Clean Water Act Section 319(h) Nonpoint Source Pollution Control Program

Medina River Below Medina Diversion Lake Watershed Protection Plan Development

TSSWCB Project # 22-03

Quality Assurance Project Plan

Texas State Soil and Water Conservation Board

Revision #1

Prepared by:

Texas A&M AgriLife Research
Texas Water Resources Institute

Effective Period: upon EPA approval through October 31, 2025

(with annual revisions required)

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

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College Station, TX 77840-2118
jason.gerlich@ag.tamu.edu

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Section A1: Approval Sheet

Quality Assurance Project Plan (QAPP) for the *Medina River Below Medina Diversion Lake Watershed Protection Plan Development* project.

United States Environmental Protection Agency (USEPA), Region VI

Name: Nelly Smith
Title: USEPA Chief State/Tribal Programs Section

Signature:_____ Date:_____

Name: Anthony Suttice
Title: USEPA Texas Nonpoint Source Project Officer

Signature:_____ Date:_____

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)

Signature:_____ Date:_____

Texas AgriLife Research – Texas Water Resources Institute (TWRI)

Name: Jason Gerlich
Title: TWRI Project Manager

Signature:_____Date:

Name: Lucas Gregory
Title: TWRI QAO

Signature:_____Date:

Name: Stephanie DeVilleneuve
Title: TWRI DM

Signature:_____Date:

Section A2: Table of Contents

Section: Title

List of Acronyms and Abbreviations

BMP	Best Management Practice
CAR	Corrective Action Report
CRP	Clean Rivers Program
CWA	Clean Water Act
DMRG	Data Management Reference Guide
DQO	Data Quality Objectives
FDC	Flow Duration Curve
GIS	Geographic Information System
HSPF	Hydrologic Simulation Program Fortran
LDC	Load Duration Curve
LID	Low Impact Development
MS4	Municipal Separate Storm Sewer System
NLCD	National Land Cover Database
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
OSSF	On-Site Sewage Facility
PCR	Primary Contact Recreation
PM	Project Manager
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
SARA	San Antonio River Authority
SAWS	San Antonio Water System
SSO	Sanitary Sewer Overflow
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TPDES	Total Pollution Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWRI	Texas AgriLife Research, Texas Water Resources Institute
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WPP	Watershed Protection Plan

Section A3: Distribution List

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

United States Environmental Protection Agency Region 6

Water Division (WDAS)
1201 Elm Street
Dallas, TX 75270

Name: Anthony Suttice
Title: USEPA Texas Nonpoint Source Project Officer

Name: Nelly Smith
Title: USEPA Chief State/Tribal Programs Section

Texas State Soil and Water Conservation Board

1497 Country View Lane
Temple, TX 76504-8806

Name: Jana Lloyd
Title: TSSWCB PM

Name: Mitch Conine
Title: TSSWCB QAO

Texas AgriLife Research - Texas Water Resources Institute

1001 Holleman Drive East, Suite 103
2118 TAMU
College Station, TX 77840-2118

Name: Jason Gerlich
Title: TWRI Project Manager

Name: Lucas Gregory
Title: TWRI QAO

Name: Stephanie DeVilleneuve
Title: TWRI DM

Section A4: Project/Task Organization

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

USEPA – United States Environmental Protection Agency, Region VI. Provides project oversight and funding at the federal level.

Anthony Suttice, USEPA Texas Nonpoint Source Project Officer
Responsible for overall performance and direction of the project at the federal level. Ensures that the project assists in achieving the goals of the Clean Water Act (CWA). Reviews and approves the QAPP, project progress, and deliverables.

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 TWRI. 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 TWRI.

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 assurance (QA), quality control (QC), and reporting under the TSSWCB Nonpoint Source Management Program.

TWRI – Texas Water Resources Institute, College Station, Texas. Responsible for general project oversight, coordination and administration, project reporting, acquisition of water quality data, data assessment, stakeholder facilitation, WPP development, development of data quality objectives (DQOs) and a QAPP.

Jason Gerlich, TWRI PM
The TWRI PM is 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.

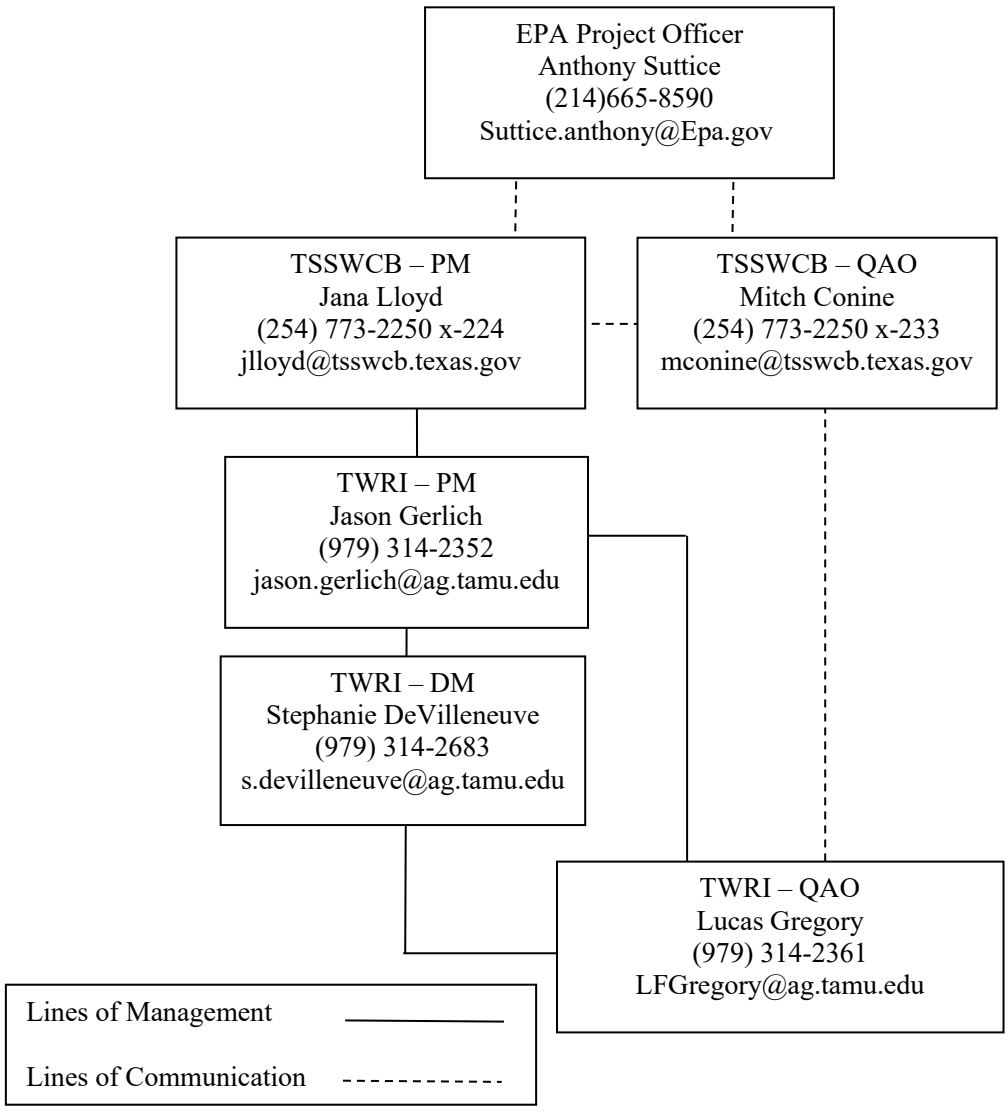
Stephanie DeVilleneuve, TWRI DM

Responsible for acquisition, verification, and transfer of data to the TSSWCB PM. Oversees data management for the project. 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.

Lucas Gregory, Associate Director, QAO

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

Figure A.4-1. Project Organization Chart



Section A5: Problem Definition/Background

The 2020 303(d) List identified the Medina River below Medina Diversion Lake (Segment 1903) and Medio Creek (Segment 1912) as exceeding the contact recreation criterion for E. coli bacteria. The Medina River and Medina Lake have tremendous recreational value to local residents. They are used for swimming, fishing, kayaking and more throughout the year, and water from the Medina Diversion Lake is used for irrigation within the watershed and as potable water for the San Antonio Water System (SAWS). The Medina River contains multiple sensitive recharge features and contributes significant volumes of recharge to the Edwards Aquifer. Increasing development pressure expanding outward from the San Antonio metropolitan area is adding further environmental stress to the system by increasing landscape disturbance, the amount of impervious cover, and the amount of potential pollutant loading in the watershed. Each of these increases will undoubtedly affect the overall quality, health and function of the Medina River.

In 2015, the San Antonio River Authority (SARA) conducted a Medina River Holistic Watershed Master Plan on the entire watershed. The project focused on addressing common water quality, flood control, and ecosystem problems by identifying structural flood retention solutions, identifying potential parks and open spaces, and watershed and water quality best management practices (BMPs), low impact development (LID) concepts and conservation easements. Major issues identified in the plan include illegal dumping, flooding and erosion. This plan outlines implementation of BMPs and LID to protect areas where development and land use change is occurring rapidly. Issues identified in the master plan include water quality issues consistent with the 2020 Integrated Report and showed through monitoring that chloride and sulfate levels have been increasing, while dissolved oxygen levels have been decreasing.

In 2021, TWRI worked with TCEQ TMDL team to create a data summary report of the Medina River Watershed below Medina Lake. The report summarizes previous research in the watershed, analyzes historic water quality data, and identifies potential sources of pollution. The project also includes meetings with targeted stakeholders to discuss the next steps in the watershed and overall goals of stakeholders. Initial feedback from stakeholders during the data summary process indicates a preference for developing a WPP in the watershed instead of a TMDL.

The published master plan and data summary report serve as a great start in protecting the Medina River but do not fully address water quality challenges faced in the watershed. A WPP is needed to incorporate water quality management into this vision and establish the linkages between pollutant loads and instream water quality. Likewise, management recommendations must be related to expected water quality improvements. Together, the Medina River WPP and Holistic Watershed Master Plan will outline a clear path for improving water quality and enhancing the resilience of the Medina River ecosystem. Initial meetings during the data summary report project with stakeholders will help ensure participation from the community and support for the development of the WPP.

Section A6: Project Goals and Task Description

This project will result in the production of a stakeholder driven WPP developed with buy-in from local stakeholders and governmental entities. Stakeholder interest in developing a WPP to aid in protecting and preserving the river and its water quality has gained momentum in recent years. Groups engaged in discussions about local issues that affect water quality, instream habitat, and the need to mitigate future adverse effects include the Bexar Regional Watershed Management partnership, the Bandera County River Authority and Groundwater District, the San Antonio SALSA squad, Friends of the Medina River, local groundwater districts, and Bandera, Bexar, and Medina counties among others. We will work with local watershed stakeholders to establish water quality goals and targets for the watershed through the development of a watershed protection plan (WPP). In addition, the plan will work to address other water quality concerns present in the Medina River, specifically, sediment, nitrate, and total phosphorus levels.

Initially, efforts will be made to form a well-rounded stakeholder group that appropriately represents these and other interests in the watershed. This stakeholder group will be informed of local water quality impairments, potential causes and sources of pollution and needed levels of pollutant reduction to restore instream water quality. Educational resources will be delivered in the watershed to raise awareness of water quality issues. TWRI will work with SARA to guide the formed stakeholder group through the process to develop and deliver a WPP for the Medina River that addresses EPA's nine key elements for successful watershed-based plans. Stakeholders will play an integral role in WPP development process by providing local insight into issues affecting water quality, identifying critical sources of pollution in the watershed, identifying palatable management measures to include in the WPP and setting implementation and water quality goals and milestones. Ultimately, the WPP will include a comprehensive watershed approach which focuses efforts on the most significant pollution sources contributing to water quality impairments, but at the same time will look ahead at potential pollution sources from future growth and activity in the watershed.

TWRI will use the Medina River Holistic Watershed Master Plan, developed in 2015 by SARA, and the data summary report, developed in 2021 by TWRI, as a basis for providing relevant background, watershed conditions, water quality trends, identified issues, and stakeholder feedback to include in the WPP. Information in these documents will be synthesized and summarized for presentation to the WPP stakeholder group to allow them to make informed decisions regarding WPP development. Recommendations from the master plan that intersect with watershed planning include: (a) develop and maintain partnerships for watershed management and implementation; (b) encourage the use of ordinances and other programs to assure implementation of BMPs; (c) encourage nutrient removal at WWTPs; (d) encourage BMPs on agricultural lands; (e) pursue protection of rural land uses and riparian buffers; (f) reduce illegal dumping; and (g) develop park facilities. These recommendations will serve as a starting point for management measure discussions.

Following plan development, TWRI will work with watershed stakeholders and local professionals to develop conceptual WPP implementation project content. These documents will serve as a catalyst for future plan implementation and further funding acquisition to support continued WPP implementation locally. Local support to facilitate implementation will initially be provided by

TWRI but will be transitioned to a local partner once implementation efforts are underway. Additionally, the existence of, and efforts by SARA to implement their Medina River Holistic Watershed Master Plan provides complimentary long-term support for continued implementation of items likely to be included in the Medina River WPP.

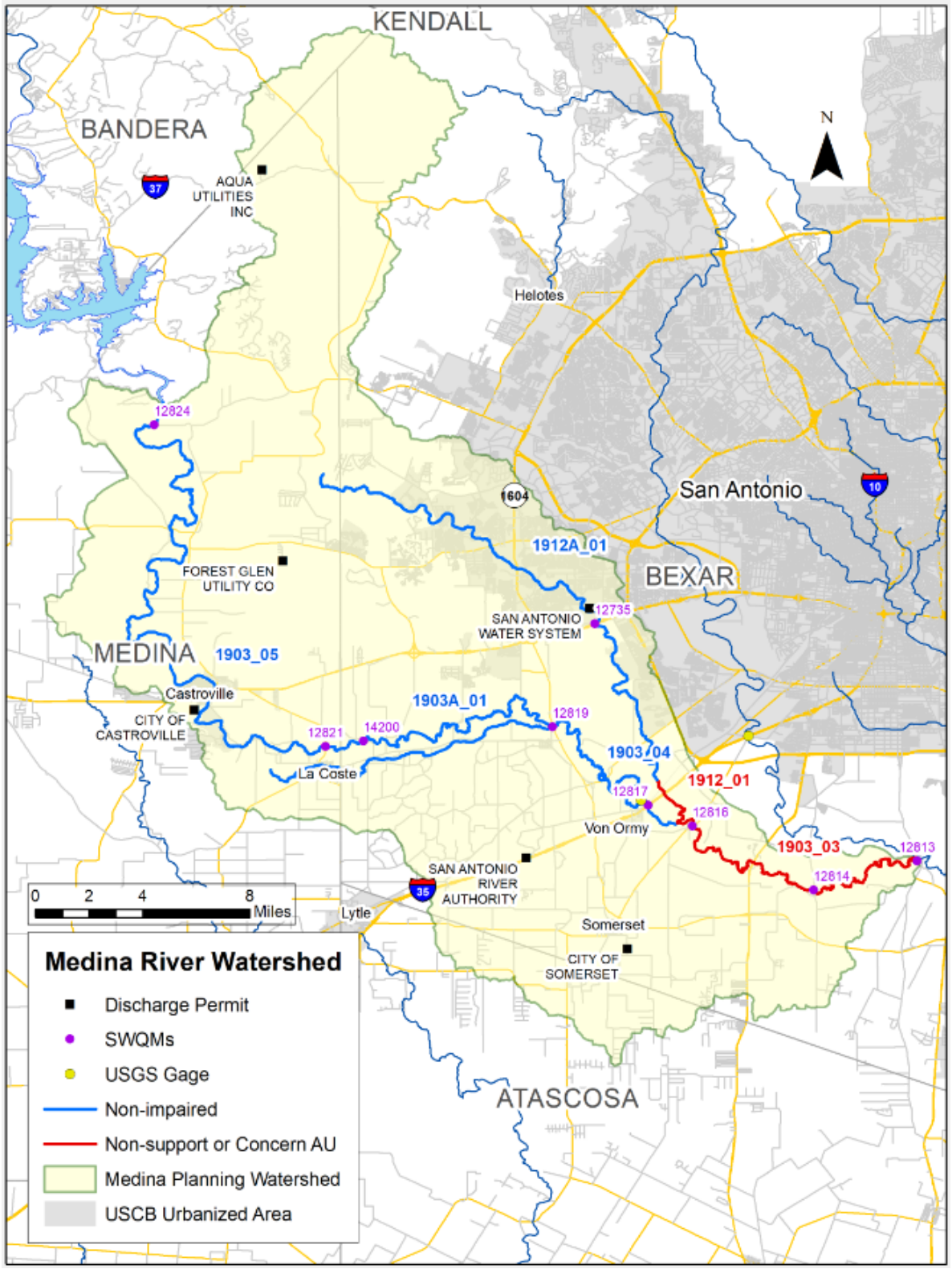


Figure A6-1. The Medina River Watershed below Medina Diversion Lake

Table A6-1. Project Plan Milestones

Task	Project Milestones	Agency	Start Month	End Month
4.1	**WPP Development** — TWRI, in collaboration with project partners, will develop a WPP that is consistent with and satisfies the expectations of the EPA's nine key elements fundamental to WBPs as described in the latest EPA document, Nonpoint Source Program and Grants Guidelines for State and Territories. The WPP will be founded on decisions made by stakeholders through the watershed planning process and incorporate findings from project data, analysis and reports. TWRI will facilitate public review and stakeholder approval of the WPP. The WPP will: A. Identify and quantify existing pollutant loadings that need to be controlled; B. Determine pollutant load reductions needed to meet water quality standards; C. Identify management practices to achieve water quality standards; D. Estimate technical and financial assistance needed to implement the plan; E. Describe information and education components needed to implement the plan; F. Develop an implementation schedule; G. Describe interim measurable milestones for management measure implementation; H. Describe water quality evaluation criteria; and I. Describe the monitoring program to assess water quality conditions.	TWRI	6	24
4.2	Development of WPP Demonstration/Implementation Project Ideas — TWRI, in collaboration with project partners, will work with stakeholders to identify possible demonstration/implementation projects that could be implemented in the watershed. Possible projects may include, but are not limited to, riparian restoration work, creation of green stormwater infrastructure, and conservation plans. These catalyst projects will be linked with WPP identified practices. From the discussion, at least three high level one-pagers that further develop project concepts will be created describing implementation projects. The one-pagers will help promote and start the implementation process once the WPP is finalized and accepted. These documents will also serve as high-level project proposals that will be used as a basis for future funding acquisition.	TWRI	24	36
4.3	Review and Approval Process — TWRI will develop a timeline and stakeholder document review plan at the beginning of the project. The review plan will include submittal of multiple interim partial drafts for review by stakeholders and TSSWCB. Stakeholders and TSSWCB will approve the WPP before it is submitted to EPA for review. TWRI will work with stakeholders and TSSWCB to address any EPA comments. TWRI will release a draft of the WPP to the public and address any comments that may be received. TSSWCB will submit to EPA a Final WPP with all EPA comments addressed.	TWRI	24	36

Task	Project Milestones	Agency	Start Month	End Month
4.4	Executive Summary Creation — TWRI will develop an executive summary style document, based on the WPP, which will serve as a public outreach tool to garner support for the implementation of the WPP and achieve long-term sustainability.	TWRI	33	36
4.5	Executive Summary Distribution —TWRI will publish and distribute the WPP and the executive summary style document to stakeholders.	TWRI	33	36

Model Description

LDCs

This is a simple and an effective first-step methodology to obtain data-based Total Maximum Daily Loads (TMDLs) (Cleland, 2003; Stiles, 2001). 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 hydrograph of the observed stream flows to calculate and depict the percentage of time the flows are equaled or exceeded.

A LDC (Figure A6.3), which is related to the FDC, shows the corresponding relationship between the contaminant loadings and stream flow conditions at the monitoring site. In this manner, it assists in determining patterns in pollution loading (point sources, nonpoint sources, erosion, etc.) depending on the streamflow conditions. Based on the observed patterns, specific restoration plans can be implemented that target a particular kind of pollutant source. For example, if the pollutant loads exceed the allowable loads (Figure A6.3) for low stream flow regimes, then the point sources such as wastewater treatment plants and direct deposition sources (wildlife, livestock) should be targeted for the restoration plans. Another main advantage of the LDC method is that it can also be used to evaluate the current impairment as some percent of samples which exceed the standard, and therefore it allows for the rapid development of TMDLs (Stiles, 2001). Figures A6.2 and A6.3 are examples of a FDC and LDC from a project that focused on the Plum Creek watershed.

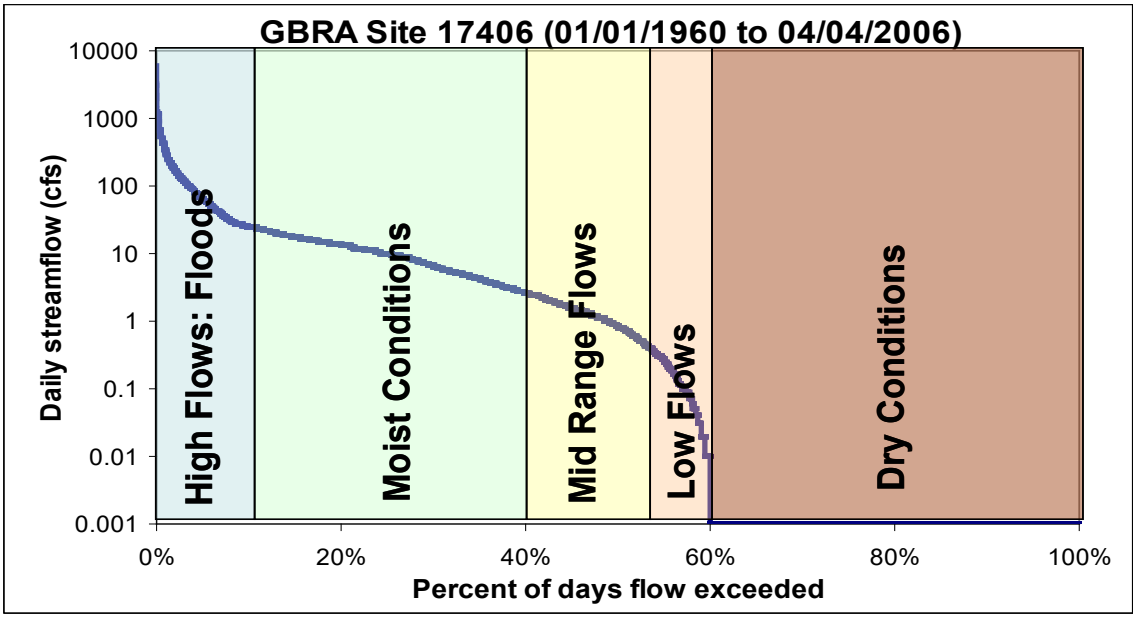


Figure A6-2. FDC for streamflow conditions at GBRA monitoring station 17406 on Plum Creek, near Uhland, TX. The flow data at 17406 was obtained from the nearest USGS gage station 8172400, after adjusting for subwatershed aerial contribution during runoff events.

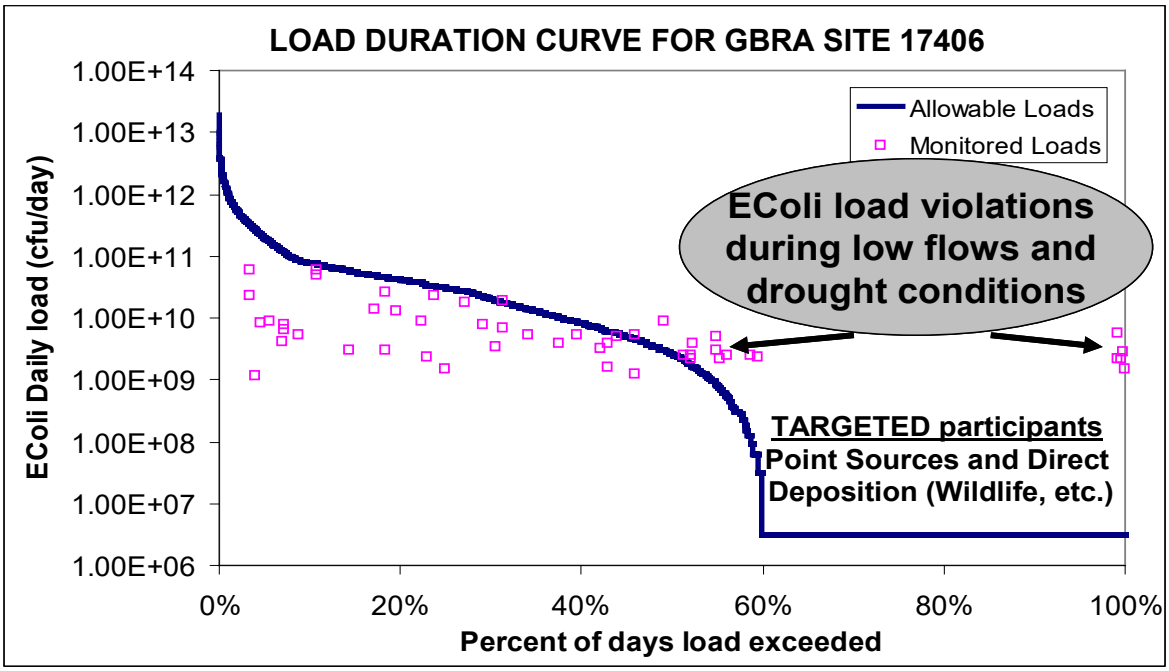


Figure A6-3. LDC for *E. coli* at GBRA monitoring station 17406 on Plum Creek, near Uhland, TX. The flow data at 17406 was obtained from the nearest USGS gage station 8172400, after adjusting for subwatershed aerial contribution during runoff events.

Section A7: Quality Objectives and Criteria for Data Quality

Personnel at TWRI will conduct a phased data assessment effort to develop pollutant source and loading information and estimates of needed bacteria and nutrient reductions. The objectives of the water quality assessment for this project are as follows:

The objectives for this project are as follows:

1) Spatially characterize and rank sources of pollutants within the watershed. Divide the area into sub-watersheds and identify, quantify and rank pollutant loads from various sources, i.e. wildlife, livestock, and other sources in the study area.
2) Develop LDCs to analyze the temporal trends in the observed water quantity and quality data for the watershed. The LDCs will be developed using currently existing water quality and flow data available from the Texas Commission on Environmental Quality (TCEQ) Surface Water Quality Monitoring Information System (SWQMIS) Database. Evaluate the exceedances and the required load-reductions of bacteria and nutrients for different flow-rate regimes (low, medium, and high flow) using LDC and interpolated model.

LDCs

This approach has been utilized in several TMDL projects as an initial screening-tool to evaluate the actual temporal load trends in streams (Cleland, 2003; Stiles, 2001). In cases of violations, it is necessary to determine the required load-reduction in that region near the monitoring station. Load-reductions should be calculated for all flow-regimes of the stream. In order to do this continuous monitoring data will be simulated using the actual monitoring data by regression methods. Uncertainty of the model will be estimated via residual error analysis. The straight line passing through residual error plot should have a slope of zero.

Section A8: Special Training Requirements/Certification

LDCs

All personnel involved in model calibration, validation, and development will have the appropriate education and training required to adequately perform their duties. No special certifications are required.

Section A9: Documentation and Records

LDC

All records, including modeler's notebooks and electronic files, will be archived by TWRI for LDCs for at least five years. Electronic data on the project computers and the network server are backed up daily to the network drive and weekly to an external hard drive and the principal investigator's computer. 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.

General Project Documentation

Quarterly progress reports (QPRs) disseminated to the individuals listed in section A3 will note activities conducted in connection with the project, items or areas identified as potential problems, and any variations or supplements to the QAPP. Final reports on the project will be developed as chapters (or portions of chapters) to the WPP. Outcomes will be submitted to the established stakeholder group and utilized in WPP development.

Corrective action reports (CARs) will be utilized when necessary (Appendix A). CARs will be maintained in an accessible location for reference at TWRI 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. The TSSWCB may elect to take possession of records at the conclusion of the specified retention period.

Table A9-1 lists documents, storage locations, retention times and forms.

Table A9-1. Project Documents and Records

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	TWRI	5 years	Electronic
QAPP distribution documentation	TWRI	5 years	Electronic
Corrective Action Reports (CARs)	TWRI	5 years	Electronic
Progress reports, final reports, data	TWRI/TSSWCB	3 years	Paper/Electronic

Data Transfer between Entities

Data transfer between entities occurs via electronic means. The specific format of the data transferred depends on the specific data and includes ArcPro, 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 TWRI PM to the TSSWCB PM in writing. The changes are effective immediately upon approval by the TSSWCB PM and QAO, or their designees. 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 TWRI QAO. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process.

Section B1: Sampling Process Design (Experimental Design)

Elements B1 – B8 address various quality aspects of the design and procedures for collecting, handling, and analyzing new environmental data. Since this project uses existing data sources, these sections do not apply to this QAPP.

B2 Sampling Methods

Does not apply to this QAPP. See B1 for more information.

B3 Sample Handling and Custody

Does not apply to this QAPP. See B1 for more information.

B4 Analytical Methods

Does not apply to this QAPP. See B1 for more information.

B5 Quality Control

Does not apply to this QAPP. See B1 for more information.

B6 Instrument/Equipment Testing, Inspection and Maintenance

Does not apply to this QAPP. See B1 for more information.

B7 Instrument/Equipment Calibration and Frequency

Does not apply to this QAPP. See B1 for more information.

B8 Inspection/Acceptance of Supplies and Consumables

Does not apply to this QAPP. See B1 for more information.

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

SWQM- Water quality data available in TCEQ's SWQMIS will be used as historical references for instream water quality and conditions. US Geologic Survey (USGS) flow data available in the watershed may also be useful for evaluating instream conditions. The collection and qualification of the TCEQ and USGS data are addressed in the TCEQ Surface Water Quality Monitoring QAPP <www.tceq.texas.gov/waterquality/monitoring/swqm_guides.html>. The collection and qualification of the Texas CRP data are addressed in the Texas CRP QAPPs <www.tceq.texas.gov/waterquality/clean-rivers/qa/index.html>.
These data will support the development of pollutant load assessments during the waterbody assessment. This is the only water quality data collected outside this project that will be utilized.

Table B9.1. Monitoring Data Sources

Data Type	Monitoring Project/Program	Collecting Entity	Dates of Collection	QA Information	Data Use(s)
Monitoring 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
Flow Data	United States Geological Survey (USGS) flow data	USGS	For the period of record collected by the USGS at stations in Table A6.2	USGS QAPP; USGA database	Flow measurements
Precipitation Data	National Weather Service (NWS)	NWS	Most up-to-date precipitation data will be downloaded from the NWS website	NWS Website	Days since last precipitation

Any non-direct measurements will comply with all requirements under this QAPP. 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 and USGS data are addressed in the TCEQ Surface Water Quality Monitoring QAPP. Potential sources where data will be acquired from 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.

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.

LDCs
The LDCs will be updated using currently existing water quality and flow data available from the TCEQ SWQMIS Database, USGS (where available) and data generated through this project.

All data used in the assessment procedures for this project are collected in accordance with approved quality assurance measures under TCEQ, Texas Water Development Board, USDA, National Weather Service, 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 use, precipitation, soil type, ecoregion, TCEQ monitoring location, TCEQ permitted outfall, gage location, city/county/state boundary, stream hydrology, reservoir, drought, road, watershed, municipal separate storm sewer system, urbanized area, basin, railroad, recreational area, area landmark, aerial photography, and park information. The above data comes 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 updating this project maps based on the reputability of these data sources and the fact that there are no known comparable sources for these data. Geospatial data will be cited in reports.

Other data that is 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 is of known and acceptable quality and was 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 planned acquisition

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)	USGS http://waterdata.usgs.gov/tx/nwis/sw	Data noted as "Approved" (quality-assured data) or "Provisional" (of unverified accuracy and subject to revision). More recent "provisional" data may be used in the project after thorough review. "Approved" data have successfully undergone USGS quality assurance.	FDCs	All data available
Bacteria, conventional water quality, field and flow parameters	Concentration/ quantity at various points in time	CFU or MPN/100mLfor bacteria; µmhos/cm, mg/L, ppm as appropriate for conventional; cfs for flow	TCEQ SWQMIS http://www.tceq.texas.gov/waterquality/data-management/wdma_forms.html	Data requested will include only data that met quality assurance/quality control (QA/QC) requirements as outlined under the SWQM Data Management Reference Guide.	LDCs	most recent 7 years; or more if insufficient data exists
TCEQ Surface Water Quality Monitoring Stations	Spatial data, location of active and historical SWQM stations	Shapefile - Points	TCEQ GIS Site Layers Download Page http://www.tceq.texas.gov/gis/sites.html	Data Management Reference Guide (DMRG) for Surface Water Quality Monitoring http://www.tceq.texas.gov/waterquality/data-management/dmrg_index.html	Map development and FDCs/LDCs	N/A
TCEQ Segments	Spatial data, official TCEQ Segments	Shapefile - Polylines	TCEQ GIS Hydrology Layers http://www.tceq.texas.gov/gis/hydro.html	TCEQ 2010 Stream Segments Metadata http://www.tceq.texas.gov/assets/public/gis/metadata/stream_segments.pdf	Map development	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
Watershed Boundary Dataset	Spatial GIS data, GIS shapefiles	1:24,000 or better	https://gdg.sc.egov.usda.gov/	https://pubs.usgs.gov/tm/11/a3/pdf/tm11-a3_1ed.pdf	Subwatershed delineation	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
TWDB/TPWD Continuous Water Quality data	Salinity data	Salinity (PSU)	https://www.waterdatafortexas.org/coastal	None accessible, TWDB database.	Estimation of salinities to use in mass balance equation for modified LDCs	1990-2019
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/nlcd-2016-land-cover-conus	Yang, L., Jin, S., Danielson, P., Homer, C., Gass, L., Costello, C., Dewitz, J., Fry, J., Funk, M., Grannemann, B., Rigge, M. and G. Xian. 2018. https://www.mrlc.gov/data/references/national-land-cover-database-2016-landcover-imperviousness-nlcd2016 *A New Generation of the United States National Land Cover Database: Requirements, Research Priorities, Design, and Implementation Strategies*, p. 108 – 123.	Map development	Based on Landsat imagery between 2001 and 2016
Land Use/Land Cover	Crop Data Layer – GIS raster dataset	Raster – 30 m resolution	https://www.nass.usda.gov/Research_and_Science/Cropland/Release/index.php	USDA National Agricultural Statistics Service Cropland Data Layer. 2017. Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/. USDA-NASS, Washington, DC.	Map development	2008-2016

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	Ecological mapping coverage	Raster – 10 m resolution	https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/	Elliott, Lee F., Amie Treuer-Kuehn, Clayton F. Blodgett, C. Diane True, Duane German, and David D. Diamond. 2009-2014. Ecological Systems of Texas: 391 Mapped Types. Phase 1 – 6, 10-meter resolution Geodatabase, Interpretive Guides, and Technical Type Descriptions. Texas Parks & Wildlife Department and Texas Water Development Board, Austin, Texas. Documents and Data Available at: http://www.tpwd.state.tx.us/gis/data/downloads#EMS-T	Map development	2016 or most recent available
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 9 & 11 Excel database provided upon request by regional staff	Data entry based on reported occurrences, Level of QA unknown	Quantify reported SSOs	2015-2021
Municipal & Industrial WWTF Discharge Monitoring Reports	Self-reporting monthly discharge and concentration data	concentration bacteria (MPN/100mL or colonies/100mL), flow (MGD)	USEPA Enforcement & Compliance History Online (ECHO) website http://echo.epa.gov/echo/ 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 http://www2.tceq.texas.gov/wq_dpa/index.cfm	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
Waste Application Field Data	Spatial GIS or physical description	Currently Unknown	TCEQ Central Registry http://www15.tceq.texas.gov/crpub/ or TCEQ Public Drinking Water Section	None accessible; TCEQ databases	ID municipal and OSSF sludge application fields	Most recent available

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
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 or most recent
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 http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml	Metadata available with download	Map and source development	2010 or most recent
Address locations	Spatial GIS, point data	Shapefile - points	Arctur, D., D. Maidment (2018). Texas Address and Base Layers Story Map, HydroShare, http://www.hydroshare.org/resource/6d5c7dbe0762413fbe6d7a39e4ba1986	Programmatic	Map and source development, OSSF estimations	N/A
Coastal OSSF permits	Spatial GIS, point data	Shapefile – points	Draft Coastal Zone OSSF data files from TCEQ project managers	None accessible, TCEQ database	Map and source develop, OSSF estimation	N/A
Hydrography	Vector GIS data	Geodatabase – points, polylines, polygons	National Hydrography Data set (NHD)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 source development	2007-2017 (when available)
Deer	Spatial wildlife density	Density (animal per unit area)	Texas Parks & Wildlife Department surveys and/or information from biologists	Jester & Dillard (undated)	Source development	N/A
Cats and dogs	Spatial, pet density	number per household	AVMA 2002 U.S. Pet Ownership data and stakeholder input	[AVMA] American Veterinary Medical Association. 2002. U.S. Pet Ownership and Demographics Source Book.Schaumberg (Illinois): Center for Information Management, American Veterinary Medical Association.	Source development	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
Feral hogs	Spatial feral animal density	Feral hog density (animals per unit area)	TWRI, http://twri.tamu.edu/reports/2009/tr347.pdf TPWD, literature values and stakeholder input	Mellish et al. 2013.	Source development	N/A
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 source development	Present
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 source development, LDC	2020 -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

Section B10: Data Management

Personnel

Jason Gerlich is the TWRI PM and will provide overall project management for TWRI. He is responsible for ensuring that the data are managed according to the data management plan and QAPP.

Dr. Lucas Gregory is the QAO responsible for ensuring that project data are scientifically valid, legally defensible, of known precision, accuracy, integrity, meet the data quality objectives of the project, and are reportable to TSSWCB.

Stephanie DeVilleneuve is the TWRI DM and is responsible for oversight of all acquired data and confirming that all data were appropriately obtained and documented. She is responsible for overseeing all required data control checks on the data.

Systems Design

TWRI uses laptop and desktop personal computers. The computers run Windows 10 operating system or newer. Software includes Microsoft® Word, Microsoft® Excel, Microsoft® Access, and Program R Statistical Software. All GIS analysis will be performed using ArcGIS Pro or newer.

TWRI utilizes Microsoft Teams, OneDrive, and SharePoint for enterprise file services. The enterprise file system utilizes the Microsoft Cloud to ensure secure data storage of critical operational and project files, automated and distributed data backup that meets AgriLife system policies, and automated file versioning. Microsoft Cloud services utilize multiple geographic redundancies that ensure 99.99% data availability in the event of data loss. Any information deleted is also recoverable within 93 days of deletion. File versioning is enabled to automatically save the previous 25 versions of a file so they can be rolled back in the event of file corruption or unintended changes. Microsoft Enterprise Cloud services are described in detail at: https://docs.microsoft.com/en-us/office365/Enterprise/office-365-data-resiliency-overview.

Table B10.1. Hardware and Software used to Support Data Processing

Equipment & software name	Type	Specification	Use
Dell/HP PC Computers	Hardware	Intel Core Processor, 8 GB Ram or more, Windows 10 Enterprise	Support data gathering, data analysis, and report generation.
Microsoft Teams and OneDrive	Software	Enterprise managed software	Project file management and data backup.
ArcGIS Pro or higher	Software	Window interface	Development of maps and spatial analyses

Equipment & software name	Type	Specification	Use
Program R 3.5 or higher and R-Studio	Software	Window interface	Statistical analysis and figure development.
Microsoft Office 2013 and 2016 Software (Excel, Word, PowerPoint)	Software	Windows platform	Data preparation, report writing, presentations.

Data Migration/Transfer/Conversion

Data is processed using Microsoft Excel, Microsoft Access, ArcGIS Pro, and/or Program R. The TWRI DM is responsible for the oversight of the transfer of electronic data files from the Internet to the project directory, which is located on the TWRI Intranet. The various types of data to be downloaded from the Internet are included in Table B9.1. GIS data (e.g. shapefiles, raster datasets, DEMs, etc.) will be downloaded into a GIS project directory. All files created from GIS analyses will be stored in the GIS project directory.

Databases on the Internet are stored in a variety of formats. Some data or files required for the project can be downloaded from the Internet into text or Excel files, where they can be manipulated to create text files or other types of data files that can be used directly in a meta-analysis. Data is downloaded into Excel, R and R-Studio for data management, calculations, and statistical tests prior to being moved into Excel workbooks.

Backup/Disaster Recovery

TWRI utilizes Microsoft Teams, OneDrive, and SharePoint for enterprise file services. The enterprise file system utilizes the Microsoft Cloud to ensure secure data storage of critical operational and project files, automated and distributed data backup that meets AgriLife system policies, and automated file versioning. Microsoft Cloud services utilize multiple geographic redundancies that ensure 99.99% data availability in the event of data loss. Any information deleted is also recoverable within 93 days of deletion. File versioning is enabled to automatically save the previous 25 versions of a file so they can be rolled back in the event of file corruption or unintended changes. Microsoft Enterprise Cloud services are described in detail at: https://docs.microsoft.com/en-us/office365/Enterprise/office-365-data-resiliency-overview

Archives and Data Retention

Complete original data sets are archived on permanent paper and electronic media and retained on-site by TWRI for a retention period specified in section A9.

Information Dissemination

Project updates will be provided to the TSSWCB PM in progress reports and the information will be made available at stakeholder meetings as appropriate. Data collected through this

project will be synthesized into a project final report delivered to TSSWCB at the end of the project. No environmental data collected will be collected as part of the project.

Section C1: Assessments and Response Actions

The following table presents types of assessments and response actions applicable to the QAPP.

Table C1.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	TWRI	Monitor project status and records to ensure requirements are being fulfilled. Monitoring & review performance & data quality	Report to TSSWCB in QPR.
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

In-house review of data quality and staff performance to assure that work is being performed in compliance with the QAPP will be conducted by all entities as needed. If review shows 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 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 TWRI 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 and procedures referenced herein. It is the responsibility of the TWRI PM, in consultation with the TWRI 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 may need to be conveyed to the TSSWCB PM in writing by completion of a CAR (Appendix A) within 30 days of the occurrence (or its discovery).

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 solution, 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 TWRI PM is responsible for implementing and tracking corrective actions. Records of audit findings and corrective actions are maintained by the TWRI PM. Audit reports and corrective action documentation will be submitted to the TSSWCB with the Progress Report.

Section C2: Reports to Management

Quarterly progress reports developed by the TWRI PM 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 TWRI 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 problems. 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 the Medina River Watershed Protection Plan. It will include information detailing the results and findings of LDCs and SWQM work conducted under this QAPP. Items in this report will include a brief description of methodologies utilized and implications of these findings as they relate to watershed plan development and implementation.

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.

Data collected by the TCEQ, the USGS, and the Texas CRP partners have been reviewed, verified, and validated according to the requirements of the respective programs prior to their use in this project. Data acquired from SWQMIS will be reviewed to ensure that the data type and monitoring type are appropriate for FDC/LDC development. Additionally, comments and qualifier codes will also be reviewed to ensure that data are suitable for the FDC/LDC development. The sources of GIS data for the project, e.g., TCEQ, National Hydrography Dataset, National Land Cover Database, NRCS, and U.S. Census Bureau and others, undergo review, verification, and validation of the shapefiles and other spatial resources by their respective programs before the data and information are publicly available and prior to use in this project. Non-geospatial data include SSOs, livestock from the agricultural census, and regulated dischargers and are reviewed for consistency to identify potential errors prior to use.

Section D2: Validation Methods

Data compilations created for this project will be visually screened for errors. Water quality and streamflow data collected by USGS and Texas CRP partners are verified and validated according to 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 TWRI Staff. To verify the correctness of FDCs/LDCs, the TWRI Staff will ensure that the methods for the development of FDCs/LDCs (EPA, 2008) are followed and will verify that data formatting and inputting were done correctly and that outputs were produced error free and appear to be reasonable based on current knowledge.

All other data for this portion of the project (e.g., land use, urban areas, population projections, DEMs, stream layers, and population projections) as provided in Table B9.1 have been collected and made publicly accessible by authoritative sources such as the USGS, USDA, EPA, and U.S. Census Bureau. Data from these sources are considered verified and validated by the agencies providing the data. Regardless, data compilations created for this project will be visually screened for errors. Errors detected by project staff will be reported to the TWRI 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 or corrected prior to further analysis.

The TWRI PM and QAO are responsible for ensuring that project data used for LDCs are scientifically valid, legally defensible, of known precision, accuracy, integrity, meet the data quality objectives of the project, and are reportable to TSSWCB. The TWRI QAO and PM may designate other staff familiar with specific types of data to perform this evaluation. Any suspected errors or anomalous data must be addressed before data validation can be completed.

Section D3: Reconciliation with User Requirements

LDCs

The LDC framework utilized for this project will be used to evaluate bacteria and nutrient loading in relation to flow regimes in the Medina River watershed. This approach will aid in determining pollutant load allocations throughout the watershed.

The LDC results will be described in detail in the watershed protection plan 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.

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 the user by allowing them to visualize watershed features and influences within the watershed that could contribute to the overall bacteria and nutrient loadings. The limitations of maps produced will be described in the project deliverables and conveyed to audiences when discussed. Potential limitations may include accuracy and precision of the land use data and planning documents.

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.

Stiles, T.C., 2001. A simple method to define bacteria TMDLs in Kansas. KS Dept. of Health and Environment. Topeka, KS. http://www.wef.org/pdffiles/TMDL/Stiles.pdf (last accessed, 9/12/2006).

USEPA. 2008. "Development of Duration-Curve Based Methods for Quantifying Variability and Change in Watershed Hydrology and Water Quality." EPA/600/R-08/065. http://www.epa.gov/nrmrl/pubs/600r08065/600r08065.pdf

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Appendix A: Corrective Action Report

SOP-QA-001
CAR #:_____

Date:_____ Area/Location:_____

Reported by:_____ Activity:_____

State the nature of the problem, nonconformance or out-of-control situation:
_____
_____
_____
_____

Possible causes:
_____
_____
_____

Recommended Corrective Actions:
_____
_____
_____

CAR routed to:_____
Received by:_____

Corrective Actions taken:
_____
_____
_____
_____

Has problem been corrected?: YES NO

Immediate Supervisor:_____

Program Manager:_____

TWRI Quality Assurance Officer:_____

TSSWCB Quality Assurance Officer: _____