Clean Water Act §319(h) Nonpoint Source Grant Program

Development of a Watershed Protection Plan for Double Bayou

TSSWCB Project No. 11-08
Revision 2

Quality Assurance Project Plan - Modeling

Texas State Soil and Water Conservation Board

Prepared by:

Geotechnology Research Institute (GTRI)

Effective Period: Upon EPA Approval through March 31, 2016

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

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(281)362-6042
sglenn@harc.edu

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Section A1: Approval Page

Modeling Quality Assurance Project Plan (QAPP) for the *Development of a Watershed Protection Plan for Double Bayou.*

United States Environmental Protection Agency (EPA), Region VI

Name: Curry Jones
Title: EPA Chief State/Tribal Programs Section

Signature: _____ Date:_____

Name: Henry Brewer
Title: EPA Texas Nonpoint Source Project Officer

Signature: _____ Date:_____

Texas State Soil and Water Conservation Board (TSSWCB)

Name: Brian Koch
Title: TSSWCB Project Manager (PM)

Signature:_____Date:_____

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

Signature:_____Date:_____

Geotechnology Research Institute (GTRI)

Name: Stephanie Glenn
Title: GTRI PM

Signature: _____ Date: _____

Name: Alex Cuclis
Title: GTRI QAO

Signature: _____ Date: _____

Section A2: Table of Contents

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List of Acronyms and Abbreviations

CAR	corrective action report
CWA	Clean Water Act
DQO	data quality objectives
GIS	geographic information system
GTRI	Geotechnology Research Institute
EPA	United States Environmental Protection Agency
LDC	load duration curve
PM	Project Manager
QA	quality assurance
QAPP	quality assurance project plan
QAO	Quality Assurance Officer
QC	quality control
QPR	quarterly progress report
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SOP	standard operating procedures
TAMU	Texas A&M University; College Station Campus
TCEQ	Texas Commission on Environmental Quality
TMDL	total maximum daily load
TSSWCB	Texas State Soil and Water Conservation Board
TWRI	Texas Water Resources Institute
USGS	United States Geological Survey

Section A3: Distribution List

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

EPA, Region VI1445 Ross Avenue, Suite 1200 (6WQ-AT)
Dallas, TX 75202-2733

Name: Henry Brewer
Title: EPA Texas Nonpoint Source Project Officer

TSSWCB
PO Box 658
Temple, TX 76503

Name: Brian Koch
Title: TSSWCB PM

Name: Mitch Conine
Title: TSSWCB QAO

GTRI
4800 Research Forest
The Woodlands, TX 77381

Name: Stephanie Glenn
Title: GTRI PM/Data Manager

Name: Alec Cuclis
Title: GTRI Safety Coordinator and QA

Section A4: Project/Task Organization

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

EPA, Region IV – United States Environmental Protection Agency, Dallas, Texas. Provides project oversight and funding at the federal level.

Henry Brewer, EPA 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 quality assurance project plan (QAPP) and QAPP amendments, project progress, and deliverables.

TSSWCB –Texas State Soil and Water Conservation Board, Temple, Texas. Provides project overview at the State level.

Brian Koch, 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 GTRI and TSSWCB. Tracks and reviews deliverables to ensure that tasks in the workplan are completed as specified in the contract. Notifies the TSSWCB QAO of significant project nonconformances and corrective actions taken as documented in quarterly progress reports (QPRs) from the GTRI PM. Enforces corrective action. Reviews and approves QAPP and any amendments or revisions.

Mitch Conine, TSSWCB QAO

Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TSSWCB participants. Responsible for verifying that the QAPP is followed by project participants. Assists the TSSWCB PM on quality assurance related issues. Monitors implementation of corrective actions. Coordinates or conducts audits. Determines that the project meets the requirements for planning, quality assessment (QA), quality control (QC), and reporting under the TSSWCB CWA §319(h) Nonpoint Source Grant Program.

GTRI

Stephanie Glenn, PM/Data Manager

Guides and oversees the work of the GTRI Software Engineer and GIS Analyst. Drafts progress reports and communicates directly with the TSSWCB PM. The Data Manager acquires agency data, and with assistance from other members of the project team, conducts statistical analyses and oversees the final graphic and textual deliverables. The Data Manager acquires the necessary data for modeling, conducts and/or oversees modeling as appropriate. The Data Manager has previous training and

experience with modeling, and will ensure all all team members receive training as needed. The PM also revises and submits the QAPP as needed, distributes the QAPP and revisions to project team members, and ensures that all QA elements of the project are implemented by project staff per the QAPP and workplan. Ensures TSSWCB PM and/or QAO are notified of deficiencies and nonconfomances, and that issues are resolved. Complies with corrective action requirements.

Alex Cuclis, GTRI QAO

Assists the GTRI PM in the development and review of QAPPs and other QA/QC elements of projects as required by GTRI QA guidelines and granting agencies. The QAO is not directly involved in the data validation process at the project level. Data validation is overseen by the GTRI PM.

Jeff Williams, GTRI Software Engineer

Works under the supervision of the GTRI PM to construct and maintain databases required for the Double Bayou Project. The Software Engineer also maintains project servers, and is responsible for all data backups. The Software Engineer follows QA procedures outlined in the QAPP under the direct supervision of the GTRI PM.

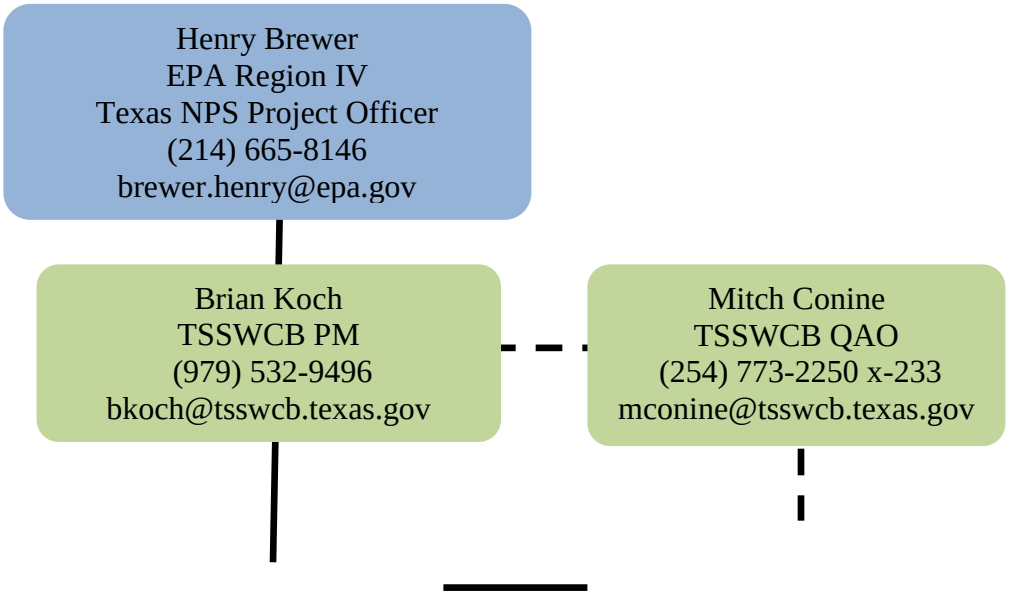
Brad Neish, GTRI GIS Analyst/Webmaster

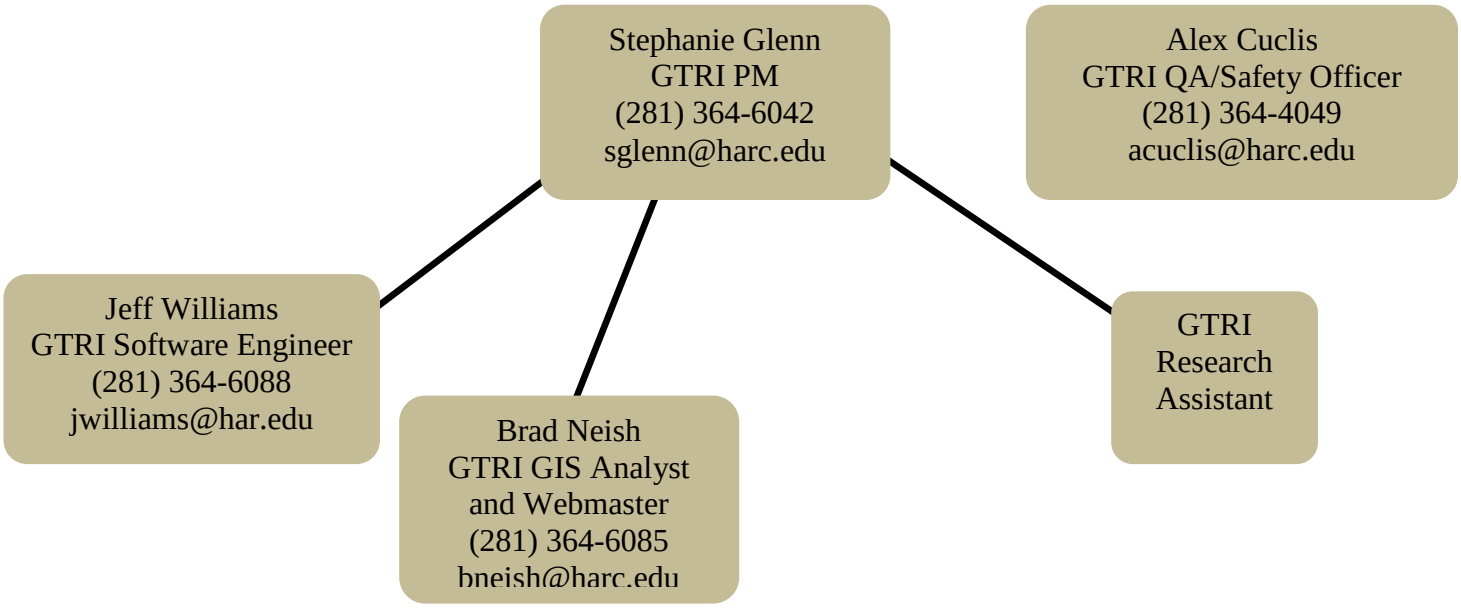
Works under the supervision of the GTRI PM to develop mapping and GIS products required for the Double Bayou Project. The analyst follows QA procedures outlined in the QAPP under the direct supervision of the GTRI PM.

GTRI Research Assistant

Works under the supervision of the GTRI PM to obtain data and associated metadata, and assist with spatial and statistical analyses. The Research Assistant follows QA procedures outlined in the QAPP under the direct supervision of the GTRI PM.

Figure A4.1 - Project Organizational Chart* – Lines of Communication





* See Project/Task Organization in this section for a description of each position's responsibilities.

Section A5: Problem Definition/Background

The purpose of the Double Bayou Watershed Protection Plan project is to develop a nine element Watershed Protection Plan (WPP) for the Double Bayou watershed by establishing and providing direction for a stakeholder group that will serve as a decision-making body, conducting targeted water quality sampling and analysis, identifying and analyzing spatial and temporal patterns in watershed data; and increasing education among targeted audience.

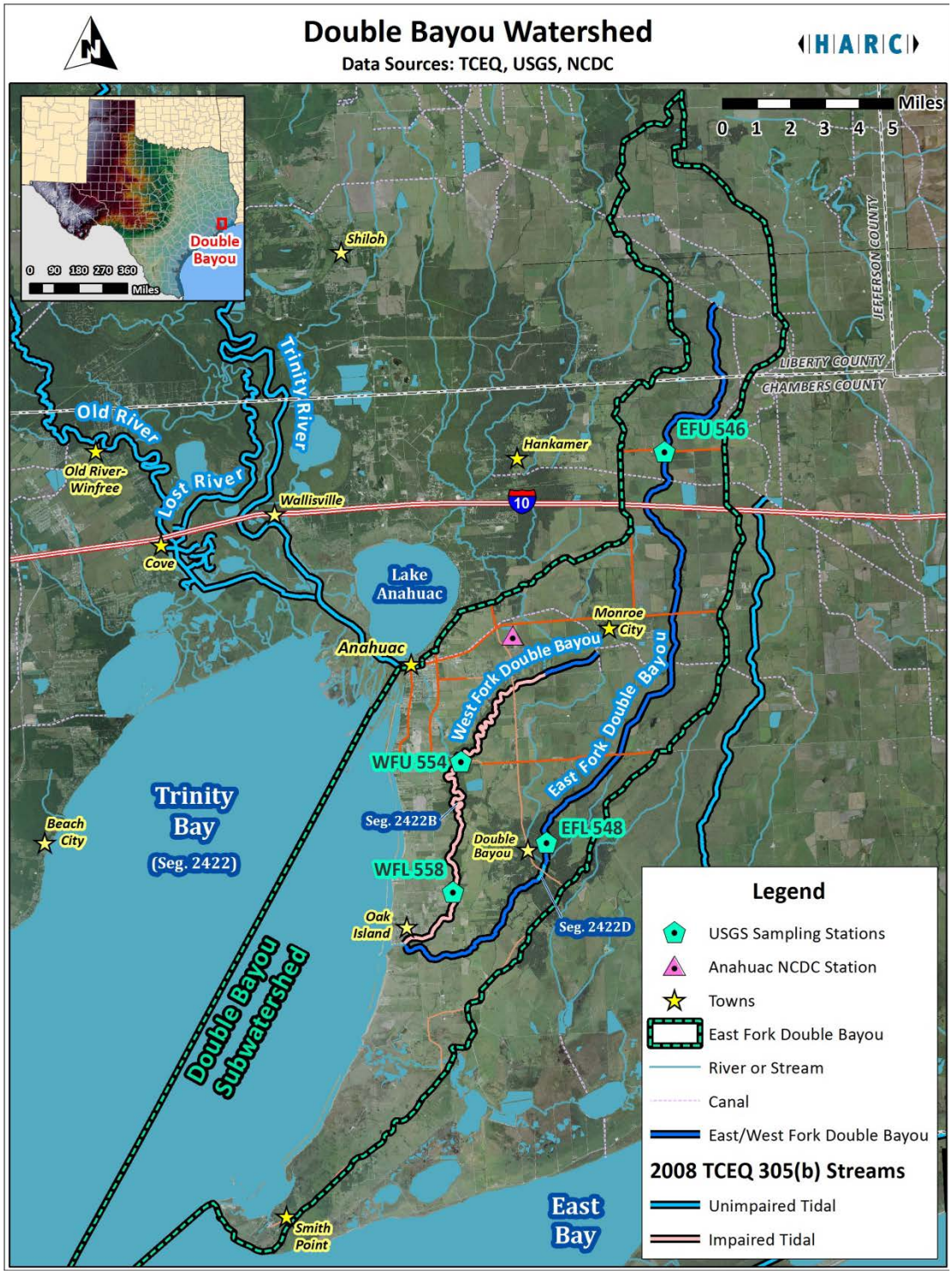
The East and West Forks of Double Bayou are located northeast of Galveston Bay in Chambers County (Figure A5.1). The Double Bayou watershed starts in southern Liberty County and drains to the East and West Forks of Double Bayou, which join at the southern part of the watershed and discharge into Trinity Bay at Oak Island. The total Watershed area is 61,445 acres (about 98 square miles). Due to high bacteria levels, the West Fork of Double Bayou is on the 303(d) list for contact recreation activities, including swimming. In addition, the West Fork of Double Bayou is on the 303(d) for low dissolved oxygen levels, which are stressful for fish and other aquatic life. Some recent studies have also found bacteria and dissolved oxygen issues in the East Fork of Double Bayou as well. While the East Fork is not currently on the 303(d) list as impaired, it is currently listed for "concern" for dissolved oxygen and bacteria levels. The West Fork and the southern portion of the East Fork are considered tidal bayous.

Since 2009, GTRI has worked with the United States Geological Survey and Shead Conservation Solutions with funding from the Galveston Bay Estuary Program (GBEP)/Texas Commission on Environmental Qualtiy (TCEQ), through the American Recovery and Reinvestment Act of 2009 (ARRA), to develop a watershed characterization for Double Bayou. The watershed characterization project included establishing a baseline set of data, identifying data gaps, developing and initiating a Data Monitoring Plan and QAPP, and initial stakeholder work.

The work conducted under this QAPP will provide essential information by incorporating data collected in this TSSWCB project 11-08 and, where appropriate, a previous Texas Commission on Environmental Quality GBEP Grant Agreement 582-9-84999 project entitled "Water Quality: Watershed Characterization Report for the East and West Forks of Double Bayou" into a SELECT model and by developing LDCs for the creek. The SELECT model will utilize a spatially-explicit Geographic Information System (GIS) methodology to identify and rank specific areas of the watershed that likely contribute higher amounts of bacteria to the bayous. The LDCs will be used to specifically determine what level of reductions will be needed to reduce pollutant levels in the bayou. Note that there is only one non-tidal station in the watershed, EFU 546 (see Figure A5.1), and therefore it will be used for LDC development. EFU 546 does not have a flow meter, so the grab samples (which will include single sample flow measurements conducted at the same date and time as the bacteria grab samples are collected) will be used for LDC development. All samples taken from this project and the above mentioned GBEP project will be used for calculations. Stakeholders will use this information to help in selecting best management practices for Double Bayou;

the information will ultimately be used to develop a Watershed Protection Plan for the Double Bayou Watershed.

Figure A5.1 - Double Bayou Watershed and Sampling Locations



Section A6: Project Goals and Task Description

The primary goal of this effort will be to gather basic information to facilitate and support stakeholder decision-making processes as a part of the Double Bayou WPP development process (TSSWCB Project 11-08). At the same time and in the process of plan development, GTRI will determine the level of model-based information necessary to meet the needs of the stakeholders and satisfy EPA's nine key elements for developing WPPs.

GTRI will conduct a statistical trend analysis of historic and existing water quality data for the watershed. Using water quality data collected as part of the WPP effort and assimilated data collected by other entities during the same period as well as the initial baseline data set assembled for the GBEP Watershed Characterization Reprot, GTRI will conduct statistical analysis of trends and spatial patterns in water quality in Double Bayou. Water quality data will be analyzed using non-parametric trend analysis tests. Data will be compared to both regulatory and toxicologically significant endpoints where appropriate. All monitoring and data analysis efforts will be conducted under existing EPA/TSSWCB-approved Quality Assurance Project Plans (QAPPs).

GTRI will develop Load Duration Curves (LDCs) to determine load reductions needed to achieve water quality goals for bacteria on the one non-tidal station (upper East Fork) in the watershed. The developed LDCs will be consistent with EPA's Approach for Using Load Duration Curves in the Development of TMDLs (EPA 2007a), EPA's Options for Expressing Daily Loads in TMDLs (EPA 2007b) and EPA's Development of Duration-Curve Based Methods for Quantifying Variability and Change in Watershed Hydrology and Water Quality (EPA 2008). This analysis will provide a goal for needed bacteria load reductions and aid in identifying potential sources of bacteria based on flow conditions. Any other constituents that are identified as constituents of concern will also be considered for LDC development, dependent on data availability.

LDCs are a simple and an effective first-step methodology to obtain data-based Total Maximum Daily Loads (Cleland, 2003) that are graphical representations of streamflow and pollutant loading. A duration curve is a graph that illustrates the percentage of time during which a given parameter's value is equaled or exceeded by plotting the daily value average of streamflow (volumetric) by percent of days a load is exceeded. For example, a flow duration curve uses the hydrograph of the observed stream flows to calculate and depict the percentage of time the flows are equaled or exceeded.

As mentioned previously, the sampling station at upper East Fork should have just the minimum number of samples necessary to calculate a scientifically defensible LDC. Experts at the Texas Watershed Planning Short Course in August 2009, offered by the Texas Water Resources Institute of Texas A&M University in Bandera, Texas, stated that 20-24 samples are the minimum number of samples required to calculate representative flow and load duration curves. There are six samples of flow with constituent from the upper East Fork sampling station sampled for the Galveston Bay Estuary Program's previous project,

Watershed Characterization Report for the East and West Forks of Double Bayou. At the end of the current TSSWCB 11-08 project, there will be an additional 24 samples of flow with constituents from the upper East Fork sampling station. Load duration curves will be important to ascertain the health of the watershed.

GTRI will also be responsible for evaluating bacterial contamination sources in Double Bayou watershed using SELECT. Information collected in the development of the GIS inventory, water quality monitoring and LDC development will be incorporated into SELECT to determine bacteria loads for specific areas of the watershed. The SELECT approach will also provide an appropriate ranking of each pollutant source based on its potential to contribute to the overall bacteria loading in the watershed.

A spatially-explicit tool, SELECT was originally developed as a model for rural areas that are experiencing growth; the model aids in developing an inventory of potential bacterial sources and distributing loads based on land use classification data, watershed delineation, soils, demographics, and other data. The model identifies subwatersheds with the greatest contamination potential. Note that SELECT tends to overestimate potential sources because it does not account for mitigation processes in the watershed. SELECT spatially references the sources to the sub-watershed level using an ArcGIS platform. SELECT will calculate and allocate pathogen loading to a stream from various sources within a watershed. Once the watershed profile is developed for each potential source, the information can be aggregated to the sub-watershed level to identify the top contributing areas in the watershed.

As discussed in the QAPP "Development of a Watershed Protection Plan for Double Bayou TSSWCB Project No. 11-08 Revision No. 2 Monitoring Quality Assurance Project Plan", a flow meter was installed at WFL558 to measure both positive (ebb) and negative (flows). Using this data the team will perform a watershed tidal kinetic analysis to determine loads during ebb and flood tides as well as load percent reductions necessary for meeting stakeholder goals.

Table A6.1 summarizes the project plan milestones for the modeling efforts represented in the tasks above.

Table A6.1 QAPP Tasks and Milestones

Task	Project Milestones	Agency	Start	End
2.1	Develop DQOs and QAPP for review by USEPA.	GTRI, USGS	M1	M3
2.2	Submit revisions to QAPP as necessary.	TSSWCB, GTRI, USGS	M4	M48
5.1	GTRI will conduct a statistical trend analysis of all historic and existing water quality data for the watershed. Using water quality data collected through Task 4 and assimilated data collected by other entities during the same period, GTRI will conduct statistical analysis of trends and spatial patterns in water quality in Double Bayou.	GTRI	M20	M44

Task	Project Milestones	Agency	Start	End
5.2	GTRI will develop LDCs for the non-tidal portion of the watershed for at least one critical index site per assessment unit to determine load reductions needed to achieve water quality standards. LDCs will be developed using water quality data collected through Task 4 and assimilated data, if any, collected by other entities during the project period. LDCs shall be consistent with 1) EPA's An Approach for Using Load Duration Curves in the Development of TMDLs, 2) EPA's Options for Expressing Daily Loads in TMDLs, and 3) EPA's Development of Duration-Curve Based Methods for Quantifying Variability and Change in Watershed Hydrology and Water Quality.	GTRI	M20	M44
5.3	GTRI will utilize SELECT to model pollutant loadings from across the watershed. Utilizing information from the ARRA-funded watershed characterization, SELECT will be developed for the entire watershed, tidal and non-tidal portions. Modeling will be used to estimate loadings from various sources and to identify critical loading areas within the watersheds.	GTRI	M20	M44
5.4	GTRI will use data from Task 4 to analyze pollutant loadings and needed load reductions in the tidal portion of the watershed. There will be a quantitative analysis of the tidal mixing processes between Double Bayou and the Galveston Bay system. The watershed tidal kinetic analysis will be used to understand percent changes over time at which tidal mixing removes pollutants from the bayou.	GTRI	M28	M44
5.5	Using the results from Subtasks 5.1 and 5.2, GTRI will develop a technical report that further defines water quality problems, assesses critical and possible source areas, and discusses loading estimates.	GTRI	M20	M44

Section A7: Quality Objectives and Criteria for Data as Model Inputs

GTRI will conduct a modeling effort to develop pollutant source and loading information and estimates of needed pollutant reductions. The objectives of the water quality modeling for this project will support the needs of the stakeholders and satisfy EPA's nine key elements for developing WPPs are as follows:

1) Develop and obtain approval for a QAPP
2) Conduct a statistical trend analysis of all historic and existing water quality data for the watershed.
3) Develop LDCs to analyze the temporal trends in the observed water quantity and quality data for the watershed. The LDCs will be developed using water quality data collected under this WPP effort as well as the previous Watershed Characterization Report project.
4) Spatially characterize and rank sources of bacteria within the watershed using SELECT, a spatially-explicit GIS methodology. Use subwatershed areas and identify, quantify and rank pollutant loads from various sources, i.e. agriculture, urban/human, wildlife, and other sources in the study area.

Statistical Trend Analysis

Historical data from the watershed will be evaluated for trends and variability, both spatially and temporally between sampling locations and for the watershed as a whole.

LDC

Load duration curves show the relationship between flow and water quality. They are used as a tool to quantify pollutant loads and load reductions by comparing stream flow and pollutant concentrations. They identify critical hydrological conditions in which the waterbody does not meet the standard for any specific pollutant. In cases of exceedances of the standard, it is necessary to determine the required load reduction in that region near the monitoring station.

SELECT

The Spatially Explicit Load Enrichment Calculation Tool (SELECT) is developed in an ArcGIS 9.X environment. SELECT was originally developed as a model for rural areas that are experiencing growth; the model aids in developing an inventory of potential bacterial sources and distributing loads based on land use classification data, watershed delineation, soils, demographics, and other data. The model identifies subwatersheds with the greatest contamination potential. SELECT tends to overestimate potential sources because it does not account for mitigation processes in the watershed. Since SELECT predicts bacteria loading to land areas, which cannot be representatively sampled, there are no calibration parameters in SELECT. To assist in assessment of most likely bacteria sources, SELECT calculates potential (not actual) bacteria loading to the ground surface (not into a waterbody).

Distributions for input parameters for SELECT will be created based on literature values and expert knowledge. Loads from each land use will be generated by SELECT.

Tidal kinetic analysis

The data from the tidal flow meter installed at WFL558 will be used in a watershed tidal kinetic analysis - much like a load duraction curve, this analysis will use observed stream flows to calculate and depict the percentage of time the flows are equaled or exceeded. The first step will be in determining tidal trends for each sample measurement time and categorizing the data into flow groups (high, medium low for ebb flow and appropriate groupings for flood flow). Slack tides, as appropriate, will be represented as well. This will allow for identification of critical hydrological conditions in which the waterbody does not meet the standard for bacteria and determine the necessary load reductions. In addition, the analysis will be able to determine if there is a statistically significant difference between flood flow bacteria and ebb flow bacteria, contributing to the understanding of the degree of effect of tidal effects on pollutant loads.

Section A8: Special Training Requirements/Certification

All personnel involved in model 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

Records produced by this project will consist of the results of data and modeling analysis. Progress reports on data and modeling analysis will be submitted quarterly. Data validation and QA checks will be conducted by the GTRI PM, GTRI GIS Analyst, and GTRI Software Engineer. Copies of data documentation generated by GTRI project personnel and agency metadata will be stored on the server and backed up to a tape drive on a weekly basis. The Double Bayou Watershed Project will ensure against catastrophic loss of data (e.g. physical damage/data loss due to fire or storm damage) by storing data backups offsite at a secure location per data backup procedures implemented by the GTRI Information Technology (IT) Department.

All data reports, summaries, and other project documentation will be retained in a specially designated folder on the server. Only GTRI project staff will have access to these password-protected project files and documentation. CDs containing backed up information and all data reports, summaries, and other project documentation will be retained by the GTRI PM for one year after completion of the project. At the end of that one-year period, all backup discs, data reports, summaries and documentation will be transferred to the TSSWCB PM who will retain the backup materials for a minimum of five years following the grant closing date.

The data report and web-based products will be organized according to data type (water quality, land use, etc.). Contributing agency programs, their quality assurance procedures, the parameters for which values are obtained, and associated metadata will be described (see Section B9). All statistical programs used to produce output submitted to the TSSWCB PM will be documented as well as the form and content of the output.

All records, including modeler's notebooks and electronic files, will be archived by GTRI for at least five years. These records will document model testing and evaluation and 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, and sensitivity analyses results.

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

A technical report detailing the results of the trend, statistical and SELECT modeling analyses, LDCs development, and watershed kinetic analysis will be developed. Outcomes will be discussed with the Double Bayou WPP stakeholder group and utilized in the development of the WPP. All files used to produce the technical reports will be saved electronically by GTRI for at least seven years.

Corrective Action Reports (CARs) will be utilized when necessary (Appendix A). CARs will be maintained in an accessible location for reference at GTRI 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 when appropriate.

The documents that describe, specify, report, or certify activities are listed in Table 3.

Table A9.1 - Project Quality Assurance Documents and Records

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	GTRI	7 years	Electronic/Paper
QAPP distribution documentation	GTRI	7 years	Electronic/Paper
Modeler's notebooks or data sheets	GTRI	5 years	Electronic/Paper
Corrective Action Reports (CARs)	GTRI	5 years	Paper/Electronic
Progress report/final report/data	GTRI	7 years	Electronic/Paper

The TSSWCB may elect to take possession of records at the conclusion of the specified retention period. Further, as requested, the model and its inputs and outputs will be delivered to the TSSWCB.

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 will be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP.

QAPP amendments may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address deficiencies and nonconformance; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Written requests for amendments are directed from the GTRI PM to the TSSWCB PM and are effective immediately upon approval by the TSSWCB PM and QAO, and EPA Project Officer. Amendments to the QAPP and the reasons for the changes will be documented and distributed to all individuals on the QAPP distribution list by the GTRI PM or designee. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process.

Section B1: Sampling Process Design (Experimental Design)

Not relevant.

Section B2: Sampling Method Requirements

Not relevant.

Section B3: Sample Handling and Custody Requirements

Not relevant.

Section B4: Analytical Methods

Not relevant.

Section B5: Quality Control Requirements

Not relevant.

Section B6: Equipment Testing, Inspection, & Maintenance Requirements

Not relevant.

Section B7: Instrument Calibration and Frequency

Not relevant.

Section B8: Inspection/Acceptance Requirements for Supplies and Consumables

Not relevant.

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

Water quality data collected by TCEQ and the Trinity River Authority will be used for the analyses. Currently, routine ambient monitoring is conducted once per quarter year at one station by TCEQ (10657; field, conventional, and bacteria parameters only) and at two stations by the Trinity River Authority (18361, 10658; field and conventional parameters only) through the Clean Rivers Program. The Clean Rivers Program collects data on a regular basis for routine water quality assessment as part of the state's mandate for CWA §305(b) – Water Quality Inventory Report. These data also are used by Texas for consideration of water bodies to be added to their list of impaired water body segments, as described in CWA §303(d).

Data collected under the *Watershed Characterization Report for Double Bayou* project (GBEP Project) will also be used to develop statistical and modeling analyses. These data were taken in accordance with the approved QAPP for the project and encompasses data collected during Fall of 2009 and Spring of 2010. Data that may be used from this project include water quality and streamflow information.

All data used in the modeling procedures and data analysis for this project are collected in accordance with the approved Monitoring QAAP for the project that follows quality assurance measures under the state's Clean Rivers Program, TCEQ, Texas Water Development Board, USDA, National Weather Service, or USGS.

GIS data to be used are listed in Table B9.1. Depending on the availability of the GIS layers from different data sources, efforts will be made to update the spatial data to the most recent year. GIS analysis will be conducted using ArcGIS Desktop 10.1, ArcScene 10.1, ArcHydro, and the following ArcGIS extensions: 3D Analyst, Geostatistical Analyst, and Spatial Analyst. In addition to the GIS data collected digitally, hard-copy maps have been acquired from local sources and will be geo-referenced and digitized to create unique digital datasets. All of the listed data sets will be evaluated for use in the SELECT modeling process; as soon as all possible sources are listed by the stakeholders the final list of data sets for the SELECT process will be created.

Since SELECT predicts bacteria loading to land areas, which cannot be representatively sampled, there are no calibration parameters in SELECT. To assist in assessment of most likely bacteria sources, SELECT calculates potential (not actual) bacteria loading to the ground surface (not into a waterbody). Since data are not available to determine actual bacteria loading to the ground surface across a watershed, calibration of SELECT predictions to field data is not possible and will not be performed. A qualitative assessment of model outputs will evaluate appropriate incorporation of data inputs; results of the assessment will be reported in the project-associated reports (Double Bayou WPP).

Table B9.1 GIS Data Sets

Dataset	Source	Date(s)
National Agricultural Imagery Program aerial photography	USDA Farm Service Agency	2006, 2008, 2010
Land Use Land Cover polygons	USGS Geographic Information Retrieval and Analysis System	1979
30m National Land Cover Dataset	USGS Land Cover Institute	1992
30m Coastal Land Use Land Cover	NOAA Coastal Change Analysis Program	1996, 2005
Croplands	USDA National Agricultural Statistics Service	2008-2011
Agricultural Census crop totals	USDA National Agricultural Statistics Service	2007
Soil Survey Geographic Data	USDA Natural Resources Conservation Service	1976
1m Digital Elevation Model	USGS Coastal and Marine Geology Program	2005
3m National Elevation Dataset	USGS	multiple
30m National Elevation Dataset	USGS	multiple
Climate Averages (Min/Max Temperature, Precipitation)	Oregon State University's PRISM Model	1971-2012
Level II, III, IV Ecoregions	EPA	multiple
National Hydrography Dataset	USGS	multiple
On-site Sewage Facilities (septic)	Houston-Galveston Area Council	2002-2008
Census SF1-SF4	US Census	1980, 1990, 2000, 2010

Section B10: Data Management

Data Errors and Loss

For data processing and management, the introduction of errors and loss of data will be managed through procedures for record keeping and auditing. Documentation will describe project personnel that made changes and the time at which the changes were made. Every time a file is changed significantly it is saved in a new version and the old version will be archived. New file names and locations will be recorded in the database documentation. Archival files will be deleted when the data updates are received from the responsible agency and the data processing cycle starts over. Periodic comparisons between recent and early versions will be used to detect problems and quality assurance training will be implemented if problems are detected.

Record Keeping and Data Storage

For data processing and management, this project is built upon the use of computing and electronic communications resources for the transfer, processing and maintenance of data. GTRI staff will manage the project's computing resources currently housed at GTRI. The project staff will coordinate with the GTRI IT Department to ensure that server and network maintenance will minimally interfere with project computing, storage, and network connectivity needs. All data for this project will be backed up to other server locations and to tape prior to any server or network maintenance.

Data Handling, Hardware, and Software Requirements

For data processing and management, three servers with dual processors and a high capacity hard drives will be used for this project. All of the other computing resource components will be employed as part of the GTRI computing network. GTRI employs security systems and software to protect the data from virus infection and tampering by unauthorized users. The GTRI IT Department and the Double Bayou Watershed project staff work together to administer user rights by means of password protection to limit access to the project's data files. The data servers are equipped with writable CD drive or tape backup and an archival system to provide additional security. The data servers also have emergency power supplies.

The project will use Microsoft software packages for processing and maintaining the data: Microsoft (MS) SQL Server, Access and Excel. ArcView will be used to produce maps. SPSS, S-Plus, and Analyse-It will be used to perform statistical analyses. MS Access and SQL Server will be used as the database maintenance software packages. Web products will be created using .HTML, .ASP, and .NET languages. Data sets processed for access by personnel not directly involved in data management or analysis will be provided with read-only permission.

Section C1: Assessments and Response Actions

Table C1.1 presents the types of assessments and response actions for activities applicable to the QAPP.

Table C1.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party(ies)	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	GTRI	Monitoring of the project status and records to ensure requirements are being fulfilled. Monitoring and review of performance and data quality.	Report to project lead in Quarterly Report
Technical Systems Audit	Minimum of one during the course of this project.	TSSWCB QAO	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Facility review and data management as they relate to the project.	30 days to respond in writing to the TSSWCB QAO to address corrective actions

In addition to those listed above, the following assessment and response actions will be applied to modeling activities. As described in Section B9 (Non-direct Measurements), modeling staff will evaluate data as model input according to criteria discussed in Section A7 (Quality Objectives and Criteria for Model Inputs/Outputs Data) and will follow-up with the various data sources on any concerns that may arise.

Results will be reported to the project QAO in the format provided in Section A9. 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 (Appendix A) will be filled out to document the problems and the remedial action taken. Copies of CARs will be included in QPRs and will discuss any problems encountered and solutions made. The Quality Assurance reports are the responsibility of the GTRI QAO and PM and will be disseminated to individuals listed in section A3.

Software requirements, software design, or code are examined to detect faults, programming errors, violations of development standards, or other problems. All errors found are recorded at the time of inspection, with later verification that all errors found have been successfully corrected. Software used to compute model predictions are tested to assess its performance relative to specific response times, computer processing usage, run time, convergence to solution, stability of the solution algorithms, the absence of terminal failures, and other quantitative aspects of computer operation.

Checks are made to ensure that the computer code for each module is computing module outputs accurately and within any specific time constraints. The full model framework is tested as the ultimate level of integration testing to verify that all project-specific requirements have been implemented as intended. All testing performed on the original version of the

module or linked modules is repeated to detect new “bugs” introduced by changes made in the code to correct a model.

Modeling data and project deliverables will be quality controlled by the TSSWCB PM in-house review. The TSSWCB PM will maintain overall responsibility for examining GTRI’s work to ensure methodologies and processes are consistent with the procedures outlined in this QAPP.

The TSSWCB QAO (or designee) may conduct an audit of the technical systems activities for this project as needed. The GTRI PM 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 GTRI 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.

Section C2: Reports to Management

Quarterly progress reports developed by the GTRI PM will note activities conducted in connection with the water quality modeling and analysis 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 at GRTI 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. A technical report detailing the results of the trend, statistical and SELECT analyses, LDCs development, and watershed kinetic analysis will be developed. Outcomes will be discussed with the Double Bayou WPP stakeholder group and utilized in the development of the WPP.

Section D1: Data Review, Validation and Verification

All data obtained will be reviewed, validated, and verified against the data quality objects outlined in Section A7 (Quality Objectives and Criteria). Only those data that are supported by appropriate QC will be considered acceptable for use.

The procedures for verification and validation are described in Section D2, below. The GTRI PM is responsible for ensuring that data are properly reviewed, verified, and submitted in the required format for the project database. Finally, the GTRI QAO is responsible for validating that all data collected meet the DQOs of the project and are suitable for reporting.

Section D2: Validation Methods

There is no validation and calibration for either the historical trend analysis, the SELECT model or LDC (as they are data processors). Sensitivity analysis will be conducted to better understand the relationship of inputs to outputs in anticipation of changing conditions in the watershed.

Section D3: Reconciliation with User Requirements

Determination of which management questions to model and analyze is derived from the needs of the planning process of the Double Bayou Watershed Stakeholder group. The GTRI project management will work with the data users who participate in the Double Bayou Watershed Stakeholder group. Specific requests from data users for changes in analyses will be accommodated if the request is made through the Double Bayou Watershed Stakeholder group leader.

The modeling framework developed for this project will be used to evaluate loadings in the Double Bayou Watershed. It will provide information pertaining to watershed characteristics and to the prediction of possible pollution, the sources of this pollution and will provide critical information to assist in identifying management practices to prevent pollution loading in area streams. This, in turn, will be useful for incorporation in the WPP being developed under TSSWCB Project 11-08.

The final data will be reviewed to ensure that it meets the requirements as described in this QAPP. CARs will be initiated in cases where invalid or incorrect data have been detected. Data that have been reviewed, verified, and validated will be summarized for their ability to meet the DQOs of the project and the informational needs of water quality agency decision-makers. These summaries, along with a description of any limitations on data use, will be included in the technical report.

The SELECT modeling framework developed for this project will be used to evaluate bacteria loading in the Double Bayou watershed. It will provide information pertaining to watershed characteristics and to the prediction of possible pollution, the possible sources of this pollution, and will provide critical information to assist in identifying best management practices to mitigate future pollution loading. The LDC framework utilized for this project will be used to evaluate loading in relation to flow regimes in Double Bayou. This, in turn, will be useful for incorporation in the WPP being developed under TSSWCB Project 11-08.

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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.

USEPA. 2007a. "An Approach for Using Load Duration Curves in the Development of TMDLs." EPA 841-B-07-006. http://www.epa.gov/owow/tmdl/duration_curve_guide_aug2007.pdf

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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

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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:_____

GTRI Quality Assurance Officer:_____

TSSWCB Quality Assurance Officer:_____