussel, *Dreissena polymorpha,* is an invasive species that was first discovered in Texas waters in 2009 and the Trinity River Basin in 2012 at Lake Ray Roberts. Zebra mussels establish themselves by clinging to stationary objects with strong fibers they excrete called byssal threads and can form large, jagged clusters that can damage underwater infrastructure, make swimming areas dangerous, and cause changes to the tropic structure of water bodies.

Lake Arlington is a major water supply reservoir in the Dallas/Fort Worth Metroplex that provides drinking water for more than half a million people. Yields of the reservoir are supplemented by water pumped in from the Cedar Creek and Richland Chambers reservoirs. Of particular concern, Richland Chambers Reservoir has a confirmed presence of adult zebra mussels.

Current results indicate the presence of environmental DNA (eDNA) in Lake Arlington from two sampling efforts in 2018 and one in 2020 (see **Table 3**). Though eDNA does not confirm the existence of a reproducing live colony, it may be an effective tool for the early detection of aquatic invasive species such as the zebra mussel (Pilliod et al., 2013[2]).

Table 3: Lake Arlington Zebra Mussel Sample Results

Event	Date	Juveniles/Adults	Veligers	eDNA
1	6/6/2018	Negative	Negative	Positive
2	6/28/2018	Negative	Negative	Negative
3	10/22/2018	Negative	Negative	Positive
4	5/6/2019	<unable to sample>*	Negative	Negative
5	10/8/2019	Negative	Negative	Negative
6	4/28/2020	Negative	Negative	Positive
7	10/7/2020	Negative	Negative	Negative

[2] Pilliod, D.S., Goldberg, C.S., Laramie, M.B., and Waits, L.P., 2013, Application of environmental DNA for inventory and monitoring of aquatic species: U.S. Geological Survey Fact Sheet 2012-3146, 4 p.

White Rock Creek *E. coli* Study

TRA began monitoring on White Rock Creek upstream of White Rock Lake (Segment 0827A) in November 2007 due to a lack of data for this area of the basin in the TCEQ water quality database. By the TCEQ 2010 Texas Integrated Report, this stream had been identified as having a concern for elevated levels of *E. coli*. By the 2016 Texas Integrated Report, this segment was identified as not supporting its recreation use and this impairment has continued into the 2018 and 2020 Texas Integrated Reports.

In 2019, TRA began a study to learn more about the bacteria levels in this stream. A study was developed based on samples collected at multiple bridge crossings upstream of the TRA monitoring station 20289 (White Rock Creek at IH635 service road in Dallas). The first part of the study consisted of samples collected at 23 bridges from IH635 in Dallas to College Parkway in Frisco during dry weather conditions on July 16, 2019. Based on the results of this sampling, two reaches were identified for fine-scale sampling where there were the two highest relative percent differences and an order of magnitude increase in *E. coli* concentrations from an upstream bridge to the next bridge downstream. These reaches were sampled on October 10, 2019. The reaches were walked and additional *E. coli* samples were collected in various locations that appeared to be potential *E. coli* inputs. This sampling found that a small tributary entering White Rock Creek downstream of SH 121 may have contributed *E. coli*. The land surrounding the tributary immediately upstream of its confluence had been an agricultural field during the July 2019 samples and had transitioned to a residential construction area by the October 2019 samples (see **Figure 4**). It is believed that the disturbed sediments in the agricultural field and then the construction site may have contributed to the elevated *E. coli* concentrations seen in this reach.

The second part of this study was conducted during wet weather conditions. The same 23 locations were sampled on May 12, 2020. Three reaches were identified for further sampling using the same logic described above for the dry weather fine-scale sampling. These samples were collected on June 23, 2020. The results of the wet weather sampling did not identify any obvious sources of *E. coli*; rather it appeared that *E. coli* is ubiquitous in the system. However, wildlife on golf courses may be a significant contributor of bacteria in this watershed but bacterial source tracking would be required to confirm this assumption.

It is interesting to note that the measured *E. coli* levels from the dry weather and wet weather sampling followed the same patterns although with vastly different concentrations as shown in **Figure 5**. This pattern appears to be a function of the changes in land uses and the presence of riparian buffer zones throughout the watershed.

A detailed report for this project is currently being written and will be available on the TRA Report webpage under the Special Studies section at a later date.

Figure 4: Comparison of two aerial images taken before and after the conversion of pastureland to a large construction site (NearMap, 2020)

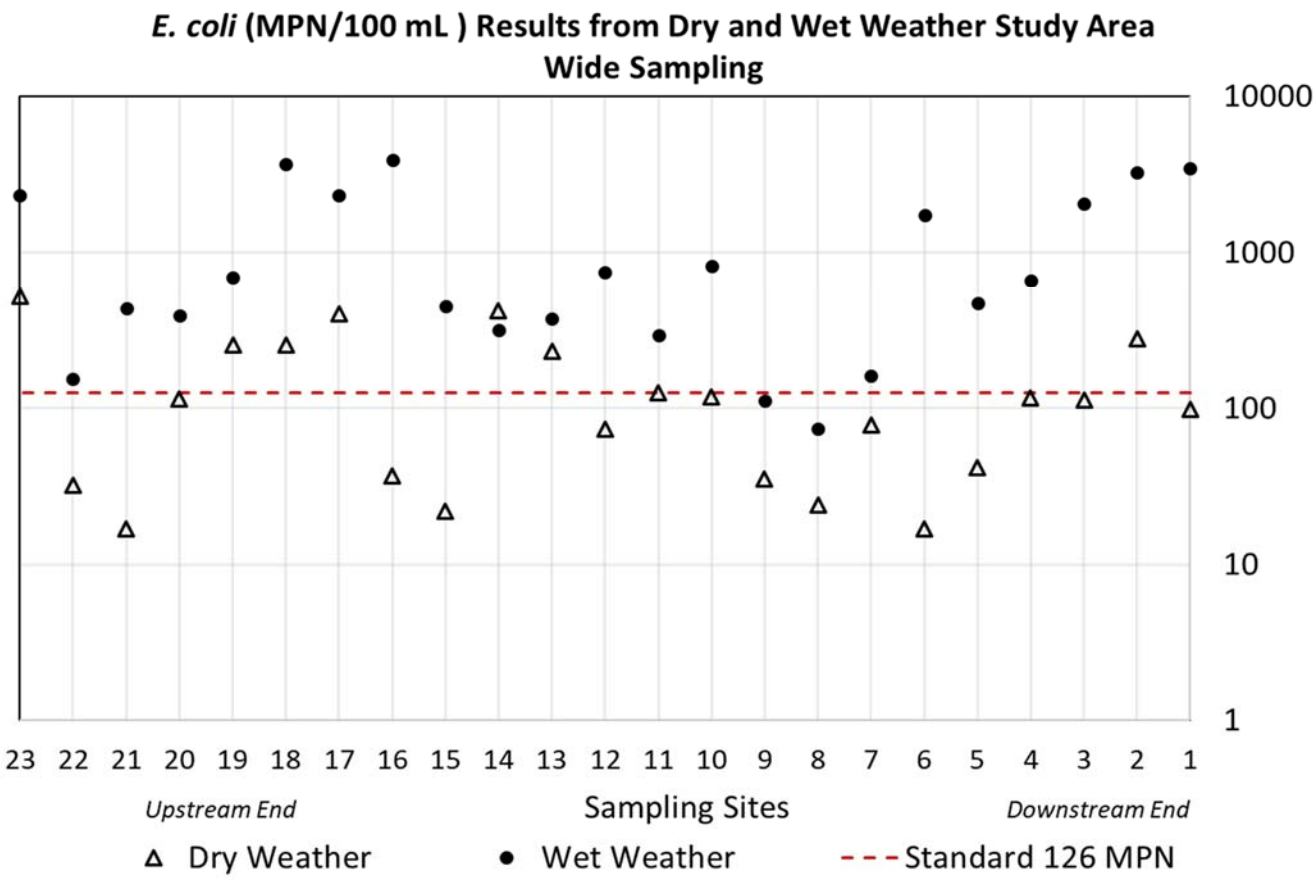

Figure 5: Comparison of E.coli Results Between the Coarse-scale Wet and Dry Sampling Events

E. coli in Sediment Study

Over the past two decades, fecal bacteria, or *E. coli,* has become a concern for many stakeholders in the Trinity River basin, and throughout the state of Texas in general. Based on the TCEQ 2020 Texas Integrated Report of Surface Water Quality, there are sixty-six (66) water bodies within the Trinity River basin that have concerns or are impaired due to elevated levels of bacteria. These impairments can sometimes be attributed to point sources of bacteria such as malfunctioning human sewage infrastructure, but commonly bacteria impairments arise from nonpoint source pollution that is delivered to the stream as runoff during storm events. However, streams may retain elevated levels of bacteria well after disturbances from storm events have taken place. Current scientific literature indicates that shallow bed sediments can be a significant reservoir of bacteria when resuspended by a disturbance event such as incoming stormwater runoff, floodwater erosion, or other in-stream physical agitation (wildlife, livestock, or human activity). However, the majority of these studies focus on coastal tidal zones, or along beaches of reservoirs or lakes. These are areas where flow velocity slows, where sediment conditions are more likely to be accretive, and where unconsolidated bed sediments are common. A literature review suggests that very little is known about this phenomenon in inland, eroding systems where particle sizes, sediment consolidation conditions, and fluvial geomorphology may differ from those conditions evaluated in preceding studies.

Furthermore, there is indirect acknowledgment that sediments can affect water quality; the Texas Commission on Environmental Quality's (TCEQ) *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods* (RG-415, Revised August 2012) provides guidance that seeks to minimize sediment disturbance when taking water quality samples. However, studies to evaluate sediment influence on water quality are limited.

In 2018, TRA began a study to explore the extent to which bacteria in sediments may affect water column concentrations. The study consisted of water column *E. coli* samples taken before and after an artificial disturbance of the instream sediments as well as sediment samples for particle size and *E. coli* analysis. Sampling was broken into two phases. The first phase consisted of samples collected at seven sites in the Village Creek and Mountain Creek watersheds as shown by the red points in **Figure 6**. Twelve samples were collected from March 2018 to January 2021. The second phase of sampling began in December 2020 and will include 12 events approximately every other week at one location as shown by the purple point in **Figure 6**. Samples are being collected from three discrete sediment types at that location – fines, sand, and gravel.

The results of these studies will be written up in individual reports upon completion of sampling and data analysis, but initial results are provided below.

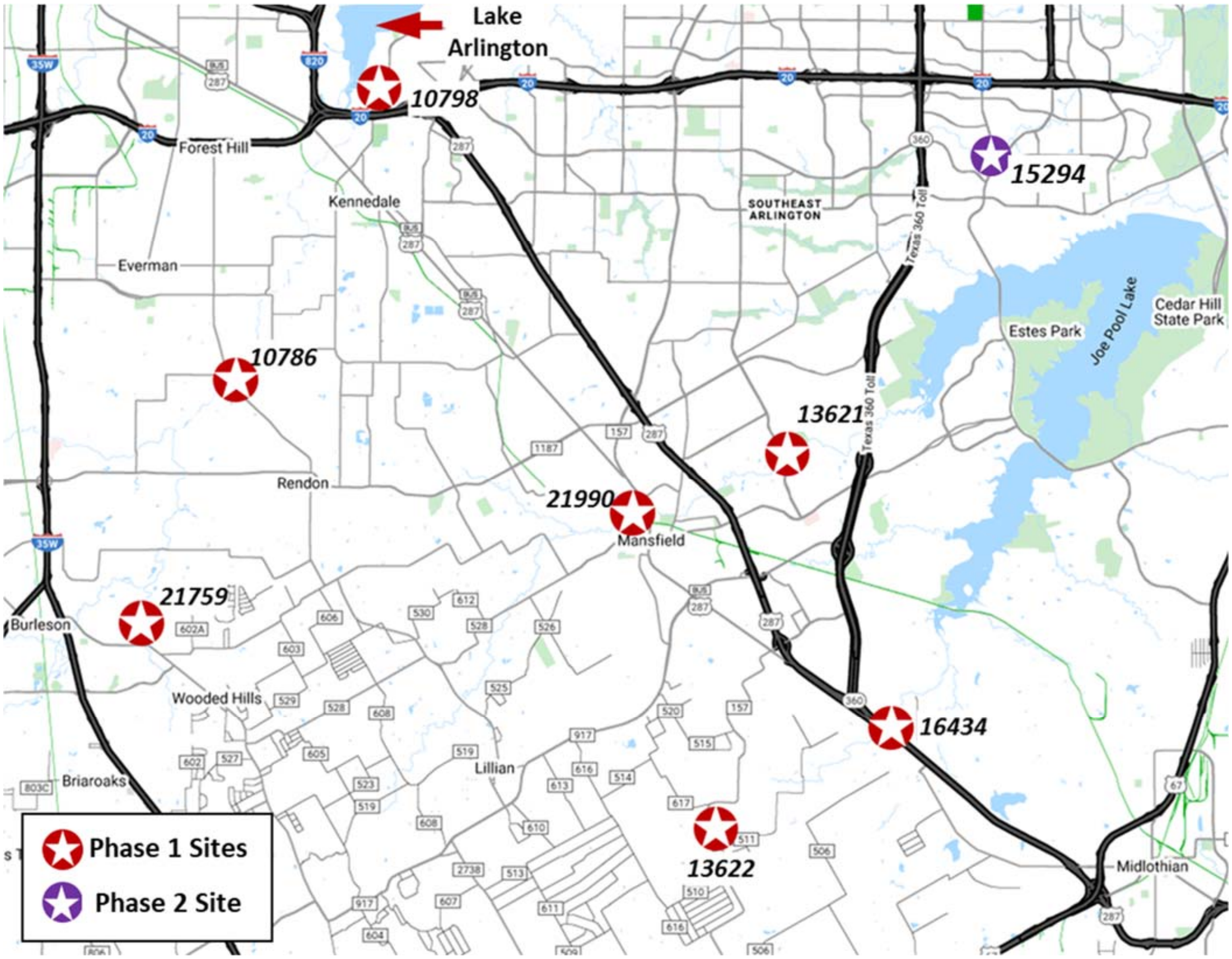

Figure 6: Sediment E. coli Monitoring Stations

Five of the seven sites sampled during Phase 1 were predominately sand and gravel systems. The two sites sampled on Mountain Creek were predominately fines and sands. A summary of the results is shown in **Table 4**. Sediment analysis results are not yet available for the final event, but preliminary results show an overall increase in *E. coli* levels measured after the stream sediments were disturbed.

The three sites in the Village Creek watershed – 10798, 21759, and 10786 – had a range of influences from the disturbed sediments. Station 10798 is a small tributary into Lake Arlington. This station showed the greatest impact from disturbed sediments. This stream is a relatively slow-moving stream with a narrow incised channel and heavy shading around the sample point that drains a largely residential area. This shading and slow-moving water may have increased the sediment *E. coli* population's protection from ultraviolet die-off and from being washed out of the sediment. Station 21759 is on a tributary to Village Creek and has slightly less shading and higher flows than station 10798 and drains a more rural area. Station 10786 is located on Village Creek. It had much higher flows, a wider channel, and less shading than the other sites in this watershed. In addition, the stream bed at this station was largely bedrock with the loose sediments being confined to holes in the bedrock and velocity shelters around snags and bridge pylons. It is believed that all these factors combined resulted in the lower overall *E. coli* concentrations at this site.

The remaining four stations were located in the Mountain Creek watershed with two sites on Walnut Creek and two sites on Mountain Creek. Similar to the Village Creek sites, the Walnut Creek sites were predominately sand and gravel. The channels at both stations were similarly wide but the upstream station 21990 was more shaded and with lower flows than the downstream station 13621. This is reflected in the summary data with higher *E. coli* concentrations at the upstream station 21990.

Sediments at the two Mountain Creek stations were markedly different than the other sites in this study. Both sites were predominately fines and sand. However, the upstream station 13622 was loose material while the downstream station 16434 was mostly hardpacked sediments. Station 13622 had lower flows than station 16434 and the channel was similarly shaded at both locations. It is interesting to note that, while the sediment *E. coli* concentration was higher at the upstream station, pre/post-disturbance water column *E. coli* concentrations were much lower. The organic carbon content of the upstream station was also much higher than any of the other stations which may have provided food for the sediment *E. coli* populations but it is unknown at this time why the water column *E. coli* levels were so low.

Further data analysis will be conducted and provided in the final report for this project at a later date.

Table 4: Phase 1 Sediment E. coli Preliminary Results

Station	Pre-Disturbance *E. coli* Geomean (MPN/100 mL)	Sediment *E. coli* Geomean (MPN/100 g)	Post-Disturbance *E. coli* Geomean (MPN/100 mL)	Average Organic Carbon (mg/kg)	Average Fines - <0.005 to 0.074 mm (%)	Average Sand – 0.075 to 4.75 mm (%)	Average Gravel – 4.75 mm to 3 inches (%)
10798 - Unnnamed tributary of Lake Arlington at Bowman Springs Road	257	254094	3615	3660	6.4	56.6	37.0
21759 - Quil Miller Cree at CR 532 in Burleson	162	226295	466	3513	4.9	54.4	40.7
10786 - Village Creek at Rendon Road southwest of Arlington	51	92650	100	3465	4.0	53.6	42.4
13621 - Walnut Creek at Matlock Road northeast of Mansfield	103	285318	991	4797	8.2	62.5	29.2
21990 - Walnut Creek at Katherine Rose Memorial Park in Mansfield	276	368200	1205	5541	17.2	51.1	31.5
16434 - Mountain Creek at US 287 northwest of Midlothian	57	45195	189	8052	39.6	42.0	19.3
13622 - Mountain Creek at FM 157 north of Venus	16	207669	25	19597	53.8	31.1	15.0

Figure 7: Sub-area Sediment Samples for Phase 2 Sediment E. coli

Phase 2 sampling was designed to remove any differences across watersheds from the resultant data. Samples are being collected from a roughly 6,500 square foot area to exclude any confounding factors such as shading, upstream contributions, and general water chemistry. Within this 6,500 square foot area are sub-areas that are predominately fines, sands, or gravels (see **Figure 7**). Samples are being collected from these three subareas. Since sampling has only just begun, results are limited and sediment analyses are not yet available. Based upon the pre/post-disturbance water column *E. coli* samples and the sediment concentrations, it appears that disturbance of fine sediments has the greatest impact on water column concentrations as shown in **Table 5**.

Table 5: Phase 2 Sediment E. coli Preliminary Results

Sub-areas of Station 15294 - Fish Creek at Great Southwest Parkway in Grand Prairie	Pre-Disturbance *E. coli* Geomean (MPN/100 mL)	Post-Disturbance *E. coli* Geomean (MPN/100 mL)	Relative Percent Increase	Sediment *E. coli* Geomean (MPN/ 100 g)
Fine Sediment	83	2030	2,341	44,903
Sandy Sediment	141	252	79	13,942
Gravel	169	429	154	4,596

PCBs, Dioxins, and Furans in Sediment Study

TRA began a study in 2017 to identify areas that may be contributing polychlorinated biphenyls (PCBs), dioxins, and furans to the river. In the summer of that year, sediment samples were collected at 26 locations in the Trinity River basin. The results of this sampling were discussed in the TRA 2020 Basin Summary Report. Based on those results, three areas were identified as having potential sources of these contaminants; along the Clear Fork Trinity River in Fort Worth, along the main stem Trinity River in Dallas between the confluence with the Elm Fork Trinity River and Cedar Crest Boulevard, and upstream of the White Rock Creek cove of Lake Livingston. Four sites within each of these three areas (see **Figure 8**) will be sampled in the winter/early spring of 2021.

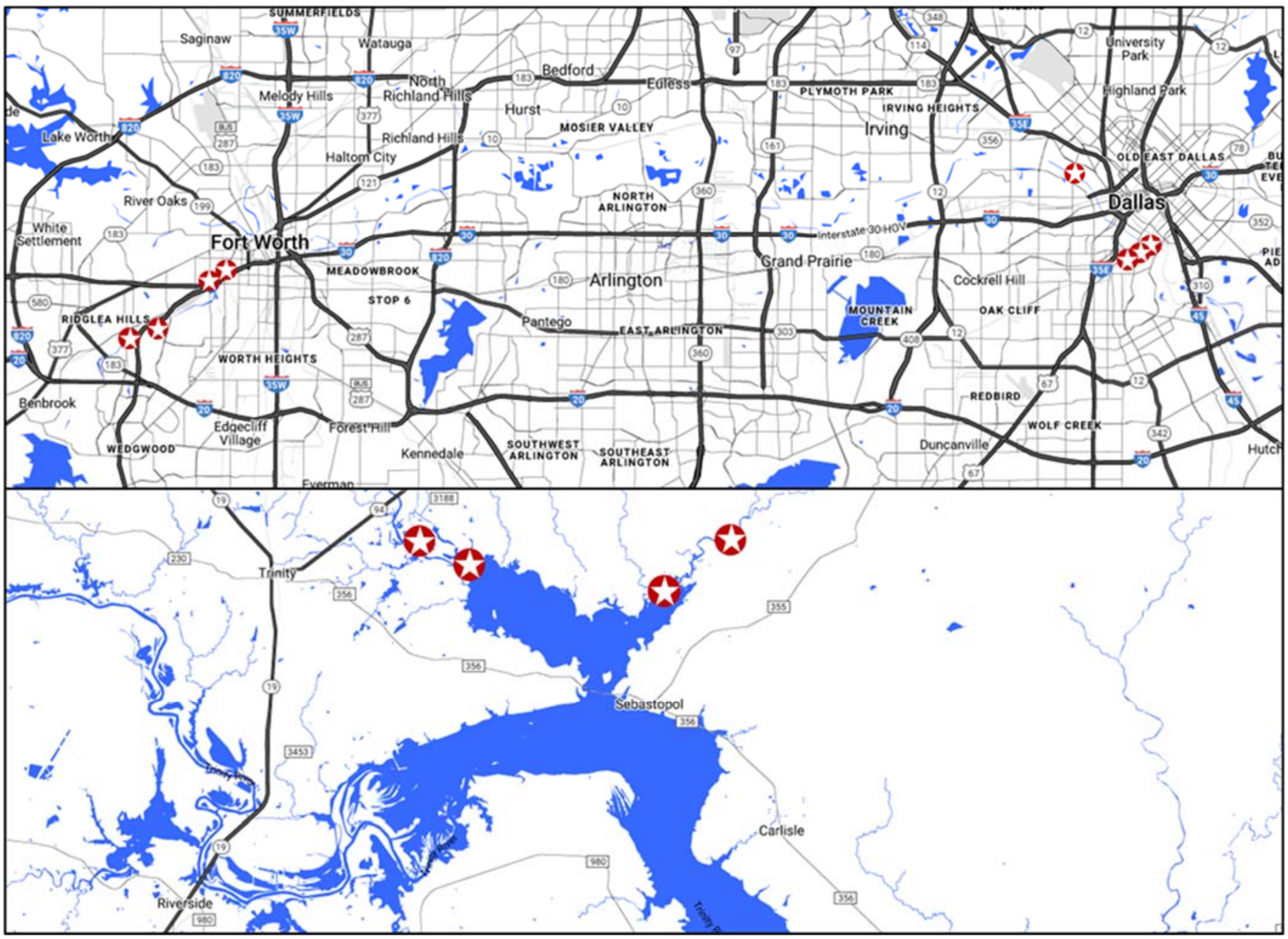

Figure 8: Fort Worth and Dallas PCB sites (top) and Lake Livingston sites (bottom)