Texas State Soil and Water Conservation Board
State Nonpoint Source Grant Program

Kickapoo Creek in Henderson County Watershed Protection Plan

TSSWCB Project # 21-54

Quality Assurance Project Plan

Texas State Soil and Water Conservation Board

Revision # 1

prepared by

Texas Institute for Applied Environmental Research

Effective Period: Upon final approval through May 31, 2023

Questions concerning this quality assurance project plan should be directed to:

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Section A1: Approval Sheet

Quality Assurance Project Plan (QAPP) for *Characterizing the Kickapoo Creek in Henderson County Watershed*

Texas State Soil and Water Conservation Board (TSSWCB)

Name: Jana Lloyd
Title: TSSWCB Project Manager (PM)

Signature:_____Date:_____

Name: Mitch Conine
Title: TSSWCB Quality Assurance Officer (QAO)

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Texas Institute for Applied Environmental Research (TIAER)

Name: Leah Taylor
Title: TIAER Project Leader

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Name: Nancy Easterling
Title: TIAER Project QAO and Data Manager

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Name: Jeff Stroebel
Title: TIAER Field Supervisor

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Name: James Hunter
Title: TIAER Laboratory Manager

Signature:_____Date:_____

Name: Dr. Michael Machen
Title: TIAER Laboratory QAO

Signature:_____Date:_____

Angelina & Neches River Authority (ANRA)

Name: Melissa Garcia
Title: ANRA Laboratory Manager (LM)

Signature:_____Date:_____

Section A2: Table of Contents

List of Acronyms and Abbreviations

ANRA	Angelina & Neches River Authority
AWRL	Ambient Water Reporting Limits
CAR	corrective action report
COC	chain of custody
DM	Data Manager
DMRG	Data Management Reference Guide
DDO	depressed dissolved oxygen
DO	dissolved oxygen
DQO	data quality objectives
FDC	flow duration curve
GIS	geographic information system
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LDC	load duration curve
LM	Laboratory Manager
LOD	limit of detection
LOQ	limit of quantitation
NCDC	National Climatic Data Center
NELAP	National Environmental Laboratory Accreditation Program
NWS	National Weather Service
OSSF	onsite sewage facility
PM	Project Manager
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	quality assurance project plan
QC	quality control
QM	quality manual
QPR	quarterly progress report
RPD	relative percent difference
SLOC	station location request
SOP	standard operating procedure
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TNRIS	Texas Natural Resources Information System
TIAER	Texas Institute for Applied Environmental Research
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TXDOT	Texas Department of Transportation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
%R	percent recovery

Section A3: Distribution List

Organizations, and individuals within, which will receive copies of the approved QAPP and any subsequent revisions include:

Texas State Soil and Water Conservation Board
1497 Country View Lane
Temple, TX 76504

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TSSWCB PM

Mitch Conine
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Texas Institute for Applied Environmental Research
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Jeff Stroebel
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Dr. Michael Machen
TIAER Laboratory QAO

Angelina & Neches River Authority
2901 N. John Redditt Dr.
Lufkin, Texas 75904

Melissa Garcia
ANRA Laboratory Manager

Section A4: Project/Task Organization

The following is a list of individuals and organizations participating in the project with their specific roles and responsibilities:

TSSWCB – Texas State Soil and Water Conservation Board, Temple, Texas. Provide state oversight and management of all project activities and ensure coordination of activities with related projects and TCEQ.

Jana Lloyd, TSSWCB PM

Responsible for ensuring that the project delivers data of known quality, quantity, and type on schedule to achieve project objectives. Provides the primary point of contact between TSSWCB and TIAER. Tracks and reviews deliverables to ensure that tasks in the work plan are completed as specified. Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TSSWCB participants. Notifies TSSWCB QAO of any project non-conformances or corrective actions reported or taken by TIAER.

Mitch Conine; TSSWCB QAO

Reviews and approves QAPP and any amendments or revisions. Responsible for verifying that the QAPP is followed by project participants. Monitors implementation of corrective actions. Coordinates or conducts audits of field and laboratory systems and procedures. Determines that the project meets the requirements for planning, quality assessment (QA), quality control (QC), and reporting under the TSSWCB Nonpoint Source Management Program.

TIAER – Texas Institute for Applied Environmental Research, Stephenville, Texas. Responsible for general project oversight, coordination and administration, project reporting, collection of water quality data, data analysis and characterization, Load Duration Curve (LDC) development, stakeholder facilitation, public education and outreach, development of data quality objectives (DQOs) and QAPP development.

Leah Taylor, TIAER Project Lead and PM

Responsible for supporting the development and ensuring the timely delivery of project deliverables, ensuring cooperation between project partners, providing fiscal oversight and completing project reporting.

Responsible for ensuring that tasks and other requirements in the contract are executed on time and with the QA/QC requirements in the system as defined by the contract and in the project QAPP; assessing the quality of subcontractor/participant work; and submitting accurate and timely deliverables to the TSSWCB PM.

Nancy Easterling, TIAER Project QAO and Project Data Manager

Responsible for determining that the QAPP meets the requirements for planning, QA and QC. Conducts audits of field and laboratory systems and procedures. Responsible for maintaining the official, approved QAPP, as well as conducting quality assurance audits in conjunction with TSSWCB personnel.

Responsible for acquisition, verification, and transfer of data to the TSSWCB PM. Oversees data management for the project. Performs data quality assurances prior to transfer of data to the Texas Commission on Environmental Quality (TCEQ) in the format specified in the most recent version of the Surface Water Quality Monitoring (SWQM) Data Management Reference Guide (DMRG). Ensures that the data review checklist is completed and data is submitted with appropriate codes. Provides the point of contact for the TSSWCB PM to resolve issues related to the data and assumes responsibility for the correction of any data errors.

Jeff Stroebel, TIAER Field Supervisor & Data Manager

Responsible for supervising all aspects of the sampling and measurement of surface waters and other field parameters. Responsible for the collection of water samples and field data measurements in a timely manner that meet the quality objectives specified in Section A7 (Table A7.1), as well as the requirements of Sections B1 through B8. Responsible for field scheduling, staffing, and ensuring that staff is appropriately trained. Reports status, problems, and progress to TIAER PM.

James Hunter, TIAER Laboratory Manager

Responsible for overall performance, administration, and reporting of analyses performed by TIAER. Responsible for supervision of laboratory personnel involved in generating analytical data for the project. Ensures that laboratory personnel have adequate training and a thorough knowledge of the QAPP and related SOPs. Responsible for oversight of all laboratory operations ensuring that all QA/QC requirements are met, documentation is complete and adequately maintained, and results are reported accurately. Enforces corrective action, as required. Facilitates monitoring systems audits. Reviews and verifies all laboratory data for integrity and continuity, reasonableness and conformance to project requirements, and then validates the data against the measurement performance specifications listed in Table A7.1 of the QAPP.

Dr. Michael Machen, TIAER Laboratory QAO

Maintains quality assurance manual for laboratory operations, maintains operating procedures that are in compliance with the QAPP. Responsible for the overall quality control and quality assurance of analyses performed by the TIAER laboratory.

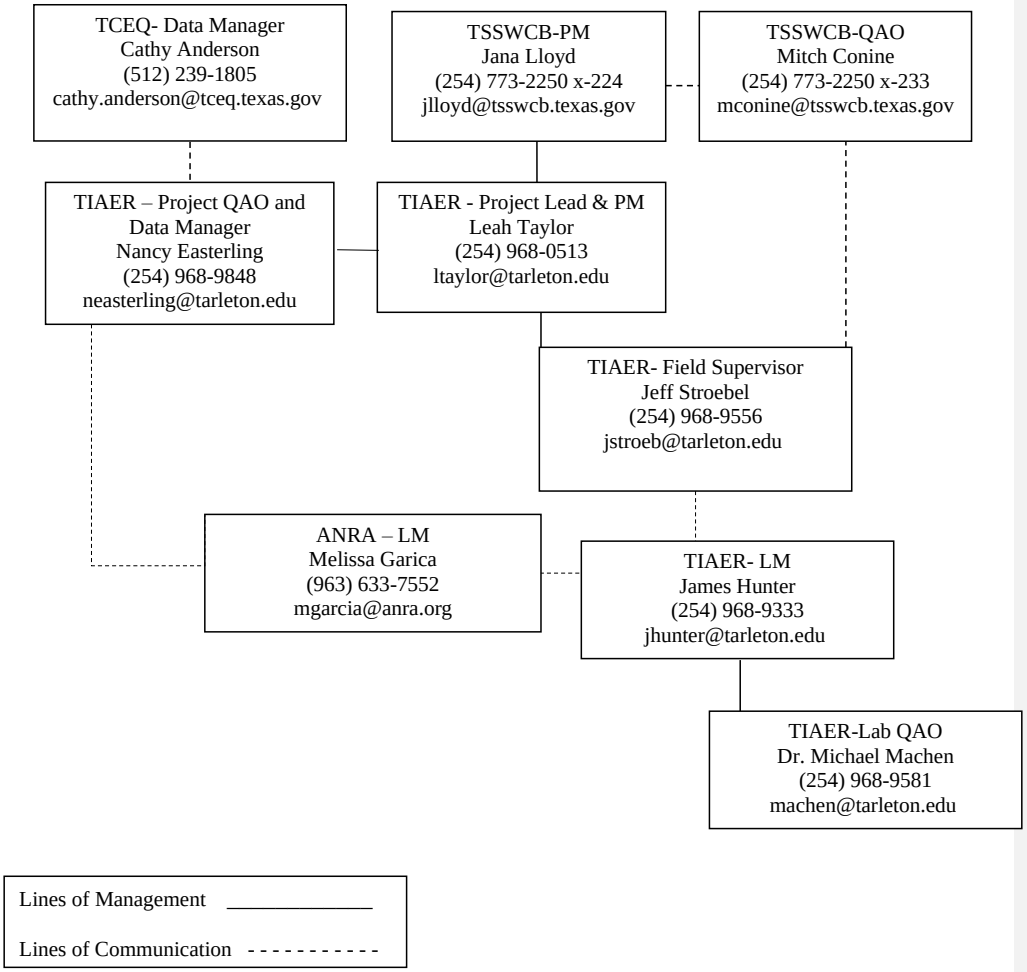
Responsible for the data analysis and the characterization of Kickapoo Creek for water quality, and development of Load Duration Curves (LDCs) for bacteria and DO analysis.

ANRA – Angelina & Neches River Authority, Lufkin, Texas. Responsible for conducting laboratory analysis for bacteria.

Melissa Garcia, ANRA Laboratory Manager

Responsible for overall performance, administration, and reporting of analyses performed by ANRA. Responsible for supervision of laboratory personnel involved in generating analytical data for the project. Ensures that laboratory personnel have adequate training and a thorough knowledge of the QAPP and related SOPs. Responsible for oversight of all laboratory operations ensuring that all QA/QC requirements are met, documentation is complete and adequately maintained, and results are reported accurately. Enforces corrective action, as required. Facilitates monitoring systems audits. Reviews and verifies all laboratory data for integrity and continuity, reasonableness and conformance to project requirements, and then validates the data against the measurement performance specifications listed in Table A7.1 of the QAPP.

Figure A4.1. Project Organization Chart



Section A5: Problem Definition/Background

Segment 0605A was first listed on the 2000 303(d) list for elevated bacteria concentrations. The 2020 303(d) list continues to identify Segment 0605A for elevated bacteria concentrations. In addition, assessment unit 0605A_01 Kickapoo Creek in Henderson County is on the 303(d) list for a depressed dissolved oxygen impairment. A Recreational Use Attainability Analysis conducted on the waterbody in 2014 (https://www.tceq.texas.gov/waterquality/standards/ruaas/upperneches) found that primary contact recreation occurs throughout the waterbody. Consequently, Kickapoo Creek is classified for primary contact recreation.

The project will build on the previous project, Characterizing the Kickapoo Creek in Henderson County Watershed, for which TIAER is the lead, partnering with ANRA. The previous project satisfies Elements A and B of the EPA guidance by characterizing sources of pollution and determining the load reductions as needed to meet water quality standards. The current project will consolidate the stakeholder group and process and continue to maintain it. The current project seeks to address Elements C through I and develop a WPP to achieve the needed pollutant load reductions.

Throughout this project, TIAER will work with local stakeholders, administrative groups within the watershed, and ANRA to develop a watershed protection plan (WPP). The purpose of this project is to develop a stakeholder-driven WPP for the Kickapoo Creek in Henderson County watershed that meets the nine essential elements outlined by EPA as fundamental to a successful watershed-based plan. Data collected as a result of the project will be used to inform stakeholders of changes in water quality, as well as to aid in targeting sources to facilitate a WPP development.

This QAPP is reviewed by TSSWCB to help ensure that environmental data generated for the purposes described above are scientifically valid and legally defensible. This process will ensure that all data submitted to SWQMIS have been collected and analyzed in a way that helps guarantee their reliability and therefore can be used by programs deemed appropriate by TSSWCB.

Section A6: Project Goals and Task Description

The purpose of this project is to develop a stakeholder driven WPP for the Kickapoo Creek in Henderson County watershed that meets the nine essential elements outlined by EPA as fundamental to a successful watershed-based plan. The current project will build on a previous 319 project, Characterizing the Kickapoo Creek in Henderson County Watershed, for which TIAER was the lead, partnering with ANRA. The current project satisfies Elements A and B of the EPA guidance by characterizing sources of pollution and determining the load reductions as needed to meet water quality standards. The current project has also established the stakeholder group and process. This proposal seeks to address Elements C through I and develop a WPP to achieve the needed pollutant load reductions.

The WPP will be assembled in accordance with EPA's 9-element criteria. Monitoring of the watershed will also continue to provide stakeholders with feedback on current conditions as a mechanism to engage stakeholders as well as track changes in water quality conditions spatially and temporally.

As a part of the proposed project, additional data will be collected and they will also be used in the watershed characterization process. Direct water quality monitoring will be conducted to supplement existing data and allow better targeting of sources by increasing the frequency and number of locations where specifically bacteria data are collected. Routine water quality data will be collected monthly at 9 stations within the watershed for up to 18 months. Sampling will include routine field parameters (water temperature, pH, DO, conductivity, and instantaneous flow) and collection of water samples for analysis of *E. coli*, ammonia (NH_3-N), total suspended solids (TSS), volatile suspended solids (VSS), nitrite-nitrogen+nitrate-nitrogen (NO_2-N+NO_3-N), total Kjeldahl nitrogen (TKN), ortho-phosphorus (PO_4-P), total phosphorus (TP), biochemical oxygen demand (BOD), and chlorophyll-a (CHLA). Water samples will be delivered to ANRA within the appropriate holding time for analysis of bacteria. All other laboratory analyses will be conducted by TIAER's laboratory. To provide additional data to aid with assessment of the indicated DO impairment, 24-hr DO monitoring will occur in conjunction with routine monthly at up to three locations. The direct data from this project will be evaluated along with historical data to indicate current conditions and trends.

Table A6.1 Project Plan Milestones

Task	Project Milestones	Agency	Start Month	End Month
3.1	TIAER will work with watershed stakeholders to inventory and evaluate existing watershed management program needs and opportunities.	TIAER	1	27
3.2	TIAER will work with watershed stakeholders to assemble the WPP into a document that will satisfy EPA's nine key elements (A-I) for a watershed plan.	TIAER	6	27
3.3	TIAER and project partners will present and deliver a final draft WPP to stakeholders for comment and review. Comments received will be addressed and the WPP will be sent to TSSWCB and EPA for review. The project team will work with stakeholders to address any EPA comments.	TIAER	6	27

Task	Project Milestones	Agency	Start Month	End Month
4.1	TIAER will conduct routine, monthly, ambient water quality monitoring at 9 sites in the Kickapoo Creek in Henderson County watershed for up to 18 months. Routine field parameters will include water temperature, pH, DO, conductivity, and instantaneous flow. Water samples will be collected for analysis of *E. coli*, NH_3-N, TSS, VSS, NO_2-N+NO_3-N, TKN, PO_4-P, TP, BOD, and Chla. ANRA will conduct *E. coli* analyses. All other laboratory analyses will be conducted by TIAER's laboratory. If the TIAER Laboratory has issues with testing or equipment, the ANRA Laboratory will perform the analyses, as needed. To provide additional data to aid with assessment of the indicated DO impairment, TIAER will conduct 24-hr DO monitoring in conjunction with routine monthly at up to three locations.	TIAER/ ANRA	1	27
4.2	ANRA Laboratory will transfer completed lab analysis data to TIAER who will maintain a master database of collected data. Data will be submitted to TSSWCB by TIAER for submission to SWQMIS on a quarterly basis.	TIAER/ ANRA	3	27
5.1	TIAER will develop and continue to build on the comprehensive data inventory for the watershed (originally created during the previous watershed characterization) by assembling all the existing information. This data inventory will include historical weather, water quality, streamflow, and estimated information on wildlife and livestock densities, population characteristics, discharges from wastewater treatment facilities (WWTFs), on-site sewage facilities (OSSFs), and other relevant information, such as soils, topography, and land cover.	TIAER	3	22
5.2	TIAER will conduct water quality data analysis using GIS information collected with the data inventory of the previous watershed characterization to spatially display potential sources of water quality impairments and concerns in conjunction with water quality information. Water quality data for bacteria and streamflow data (estimated) will be used to develop LDCs for bacteria to aid in assessing flow conditions under which exceedances to bacteria and water quality standards occur. DO and saturation DO will be correlated with various water quality variables to identify the probable causes of depressed DO. A graphical analysis will also be carried out to support the interpretation of results.	TIAER	7	24
5.3	Using loading data from causes and sources and LDC analysis collected in subtask 4.1, estimated pollutant loading reductions needed to meet water quality standards and other goals will be calculated.	TIAER	10	27

TIAER will be responsible for the collection and transport of all water quality samples for bacteria analysis to ANRA within appropriate sample holding times and in accordance with this QAPP. Sampling will be conducted routinely at the sampling sites designated in Table A6.2.

ANRA will receive water samples and analyze them for *E. coli* enumeration.

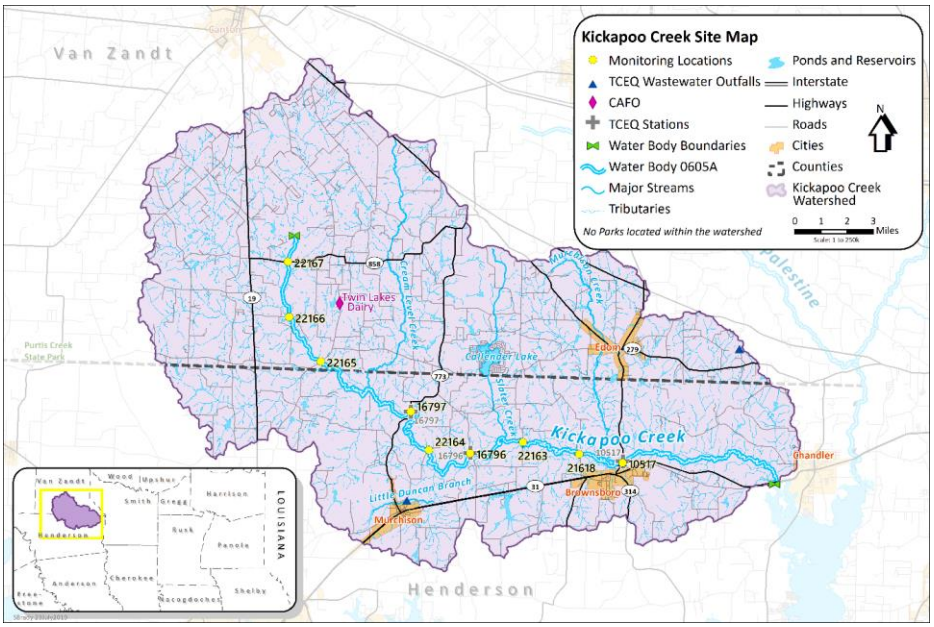


Figure A6.1. Kickapoo Creek Watershed and monitoring stations

Nine sampling stations were selected for collection of project data (shown in Figure A6.1). All stations are located at intersections and are publicly accessible. Sampling station 10517 is located at a WWTF (TCEQ Permit WQ0010540-001). Sampling stations 10517, 16796, and 16797 have historically been monitored by TCEQ and have TCEQ Station IDs. Station 21618 was established by TCEQ as a replacement for station 10517, which is in the mixing zone of the Brownsboro WWTP. TIAER prepared SLOCs and obtained TCEQ Station IDs for the remainder of the stations.

Table A6.2. Kickapoo Creek in Henderson County – Sampling Site Locations

TCEQ Station ID	Site Description	Latitude	Longitude	Mode of Sampling	Sample Matrix	Annual Monitoring Freq.	Agency Responsible for Sampling	Monitor Type [1, 2]
10517	Kickapoo Creek crossing at FM 314 in Henderson County	32.309099	-95.605826	Grab and 24-hr	Water	12	TIAER	RTWD
16796	Kickapoo Creek crossing at FM 1803 in Henderson County	32.312309	-95.705716	Grab	Water	12	TIAER	RT
16797	Kickapoo Creek crossing at FM 773 in Henderson County	32.334668	-95.745165	Grab	Water	12	TIAER	RT
21618	Kickapoo Creek crossing at Henderson CR 3514 in Henderson County	32.313294	-95.634427	Grab	Water	12	TIAER	RT
22163	Kickapoo Creek near the crossing at Henderson CR 3520 in Henderson County	32.319250	-95.671307	Grab	Water	12	TIAER	RT

TCEQ Station ID	Site Description	Latitude	Longitude	Mode of Sampling	Sample Matrix	Annual Monitoring Freq.	Agency Responsible for Sampling	Monitor Type [1, 2]
22164	Kickapoo Creek crossing at Henderson CR 3806 in Henderson County	32.313565	-95.732693	Grab and 24-hr	Water	12	TIAER	RT
22165	Kickapoo Creek crossing at FM 1861 in Van Zandt County	32.361167	-95.805017	Grab	Water	12	TIAER	RT
22166	Kickapoo Creek crossing at CR 4206 in Van Zandt County	32.385408	-95.826422	Grab and 24-hr	Water	12	TIAER	RT
22167	Kickapoo Creek crossing at FM 858 in Van Zandt County	32.416093	-95.828130	Grab	Water	12	TIAER	RT

1 RT stands for routine monitoring.

2 RTWD stands for routine monitoring – watershed characterization.

Water Quality Characterization for Bacteria

Load Duration Curve (LDC)

The preferred approach for addressing bacteria impairments in Kickapoo Creek is the LDC method. It is a simple and an effective first-step methodology to obtain data-based TMDLs (Cleland, 2003; Stiles, 2001). While technically this is a non-modeling approach, the LDC method is often used in lieu of mechanistic models because the required resources for this approach is much less than for true models and this approach is broadly accepted by EPA and TCEQ for addressing bacterial impairments in TMDLs and WPPs.

A duration curve is a graph that illustrates the percentage of time during which a given parameter's value is equaled or exceeded. For example, a flow duration curve (FDC) (Figure A6.2) uses the average daily observed or estimated stream flows to calculate and depict the percentage of time the flows are equaled or exceeded.

A United States Geological Survey (USGS) streamflow gauge (Gauge ID: 08031200) located near Brownsboro continuously monitored streamflow data of the Kickapoo Creek from 05/01/1962 until 09/29/1989. However, the continuous monitoring was discontinued in 1989, and more recent data on daily streamflow was not available for this watershed. However, instantaneous streamflow information is available for all the nine stations, along with the water quality data. Therefore, continuous streamflow data was estimated for all the nine stations at which water quality is currently monitored, based on the Drainage-Area Ratio method (DAR).

In the Drainage-Area Ratio Method (DAR), streamflow data from source stations at which continuous flow data is available will be converted to flow per unit area (ft^3/sec of discharge/mi^2) by dividing each value of the time series with the drainage area corresponding to the source station. The flow per unit area time series from the source station will be used to estimate the flow data for the target location by simply multiplying it by the drainage area of the target location. When multiple source stations are involved to estimate flow for a single target station, appropriate weights need to be used. To estimate the streamflow of Kickapoo Creek two nearby stations with similar watershed characteristics to that of Kickapoo Creek are available. They are Neches River at Neches, TX and Sabine River at Minneola, TX.

Therefore, a combination of the two stations (with equal weights) were used to estimate continuous daily streamflow for the Kickapoo Creek watershed as a part of the recently completed Kickapoo Creek watershed characterization project. The flow data was estimated for all nine stations from January 1968 to December 2020. The estimation of flow data will be extended until December 2022 as a part of the current project.

The LDC, which is based on the FDC, shows the corresponding relationship between the contaminant loadings and streamflow exceedance conditions at the monitoring site. In this manner, it assists in determining patterns in pollutant loading (point sources, nonpoint sources, erosion, etc.) depending on the streamflow conditions. Depending on the observed patterns, specific restoration plans can be implemented that target a particular kind of pollutant source. Another main advantage of the LDC method is that it can also be used as a technical framework for more rapid development of TMDLs (EPA, 2008). For this LDC analysis, the pollutant loading will be developed for *E. Coli* as the relevant parameter of concern.

The LDC will be developed by multiplying the daily streamflow by the appropriate water quality criterion for bacteria (e.g. 126 MPN/100 mL for *E. -Coli*) and then by a conversion factor, which gives a loading in units of Most Probable Number (MPN) per day. The geometric mean criterion loading will then be plotted against the exceedance percentages. The LDC will be divided into flow-regime regions to analyze exceedance patterns in smaller portions of the duration curve. The final step in creating the LDC will be to convert existing *E. coli* data into a daily load by multiplying the data by the corresponding streamflow and the appropriate conversion factor. The existing *E. Coli* loading is then plotted against the exceedance percentage for its corresponding streamflow. An example of a typical LDC is shown in Figure A6.3.

While sometimes considered as models, FDCs and LDCs are not in the truest sense models. Further, they do not require calibration to measured data nor do they require validation to measured data, thus obviating these tasks of typical model development and coverage of these tasks by a QAPP.

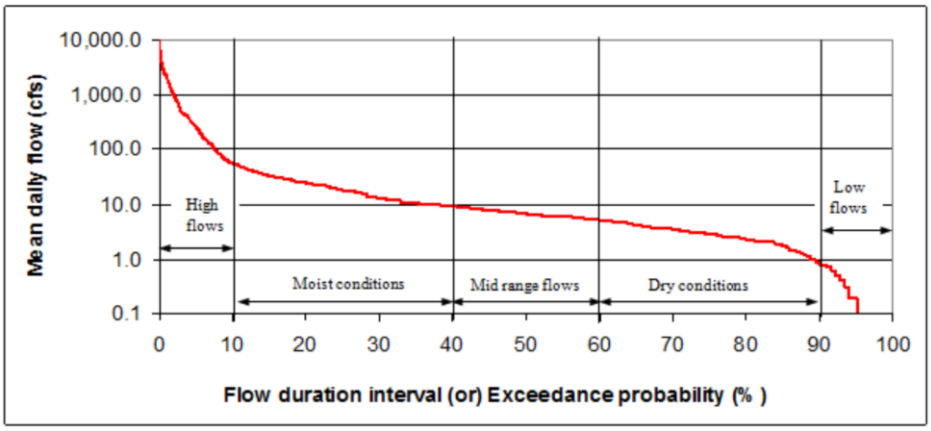


Figure A6.2. An example flow duration curve (FDC).

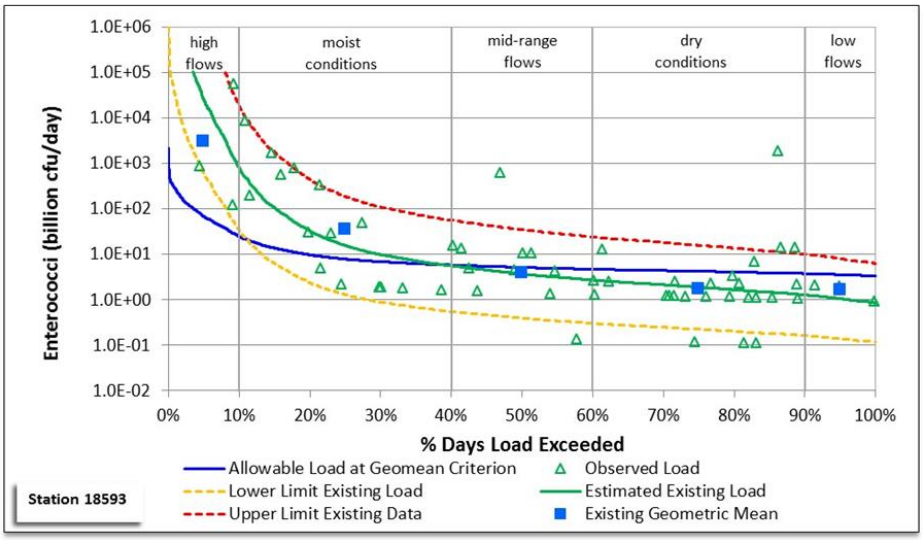


Figure A6.3. An example load duration curve (LDC) showing allowable and existing enterococci bacterial loads.

Dissolved Oxygen Assessment

TIAER will perform data analysis to determine the cause of the dissolved oxygen impairments in the Kickapoo Creek.

The data analysis will include graphical presentation, descriptive statistics, and inferential statistics. The purpose of the analysis is to enhance understanding of any significant relationships between DO as the dependent variable to various physical parameters (e.g., streamflow, water temperature, and rainfall as a surrogate to streamflow) and water quality parameters (e.g., organic matter, nutrient forms, chlorophyll-a as a measure of suspended algae) as independent variables. The results of this analysis will be used to guide the approach to be taken to address the dissolved oxygen impairments in the watershed.

The various data analyses that will be considered are briefly mentioned below, and the analyses will progress in an exploratory and sequential manner wherein, depending on findings, not all the components of the data analyses described below will be performed, if it is not necessary.

Descriptive Statistics: The initial step of the analysis will be to develop various descriptive statistics (e.g., mean, median, standard deviation) of water quality parameters commonly collected, such as, but not limited to, standard field parameters (e.g., DO, water temperature, 24-hour minimum DO, 24-hour average DO), nutrient forms (e.g., total phosphorus, total Kjeldahl nitrogen), and suspended solids.

Graphical Data Presentation: The descriptive statistics will only provide very broad information, and the graphical presentation of data will begin the more intense part of the data analysis. Scatter plots will be developed of the various dependent DO variables (e.g., 24-hour DO average, DO deficit or %DO saturation) along the y-axis against the various independent variables along the x-axis. Linear least squares regression analysis will also be part of this analysis (see Inferential Statistics). Time series plots will be developed with time along the x-axis and various variables such as the DO parameters and precipitation along the y-axis.

Inferential Statistics: Correlation analysis will be performed to determine the strength of linear relationships between all parameters (independent and dependent). The linear regression equation and coefficient of determination will be conducted as described under Graphical Data Presentation. Multiple regression analyses will be considered for the dependent DO variables using various independent variables that show some reasonable degree of correlation to the DO variables.

If the population of a variable has a non-normal distribution, a logarithmic transformation will be performed to see if that provides a normal distribution. In the event variables are strongly non-normal in their distribution, the Spearman's rank correlation (non-parametric test) will be determined instead of the Pearson's r (parametric testing) in the correlation analysis. The Spearman's rank correlation determines the strength of a monotonic relationship between two variables, whereas the Pearson's r quantifies the strength of a linear relationship.

Section A7: Quality Objectives and Criteria for Data Quality

Personnel at TIAER will conduct water quality monitoring, data analysis and water quality characterization to develop pollutant source and loading information and estimates of needed bacteria reductions and restoration of dissolved oxygen to acceptable levels. The objectives of the water quality characterization for this project are as follows:

The objectives for this project are as follows:

1) Collection of environmental data, such as wildlife densities, livestock densities, information on septic systems, wastewater, and stormwater infrastructure (if available) and water quality and flow data, to characterize causes and sources of pollution.
2) Development of LDCs to analyze the trends and patterns in the observed flow and water quality data for the watershed. The LDCs will be developed using currently existing water quality and flow data available from the TCEQ SWQMIS Database and data generated through this project.
3) Identification of the causes of depressed dissolved oxygen conditions and the required load-reductions for bacteria at different flow-rate regimes (low, medium, and high flow), using LDC and an interpolated model.

Surface Water Quality Monitoring – The goal of this section is to ensure that collected data meet the data quality objectives (DQOs) of the project. The objectives of this project are to identify the level and specific sources of bacteria entering Kickapoo Creek in Henderson County and the causes of depressed dissolved oxygen levels.

The following actions will be undertaken by this project to assess bacterial pollution and depressed DO within the Kickapoo Creek watershed in Henderson County:

- Monitor water quality to determine bacteria concentrations
- Analyze bacteria loading using LDCs
- Measure dissolved oxygen during 24-hour multiprobe deployments
- Relate DO concentrations to various measured pollutants (i.e., NH_3-N, TSS, VSS, NO_2+NO_3-N, TKN, PO_4-P, TP, BOD, and chlorophyll-a).

The measurement performance criteria to support the project objectives are specified in Table A7-1.

Consistent with the most recent version of the TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods* (TCEQ 2019), routine grab samples will be collected monthly. During routine sampling measurements of DO, conductivity, pH, water temperature, and stream flow will be obtained *in situ*. These data will be logged on field data sheets and incorporated into a computer-based database maintained by TIAER. In addition, multiprobes will be deployed at three stations (Stations 10517, 22164, and 22166) for 24-hours to determine dissolved oxygen concentrations throughout the 24-hour period.

Water samples collected by TIAER will be transported to ANRA for bacteria enumeration. TIAER will deliver bacteria water samples to ANRA within designated holding times for bacteria analysis and to the TIAER Laboratory within holding times for the other types of analyses. TIAER and ANRA laboratories will use designated methods outlined in Tables A7.1 and B2.1. Appropriate DQOs and QA/QC requirements for these analyses are also reported in Table A7.1 and Section B2.1.

Ambient Water Reporting Limits (AWRLs)
The AWRL establishes the reporting specification at or below which data for a parameter must be reported to be compared with freshwater screening criteria. The AWRLs specified in Table A7.1 are the program-defined reporting specifications for bacteria and yield data acceptable for the TCEQ's water quality assessment. A full listing of AWRLs can be found at https://www.tceq.texas.gov/assets/public/waterquality/crp/QA/awrlmaster.pdf.

The limit of quantitation (LOQ) is the minimum level, concentration, or quantity of a target analyte that can be reported with a specified degree of confidence by the laboratory analyzing the sample. Analytical results shall be reported down to the laboratory's LOQ (i.e., the laboratory's LOQ for a given parameter is its reporting limit).

Laboratory Measurement Quality Control Requirements and Acceptability Criteria are provided in Section B5.

Precision
Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. It is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions, and is an indication of random error.

Laboratory precision is assessed by comparing replicate analyses of laboratory control samples (LCS) in the sample matrix (e.g., deionized water, sand, commercially available tissue) or sample/duplicate pairs in the case of bacterial analysis. Precision results are compared against measurement performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for precision are defined in Table A7.1.

Representativeness
Site selection, the appropriate sampling regime, the sampling of all pertinent media according to TCEQ SOP, V1, and use of only approved analytical methods will assure that the measurement data represents the conditions at the site. Routine data collected for water quality assessment are considered to be spatially and temporally representative of routine water quality conditions. Water quality data are collected on a routine frequency and are separated by approximately even time intervals. At a minimum, samples are collected over at least two seasons (to include inter-seasonal variation) and over 18 months (to include inter-year variation) and include some data collected during an index period (March 15- October 15). For this project, monthly sampling will be conducted. Although data may be collected

during varying regimes of weather and flow, the data sets will not be biased toward unusual conditions of flow, runoff, or season. The goal for meeting total representation of the water body will be tempered by the potential funding for complete representativeness.

Comparability
Confidence in the comparability of routine data sets for this project and for water quality assessments is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP and in TCEQ SOP, V1. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in the Data Management Plan Section B10.

Completeness
The completeness of the data is basically a relationship of how much of the data are available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project(s) that 90% data completion is achieved.

Limit of Quantitation
AWRLs (Table A7.1) are used in this project as the *limit of quantitation specification*, so data collected under this QAPP can be compared against the Texas Surface Water Quality Standards. Laboratory *limits of quantitation* (Table A7.1) must be at or below the AWRL for each applicable parameter.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria are provided in Section B5.

Load Duration Curve
Staff at TIAER performed LDC analysis in the past and confirmed that the method can be successfully applied to estimate pollutant load reductions required in TMDLs. The basic LDC method has been applied on several WPPs and TMDLs, and TIAER will follow the procedures outlined in such sources as Cleland (2003), EPA (2007), and ODEQ (2006). The LDC developed for this project will be consistent with *An Approach for Using LDCs in the Development of TMDLs* (EPA 2007).

With regard to data representativeness, daily flow data used in development of the FDC should be representative of current conditions. Estimated flow data of the most recent 30 years will be used to represent the range of flow conditions at a station, along with the corresponding historical bacteria data.

Load Reduction Analysis

The successful development of the LDCs for monitoring stations in the Kickapoo Creek allows the approach to be used to estimate existing and allowable loadings. At the selected monitoring station locations, the LDC will be used to determine an allowable load of indicator bacteria and the plotted bacteria data will be used through regression analysis to determine an estimated existing load.

Dissolved Oxygen Assessment

The desired outcome of this data analysis is to determine if occurrences of depressed DO in Kickapoo Creek are associated with water quality related parameters, such as nutrients and organic matter that can be addressed through measures to restore water quality.

Table A7.1 Measurement Performance Specifications

PARAMETER	UNITS	MATRIX	METHOD	PARA-METER CODE	AWRL	LOQ	LOQ CHECK STD %Rec	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Lab
Field Parameters										
pH	standard units	water	SM 4500-H^+ B. and TCEQ SOP, V1	00400	NA	NA	NA	NA	NA	Field
DO	mg/L	water	SM 4500-O G. and TCEQ SOP, V1	00300	NA	NA	NA	NA	NA	Field
Specific Conductance	µS/cm	water	SM 2510 and TCEQ SOP, V1	00094	NA	NA	NA	NA	NA	Field
Temperature	ºC	water	SM 2550 and TCEQ SOP, V1	00010	NA	NA	NA	NA	NA	Field
Flow	cfs	water	TCEQ SOP, V1	00061	NA	NA	NA	NA	NA	Field
Flow estimate	cfs	water	TCEQ SOP, V1	74069	NA	NA	NA	NA	NA	Field
Days since precipitation event	days	water	TCEQ SOP V1	72053	NA	NA	NA	NA	NA	Field
Flow measurement method	1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler	water	TCEQ SOP, V1	89835	NA	NA	NA	NA	NA	Field
Flow severity	1-no flow 2-low 3-normal 4-flood 5-high 6-dry	water	TCEQ SOP, V1	01351	NA	NA	NA	NA	NA	Field
24-hr avg. water temperature	Celsius	water	TCEQ SOP V1	00209	NA	NA	NA	NA	NA	Field
24-hr max water temperature	Celsius	water	TCEQ SOP V1	00210	NA	NA	NA	NA	NA	Field
24-hr min water temperature	Celsius	water	TCEQ SOP V1	00211	NA	NA	NA	NA	NA	Field
24-hr avg. Specific Conductance	µS/cm	water	TCEQ SOP V1	00212	NA	NA	NA	NA	NA	Field
24-hr max specific conductance	µS/cm	water	TCEQ SOP V1	00213	NA	NA	NA	NA	NA	Field
24-hr min specific conductance	µS/cm	water	TCEQ SOP V1	00214	NA	NA	NA	NA	NA	Field
24-hr max pH	standard units	water	TCEQ SOP V1	00215	NA	NA	NA	NA	NA	Field
24-hr min pH	standard units	water	TCEQ SOP V1	00216	NA	NA	NA	NA	NA	Field

PARAMETER	UNITS	MATRIX	METHOD	PARA-METER CODE	AWRL	LOQ	LOQ CHECK STD %Rec	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Lab
# water temp measurements during 24-hrs.	# meas.	water	TCEQ SOP V1	00221	NA	NA	NA	NA	NA	Field
# Spec Cond measurements during 24-hrs.	# meas.	water	TCEQ SOP V1	00222	NA	NA	NA	NA	NA	Field
# pH measurements during 24-hrs.	# meas.	water	TCEQ SOP V1	00223	NA	NA	NA	NA	NA	Field
24-hr min dissolved oxygen	mg/L	water	TCEQ SOP V1	89855	NA	NA	NA	NA	NA	Field
24-hr max dissolved oxygen	mg/L	water	TCEQ SOP V1	89856	NA	NA	NA	NA	NA	Field
24-hr avg dissolved oxygen	mg/L	water	TCEQ SOP V1	89857	NA	NA	NA	NA	NA	Field
# DO measurements during 24-hrs	# meas.	water	TCEQ SOP V1	89858	NA	NA	NA	NA	NA	Field
Maximum pool width at time of study[1]	meters	other	TCEQ SOP V1	89864	NA	NA	NA	NA	NA	Field
Maximum pool depth at time of study[1]	meters	other	TCEQ SOP V1	89865	NA	NA	NA	NA	NA	Field
Pool length[1]	meters	other	TCEQ SOP V1	89869	NA	NA	NA	NA	NA	Field
% pool coverage in 500 meter reach[1]	meters	other	TCEQ SOP V1	89870	NA	NA	NA	NA	NA	Field
Conventional and Bacteriological Parameters										
TSS	mg/L	water	SM 2540 - D	00530	5	4	NA	20[3]	80-120%	TIAER
Chlorophyll-a, spectrophotometric method	µg/L	water	SM 10200 - H	32211	3	3	70-130%	20[3]	80-120%	TIAER
NH_3-N:Nitrogen, ammonia, total, (mg as N), (acidified field, lab filtered)	mg/L	water	SM 4500-NH3 G	00610	0.1	0.06	70-130%	20[3]	80-120%	TIAER
Total Kjeldahl Nitrogen	mg/L	water	SM 4500 – NH_3 G	00625	0.2	0.2	70-130%	20[3]	80-120%	TIAER
Nitrite+Nitrate-N, total	mg/L	water	SM 4500 – NO_3 F	00630	0.05	0.05	70-130%	20[3]	80-120%	TIAER
OPO_4-P: Orthophosphate phosphorus, dissolved, field filtered < 15 min	mg/L	water	SM 4500P-E	00671	0.04	0.005	70-130%	20[3]	80-120%	TIAER
OPO_4-P: Orthophosphate phosphorus, dissolved, lab filtered > 15 min	mg/L	water	SM 4500-P E	70507	0.04	0.005	70-130%	20[3]	80-120%	TIAER
Total Phosphorus	mg/L	water	EPA 365.4	00665	0.06	0.06	70-130%	20[3]	80-120%	TIAER
Volatile Suspended Solids	mg/L	water	EPA 160.4	00535	5	4	NA	20[3]	80-120%	TIAER
BOD_5	mg/L	water	SM 5210 B	00310	2	2	NA	20[3]	NA	TIAER
E. coli, IDEXX	MPN/ 100mL	water	SM 9223 B	31699	1	1	NA	0.5[2]	NA	ANRA
E.coli, IDEXX, Holding Time	hours	water	NA	31704	NA	NA	NA	NA	NA	ANRA

1 Parameters for pools to be reported only if pooled conditions are sampled as outlined under the TCEQ Interim Guidance for Routine Surface Water Quality Monitoring During Extended Drought.
2 This value represents the maximum allowable difference between the logarithm of the sample result and the logarithm of the duplicate result.

3 For method specific QC requirements, precision will be based on precision of the LCS and MS duplicate results when the RPD for environmental sample duplicates is out of control and the value of the environmental sample and/or the environmental sample duplicate is less than five times the LOQ.

References for Table A7.1:

United States Environmental Protection Agency (USEPA) "Methods for Chemical Analysis of Water and Wastes," Manual #EPA-600/4-79-020

American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF), "Standard Methods for the Examination of Water and Wastewater," Online Edition, most recent version

TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, most recent editions (RG-415)

TCEQ IGD – TCEQ's Interim Guidance for Routine Surface Water Quality Monitoring During Extended Drought. Oct. 3, 2011

Section A8: Special Training Requirements/Certification

Surface Water Quality Monitoring

Work conducted for this project is covered under and documented in this QAPP. Personnel conducting work associated with this project are deemed qualified to perform their work through educational credentials, specific job/task training, required demonstrations of competency, and internal and external assessments. Laboratories are NELAP-accredited as required. Records of educational credentials, training, demonstrations of competency, assessments, and corrective actions are retained by project management and are available for review.

Staff responsible for operating the multi-parameter sondes and flow loggers have undergone training by a qualified trainer (the equipment manufacturer, TCEQ SWQM personnel, or an experienced field sampler).

Field personnel have received training in proper sampling and field analysis. They have demonstrated to the Field Supervisor their ability to properly operate the multi-parameter sondes and retrieve the samples. Field personnel training is documented and retained in the personnel file and will be available during a monitoring systems audit.

LDC Analyses

All personnel involved in water quality characterization have the appropriate education and training required to adequately perform their duties. No special certifications are required.

Section A9: Documents and Records

The document and records that describe, specify, report, or certify activities listed are provided in Table A9.1 below.

Table A9.1 Project Documents and Records

Document/Record	Location	Retention	Form
QAPPs, amendments, and appendices	TIAER	5 years	Paper/Electronic
QAPP distribution documentation	TIAER	5 years	Paper/Electronic
Field notebooks or field data sheets	TIAER	5 years	Paper/Electronic
Field equipment calibration/maintenance logs	TIAER	5 years	Paper/Electronic
Chain of custody records	TIAER	5 years	Paper/Electronic
Field SOPs	TIAER	5 years	Paper/Electronic
Media/incubation logs	TIAER & ANRA Labs	5 years	Paper/Electronic
Laboratory sample reception logs	TIAER & ANRA Labs	5 years	Paper/Electronic
Laboratory QA manuals	TIAER & ANRA Labs	5 years	Paper/Electronic
Laboratory SOPs	TIAER & ANRA Labs	5 years	Paper/Electronic
Instrument raw data files	TIAER & ANRA Labs	5 years	Electronic
Field and Lab Instrument readings/printouts	TIAER & ANRA Labs	5 years	Paper/Electronic
Laboratory data reports	TIAER & ANRA Labs	5 years	Paper/Electronic
Laboratory equipment maintenance logs	TIAER & ANRA Labs	5 years	Paper/Electronic
Laboratory calibration records	TIAER & ANRA Labs	5 years	Electronic
TIAER corrective action documentation	TIAER	5 years	Paper/Electronic
ANRA Lab corrective action documentation	ANRA Lab	5 years	Paper/Electronic
Project data files	TIAER /TSSWCB	3 years	Electronic
Progress report/final report/data	TIAER /TSSWCB	3 years	Paper/Electronic
Field staff training records	TIAER	5 years	Paper/Electronic

Laboratory records must be retained in accordance with TNI standards (2016). The TSSWCB may elect to take possession of records at the conclusion of the specified retention period.

Laboratory Data Reports

Test/data reports from the laboratory must document the test results clearly and accurately. Routine data reports should be consistent with *TNI Volume 1 Module 2 Section 5.10* (2016) and include the information necessary for the interpretation and validation of data.

Laboratory data reports include the following:

- Sample results,
- Units of measurement,
- Sample matrix,
- Station information,
- Date and time of collection,
- Sample depth,
- Holding time for *E. coli* (if exceeded),

Electronic Data

Data will be submitted to TCEQ by TIAER in the event/result format specified in the most current version of the TCEQ Data Management Reference Guide for upload to SWQMIS. The DMRG can be found at https://www.tceq.texas.gov/waterquality/data-management/dmrg_index.html. The Data Review Checklist and Summary as contained in Appendix D of this document will be submitted with the data.

All reported Events will have a unique TagID (see DMRG). TagIDs used in this project will be seven-character alphanumeric codes with the structure of the two-letter Tag prefix followed by a five-digit number: for example – TX01234.

Submitting Entity, Collecting Entity, and Monitoring Type codes will reflect the project organization and monitoring type in accordance with the DMRG. The proper coding of Monitoring Type is essential to accurately capture any bias toward certain environmental condition (for example, high flow events), and intent of sample collection.

Table A9.2 SWQMIS Data Entry Codes*

Sample Description	Tag Prefix	Submitting Entity	Collecting Entity	Monitoring Type
Routine Monitoring	TX	TX	TA	RT
Routine Monitoring – Watershed Characterization	TX	TX	TA	RTWD

* Code descriptions are as follows:

- TX is the code for the Texas State Soil and Water Conservation Board
- TA is the code for the Texas Institute for Applied Environmental Research
- RT is the code for routine samples that are scheduled in advance without intentionally trying to target any certain environmental condition. The sample is collected regardless of the conditions encountered. Water quality monitoring data which are determined to meet spatial, temporal, and other sample collection and quality requirements necessary for 305(b)/303(d) assessment should be coded "RT". Additional details about the sampling considerations for the 305(b)/303(d) assessment are included in the *Guidance for Assessing and Reporting Surface Water Quality in Texas.*

- RTWD is the code for routine monitoring solely intended to understand the basic physical, environmental, and human elements of the watershed.

LDC Analyses- All records, including modeler's notebooks and electronic files, will be archived by TIAER for LDCs for at least five years. These records will include documentation of written rationale for selection of models, record of code verification (hand-calculation checks, comparison to other models), source of historical data, and source of new theory. Electronic data on the project computers and the network server are backed up daily to the network drive. In the event of a catastrophic systems failure, the tapes can be used to restore the data in less than one day's time. Data generated on the day of the failure may be lost but can be reproduced from raw data in most cases.

Combined Project Documentation

Quarterly progress reports disseminated to the individuals listed in section A3 will note activities conducted in connection with the water quality characterization project, items or areas identified as potential problems, and any variations or supplements to the QAPP. Final reports on the LDC analysis will be developed.

Corrective Action Reports (CARs) will be utilized when necessary (Appendix A). CARs will be maintained in an accessible location for reference at TIAER and will be disseminated to the individuals listed in section A3. CARs resulting in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in updates or amendments to the QAPP.

All electronic data are backed up routinely. The TSSWCB may elect to take possession of records at the conclusion of the specified retention period.

Data Transfer between Entities

Data transfer between entities occurs via electronic means. Specific format of the data transferred depends on the specific data and includes ArcGIS, MS Office, and PDF formats.

QAPP Revision and Amendments

Until the work described is completed, this QAPP shall be revised as necessary and reissued annually on the anniversary date or revised and reissued within 120 days of significant changes, whichever is sooner. The last approved versions of QAPPs shall remain in effect until revised versions have been fully approved; the revision must be submitted to the TSSWCB for approval before the last approved version has expired. If the entire QAPP is current, valid, and accurately reflects the project goals and the organization's policy, the annual re-issuance may be done by a certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP.

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives, and methods; address deficiencies and non-conformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests or amendments are directed from the TIAER Project Lead to the TSSWCB PM in writing. The

changes are effective immediately upon approval by the TSSWCB PM or designee. Amendments to the QAPP and the reasons for the changes will be documented, and copies of the approved QAPP Expedited Amendment form will be distributed to all individuals on the QAPP distribution list by the TIAER QAO. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process.

Section B1: Sampling Process Design (Experimental Design)

Surface Water Quality Monitoring- The sampling conducted for this project is intended to assess water quality in the Kickapoo watershed. Sampling will be conducted monthly at nine stations in the Kickapoo watershed for all constituents included in Table A7.1, except the 24-hour monitoring, which will occur at only three stations. Sampling types, frequencies and locations are described in Table A6.2. Physical parameters that will be measured *in situ* during routine sampling and include flow, specific conductance, DO, pH, and water temperature; other noted parameters will include the flow measurement method, flow severity, flow estimate, days since last significant rainfall and present weather conditions. Water quality samples collected as part of the routine sampling schedule will be analyzed for bacteria as outlined in Table A7.1.

In order to obtain representative results, ambient water sampling will occur on a routine schedule over the course of 12 months, capturing dry and runoff-influenced events at their natural frequency. There will be no prejudice against sampling during rainfall or high flow events, except that the safety of the sampling crew and equipment will not be compromised in case of lightning or flooding; this is left to the discretion of the sampling crew. It is the general goal of the project that 90% data completion is achieved.

Site Descriptions
Monitoring will be conducted at nine stations, three of which have been historically monitored by TCEQ, one established by TCEQ more recently, and five established for this project. All monitoring stations are located on Water Body 0605A. The nine stations are as follows:

Station 10517, Kickapoo Creek at FM314, is located at the crossing of Kickapoo Creek and FM 314 in Henderson County. This monitoring station is one of three that have been historically monitored by TCEQ and is located at the WWTP permit WQ0010540-001 outfall.

Station 21618, Kickapoo Creek at CR 3514, is located at the crossing of Kickapoo Creek and CR 3514 in Henderson County.

Station 22163, Kickapoo Creek at CR 3520, is located near the crossing of Kickapoo Creek and CR 3520 in Henderson County.

Station 16796, Kickapoo Creek at FM 1803, is located at the crossing of Kickapoo Creek and FM 1803 in Henderson County. This monitoring station is one of three that have been historically monitored by TCEQ.

Station 22164, Kickapoo Creek at CR 3806, is located at the crossing of Kickapoo Creek and CR 3806 in Henderson County.

Station 16797, Kickapoo Creek at FM 773, is located at the crossing of Kickapoo Creek and FM 773 in Henderson County. This monitoring station is one of three that have been historically monitored by TCEQ.

Station 22165, Kickapoo Creek at FM 1861, is located at the crossing of Kickapoo Creek and FM 1861 in Van Zandt County.

Station 22166, Kickapoo Creek at CR 4206, is located at the crossing of Kickapoo Creek and CR 4206 in Van Zandt County.

Station 22167, Kickapoo Creek at FM 858, is located at the crossing of Kickapoo Creek and FM 858 in Van Zandt County.

The monitoring stations are included in Table A6.2. Detailed site location maps are located in Section A6.

Section B2: Sampling Method Requirements / Data Collection Method

Field Sampling Procedures
Field sampling will be conducted according to procedures documented in the latest version of the SWQM Procedures, Volume 1. Additional aspects outlined below reflect specific requirements for sampling. Field sampling activities are documented on field data reporting forms presented in Appendix B.

All sampling information will be logged on field data sheets. The following will be recorded for all water sampling:

- station ID
- location
- sampling time
- date
- water depth
- flow rate
- sample collector's name/signature

Detailed observational data are recorded, including water appearance, weather, biological activity, stream uses, unusual odors, specific sample information, days since last significant rainfall, and flow severity. Perennial pool measurements will also be recorded, where applicable, with observations of maximum pool width, maximum pool depth, pool length, and percent pool coverage in 500 meter reach.

Water temperature, pH, specific conductance, and DO will be measured and recorded *in situ* with a multiprobe when samples are collected. Flow will be measured with a SonTek flow tracker or an RDI ADCP (Acoustic Doppler Current Profiler). All samples will be transported in an iced container to the laboratory for analysis. Detailed collection instructions for field data are found in TCEQ's 2016 Guidance for Assessing and Reporting Surface Water Quality in Texas. Links for instructions for the SonTek and ADCP are included in the QAPP References section.

Table B2.1. Storage, Preservation and Handling Requirements

Parameter	Matrix	Container	Field Preservation	Sample Volume	Holding Time
E. coli, IDEXX*	Water	Sterile plastic pre-treated with sodium thiosulfate	< 6°C (but not frozen);	120 ml (minimum); 250 ml (duplicates)	8 hours
Nitrite + Nitrate-Nitrogen	Water	Pre-cleaned plastic	pH<2 with H_2SO_4 within 15 minutes, Cool to >0-≤6°C	60 mL	28 days
Total Phosphorus	Water	Pre-cleaned plastic	pH<2 with H_2SO_4 within 15 minutes, Cool to >0-≤6°C	250 mL	28 days
Total Kjeldahl Nitrogen	Water	Pre-cleaned plastic	pH<2 with H_2SO_4 within 15 minutes, Cool to >0-≤6°C	250 mL	28 days
Ammonia Nitrogen	Water	Pre-cleaned plastic	pH<2 with H_2SO_4 within 15 minutes, Cool to >0-≤6°C	60 mL	28 days
Orthophosphate-P	Water	Pre-cleaned plastic	Filter within 15 minutes, cool to >0-≤6°C	50 mL	48 hours
Total Suspended Solids	Water	Pre-cleaned plastic	Cool to >0-≤6°C	1000 mL	7 days
Volatile Suspended Solids	Water	Pre-cleaned plastic	Cool to >0-≤6°C	1000 mL	7 days
Chlorophyll-a	Water	Pre-cleaned Amber plastic	Dark, cool to >0-≤6°C before filtration; dark cool to <0ºC after filtration	1000 mL 2000 mL for duplicates	Filter within 48 hours; frozen filters up to 28 days
BOD_5	Water	Pre-cleaned plastic	Cool to >0-≤6°C	1000mL	48 hours

Sample Containers

The preferred bacteriological sample containers are the 120 and 290 mL bottles from QEC or IDEXX (or equivalent). The bottles contain sufficient sodium thiosulfate to remove 10 mg/L or 15 mg/L of total chlorine, respectively. ANRA will provide sealed, sterile glass and/or plastic bottles for bacteria samples and TIAER will provide appropriate containers for the other water quality samples.

Processes to Prevent Contamination

The most recent version of the TCEQ SWQM Procedures, Volume 1 outlines the necessary steps to prevent contamination of samples. These include direct collection into sample containers, when possible.

Failures in Sampling Methods Requirements and/or Deviations from Sample Design and Corrective Action

Failures in sampling methods and/or deviations from sample design requirements include but are not limited to such things as sample container problems, sample site considerations, etc. Failures or deviations from the QAPP are documented on field data reporting forms and a Corrective Action Report is completed to document the problem. The TIAER PM, in consultation with the TIAER

QAO, will determine if the deviation compromises the validity of the resulting data. The resolution of the situation will be reported to TSSWCB in the quarterly progress report.

Section B3: Sample Handling and Custody Requirements

Chain-of-Custody (COC)
Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is a record that documents the possession of the samples from the time of collection to receipt in the laboratory. The items listed below are included on the COC form (Appendix C).

1. Date and time of sample collection and receiving
2. Site identification
3. Sample matrix
4. Number of containers
5. Preservative used
6. Analyses required
7. Name of collector
8. Custody transfer signatures and dates and time of transfer

Sample Labeling
Samples will be labeled on the container with an indelible, waterproof marker. Label information will include site identification, date, and time of sampling. The COC form will accompany all sets of sample containers when they are submitted to the laboratory.

Sample Handling
Field data sheets (Appendix B) are supplied to all field personnel prior to initiation of collection procedures. The field data sheets have spaces dedicated to recording of all pertinent field observations and water quality parameters. The field staff has the prime responsibility to ensure that all pertinent information is recorded correctly and in the proper units.

After sample collection, and sealing and proper labeling of the sample container, , water samples are placed in an insulated cooler on ice and transported to the designated lab along with appropriate COCs within prescribed holding times. Bacteria aliquots will be delivered to ANRA for processing. Once at the lab, samples and COCs are transferred to lab staff, logged into the lab, and analysis/bench sheets specific to the respective laboratory are established for each sample. Samples are placed in a refrigerated cooler dedicated to sample storage until sample processing begins. The LM has the responsibility to ensure that holding times are met with water samples.

Sample Tracking
Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is used to document sample handling during transfer from the field to the laboratory and among contractors. The following information concerning the sample is recorded on the COC form (See Appendix C):

- Date and time of collection
- Site identification
- Sample matrix
- Number of containers
- Preservative used
- Whether the sample was filtered
- Analyses required
- Name of collector
- Custody transfer signatures and dates and time of transfer
- Bill of lading (*if applicable*)

Sample Tracking Procedure Deficiencies and Corrective Action
All failures associated with chain-of-custody procedures as described in this QAPP are immediately reported to the TIAER PM. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc. The TIAER PM, in consultation with the TIAER QAO, will determine if the procedural violation may have compromised the validity of the resulting data. Any failures that have reasonable potential to compromise data validity will invalidate data, and the sampling event should be repeated. The resolution of the situation will be reported to the TSSWCB PM in the project progress report. CARs will be prepared by the TIAER QAO and submitted to the TSSWCB PM along with project progress reports.

Section B4: Analytical Methods

Surface Water Quality Monitoring - The analytical methods are listed in Table A7.1 of Section A7. Laboratories must be accredited in accordance with NELAP requirements for the matrix, method, parameter combinations listed in Table A7.1 of the QAPP. Procedures for laboratory analysis will be in accordance with the most recently published or online edition of *Standard Methods for the Examination of Water and Wastewater*, the latest version of the TCEQ SWQM Procedures, Volume 1 or other procedures acceptable to TCEQ.

Laboratories that produce analytical data under this QAPP must be NELAP accredited. Copies of laboratory quality manuals (QMs) and SOPs are available for review by the TCEQ.

Standards Traceability
All standards used in the field and laboratory are traceable to certified reference materials. Standards and reagent preparation is fully documented and maintained in a standards log book. Each documentation includes information concerning the standard or reagent identification, starting materials, including concentration, amount used and lot number; date prepared, expiration date and preparer's initials/signature. The bottle is labeled in a way that will trace the standard or reagent back to preparation. Standards or reagents used are documented each day samples are prepared or analyzed.

Analytical Method Deficiencies and Corrective Actions
Deficiencies in field and laboratory measurement systems involve, but are not limited to such things as instrument malfunctions, failures in calibration, blank contamination, quality control samples outside QAPP defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst, then they will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to Field Supervisor or Laboratory Manager, who will make the determination and document the problem on a Corrective Action Report. If the analytical system failure may compromise the sample results, the affected data will not be reported to the TCEQ SWQMIS database. The nature and disposition of the problem is reported on the report included with the data submission. The TIAER PM/QAO will include this information in the CAR and submit it with the QPR, which is sent to the TSSWCB PM.

The definition of and process for handling deficiencies and deficiencies, non-conformances, and corrective action are defined in Section C1.

The TCEQ has determined that analyses associated with the qualifier codes (e.g. "holding time exceedance", "sample received unpreserved", "estimated value", etc.) may have unacceptable measurement uncertainty associated with them. Therefore, data with these types of problems will not be reported to the TSSWCB. Additionally, any data collected or analyzed by means other than those stated in the QAPP must have an appropriate data qualifier assigned which can be found in the most recent version of the SWQM DMRG.

Section B5: Quality Control Requirements

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

Batch
A batch is defined as environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAP-defined matrix, meeting the above

mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 25 hours. An **analytical batch** is composed of prepared environmental samples (extract, digestate. or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Method Specific QC requirements
QC samples, other than those specified later this section, are run (e.g., sample duplicates, surrogates, internal standards, continuing calibration samples, interference check samples, positive control, negative control, and media blank) as specified in the methods. The requirements for these samples, their acceptance criteria or instructions for establishing criteria, and corrective actions are method-specific.

Detailed laboratory QC requirements and corrective action procedures are contained within the individual laboratory QMs. The minimum requirements that all participants abide by are stated below.

Limit of Quantitation (LOQ)
The laboratory will analyze a calibration standard (if applicable) at the LOQ listed in Table A7.1 on each day calibrations are performed. In addition, an LOQ check sample will be analyzed with each analytical batch. Calibrations, including the standard at the LOQ, will meet the calibration requirements of the analytical method or corrective action will be implemented.

Laboratory Duplicates
A laboratory duplicate is prepared by taking an aliquot of a sample from the same container under laboratory conditions and processing and analyzing it independently from the original aliquot. For most parameters except bacteria, precision is evaluated using the relative percent difference (RPD) between duplicate LCS results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X_1 and X_2, the RPD is calculated from the following equation:

$$RPD = \frac{|X_1 - X_2|}{\left(\frac{X_1 + X_2}{2}\right)} \times 100$$

For bacteriological parameters, precision is evaluated using the results from laboratory duplicates. Bacteriological duplicates are collected on a 10% frequency (or once per sampling run, whichever is more frequent). These duplicates will be collected in sufficient volume (200 mL or more) for analysis of the sample and its laboratory duplicate from the same container. The base-10 logarithms of the result from the original sample and the result from its duplicate will be calculated. The absolute value of the difference between the two logarithms will be calculated.
If the difference in logarithms is greater than 0.5, the data are not acceptable for use under this project and will not be reported to TCEQ. Results from all samples associated with that failed

bacteria duplicate (usually a maximum of 10 samples) will be considered to have excessive analytical variability and will be qualified as not meeting project QC requirements.

The precision criterion in Table A7.1 for bacteriological duplicates applies only to samples with concentrations > 10 MPN/100mL. The precision criteria for the other analytes analyzed as part of this project are also included in Table A7.1.

Matrix Spike (MS)
Matrix spikes are prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.

Matrix spikes indicate the effect of the sample on the precision and accuracy of the results generated using the selected method. The frequency of matrix spikes is specified by the analytical method, or a minimum of one per preparation batch, whichever is greater. To the extent possible, matrix spikes prepared and analyzed over the course of the project should be performed on samples from different sites.

The components to be spiked shall be as specified by the mandated analytical method. The results from matrix spikes are primarily designed to assess the validity of analytical results in a given matrix, and are expressed as percent recovery (%R).

The percent recovery of the matrix spike is calculated using the following equation, where %R is percent recovery, S_{SR} is the concentration measured in the matrix spike, S_R is the concentration in the unspiked sample, and S_A is the concentration of analyte that was added:

$$\%R = \frac{S_{SR} - S_R}{S_A} \times 100$$

Matrix spike recoveries are compared to the same acceptance criteria established for the associated LCS recoveries, rather than the matrix spike recoveries published in the mandated test method. The EPA 1993 methods (i.e. ammonia-nitrogen, ion chromatography, TKN) that establish matrix spike recovery acceptance criteria are based on recoveries from drinking water that has very low interferences and variability. If the matrix spike results are outside laboratory-established criteria, there will be a review of all other associated quality control data in that batch. If all other quality control data in the associated batch passes, it will be the decision of the TIAER QAO and TIAER PM to report the data for the analyte that failed in the parent sample to TCEQ or to determine that the result from the parent sample associated with that failed matrix spike is considered to have excessive analytical variability and does not meet project QC requirements.

Method Blank

A method blank is a sample of matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. The method blanks are performed at a rate of once per preparation batch. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the LOQ. For very high-level analyses, the blank value should be less than 5% of the lowest value of the batch, or corrective action should be implemented. Samples associated with a contaminated blank shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action must be documented.

The method blank shall be analyzed at a minimum of once per preparation batch. In instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Quality Control or Acceptability Requirement Deficiencies and Corrective Actions

Sampling QC excursions are evaluated by the TIAER PM, in consultation with the TIAER QAO. QC excursions in bacterial analysis at ANRA will be reported to the TIAER PM and QAO, with sufficient detail to allow the TIAER PM and QAO to evaluate the results. In that differences in sample results are used to assess the entire sampling process, including environmental variability, the rejection of results based on pre-determined limits may not be necessary for project purposes. Therefore, the professional judgment of the TIAER PM and QAO will be relied upon in evaluating results.

Laboratory measurement quality control failures are evaluated by the laboratory staff. The disposition of such failures and the nature and disposition of the problem is reported to the QAO and the TIAER PM. If applicable, the TIAER PM will include this information in the CAR and submit with the Progress Report which is sent to the TSSWCB PM.

The definition of and process for handling deficiencies, nonconformance, and corrective action are defined in Section C1.

Failures in Quality Control and Corrective Action
Notations of blank contamination will be noted in QPRs and the final report. Corrective action will involve identification of the possible cause (where possible) of the contamination failure. Any failure that has potential to compromise data validity will invalidate data, and the sampling event should be repeated. The resolution of the situation will be discussed with PM and QAO. The TIAER PM and QAO will include this information in the CAR and submit with the Progress Report which is sent to the TSSWCB PM.

Sampling Quality Control Requirements and Acceptability Criteria

Minimum Field QC Requirements are outlined in the TCEQ *SWQM Procedures, Volume 1 (2012).*

Section B6: Equipment Testing, Inspection, & Maintenance Requirements

All sampling equipment testing and maintenance requirements are detailed in the most recent version of the TCEQ SWQM Procedures, Volume 1. Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained. All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory QM(s).

LDC Analyses- Applicability of LDC to analyses similar to this study is already proven. No additional testing is required.

Section B7: Instrument Calibration and Frequency

In-stream field equipment calibration requirements are contained in the most recent version of the TCEQ SWQM Procedures, Volume 1 or manufacturer's manuals. Equipment will be tested, maintained, inspected, and calibrated according to these procedures. Post calibration error limits and the disposition resulting from error are adhered to. Data not meeting post-error limit requirements invalidates associated data collected subsequent to the pre-calibration and are not submitted to the TCEQ.

Detailed laboratory calibrations are contained within the laboratory QM, SOPs, and manufacturer's manuals, as appropriate, and will be tested, maintained, inspected, and calibrated according to these procedures.

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Section B8: Inspection/Acceptance Requirements for Supplies and Consumables

New batches of supplies are tested before use to verify that they function properly and are not contaminated. The Laboratory Manager provides additional details on acceptance requirements for laboratory supplies and consumables.

Section B9: Data Acquisition Requirements (Non-direct Measurements)

Water quality data available in TCEQ's SWQMIS will be used as historical references for instream water quality and conditions. US Geological Survey (USGS) flow data available in the watershed may also be useful for evaluating instream conditions. Precipitation data collected by the National Weather Service (NWS) or National Climatic Data Center (NCDC) will be downloaded from the respective websites. These data will support the development of trend analysis during the waterbody assessment. These are the only water quality data collected outside this project that will be utilized.

Table B9.1. Monitoring Data Sources for Acquired Data

Data Type	Monitoring Project/Program	Collecting Entity	Dates of Collection	QA Information	Data Use(s)
Water Quality Data	TCEQ SWQM Program	TCEQ	9/1/1990 - Current at stations historically monitored by TCEQ in Table A6.2	TCEQ SWQM QAPP; SWQMIS database	summary statistics, trend analysis
Continuous Flow Data	United States Geological Survey (USGS) flow data	USGS	Will be estimated for the period of record required	USGS QAPP; USGA database	Flow measurements
Precipitation Data	National Weather Service (NWS) / National Climatic Data Center (NCDC)	NWS NCDC-NOAA	Most up-to-date precipitation data will be downloaded from the NWS website	NWS or NCDC-NOAA Website	Days since last precipitation

Any non-direct measurements used for analysis of historical water quality assessments will comply with all requirements under this QAPP. However, data collected by the above organizations that meet the data quality objectives of this project will be useful in satisfying the data and informational needs of the project. The collection and qualification of the TCEQ, USGS, and NWS data are addressed in the TCEQ Surface Water Quality Monitoring QAPP. Parameters utilized will include instantaneous stream flow, temperature, pH, specific conductivity, DO, and *E. coli* as available. Potential sources from which data will be acquired are included in Table B9.1. No limitations will be placed on these data as they have been vetted by the TCEQ SWQM Data Management and Assessment Team and were collected under a TCEQ approved QAPP.

Only data collected directly under this QAPP will be submitted to the TCEQ for storage in SWQMIS. This project will not submit any acquired or non-direct measurement data to SWQMIS that has been or is going to be collected under another QAPP. All data collected under this QAPP and any acquired or non-direct measurements will comply with all requirements/guidance of the project.

LDC Analyses- Water quality data collected by TCEQ, specifically *E. coli* and flow, will be used to conduct the LDC (*E. coli*) analyses.

All data used in the analysis procedures for this project are collected in accordance with approved quality assurance measures under TCEQ, Texas Water Development Board, USDA, National Weather Service, National Climatic Data Center (NCDC), or U.S. Geologic Survey (USGS).

GIS Inventory

Geospatial data available from various local, regional, state, and federal organizations may be used for cartographic purposes. Maps developed for reports will be for illustrative purposes. Geospatial data utilized in maps of the study area may include land cover, soil types, ecoregions, TCEQ monitoring locations, TCEQ permitted outfalls, city/county/state boundaries, stream networks, reservoirs, roads, watersheds, municipal separate storm sewer systems, urbanized areas, basin, railroads, recreational areas, area landmarks, aerial photography, and park information. The above data come from the following reliable sources: USGS, TNRIS, TCEQ, TXDOT, TSSWCB, TWDB, and US Census Bureau. Geospatial data from these sources are accepted for use in this project's maps, based on the reputability of these data sources and the fact that there are no known comparable sources for these data. Geospatial data sources will be cited in reports.

Other data that are compiled and published by other entities may also be used in preparing project reports. This may include long-term precipitation, census, ecoregion, land use and land cover, historic water quality and stream flow data. Sources of these data are the USGS, National Weather Service, US Census Bureau, USDA NRCS, TCEQ, and TPWD. Data collected by these entities are assumed to have been verified and validated according to the requirements of the respective programs. Data compilations created for this project will be visually screened for errors. Data will be cited in reports.

Table B9.2 lists the type of measurement, data, units, source, QA documentation use and data range of each acquired data set where applicable.

Because most historical data are of known and acceptable quality and were collected and analyzed in a manner comparable and consistent with needs for this project, no limitations will be placed on their use, except where known deviations have occurred.

Table B9.2. Non-Direct Data Types and Data Sources for the Waterbodies in Kickapoo Creek Watershed

Commented [EM1]: Wow, Leah. This is an impressive set of data sources. (I'm glad I won't have to read them all!)

Type of Measurement or Analysis	Type of Data (time series, rate, constant, statistic, taxa, etc.)	Units	Source (weblink when available)	Quality Assurance Documentation	Use	Date Range
Streamflow	Time series, daily streamflow	Average daily (cfs)	Derived as part of the recently completed Kickapoo Creek characterization project	Validation of the derived streamflow data was carried out with previously monitored flow data from USGS.	FDCs	All data available
E. coli, specific conductance, nitrate, phosphorous, DO, instantaneous flow	Concentration at various points in time	CFU or MPN/100mLfor bacteria; µmhos/cm for spec. cond; ppm for nutrients; mg/L for DO, cfs for flow	TCEQ SWQMIS http://www.tceq.texas.gov/waterquality/data-management/wdma_forms.html	Data requested will include only data that meet quality assurance/quality control (QA/QC) requirements as outlined under the SWQM Data Management Reference Guide.	LDCs, Analysis of trends and patterns in data	most recent 7 years; or 10 years if insufficient data exists
TCEQ Surface Water Quality Monitoring Stations	Spatial data, location of active and historical SWQM stations	Shapefile - Points	https://tceq.maps.arcgis.com/apps/webappviewer/index.html?id=b0ab6bac411a49189106064b70bbe778	Data Management Reference Guide (DMRG) for Surface Water Quality Monitoring http://www.tceq.texas.gov/waterquality/data-management/dmrg_index.html	Map development. Analyze data and obtain insights on addition of new stations	N/A
TCEQ Segments	Spatial data, official TCEQ Segments	Shapefile - Polylines	TCEQ Surface Water Quality Viewer https://tceq.maps.arcgis.com/apps/webappviewer/index.html?id=b0ab6bac411a49189106064b70bbe778	TCEQ 2010 Stream Segments Metadata https://www.tceq.texas.gov/assets/public/gis/docs/segments_userguide.pdf	Map development and obtain insights	N/A
County Boundaries	Spatial data, StratMap Boundaries	Shapefile - Polygons	TNRIS Data Search & Download http://www.tnris.org/	Metadata available with download	Map development	N/A
Watershed topography	Spatial GIS data, Digital Elevation Models (DEMs)	Raster- 10 meter resolution	National Elevation Data set from USGS National Map Viewer https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/	Digital Elevation Model Technologies and Applications: The DEM Users Manual 2nd Edition	Delineation of watershed and subwatershed boundaries for maps	N/A

Type of Measurement or Analysis	Type of Data (time series, rate, constant, statistic, taxa, etc.)	Units	Source (weblink when available)	Quality Assurance Documentation	Use	Date Range
Land Use/Land Cover#	National Land Cover Data set – GIS raster data set	Raster – 30 m resolution	National Land Cover Database 2016 (NLCD2016) from MRLC Consortium Viewer https://www.mrlc.gov/data	Jin, Suming, Homer, Collin, Yang, Limin, Danielson, Patrick, Dewitz, Jon, Li, Congcong, Zhu, Z., Xian, George, Howard, Danny, Overall methodology design for the United States National Land Cover Database 2016 products: Remote Sensing, v. 11, no. 24, at https://doi.org/10.3390/rs11242971	Map development	Based on the most recent Landsat imagery and ancillary data
Soil Map Unit Boundaries and Properties	Spatial GIS data, Soils	Shapefile - polygons	NRCS SSURGO databases via Web Soil Survey http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm or Geospatial Data Gateway http://datagateway.nrcs.usda.gov/	SSURGO/STATSGO2 Structural Metadata and Documentation http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053631	Map development	various
Sanitary Sewer Overflows (SSOs)	Individual events	Location and amount (gallons)	TCEQ Regions 12 & 14 Excel database provided upon request by regional staff	Data entry based on reported occurrences, Level of QA unknown	Quantify reported SSOs	2000-2013
Municipal & Industrial WWTF Discharge Monitoring Reports	Self-reporting monthly discharge and concentration data	Concentration of bacteria (MPN/100mL or CFU/100mL), flow (MGD)	USEPA Enforcement & Compliance History Online (ECHO) website https://echo.epa.gov/or directly from permitted facilities	Reporting data based on permit requirements	Source analysis; FDCs/LDCs	2000 - present for presently active permits
General permits involving regulation of stormwater	Regulated entities	N/A	TCEQ Information Resources Division Central Registry https://www.tceq.texas.gov/permitting/central_registry	None accessible; TCEQ databases	Determination of regulated stormwater for TMDL development	2000 - present
Water Rights Diversion Points	Spatial GIS and Tabular Data	N/A	TCEQ https://www.tceq.texas.gov/permitting/water_rights/wr-permitting/wrwud	None accessible; TCEQ databases	Understanding uses of surface water in the watershed	2013
Urbanized Areas	Spatial GIS	Shapefile - polygons	U.S. Census Bureau TIGER/Line® Shapefiles http://www.census.gov/cgi-bin/geo/shapefiles2010/main and information from municipalities	Urban-Rural Classification Program http://www.census.gov/geo/reference/urban-rural.html	Map development; define regulated stormwater	2010

Type of Measurement or Analysis	Type of Data (time series, rate, constant, statistic, taxa, etc.)	Units	Source (weblink when available)	Quality Assurance Documentation	Use	Date Range
Population	Spatial GIS and tabular data	2010 Census blocks, Shapefile – polygons	US Census Bureau, 2010 TIGER/Line® Shapefiles download interface http://www.census.gov/cgi-bin/geo/shapefiles2010/main; Tabular data from US Census Bureau, American Fact Finder https://data.census.gov/cedsci/	Metadata available with download	Map and source development	2010
Building locations	Spatial GIS, point data	Shapefile - points	Brazos Valley and Heart of Texas Councils of Government 911 address shapefiles	Programmatic	Map and source development, OSSF estimations	N/A
Hydrography	Vector GIS data	Geodatabase – points, polylines, polygons	National Hydrography Data (NHD) set Pre-staged Subregions http://nhd.usgs.gov/data.html	NHD Program Documentation http://nhd.usgs.gov/program_documentation.html	Map development	N/A
Livestock population estimates	County-level livestock density	County level individual animals	USDA Census of Agriculture http://www.agcensus.usda.gov/	Regulations Guiding NASS http://www.agcensus.usda.gov/About_the_Census/Regulations_Guiding_NASS/index.php	Map and pollutant source identification	2002-2012 (when available)
Deer	Spatial wildlife density	Density (animal per unit area)	Texas Parks & Wildlife Department surveys and/or information from biologists	Jester & Dillard (undated)	Pollutant Source identification	N/A
Cats and dogs	Spatial, pet density	number per household	AVMA 2002 U.S. Pet Ownership data and stakeholder input	American Veterinary Medical Association [AVMA]. 2002. U.S. Pet Ownership and Demographics Source Book.Schaumberg (Illinois): Center for Information Management, American Veterinary Medical Association.	Pollutant source identification	N/A
Feral hogs	Spatial feral animal density	Feral hog density (animals per unit area)	TIAER, https://agrilifeextension.tamu.edu/solutions/feral-hogs/ TPWD, literature values and stakeholder input	Mellish et al. 2013.	Pollutant source identification	N/A

Type of Measurement or Analysis	Type of Data (time series, rate, constant, statistic, taxa, etc.)	Units	Source (weblink when available)	Quality Assurance Documentation	Use	Date Range
Water and sewer service areas	Spatial GIS data	Shapefile - polygons	TCEQ GIS Regulatory/ Administrative Boundaries, Water & Sewer Certificates of Convenience and Necessity Service Areas, https://www.puc.texas.gov/industry/water/utilities/gis.aspx	None accessible; PUC databases	Map and Pollutant source identification	Present
State Water Plan Population projections	Tabular data, organized by Region, includes Census 2010 data and population projections for 2020 - 2070	Water User Group (WUG)	TWDB Water Planning, 2017 State Water Plan Projections Data, DRAFT https://www.twdb.texas.gov/waterplanning/data/projections/2017/popproj.asp	Projection Methodology – Draft Population and Municipal Water Demands, http://www.twdb.texas.gov/waterplanning/data/projections/methodology/doc/2017methodology.pdf?d=7281.700000021374	Map and Pollutant source identification, LDC	2010 -2070
Air temperature and precipitation	Daily time series and monthly and annual normal values	Air Temperature (ºC or ºF), Precipitation (mm or inches)	National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) http://www.ncdc.noaa.gov/cdo-web/	NOAA Information Quality Guidelines, http://www.cio.noaa.gov/services_programs/info_quality.html	Summarize past and current weather conditions for reports	1972 - 2012
Average annual air temperature and precipitation	Spatial GIS data	Raster – 800 m resolution	PRISM Climate Group, Oregon State University, 30-arcsec NORMALS http://www.prism.oregonstate.edu/	PRISM Climate Group, Documentation FGDC Metadata http://prism.oregonstate.edu/documents/PRISM_datasets.pdf	Map development	1981 -2010

The most recent version of land cover map NLCD 2016 will be used in this project.

Section B10: Data Management

Data Management Process
Samples are collected by field staff and delivered to the laboratory for analyses as described in Sections B1 and B2. Sampling information (e.g., site location, date, time, sampling depth) is used to generate a unique sample number in the TIAER LIMS database. Measurement results from the field data sheets are manually entered by field personnel into a TIAER spreadsheet for their corresponding event. Data generated by the lab are entered onto the lab data sheets which are then transferred to the TIAER database. Following data verification and validation by the TIAER Data Manager, the data are exported from the TIAER database and spreadsheets, then formatted into the pipe-delimited Event/Result format required for submission to TCEQ's SWQMIS (as described in the SWQM DMRG July 2019 or later version). Once TCEQ approval of the data is obtained, the data are loaded into SWQMIS by TCEQ data managers. Data submittals will be made quarterly.

TIAER Personnel
Leah Taylor is the TIAER Project Lead and PM, and will provide overall management for TIAER. She is responsible for ensuring that the data are managed according to the data management plan and QAPP.

Nancy Easterling is the TIAER QAO and Data Manager. She is responsible for ensuring that data generated for the project are scientifically valid, legally defensible, of known precision, accuracy and integrity, meet the data quality objectives of the project, and are reportable to TSSWCB. She is also responsible for submitting water quality data in appropriate SWQMIS format to TSSWCB.

Jeff Stroebel is the TIAER Field Supervisor and is responsible for ensuring the use of appropriate data collection techniques in the field, proper documentation on field data sheets and the timely delivery of samples to the appropriate lab.

James Hunter is the TIAER Lab Manager and is responsible for generating analytical data for the project.

Dr. Michael Machen is the TIAER Lab QAO and is responsible for maintaining the quality assurance manual for laboratory operations and ensuring that operating procedures are in compliance with the QAPP. Dr. Machen is also responsible for the data analysis and the characterization of Kickapoo Creek for water quality, development of Load Duration Curves (LDCs) for bacteria, and DO analysis.

Hardware and Software Requirements
Hardware configurations are sufficient to run Microsoft Office 2016 or newer under the Windows 10 or newer operating system in a networked environment. Tarleton State University Information Technology (IT) staff are responsible for assuring hardware configurations meet the requirements for running current and future data

management/database software as well as providing technical support. Software development and database administration are also the responsibility of the IT department.

The types of TIAER computer equipment, hardware, and software to be used on the project are provided below. LDC data for this project will be submitted to TSSWCB using Excel workbooks, Word documents, and GIS files in formats compatible with systems and equipment used in both TSSWCB and TIAER.

Table B10.1. Project Hardware and Software

Equipment & software name	Type	Number	Specification	Use
Dell or Lenovo PC Computers	Hardware	2	P4, CPU 3.2 GHz, 2 GB Ram, Windows 7 professional or higher	Support data gathering, data analysis, and report generation.
HP Proliant DL 180 G6 Server	Hardware	1	Intel Xeon CPU 3.0GHz,1GB RAM Windows Server	Primary Server
HP Proliant DL 180 G6 Server	Hardware	1	Intel Xeon CPU 3.0GHz,1GB RAM Windows Server	Secondary Server
ArcGIS Pro 2.4 or higher	Software	1	Window interface	Development of maps and spatial analyses
IBM SPSS 21 or higher	Software	1	Window interface	Creation of historical bacteria database; statistical tests on seasonality
Microsoft Office 2016 Software (Excel, Word, PowerPoint)	Software	3	Windows platform	Data preparation, report writing, presentations

Data Handling

Data are processed using the Microsoft Office 2016 or newer suite of tools and applications. Data integrity is maintained by the implementation of password protections which control access to the database and by limiting update rights to a select user group. No data from external sources are maintained in the database. The database administrator is responsible for assigning user rights and assuring database integrity.

Data Dictionary
Terminology and field descriptions are included in the most recent version of the *SWQM Data Management Reference Guide*. For the purposes of verifying which entity codes are included in this QAPP, the following will be used when submitting data under this QAPP:

Tag Prefix: TX - Texas State Soil and Water Conservation Board

Submitting Entity: TX - Texas State Soil and Water Conservation Board

Collecting Entity: TA - Texas Institute for Applied Environmental Research

Data Errors and Loss
To prevent loss of data and minimize errors, all data generated under this project are verified against the appropriate quality assurance checks as defined in the QAPP, including but not limited to chain of custody procedures, field sampling documentation, laboratory analysis results, and quality control data.

Automated and manual data reviews are performed prior to data transmittal to TSSWCB. Examples of checks that are used to review for data errors and data loss include:

- Parameter codes are contained in the QAPP
- Sites are either in the QAPP Coordinated Monitoring Schedule or requests for TCEQ Station IDs have been submitted to TCEQ
- Transcription or input errors
- Count of reported analytes (ex: # pH = # DO = # Temperature)
- Significant figures, as specified by SWQMIS
- Values are at or above the LOQs, or are submitted as "< LOQ".
- Values are below the highest standard of the calibration curve, and appropriate dilutions (if necessary) have been used
- Outliers are are not included with the submitted data
- Use of correct reporting units
- Flows should have a flow method associated with the data
- If flow severity = 1, then flow = 0
- If flow severity = 6, then no value is reported for flow
- Depth of surface sample is reported
- Data not meeting post-calibration requirements are not submitted
- Missing values are explained in the Data Summary

Data exceeding holding times, improperly preserved samples, and estimated concentrations have unacceptable measurement uncertainty associated with them. This uncertainty will immediately disqualify data for submittal to SWQMIS. Therefore, data with these types of issues are not reported to TSSWCB or TCEQ and will be noted in the Data Summary Report.

All data are uploaded to the SWQMIS User Acceptance Test environment, and a validator report is generated. The validator report is reviewed and any issues are corrected prior to the data being transmitted to TSSWCB or TCEQ.

Archives/Data Retention
Complete original data sets are archived on electronic media and retained on-site by TIAER for a retention period specified in section A9.

Record-keeping and Data Storage
TIAER record keeping and document control procedures are contained in the water quality sampling SOPs. An approach for using load duration curves in the development of TMDLs is provided in EPA 841-B-07-006, Washington DC, and this QAPP. Original field and laboratory data sheets are stored in the TIAER offices in accordance with the record-retention schedule in Section A9. Electronic copies of the data sheets are also maintained on network servers, external drives and personal computers. The database is backed up following each data entry event on network servers, external drives and personal computers. If necessary, disaster recovery will be accomplished by information resources staff using the backup database.

Data Verification/Validation
The control mechanisms for detecting and correcting errors and for preventing loss of data during data reduction, data reporting, and data entry are contained in Sections D1, D2, and D3.

Forms and Checklists
See Appendix B for the Field Data Reporting Form.
See Appendix C for the Chain-of-Custody Form
See Appendix D for the Data Review Checklist and Summary.

Data Dissemination
At the conclusion of the project, the TIAER Project Manager will provide a copy of the complete project electronically via recordable media to the TSSWCB PM, along with the final report. Summaries of the data will be presented in the final project report.

Section C1: Assessments and Response Actions

The following table presents types of assessments and response actions for data collection and analysis activities applicable to the QAPP and all facets of the project.

Table C1.1. Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	TIAER	Monitor project status and records to ensure requirements are being fulfilled. Monitoring & review performance & data quality	Report to TSSWCB in QPR.
Equipment testing	As needed	TIAER	Pass/Fail equipment testing	Repair or replace
Data completeness	As needed	TIAER	Assess samples analyzed vs. planned analysis	Reanalyze data or amend objectives
Laboratory Inspections	TBD by TSSWCB	TSSWCB	Analytical and QC procedures in the laboratory	45 days to respond to TSSWCB with corrective actions
Technical Systems Audit	As needed	TSSWCB	Assess compliance with QAPP; review facility and data management as they relate to the project	45 days to respond to TSSWCB with corrective actions
Monitoring Systems Audit	Once per life of project	TSSWCB	Assess compliance with QAPP; review field sampling and data management as they relate to the project	45 days to respond to TSSWCB with corrective actions

In-house reviews of data quality and staff performance to assure that work is being performed in compliance with the QAPP will be conducted by all entities. If reviews show that the work is not being performed according to standards, immediate corrective action will be implemented. CARs will be submitted to TSSWCB and documented in the project QPRs.

The TSSWCB QAO (or designee) will conduct an audit of the field or technical systems activities for this project as needed. Each entity will have the responsibility for initiating and implementing response actions associated with findings identified during the on-site audit. Once the response actions have been implemented, the TSSWCB QAO (or designee) may perform a follow-up audit to verify and document that the response actions were implemented effectively. Records of audit findings and corrective actions are maintained by the TSSWCB PM and TIAER QAO. Corrective action documentation will be submitted to the TSSWCB PM with the progress report. If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in agreements or contracts between participating organizations.

Corrective Action Process for Deficiencies
Deficiencies are any deviation from the QAPP, TCEQ SWQM Procedures, DMRG, or lab QMs or SOPs. Deficiencies may invalidate resulting data and may require corrective action. Corrective action may require for samples to be discarded and re-collected. Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff. It is the responsibility of the TIAER Project Manager, in consultation with the TIAER Project QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the TSSWCB PM with an email or telephone conversation and also in the project progress reports and by completion of a CAR. All deficiencies identified by each entity will trigger a corrective action plan.

Corrective Action
Corrective Action Reports (CARs) should:

- Identify the problem, nonconformity, or undesirable situation
- Identify immediate remedial actions if possible
- Identify the underlying cause(s) of the problem
- Identify whether the problem is likely to recur, or occur in other areas
- Evaluate the need for Corrective Action
- Use problem-solving techniques to verify causes, determine solutions, and develop an action plan
- Identify personnel responsible for action
- Establish timelines and provide a schedule
- Document the corrective action
- Evaluate the need for qualification or exclusion of data

The status of CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TSSWCB immediately.

The Project Managers for TIAER and ANRA are responsible for implementing and tracking corrective actions. Records of audit findings and corrective actions are maintained by the Project Managers of each entity. Audit reports and corrective action documentation will be submitted to the TSSWCB with the Progress Report.

Load Duration Curves (LDCs)
In addition to those listed above, the following assessment and response actions will be applied to LDCs. As described in Section B9 (Non-direct Measurements), TIAER staff will evaluate data to be used for LDC assessments according to criteria discussed in Section A7 (Quality Objectives and Criteria for Data Quality) and will follow-up with the various data sources on any concerns that may arise.

Corrective action is required to ensure that conditions adverse to quality data are identified promptly and corrected as soon as possible. Corrective actions include identification of root causes of problems and successful correction of identified problem and will be documented utilizing CARs. CARs (Appendix A) will be completed to document the problems and the remedial action taken. Copies of CARs will be included in QPRs and will discuss any problems encountered and their solutions. These CARs are the responsibility of the QAO and the PM and will be disseminated to individuals listed in section A3.

Section C2: Reports to Management

Quarterly progress reports will note activities conducted in connection with the project, items or areas identified as potential problems, and any variations or supplements to the QAPP. CAR forms will be utilized when necessary (Appendix A). CARs will be maintained in an accessible location for reference by all project personnel and at TIAER and disseminated to individuals listed in section A3. CARs that result in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in an update or amendment to the QAPP.

If the procedures and guidelines established in this QAPP are not successful, corrective action is required to ensure that conditions adverse to quality data are identified promptly and corrected as soon as possible. Corrective actions include identification of root causes of problems and successful correction of identified problem. CARs will be filled out to document the problems and the remedial action taken. Copies of CARs will be included with the project's quarterly reports. These reports will discuss any problems encountered and solutions made. These reports are the responsibility of the QAO and the PM and will be disseminated to individuals listed in section A3.

The final report for this project will be a technical report detailing the Characterization of the Kickapoo Creek in Henderson County Watershed Project and will include information detailing the results and findings of work conducted under this QAPP. Items in this report will include a brief description of methodologies utilized and implications of these findings.

Section D1: Data Review, Validation and Verification

For the purposes of this document, data verification is a systematic process for evaluating performance and compliance of a set of data to ascertain its completeness, correctness, and consistency using the methods and criteria defined in the QAPP. Validation means those processes taken independently of the data-generation processes to evaluate the technical usability of the verified data with respect to the planned objectives or intention of the project. Additionally, validation can provide a level of overall confidence in the reporting of the data based on the methods used.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives listed in Section A7. Only those data supported by appropriate quality control data and meet the measurement performance specification defined for this project will be considered acceptable and submitted to TSSWCB and to TCEQ for entry into SWQMIS.

The procedures for verification and validation of data are described in Section D2, below. The TIAER and ANRA LMs and QAOs are responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and bias, and reviewed for integrity. The TIAER DM will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to be loaded into SWQMIS. The lab QAOs are responsible for validating a minimum of 10% of the data produced monthly for all data to be reported meet the objectives of the project and are suitable for reporting to TCEQ. (field supervisor or lab manager)

Section D2: Validation Methods

Surface Water Quality Monitoring

Field and laboratory data will be reviewed, verified and validated to ensure conformance with project specifications and adherence to end use as described in Section A7 of this document.

Data review, verification, and validation will be performed using self-assessments and peer and management review as appropriate to the project task. The data review tasks to be performed by field and laboratory staffs are listed in the first column of Table D2.1. Potential errors are identified by examination of documentation and by manual or computer-assisted examination of corollary or unreasonable data. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues which can be corrected are corrected and documented. If an issue cannot be corrected, the task manager consults with the higher-level project management to establish the appropriate course of action, or the data associated with the issue are rejected and not reported to the TSSWCB for submission to TCEQ for storage in SWQMIS. Field and laboratory reviews, verifications, and validations are documented.

Table D2.1. Data Review Tasks

Data to be Verified	Field	Labs	TIAER Data Manager
Sample documentation complete; samples labeled, sites identified	Y	Y	
Standards and reagents traceable	Y	Y	
Chain of custody complete/acceptable	Y	Y	
NELAP Accreditation is current		Y	
Sample preservation and handling acceptable	Y	Y	
Holding times not exceeded	Y	Y	
Collection, preparation, and analysis consistent with SOPs and QAPP	Y	Y	Y
Field documentation (e.g., biological, stream habitat) complete	Y		Y
Instrument calibration data complete	Y	Y	
Bacteriological records complete	Y	Y	
QC samples analyzed at required frequency		Y	
QC results meet performance and program specifications		Y	Y
Analytical sensitivity (LOQ/AWRL) consistent with QAPP		Y	Y
Results, calculations, transcriptions checked	Y	Y	Y
Laboratory bench-level review performed		Y	
All laboratory samples analyzed for all scheduled parameters		Y	Y
Corollary data agree		Y	Y
Nonconforming activities documented	Y	Y	Y
Outliers confirmed and documented; reasonableness check performed		Y	Y
Time based on 24-hour clock	Y	Y	Y
Absence of transcription error confirmed	Y	Y	Y
Absence of electronic errors confirmed	Y	Y	Y
Sampling and analytical data gaps checked	Y	Y	Y
Field instrument pre and post calibration results within limits	Y		Y
10% of data manually reviewed	Y	Y	Y

After the field and laboratory data are reviewed, another level of review is performed once the data are combined into a data set. This review step as specified in Table D2.1 is performed by the TIAER DM and QAO. Data review, verification, and validation tasks to be performed on the data set include, but are not limited to, the confirmation of laboratory and field data review, additional evaluation of anomalies and outliers, analysis of sampling and analytical gaps, and confirmation that all parameters and sampling sites are included in the QAPP.

The Data Review Checklist (See Appendix D) covers three main types of review: data format and structure, data quality review, and documentation review. The Data Review Checklist is transferred with the water quality data submitted to the TSSWCB to ensure that the review process is being performed.

Another element of the data validation process is consideration of any findings identified during the monitoring systems audit conducted by the TSSWCB QAO. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. After the data are reviewed and documented, the TIAER PM verifies that the

data meet the data quality objectives of the project and are suitable for reporting to TSSWCB and subsequently TCEQ.

If any requirements or specifications of the QAPP are not met, based on any part of the data review, the responsible party should document the nonconforming activities and submit the information to the TIAER DM with the data. This information is communicated to the TSSWCB by TIAER in the Data Summary (See Appendix D).

LDCs
There is no validation and calibration required for LDCs.

Water quality and streamflow data collected by the TCEQ and the USGS have been verified and validated according to the requirements of the respective programs prior to their use in this project. Data compilations created for this project will be visually screened for errors by TIAER staff. To verify the correctness of FDCs/LDCs, the TIAER staff will ensure that the methods for the development of FDCs/LDCs (USEPA 2008) are followed and will verify that data formatting and inputting were done correctly and that outputs were produced error free.

GIS Inventory
Data for this portion of the project (e.g., land cover, urban areas, population projections, digital elevation models, stream layers, and population projections) provided in Table B9.1 have been collected and made publicly accessible by authoritative sources such as the USGS, USDA, USEPA, U.S. Parks and Wildlife, and U.S. Census Bureau. Data from these sources will be considered as verified and validated by the various agencies providing the data. However, any GIS data created for this project will be visually screened for errors. Any errors detected by project staff will be reported to the TIAER PM and, if necessary, to the TSSWCB PM for resolution. Issues which can be readily corrected, e.g., removal of outlier data, will be documented and the data either removed, qualified, or corrected prior to further analysis.

Section D3: Reconciliation with User Requirements

Surface Water Quality Monitoring
Data produced in this project, and data collected by other organizations will be analyzed and used in the development of water quality restoration plans. Data that do not meet requirements described in this QAPP will not be submitted to SWQMIS, nor will the data be considered appropriate for any of the uses noted above.

Data collected from this project will be analyzed by TIAER to document the current state of water quality in Kickapoo Creek. Data will be used to augment the existing geometric means that will be compared to the water quality standard.

Data produced in this project will be analyzed and reconciled with project data quality requirements. Data meeting project requirements may be used by the TCEQ for the *Texas Water Quality Integrated Report* in accordance with the most recent approved version of the TCEQ's *Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data*, and for TMDL development, water quality standards development, and permit decisions as appropriate. Data that do not meet data quality objectives outlined in this document will not be submitted to SWQMIS.

LDC
The LDC framework utilized for this project will be used to determine maximum allowed bacteria (*E. coli*) loadings within the water bodies evaluated in Kickapoo Creek. This approach will utilize historical flow data and the primary contact recreation criterion for waters to determine this pollutant load allocation. Exceedances of the allowable load for each waterbody will be determined using the procedures outlined in USEPA (2008) by the TIAER staff and will provide the basis for future load reductions needed.

The LDC results will be described in detail in the final report and used for educational purposes as appropriate and will aid in making informed decisions about future action to address pollutant loading issues across the watershed. The limitations of LDCs produced will also be described in the report and conveyed to audiences when discussed.

Results of correlations of DO with various water quality parameters (outlined in section A7) and the likely reasons for depressed DO in the Kickapoo Creek will be described in the final project report. The limitations of the analysis will also be described in the final project report.

GIS Inventory
GIS inventory and maps developed for this project will be used for informational purposes only and will not be used exclusively to make any management decisions. Instead, these maps will aid users by allowing them to visualize watershed features and influences within the watershed that could contribute to the overall bacteria loading. The limitations of maps produced will be described in the project final report and conveyed to audiences when discussed. Potential limitations of the GIS data may include period of data development and the resolution/scale.

References

Cleland, B. 2003. TMDL Development from the "bottom up" – Part III: Duration Curves and wet-weather assessments. America's Clean Water Foundation, Washington, DC. https://www.in.gov/idem/nps/files/monitoring_loads_duration_bottomup.pdf.

National Environmental Laboratory Accreditation Conference (NELAC) Standard, 2018, The NELAC Institute (TNI). https://www.nelac-institute.org/docs/standards/2018/AR-TNIstandards-2003-2009-2016--7-7-18.pdf.

Stiles, T.C. March 2001. A Simple Method to Define Bacteria TMDLs in Kansas. ASIWPCA / ACWF / WEF TMDL Science Issues Conference: On-site Program. St. Louis, MO. pp 375-378. https://nepis.epa.gov/Exe/ZyNET.exe/P1008ZQA.TXT?ZyActionD=ZYDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc.

TCEQ. 2019. Surface Water Quality Monitoring Data Management Reference Guide. Water Quality Planning Division, Monitoring & Assessment Section, Data Management & Analysis Team. https://www.tceq.texas.gov/assets/public/waterquality/dma/dmrg/dmrg_complete.pdf.

TCEQ. 2019. 2016 Guidance for Assessing and Reporting Surface Water Quality in Texas (August 6, 2019): In Compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act. https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/16txir/2016_guidance.pdf.

TCEQ. 2012. Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods. TCEQ, RG-415 Revised August 2012. https://www.tceq.texas.gov/publications/rg/rg-415.

TCEQ. 2014. Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data. TCEQ, RG-416. Revised May 2014. https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg416/cover-toc.pdf.

United States Environmental Protection Agency (USEPA) Methods for Chemical Analysis of Water and Wastes. Manual #EPA-600/4-79-020. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30000Q10.TXT.

USGS 2013." Measuring Discharge with Acoustic Doppler Current Profilers from a Moving Boat." In Surface-Water Techniques. Techniques and Methods 3-A22 Version 2.0. https://pubs.er.usgs.gov/publicatoin/tm3A22.

Appendix A: TIAER Corrective Action Report

Corrective Action Report

SOP-Q-105

CAR #: 08-003

Report Initiation Date _____ **Report By:** _____ **Procedure or QC Typ** _____

Deviation: _____

Analyte: _____

Affected Sample #s: _____

Sampling Station: _____

Project(s): _____

Attached Documentation:
- ☐ COC
- ☐ FDS
- ☐ FlowLink
- ☐ Flow8
- ☐ GM
- ☐ Log Book
- ☐ QC Sheet
- ☐ Memo
- ☐ Other

Details of the problem, nonconformance or out-of-control situation:

Possible Causes:

Corrective Actions Taken:

Corrective Actions Suggested:

CAR routed to: _____ **Date:** _____

Supervisor: ○ **Tier 1** (does not affect final data integrity) ○ **Tier 2** (data accepted but flag required) ○ **Tier 3** (possibly affects final data integrity)

Corrective actions taken for specific incident: _____

Corrective actions taken to prevent recurrences: _____

Corrective actions to be taken: _____

Responsible Party: _____ **Proposed completion date:** _____

Effect on data quality: _____

Responsible Supervisor: _____ **Date:** _____

Concurrence:

Program/Project Manager: _____ **Date:** _____
(Tier 3 CARs only)

Quality Assurance Officer: _____ **Date:** _____

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Appendix B: Example of TIAER Field Data Reporting Form

Field Data Sheet
Streams
(Working draft: 14Dec11)

Site:TIAER TCEQ	Flowmeter level in ft. (bl sites)	Time:	Investigators:
		Color Code:	Project:
Date:		Location: *run* *glide*	**Observations (select from below):** Wind intensity Dir.(opt.)
Air Temp:		*riffle* *pool*	Present Weather

Hydrological Parameters

Total Depth: _____ft.

Sample #	Sample Depth (ft)	***Place Sonde Readings Here***						
		Temp C	Cond *u* s	DO %Sat	DO mg/L	pH		Flow Sev. (select from below)
	*							
	1.00 **							
	record depth	* If total depth is <1.5 ft. collect at 1/3 total dep ** If total depth >1.5 ft. collect at 1 ft.						
		Conventional Sample - iced plastic bottle A						
		Bacteria Sample - sterilized bottle S						
		Chlorophyl Sample - dark bottle B						
		Filtered NO2NO3N, NH3N - acidified E						
		TKN, TP acidified D						
		Filtered OPO4 (FPO4) C						
		BOD sample iced plastic A						
		Field Split of Sample _____ Nutrient Fecal Chl						

Estiimated Flow Severity 1. no flow 2. low 3. normal 5. high 4. flood 6. dry
Wind intensity 1. Calm 2. Slight 3. Moderate 4. Strong
Present Weather 1. Clear 2. Pt. Cloudy 3. Cloudy 4. Rain
Last Significant Rainfall (in days) <1 (w/in 24 hrs) 1 2 3 4 5 6 7 >7 (over a week) _____

Flow Field Data **Method** 1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler
Smp No. Start End cfs area^2
_____ _____ _____ _____ _____

Pool Dimensions **Feet** **Meters**
Max Max %
Depth:_____ Length:_____ Width:_____ Coverage:_____

DO ch **pH mv**
_____ _____

Datasonde used: _____

Comments:
Unusual Observations: (dBase info) _____

General Observations: _____

Appendix C: TIAER Chain of Custody Record

TIAER | ***Internal*** | ***Chain of Custody / Sample Information Form*** | Page __ of __ | Field data or attachments? (Y/N)

TIAER Project Manager: | Other: | Sampler(s) and Delivery information | >0-6C temp: | therm. used: | T-

TIAER Project Code	*TIAER* Lab Sample Number	*TIAER* Test Group Code	Sample Date(s) (mm/dd/yy)	Sample Time(s) (hh:mm) CST for TIAER	*Client* Sample or Site ID	Sample Type	Matrix	Preservative	Preservative and Container types/ number	Comments (if applicable): Flow Weighted data start/end date/time:	bottle numbers:	Other notes:	Composite only- last bottle collection date/time:	pH <2 check	temp check	Disposed

Relinquished by:	Date/Time: CST DST	Received by:	Date/Time: CST DST
Relinquished by:	Date/Time: CST DST	Received by:	Date/Time: CST DST

Sample Types: G=Grab, SG=Storm Grab, S=Sequential, T=Time based comp., F=Flow based comp., M=Multisonde, O=other | **Matrix:** L=Liquid (nonpotable water), S=Solid or chemical | Form review initials/ date

Preservative/container codes: **A**= plastic unfiltered (**uf**) unacidified (**ua**), **B**= dark plastic **uf/ua**, **C**= field filtered **ua** plastic, **D**=acidified **uf** plastic, **E**= acidified filtered plastic, **F**=filter, G=glass **ua/uf**, H=dark glass **uf**, J=glass acidified **uf**, O=other (describe), **S**=sterile plastic **ua/uf**, V=VOA vial **uf**, W= plastic bag **ua/uf.** I=Ice, HS=Sulfuric acid, HN=Nitric acid

Data entry:
Field review:
Lab review:

Texas Institute for Applied Environmental Research
Box T-0410, Stephenville, TX 76402, Tarleton State University 254-968-9570, 968-9556

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Appendix D: ANRA Chain of Custody Record

ANGELINA & NECHES RIVER AUTHORITY

2901 N. John Redditt Dr.
Lufkin, TX 75904
Phone: 936-632-7795
Website: www.anra.org

CHAIN-OF-CUSTODY RECORD

SECTION A – CLIENT & SAMPLER INFORMATION	
Client Name	TIAER
Project Name	Characterizing the Kickapoo Creek Watershed
Phone #	(254) 968-0513
Sampler Name	Jeff Stroebel

SECTION B – SAMPLE RECEIPT INFORMATION (LAB USE ONLY)		
Temperature, °C:	Observed: / Corrected:	Receipt #:
Thermometer ID / Correction Factor:	THERM- / CF:	Client Notification:
Preservative & pH paper Standard ID #s:		Comments:
Subcontract Lab / PO #:	Sub Lab: PO #:	

SECTION C – SAMPLE CONTAINERS AND PRESERVATION	
Container Letter	A
Container Type	S
Preservative	3

SECTION D – INSTRUCTIONS/KEYS

Label each individual sample container with a letter (A, B, C, etc.). If multiple analyses come from the same container, assign them the same letter, or write them in the same column.

Container Type Codes: A = Amber, AG = Amber Glass, G = Glass, P = Plastic, S = Sterile, V = Vial

Preservative Codes: 1 = None, 2 = Sulfuric Acid (H_2SO_4), 3 = Sodium Thiosulfate ($Na_2S_2O_3$), 4 = Nitric Acid (HNO_3), 5 = Sodium Hydroxide (NaOH), 6 = Hydrochloric Acid (HCl)

Matrix Codes: DW = Drinking Water, NP = Non-Potable Water, S = Soil, SL = Sludge

Sample Type Codes: C = Composite, G = Grab, SP = Special (DW matrix only)

SECTION E – SAMPLE INFORMATION AND ANALYSES REQUESTED / SECTION F – FIELD ANALYSES/INFORMATION / SECTION G – SAMPLE ID

Enter the applicable parameters in the fields below.

Item #	Sample Description	Analyses: E.COLI	Matrix (see Section D)	Sample Type (see Section D)	Collection Date	Collection Time	pH of preserved containers (e.g. A <2)	LAB USE ONLY: Work Order #: / Sample ID #s
1	22167	X	NP	G				
2	22166	X	NP	G				
3	22165	X	NP	G				
4	16797	X	NP	G				
5	22164	X	NP	G				
6	16796	X	NP	G				
7	22163	X	NP	G				
8	21618	X	NP	G				
9	10517	X	NP	G				
10								

SECTION H – COMPOSITE DATA (if Composite marked above)

	Date	Time	Totalizer
Start			
End			
Total Flow (MGD)			

SECTION I – TRANSFER OF SAMPLE CUSTODY

Relinquished by (Signature)	Date	Time	Transported on ice	Received by (Signature)	Date	Time
			☐ Yes ☐ No			
			☐ Yes ☐ No			
			☐ Yes ☐ No			

NOTE: Section I – Transfer of Sample Custody must reflect all transfers from sample collection to receipt at the ANRA Environmental Laboratory.

NOTE: Chain-of-Custody must be completed by the customer (or corrected, if needed, at the time of sample drop-off) before ANRA staff will accept samples and sign the COC as received.

Form ID: LAB-027
Revision #: 3
Effective: 6/9/2020
Approved: MDG

Clear Form

Appendix E: Data Review Checklist and Data Summary Sheet

Data Review Checklist

Title of associated QAPP: _____

√, X, or N/A

Data Format and Structure

A. Are there any duplicate *Tag ID* numbers? _____
B. Are the *Tag prefixes* correct? _____
C. Are all *Tag ID* numbers 7 characters? _____
D. Are TCEQ station location (SLOC) numbers assigned? _____
E. Are sampling *Dates* in the correct format, MM/DD/YYYY? _____
F. Is the sampling *Time* based on the 24-hour clock (e.g. 13:04)? _____
G. Is the *Comment* field filled in where appropriate (e.g. unusual occurrence, sampling problems, unrepresentative of ambient water quality) and any punctuation deleted? _____
H. *Source Code 1, 2* and *Program Code* are valid and used correctly? _____
I. Is the sampling date in the *Results* file the same as the one in the *Events* file? _____
J. Values represented by a valid parameter (*STORET*) code with the correct units and leading zeros? _____
K. Are there any duplicate parameter codes for the same *Tag Id*? _____
L. Are there any invalid symbols in the Greater Than/Less Than (*GT/LT*) field? _____
M. Are there any tag numbers in the *Results* file that are not in the *Events* file? _____
N. Have confirmed outliers been identified? (with a ■1" in the Verify_flg field) _____
O. Have grab data (bacteria, for example) taken during 24-hr events been reported separately as RT samples? _____
P. Is the file in the correct format (ASCII pipe-delimited text)? _____

Data Quality Review

A. Are all the values reported at or below the AWRL? _____
B. Have the outliers been verified? _____
C. Checks on correctness of analysis or data reasonableness performed?
e.g.: Is ortho-phosphorus less than total phosphorus?
Are dissolved metal concentrations less than or equal to total metals? _____
D. Have at least 10% of the data in the data set been reviewed against the field and laboratory data sheets? _____
E. Are all parameter codes in the data set listed in the QAPP? _____
F. Are all stations in the data set listed in the QAPP? _____

Documentation Review

A. Are blank results acceptable as specified in the QAPP? _____
B. Were control charts used to determine the acceptability of field duplicates? _____
C. Was documentation of any unusual occurrences that may affect water quality included in the Event file Comments field? _____
D. Were there any failures in sampling methods and/or deviations from sample design requirements that resulted in unreportable data? If yes, explain on next page. _____
E. Were there any failures in field and laboratory measurement systems that were not resolvable and resulted in unreportable data? If yes, explain on next page. _____

√ = Yes **X = No** **N/A** = Not applicable

Describe any data reporting inconsistencies with AWRL specifications. Explain failures in sampling methods and field and laboratory measurement systems that resulted in data that could not be reported to the TCEQ. (attach another page if necessary):

_____

_____

_____

_____

_____

Date Submitted to TCEQ: _____
Tag ID Series: _____
Date Range: _____
Data Source: _____
Comments (attach README.TXT file if applicable):

_____

_____

_____

_____

Planning Agency•s Data Manager Signature: _____

Date: _____

DATA SUMMARY

Data Set Information

Data Source: _____.

Date Submitted: _____.

Tag_id Range: _____.

Date Range: _____.

Comments:

Please explain in the space below any data discrepancies discovered during data review including:

- Inconsistencies with AWRL specifications or LOQs
- Failures in sampling methods and/or laboratory procedures that resulted in data that could not be reported to the TCEQ (indicate items for which the Corrective Action Process has been initiated).
- Include completed Corrective Action Plans with the applicable Progress Report.

_____

_____

_____

_____

_____

_____

_____

_____

☐ I certify that all data in this data set meets the requirements specified in Texas Water Code Chapter 5, Subchapter R (TWC §5.801 et seq) and Title 30 Texas Administrative Code Chapter 25, Subchapters A & B.

☐ This data set has been reviewed using the Data Review Checklist.

Planning Agency Data Manager: _____.

Date: _____.