APPENDIX F

QAPP Rev 2

Total Maximum Daily Loads for Fecal Pathogens in The Clear Creek Watershed Quality Assurance Project Plan

Revision 2

USEPA QTRAK#: TBD
EPA Grant #: 9962704-4

Grant Title: PPG FY2004/2005

Hanadi Rifai, Project Manager
University of Houston
4800 Calhoun, Building 1, Room N107
Houston, Texas 77204-4003
(713) 743-4271
rifai@uh.edu

Total Maximum Daily Load Program
Environmental Planning and Implementation Division
Texas Commission on Environmental Quality
P.O. Box 13087, MC - 150
Austin, Texas 78711-3087

Effective Period for entire project June to August 2005

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

A1 Title and Approval Page
Total Maximum Daily Loads for Fecal Pathogens in the Clear Creek Watershed

Texas Commission on Environmental Quality
Office of the Chief Engineer
Air Quality Planning and Implementation Division

Tom Weber, Manager Date
Water Section of Chief Engineer's Office

Faith Hambleton, TMDL Supervisor Date
Water Section

Ronald Stein, Project Manager Date
Total Maximum Daily Load Program

Faith Hambleton, Special PPG Grant Manager Date

Office of Compliance and Enforcement
Compliance Support Division

Jose A. Franco, Director Date
Compliance Support Division

Stephen Stubbs, Manager Date
Quality Assurance Program

Kyle L. Girten, QA Specialist Date
Quality Assurance Program

Monitoring Operations Division

Dr. David W. Sullivan, Manager Date
Monitoring Data Management and Analysis Section

University of Houston/Parsons Water and Infrastructure

Hanadi S. Rifai, Project Manager Date
University of Houston

Mel Vargas, Project Principal Date
Parsons Water and Infrastructure

Sandra de las Fuentes, Project QAO Date
Parsons Water and Infrastructure

Note: The University of Houston Quality Assurance Officer will secure written documentation (such as the letter in Appendix G) from each sub-tier project participant (e.g., subcontractors, other units of government, laboratories) stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan and any amendments or revisions of this plan. The University of Houston Quality Assurance Officer will maintain the documentation as part of the project's quality assurance records, and will ensure that the document is available for review. **Copies will also be submitted as deliverables to the TMDL Project Manager within 60 days of QAPP approval.**

U.S. Environmental Protection Agency, Region 6

Olivia Balandran, Chief Date
Assistance Programs Branch

Sylvia Ritzky, Project Officer Date
Water Quality Division

A2 Table of Contents

Tables

Figures

A3 Distribution List

Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Office of the Chief Engineer
Air Quality Planning and Implementation Division
Ronald Stein, TMDL Project Manager
MC-203
(512) 239-4507

Office of Compliance and Enforcement
Compliance Support Division
Kyle L. Girten, Quality Assurance Specialist
MC-176
(512) 239-0425

Monitoring Operations Division
Dr. David W. Sullivan, Manager
Monitoring Data Management and Analysis
MC-165
(512) 239-1716

Patrick Roques
Surface Water Quality Monitoring
MC-165
(512) 239-4604

TCEQ Field Operations Division
Elston Johnson, Water Program Manager
MC-174
(512) 239-6266

University of Houston
4800 Calhoun, Building 1, N107D
Houston, TX 77204-4003
Hanadi Rifai, Project Manager
(713) 713-4271

Parsons Water and Infrastructure
8000 Centre Park Drive, Suite 200
Austin, Texas 78754
Mel Vargas, Project Principal
(512)719-6021

Sandra de las Fuentes, Project QAO
(512) 719-6018

University of Houston Laboratory
4800 Calhoun Rd.
Houston, TX 77204-4003
Tina Petersen - Project Representative & QAO
(713) 743-4139

North Water District Laboratory Services
9391 Grogans Mill Suite A4
The Woodlands, TX 77380
Steve Grychka, Project Representative & QAO
(281) 363-8740

Acetech
51 Highland Cir.
Spring, TX 77381
Bin Yu - Laboratory Manager
(281) 363-2233

Eastex Environmental Laboratory Inc.
Coldspring, TX 77331
Jamey Johnson - Laboratory Manager
(936) 653-3249

A&B Environmental Services Inc.
1643 Federal Rd.
Houston, TX 77015
Joe Kresse - Laboratory Manager
(713) 453-6060

U.S. Environmental Protection Agency Region 6
6WQ-AT
1445 Ross Avenue
Suite # 1200
Dallas, TX 75202-2733

Randall Rush, Project Officer
(214) 665-7107

Note: The University of Houston Data Manager will provide copies of this project plan and any amendments or revisions of this plan to each sub-tier project participant, e.g., subcontractors, other units of government, laboratories. The University of Houston/Parsons Water and Infrastructure Quality Assurance Officer will document receipt of the plan by sub-tier participants and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review and will also be submitted to the TMDL Project Manager within 60 days of QAPP approval.

List of Acronyms

APHA	American Public Health Association
AWRL	Ambient Water Reporting Limit
CAR	Corrective Action Report
COC	Chain of Custody
CRP	Clean Rivers Program
CWA	Clean Water Act
DI	Deionized Water
DMP	Data Management Plan
DMRG	Data Management Reference Guide
DO	Dissolved Oxygen
DOC	Demonstration of Capability
DQO	Data Quality Objective
EC	*Escherichia coli*
EN	Enterococci
EPA	Environmental Protection Agency
FR	Federal Register
FRPD	Relative Percent Deviation of Field samples
GPS	Global Positioning System
HDPE	High Density Polyethylene
ISO/IEC	International Standard Organization/International Electrotechnical Commission
LA	Load Allocation
LC	Loading Capacity
LCS/LCSD	Laboratory Control Standard/Laboratory Control Standard Duplicate
LDPE	Low Density Polyethylene
LIMS	Laboratory Information Management System
LRPD	Relative Percent Deviation of Laboratory samples
MAL	Minimum Analytical Level, equivalent to EPA's Minimum Level
MDL	Method Detection Limit
MDMA	Monitoring Data Management and Analysis
MPN	Most Probable Number
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NWDLS	North Water District Lab Services
PES	Performance Evaluation Sample
PI	Principal Investigator
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Management
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist

QMP	Quality Management Plan
RPD	Relative Percent Difference
RL	Laboratory Reporting Limit
SOP	Standard Operating Procedure
SRM	Standard Reference Material
STORET	Storage and Retrieval
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TPDES	Texas Pollutant Discharge Elimination System
TRACS	TCEQ Regulatory Activities and Compliance System
TSS	Total Suspended Solids
TSWQS	Texas Surface Water Quality Standards
UH	University of Houston
USGS	United States Geological Survey
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan

A4 Project/Task Organization

U.S. EPA Region 6
Randall Rush
EPA Project Officer
Responsible for managing the project for EPA. Reviews project progress and reviews and approves QAPP and QAPP amendments.

TCEQ Air Quality Planning and Implementation Division

Faith Hambleton
Water Quality Planning Section Manager
Responsible for managing the TCEQ TMDL Program. Oversees the development of QA guidance for the TMDL Team to be sure it is within pertinent frameworks of the TCEQ. Reviews and approves all TMDL Projects, QA audits, QAPPs, agency QMPs, corrective actions, reports, work plans, and contracts. Enforces corrective action, as required, where QA protocols are not met. Ensures that all TCEQ TMDL personnel are fully trained, and TMDL projects are adequately staffed.

Ronald Stein
TMDL Project Manager
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 the University of Houston and the TCEQ. Tracks and reviews deliverables to ensure that tasks in the work plan are completed as specified in the contract. Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TCEQ participants. Responsible for verifying that the QAPP is followed by the University of Houston. Notifies the TCEQ QAS and TMDL Program Manager of significant project nonconformances and corrective actions taken as documented in quarterly progress reports from University of Houston Project Manager.

Kerry Niemann
TMDL Data Manager
Tracks and verifies data generated by TMDL projects. Responsible for receiving data (Event/Results Files) from TMDL Project Managers, converting the electronic files into Paradox tables, fixing parameter codes, dates, and times and running a Paradox Tools Program that identifies invalid stations, invalid parameter codes, outliers, and orphans. Corresponds deficiencies in data summary form to the TMDL Project Manager to ensure that data deficiencies are addressed by the University of Houston. Provides quality assured data sets to TCEQ Information Resources in compatible formats to be uploaded into the SWQM portion of TRACS. Coordinates correction of data errors with TMDL Project Manager and TCEQ Information Resources Staff.

TCEQ Compliance Support Division

Kyle L. Girten
TMDL Quality Assurance Specialist
Assists the TCEQ TMDL Project Manager on QA-related issues. Reviews and approves the QAPP and any amendments or revisions. Conveys QA problems to appropriate TCEQ management. Monitors implementation of corrective actions. May coordinate or conduct audits.

TCEQ Monitoring Operations Division

Monitoring Data Management and Analysis Data Manager
Reviews QAPP for valid stream monitoring stations, checks validity of parameter, program and source codes, and ensures that data will be reported following the *Surface Water Quality Monitoring Data Management Reference Guide* (2004) or most current version. Receives TMDL data sets from the TMDL data manager, performs validation and verification checks on the data sets with a data validation and verification tool, and checks the data set for errors against data existing in the Surface Water Quality Monitoring (SWQM) portion of the TCEQ Regulatory Activities and Compliance System (TRACS) database. Provides a data summary and historical comparison report to the TMDL project manager and TMDL data manager. Serves as Monitoring Operations data management customer service representative for TMDL Project Manager. Provides training to the TMDL Project Manager to ensure proper data submittal. Reviews and approves QAPPs.

Brenda Archer
TCEQ Surface Water Quality Monitoring Program
Assists the TMDL team by coordinating efforts with SWQM basin assessors in the review of monitoring plans and QAPPs associated with TMDL projects. This review is to ensure that data collected in the project for assessment purposes follows the guidelines set forth in the current *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue* (December 2003) and the Receiving Water Assessment Procedures Manual (June 1999).

TCEQ Field Operations Division

Linda Broach
TCEQ Region 12 TMDL Liaison
Assists in the development of the project’s water quality monitoring plan as appropriate. Ensures that the water quality monitoring plan in Appendix B adequately represents the local water quality conditions that may account for the observed impairment by corresponding with respective FOD Regional Field Staff. Works with the University of Houston to resolve problems with water quality monitoring. Maintains contact with TCEQ Project Manager to ensure coordination of issues.

University of Houston/ Parsons Water and Infrastructure

Hanadi Rifai
University of Houston Project Manager
The University of Houston Project Manager is responsible for ensuring that tasks and other requirements in the contract are executed on time and with the quality assurance/quality control requirements in the system as defined by the contract and in the QAPP; assessing the quality of subcontractor/participant work; submitting accurate and timely deliverables to the TCEQ TMDL Project Manager; and coordinating attendance at conference calls, training, meetings, and related project activities with the TCEQ. Responsible for verifying that the QAPP is distributed to and followed by the University of Houston and sub-tier participants. Responsible for verifying that the project is producing data of known and acceptable quality. Responsible for ensuring adequate training and supervision of all activities involved in generating analytical and field data, including the facilitation of audits and the implementation, documentation, verification and reporting of corrective actions.

Mel Vargas
Parsons Water and Infrastructure Project Principal
Responsible for ensuring that tasks performed by Parsons Water and Infrastructure are executed on time and with the quality assurance/quality control requirements in the system as defined by the contract and in the QAPP; submitting accurate and timely deliverables to the University of Houston Project Manager; and coordinating attendance at conference calls, training, meetings, and related project activities with the University of Houston. Responsible for verifying that the project is producing data of known and acceptable quality. Responsible for ensuring adequate training and supervision of all activities involved in generating analytical data, corrective action taken as well as facilitating internal audits.

Sandra de las Fuentes
Project Quality Assurance Officer - Parsons Water and Infrastructure
Responsible for coordinating development and implementation of the University of Houston/Parsons Water and Infrastructure's QA program. Responsible for writing and maintaining QAPPs and monitoring their implementation. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Ensures the data collected for the project is of known and acceptable quality and adheres to the specifications of the QAPP. Responsible for maintaining written records of sub-tier commitment to requirements specified in this QAPP. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for compiling and submitting the QA report. Responsible for coordinating with the TCEQ QAS to resolve QA-related issues. Notifies the Lead Organization Project Manager and TCEQ Project Manager of particular circumstances which may adversely affect the quality of data. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts assessments of participating organizations during the life of the project as noted in Section C1. Implements or ensures implementation of corrective actions needed to resolve nonconformances noted during

assessments.

Monica Suarez
Project Data Manager - University of Houston
Responsible for the acquisition, verification, and transfer of data to the TCEQ TMDL Project Manager. Oversees data management for the project. Performs data quality assurances prior to transfer of data to TCEQ in the format specified in the SWQM Data Management Reference Guide (2004) or most recent version. Ensures that the data review checklist is completed and data are submitted with appropriate codes. Provides the point of contact for the TCEQ TMDL Project Manager to resolve issues related to the data and assumes responsibility for the correction of any data errors.

Curt Burdorf
Project Field Supervisor - Parsons Water and Infrastructure
Responsible for supervising all aspects of the project sampling and measurement of surface waters and other parameters in the field. Responsible for the acquisition of water samples and field data measurements in a timely manner that meet the quality objectives specified in Section A7 (Table A.1), as well as the requirements of Sections B1 through B8. Responsible for field scheduling, staffing, and ensuring that staff is appropriately trained as specified in Sections A6 and A8. Coordinates any joint monitoring with the TCEQ Project Manager and TCEQ Regional Office TMDL Liaison. Reports status, problems, and progress to the University of Houston Project Manager.

Tina Petersen
University of Houston Laboratory Project Representative and Quality Assurance Officer
Responsible for supervision of laboratory personnel involved in generating analytical data for the project. Responsible for ensuring that UH laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all laboratory operations ensuring that all QA/QC requirements are met, documentation related to the analysis is complete and adequately maintained, and that results are reported accurately. Responsible for ensuring that corrective actions are implemented, documented, reported and verified.

Monitors the implementation of the QAM/QAP within the UH laboratory to ensure complete compliance with project data quality objectives as defined by the contract and in the QAPP. Conducts in-house audits to ensure compliance with written SOPs and to identify potential problems. Responsible for supervising and verifying all aspects of the QA/QC in the laboratory. Ensures that all QA reviews are conducted in a timely manner from real-time review at the bench during analysis to final pass-off of data to the QA Officer.

Steve Grychka - North Water District Laboratory Project Representative/ Bin Yu - Acetech Project Manager/ Jamey Johnson - Eastex Environmental Laboratory Project Manager/ Joe Kresse - A&B Environmental Services Project Manager

Responsible for supervision of their respective laboratory personnel involved in generating analytical data for the project. Responsible for ensuring that their respective laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all laboratory operations ensuring that all QA/QC requirements are met, documentation related to the analysis is complete and adequately maintained, and that results are reported accurately. Responsible for ensuring that corrective actions are implemented, documented, reported and verified.

Steve Grychka - North Water District Laboratory Quality Assurance Officer/ Rita Wells - Acetech Quality Assurance Officer/ Daniel Bowen - Eastex Environmental Laboratory Quality Assurance Officer/ Mark Johnston - A&B Environmental Services Quality Assurance Officer

Monitor the implementation of the quality assurance management plan within their respective laboratories to ensure complete compliance with QA objectives as defined by the contract and in the QAPP. Conduct in-house audits to identify potential problems and ensure compliance with written SOPs. Responsible for supervising and verifying all aspects of the QA/QC in their respective laboratories. Perform validation and verification of data before the report is sent to the University of Houston. Ensure that all QA reviews are conducted in a timely manner from real-time review at the bench during analysis to final pass-off of data to the QA officer.

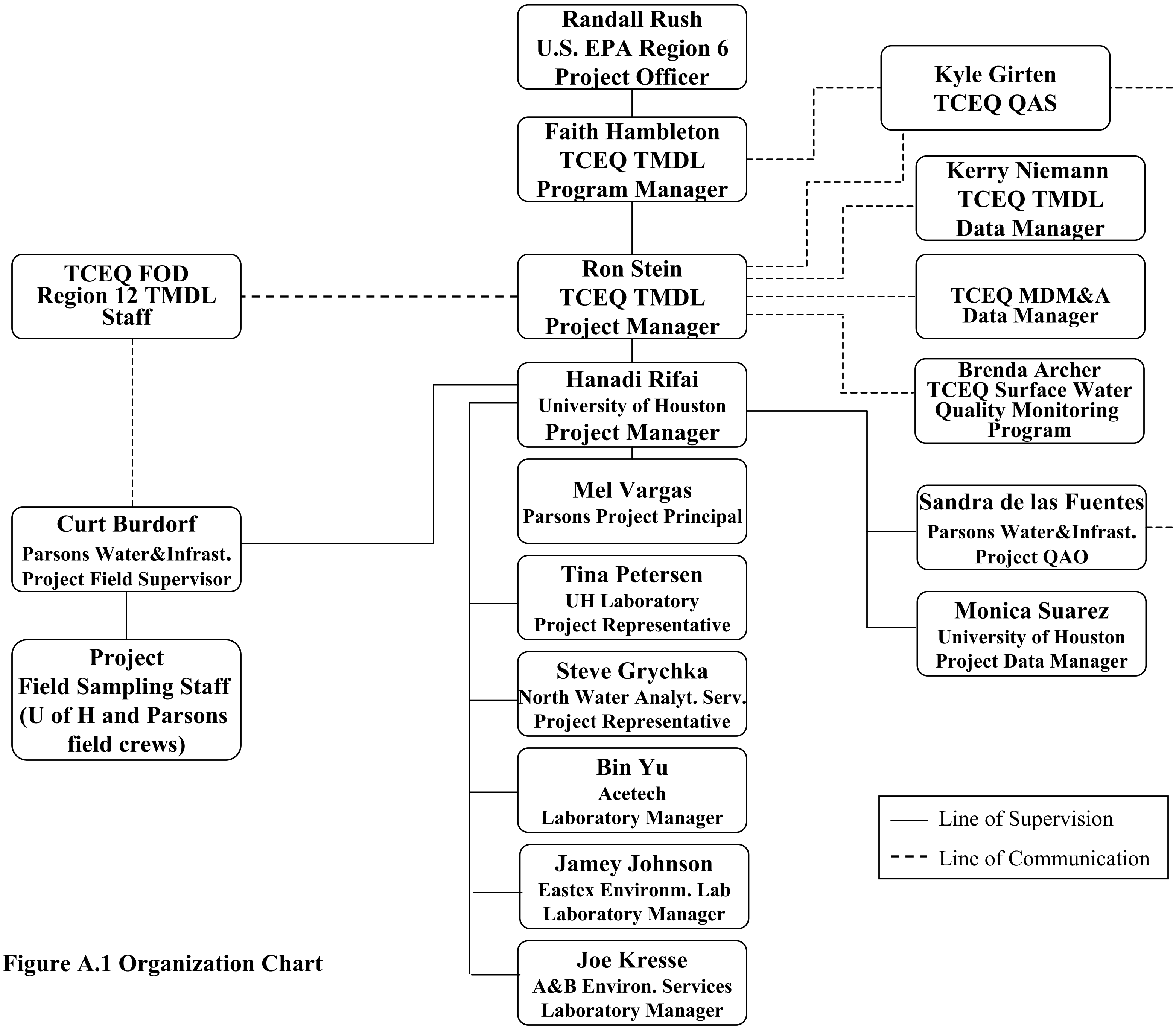

Figure A.1 Organization Chart

A5 Problem Definition/Background

The Texas Commission on Environmental Quality (TCEQ) implements the statewide approach for watershed management in Texas to improve the efficiency, effectiveness, and continuity of water quality management programs. The approach, which is summarized in *The Statewide Watershed Management Approach for Texas: The TCEQ's Framework for Implementing Water Quality Management* (TCEQ, 1997), establishes the state's process for managing water quality. It focuses on assessing watershed conditions for all waters of the state and implementing solutions where improvement is necessary. The primary goal of the approach is to ensure that management efforts provide a safe, clean, affordable water supply and healthy aquatic ecosystems for Texas.

The Total Maximum Daily Load (TMDL) Program, a major component of the approach, addresses impaired or threatened streams, lakes, and estuaries. The primary objective of the TMDL Program is to restore and maintain the beneficial uses of impaired or threatened water bodies. The Federal Clean Water Act §303(d) list identifies "impaired" water bodies not meeting applicable water quality standards for their designated uses and requiring development of TMDLs for contaminants of concern. In general, a TMDL is the total amount of a pollutant that a water body can assimilate and still meet state water quality standards. The term also refers to the assessment necessary to establish an acceptable pollutant load for an impaired water body and to allocate the load between contributing point, nonpoint, and natural background sources of pollutants in the watershed. Thus, water quality monitoring and other assessment activities are an integral part of the TMDL.

Segments 1101 (Clear Creek Tidal), 1101B (Chigger Creek), 1102 (Clear Creek Above Tidal), 1102A (Cowarts Creek), 1102B (Mary's Creek/North Fork Mary's Creek), and 2425C (Robinson's Bayou) have been identified in the 303(d) list as impaired due to elevated levels of bacteria that can negatively impact contact recreation. Consequently, this TMDL study for fecal pathogens in the Clear Creek Watershed is being conducted.

This QAPP addresses the sampling program for the TMDL project. The purpose of the QAPP is to clearly delineate the tasks, management structure, and policies which will be used to implement the Quality Assurance (QA) requirements necessary to document the reliability and validity of environmental data. The QAPP is reviewed by the TCEQ to ensure that data generated for the purposes described above are scientifically valid and legally defensible. This process will ensure that all data submitted to the SWQM portion of the TCEQ Regulatory Activities and Compliance System (TRACS) database have been collected and analyzed in a way that helps to ensure its reliability and therefore can be used in TMDL development, stream standards modifications, permit decisions, and water quality assessments.

Further details on project implementation are addressed in Appendix A, the project work plan, of this Quality Assurance Project Plan (QAPP).

A6 Project/Task Description

Appendix A includes a description of the tasks to be performed, deliverables, and the schedule for this project. This QAPP covers the monitoring tasks described in the work plan. Maps of the monitoring sites and a monitoring table listing sites, parameters, and monitoring dates are provided in Appendix B for the effective period of this QAPP (June 2005 to August 2005).

Planned Measurements

Planned measurements in the field include sampling surface water, sediment, Global Positioning System (GPS) coordinates, standard water parameters (water depth, dissolved oxygen, pH, salinity, conductivity, and temperature), physical water conditions, and ambient weather conditions.

Escherichia coli (EC), the current bacterial indicator for Texas freshwater quality standards, and/or Enterococci (EN), the current bacterial indicator for Texas saltwater quality standards, will be measured in surface water and sediment at several locations in segments 1101, 1101B, 1102, 1102A, 1102B, and 2425C. In addition to the conventional bacteria analysis, related properties will be analyzed to determine any correlation between these parameters and bacteria concentrations. Related properties include turbidity, TSS (total suspended solids), TOC (total organic carbon), orthophosphate, ammonia, volatile solids, total solids, and moisture content.

Station coordinates (latitude and longitude) will be recorded for use in generating any new monitoring station IDs. Coordinates of existing monitoring stations will be verified with GPS.

Revisions to the QAPP

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 TCEQ 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

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address deficiencies and nonconformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the Lead Organization Project Manager to the TCEQ TMDL Project Manager in writing using the TMDL QAPP Expedited Amendment form. The changes are effective immediately upon approval by the TCEQ TMDL Project Manager and Quality

Assurance Specialist, or their designees, and the EPA Project Officer (if applicable). Amendments to the QAPP and the reasons for the changes will be documented, and revised pages will be forwarded to all persons on the QAPP distribution list by the Project QAO.

Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

A7 Quality Objectives and Criteria for Measurement Data

The overall goal for this project is to collect data to support the TMDL development for fecal pathogens in Clear Creek in accordance with the TCEQ data collection and quality assurance protocols. The sampling process design is discussed in section B1 of this QAPP, and the measurement performance specifications to support the project objective are specified in Table A.1. Only data collected which have a valid TCEQ parameter code assigned in Table A.1 will be stored in the SWQM portion of the TRACS database. Any parameters listed in Table A.1 which do not have a valid TCEQ parameter code will not be stored in TRACS.

The QAPP is reviewed by the TCEQ to help ensure that data generated for the purposes described herein are scientifically valid and legally defensible. This review process will also help ensure that data submitted to the SWQM portion of the Texas Regulatory and Compliance System (TRACS) database have been collected and analyzed in a way that guarantees its reliability.

Data will be evaluated continuously by the University of Houston and Parsons Water and Infrastructure, Inc. representatives during the life-term of the project to ensure that they are of sufficient quality and quantity to meet the project goals. If the data do not meet the goals specified in Section A7, they will not be transferred to the TCEQ for upload to the SWQM portion of the TRACS database to ultimately be used in decision-making.

Table A.1 Data Quality Objectives for Field and Laboratory Measurements

PARAMETER	UNITS	MATRIX	METHOD	PARAM. CODES	AWRL	Lab Reporting Limits	PRECISION (RPD of LCS/LCSD)	BIAS (% Rec. LCS/LCSD mean)	Recovery at Reporting Limits	LAB PERFORMING ANALYSIS
Field Parameters										
pH	pH units	water	EPA 150.1 and TCEQ SOP	00400	NA[1]	NA	NA	NA	NA	Field
DO	mg/L	water	EPA 360.1 and TCEQ SOP	00300	NA[1]	NA	NA	NA	NA	Field
Conductivity	uS/cm	water	EPA 120.1 and TCEQ SOP	00094	NA[1]	NA	NA	NA	NA[1]	Field
Turbidity	NTU	water	EPA 180.1	82078	NA	NA	NA	NA	NA	Field
Temperature	◦ C	water	EPA 170.1 and TCEQ SOP	00010	NA[1]	NA	NA	NA	NA	Field
Field-filtered Orthophosphate-P (PO_4)	mg/L	water	HACH Method 8048 (EPA 365.2)	NA[2]	0.04	0.07	20	80-120	75-125	Field/UH lab
Ammonia-N (NH_3)	mg/L	water	HACH Methods 10023 (low range) and 10031 (high range)	NA[2]	0.02	0.08	20	80-120	75-125	Field/UH lab
Flow	cfs	water	TCEQ SOP	00061	NA[1]	NA	NA	NA	NA	Field
Flow severity	1-no flow 2-low 3-normal 4-flood 5-high 6-dry	water	TCEQ SOP	01351	NA[1]	NA	NA	NA	NA	Field

PARAMETER	UNITS	MATRIX	METHOD	PARAM. CODES	AWRL	Lab Reporting Limits	PRECISION (RPD of LCS/LCSD)	BIAS (% Rec. LCS/LCSD mean)	Recovery at Reporting Limits	LAB PERFORMING ANALYSIS
Conventional and Bacteriological Parameters										
TSS	mg/L	water	EPA 160.2	00530	4	4	20	NA[1]	NA	NWDLS/Acetech/ A&B Laboratory/Eastex
TOC	mg/L	water	EPA 415.1	00680	2	2	20	80-120	75-125	NWDLS/Acetech/ A&B Laboratory/Eastex
E. coli, IDEXX Colilert	MPN/100 mL	water	SM 9223-B	31699	1	1	0.54[3]	NA	NA	UH laboratory
E. coli IDEXX Colilert	MPN/100 g	sediment	Project SOP and SM9223B	31702	1	1	0.54[3]	NA	NA	UH laboratory
Enterococci IDEXX Enterolert	MPN/100 mL	water	ASTM D6053	31701	1	1	0.54[3]	NA	NA	UH laboratory
Enterococci IDEXX Enterolert	MPN/100 g	sediment	Project SOP and ASTM D6053	TBD[4]	1	1	0.54[3]	NA	NA	UH laboratory
TOC	mg/kg	sediment	Lloyd Kahn	81951	NA	500	20	80-120	75-125	NWDLS/Acetech/ A&B Laboratory/Eastex
Total solids	% by weight	sediment	SM 2540-G	81373	1	1	20	NA	NA	NWDLS/Acetech/ A&B Laboratory/Eastex
Volatile solids	%	sediment	SM 2540-G	85207	1	1	20	NA	NA	NWDLS/Acetech/ A&B Laboratory/Eastex

PARAMETER	**UNITS**	**MATRIX**	**METHOD**	**PARAM. CODES**	**AWRL**	**Lab Reporting Limits**	**PRECISION (RPD of LCS/LCSD)**	**BIAS (% Rec. LCS/LCSD mean)**	**Recovery at Reporting Limits**	**LAB PERFORMING ANALYSIS**
Moisture Content in Sediment	%	sediment	calculation	82003	1	1	20	NA	NA	NWDLS/Acetech/ A&B Laboratory/Eastex
Sediment Particle Size, Clay	% dry weight < 0.0039 mm	sediment	ASTM D422	82009	1.0	1	NA	NA	NA	NWDLS/Acetech/ A&B Laboratory/Eastex
Sediment Particle Size, Silt	% dry weight 0.0039-0.0625 mm	sediment	ASTM D422	82008	1.0	1	NA	NA	NA	NWDLS/Acetech/ A&B Laboratory/Eastex
Sediment Particle Size, Sand	% dry weight 0.0625-2 mm	sediment	ASTM D422	89991	1.0	1	NA	NA	NA	NWDLS/Acetech/ A&B Laboratory/Eastex

[1] Reporting to be consistent with SWQM guidance and based on measurement capability.
[2] Results will not be submitted to TRACS
[3] Based on range statistic as described in Standard Methods, 20th Edition, Section 9020-B, " Quality Assurance/Quality Control - Intralaboratory Quality Control Guidelines." This criterion applies to bacteriological duplicates with concentrations > 10 org/100 mL.
[4] Parameter code to be determined

References for Table A.1:

United States Environmental Protection Agency (USEPA) "Methods for Chemical Analysis of Water and Wastes," Manual #EPA-600/4-79-020
American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF), "Standard Methods for the Examination of Water and Wastewater," 20th Edition,1999.
TCEQ SOP - TCEQ Surface Water Quality Monitoring Procedures Manual, December 2003 or subsequent editions.
American Society for Testing and Materials (ASTM) Annual Book of Standards, Vol 11.02
HACH Procedures Manual. http://www.hach.com/fmmimghach?/CODE%3A48450226200%7C1

Ambient Water Reporting Limits and Laboratory Reporting Limits

Ambient water reporting limits, or AWRLs, are the specifications at or below which data will be reported to the TCEQ. The laboratory reporting limit (RL) is the lowest concentration at which the laboratory will report quantitative data within a specified recovery range. Ongoing ability to recover an analyte at the AWRL or below is demonstrated through analysis of a calibration or check standard at the laboratory's RL. The AWRL and RL for target analytes and performance limits for RLs are set forth in Table A.1.

The laboratory is required to meet the following:
1. The laboratory's reporting limit for each analyte will be at or below the AWRL; and
2. The laboratory will demonstrate and document on an ongoing basis the laboratory's ability to quantitate at its reporting limits.

Acceptance criteria are defined in Section B5.

Precision

The precision of laboratory data is a measure of the reproducibility of a result when an analysis is repeated. It is strictly defined as a measure of the closeness with which multiple analyses of a given sample agree with each other. Laboratory precision is assessed by comparing replicate analyses of laboratory control standards (LCS/LCSD) and/or sample/duplicate pairs. Performance limits for laboratory control standard/laboratory control standard duplicates are specified in Table A.1

Field splits are used to assess the variability of sample handling, preservation, and storage, as well as the analytical process, and are prepared by splitting samples in the field. Performance limits for field splits are defined in Section B5.

Bias

Bias is a statistical measurement of correctness and includes components of systemic error. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is verified through the analysis of laboratory control standards and blank samples. Performance limits for the mean results of laboratory control standards (LCS/LCSD) and results of calibration control standards at laboratory RLs are specified in Table A.1. Performance limits for blank analyses are discussed in Section B5.

Representativeness

Most data collected under the TMDL Program will be considered representative of ambient water quality conditions. These data will be coded with Program Code TQ in Table 3 of Appendix B. TQ reflects grab data collected under a TMDL QAPP that may also be used to conduct an assessment on a body of water. Data not considered representative of ambient water quality conditions include sediment samples collected along a transect. These data will be coded TN (i.e. data collected under a TMDL QAPP but not to be used for the 305(b)/303(d) assessment). See Table 3 of Appendix B.

Representativeness is a measure of how accurately a monitoring program reflects the actual water quality conditions. The representativeness of the data is dependent on 1) the sampling locations, 2) the number of samples collected, 3) the number of years and seasons when sampling is performed, 4) the number of depths sampled, and 5) the sampling procedures. Site selection and sampling of all pertinent media and use of only approved analytical methods will assure that the measurement data represents the conditions at the site.

The goal for meeting total representation of the water body is tempered by the availability of time and funding. Representativeness will be measured with the completion of samples collected in accordance with the approved QAPP.

Comparability

Confidence in the comparability of data sets from this project to those for similar uses is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP and project SOPs. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in the *Data Management Plan* (Appendix E).

Completeness

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

A8 Special Training/Certification

Field personnel will receive training in proper sampling and field analysis. Before actual sampling or field analysis occurs, they will demonstrate to the Project QAOs their ability to properly calibrate field equipment and perform field sampling and analysis procedures. Training will be documented and retained in the field logbook, field logsheets, or UH/Parsons Water and Infrastructure personnel file and be available during a monitoring systems audit.

Laboratory analysts have a combination of experience, education, and training to demonstrate knowledge of their function. To perform analyses for the TCEQ, laboratory analyst will have a demonstration of capability (DOC) on record for each test that the analyst performs. The initial DOC should be performed prior to analyzing samples and annually thereafter. In cases whereby analysts have been analyzing samples prior to an official certification of capability has been generated, a certification statement is made part of the training record to document the analyst's initial on the job training. Annual DOCs are a part of analyst training thereafter.

Global Positioning System (GPS) training and certification are required in accordance with TCEQ Operating Policies and Procedures 8.12: Global Positioning System. Certification can be obtained by: 1) completing an agency training class, 2) completing a suitable training class offered by an outside vendor, or 3) by providing documentation of sufficient GPS expertise and experience.

A9 Documents and Records

The document and records that describe, specify, report, or certify activities, requirements, procedures, or results for this project and the items and materials that furnish objective evidence of the quality of items or activities are listed.

Parsons Water and Infrastructure will provide their project documents and records at the conclusion of a task for UH to retain. Prior to the completion of a task, Parsons Water and Infrastructure are responsible for their documentation.

Table A.2 Project Documents and Records

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	Univ. of Houston	5 years	Paper
QAPP distribution documentation	Univ. of Houston	5 years	Paper
Field notebooks or field data sheets	Univ. of Houston	5 years	Paper
Field equipment calibration/maintenance logs	Univ. of Houston	5 years	Paper
Chain of custody records	Univ. of Houston	5 years	Paper
Field SOPs	Univ. of Houston	5 years	Paper
Bacteriological field sample logs	Univ. of Houston	5 years	Paper
Media/incubation logs	Lab	5 years	Paper
Laboratory sample reception logs	Lab	5 years	Paper
Laboratory QA manuals	Lab	5 years	Paper
Laboratory SOPs	Univ. of Houston	5 years	Paper
Laboratory internal/external standards	Lab	5 years	Paper
Laboratory instrument performance	Lab	5 years	Paper
Laboratory initial and continuing demonstrations of capability	Lab	5 years	Paper
Laboratory procedures	Lab	5 years	Paper
Instrument raw data files	Lab	5 years	Electronic*
Instrument readings/printouts	Lab	5 years	Paper
Laboratory data reports	Univ. of Houston.	5 years	Paper
Laboratory data verification for integrity, precision, accuracy and validation	Lab	5 years	Paper
Laboratory equipment maintenance logs	Lab	5 years	Paper
Laboratory calibration records	Lab	5 years	Electronic*
Laboratory corrective action documentation	Lab	5 years	Paper
University of Houston data base verification	Univ. of Houston	5 years	Electronic*

Table A.2 Project Documents and Records (Cont'd)

Document/Record	Location	Retention	Form
UH/Parsons data quality assurance/ Quality control verification/validation	Univ. of Houston	5 years	Paper
Field corrective action documentation	Univ. of Houston	5 years	Paper
Copy of data collected by other organizations	Univ. of Houston	5 years	Paper/Electronic*
Training records	Univ. of Houston/Parsons	3 years	Paper/Electronic*
TMDL data files	Univ. of Houston/TCEQ	3 years	Paper/Electronic*
Progress report/final report/data	Univ. of Houston/TCEQ	3 years	Paper/Electronic*
Field demonstration of capability	Univ. of Houston/Parsons	3 years	Paper

* Electronic files should be in industry standard software programs or ASCII (DOS) files.
NOTE: Lab may refer to UH Laboratory or NWDLS/Acetech/Eastex/A&B Environmental Services

The TCEQ may elect to take possession of records at the conclusion of the specified retention period.

Laboratory Data Reports

Data reports from the laboratory will report the test results clearly and accurately. The test report will include the information necessary for the interpretation and validation of data and will include the following:

1. Name and address of the laboratory
2, Name and address of the client
3. A clear identification of the sample(s) analyzed
4. Identification of samples that did not meet QA requirements and why (i.e., holding times exceeded)
5. Date of sample receipt
6. Sample results
7. Field split results (as applicable)
8. Clearly identified subcontract laboratory results (as applicable)
9. A name and title of person accepting responsibility for the report
10. Project-specific quality control results to include LCS results (% recovery), LCSD results (% recovery), the mean results of LCS/LCSD pairs (% recovery), precision of LCS/LCSD pairs (% RPD), equipment, trip, and field blank results (as applicable), and RL confirmation (% recovery)
11. Narrative information on QC failures or deviations from requirements that may affect the quality of results

Electronic Data

UH and Parsons Water and Infrastructure will use the data reporting formats included in the most recent version of the Surface Water Quality Monitoring Data Management Reference Guide (2004). A complete data review checklist (see Appendix F) will accompany each set of electronic data.

References

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1998. *Standard Methods for the Examination of Water and Wastewater*. Eds. L. Clesceri, A. Eaton, and A. Greenberg. 20^{th} Edition. American Public Health Association, Washington. DC.

TCEQ. 2004 (or most recent version). *Data Management Reference Guide, Surface Water Quality Monitoring* (December 2004).

TCEQ. 2003a (or most recent version). *Program Guidance & Reference Guide FY 2004-2005*, Texas Clean Rivers Program.

TCEQ. 2003b (or most recent version). *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue*. Document No. RG-415. (December 2003).

USEPA. 2000. Improved enumeration methods for the recreational water quality indicators: Enterococci and E. coli. EPA-821-R-97-004.

Note: when references are made to documents that are not attached to the QAPP, the Project Manager of the University of Houston assumes responsibility for compliance of the documentation with the QAPP requirements.

B1 Sampling Process Design

The sampling process design for this investigation is based on the need to obtain bacteria data in the Clear Creek watershed from the headwaters to the confluence of Robinson's Bayou at Clear Creek in League City, Texas. The limited time available due to the fiscal year end of this investigation imposes constraints on the sample process design. Based on an anticipated date for QAPP and Work Plan approval of early June 2005, and the end of contract date of August 31, 2005, approximately only 3 months will remain for sample collection, sample analysis, quality control verification of lab analysis data and protocols, and reporting. For this reason, the sampling process is designed to provide a snapshot of water flow values and bacteria concentrations in surface water and sediment over the entire study area.

Historical data from the TRACS database covers the following: limited EC data in the urban areas, significant fecal coliform data in the urban areas and a few non-urban areas, and a fair amount of enterococci data for urban areas and downstream of the area covered of this investigation (Clear Lake, etc.).

Presentation and analysis of historical data and sample scheme design is addressed in detail in Appendix A (the Work Plan) of this QAPP. Sample station selection is based on stations with historical exceedances in pathogen indicators, obtaining adequate spatial coverage of the entire watershed to include different land uses, wastewater dischargers, potential bacteria sources, physical and hydrological characteristics of the watershed, and TMDL modeling needs.

B2 Sampling Methods

Field Sampling Procedures

The University of Houston and Parsons Water and Infrastructure, Inc. sampling teams will follow the field sampling procedures documented in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003).

In-stream water quality measurements will be collected following the TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003). Measurements will be collected at approximately 1 foot below the surface of the water.

Water samples will be collected using a sterile 1000 mL polypropylene bottle. The bottle will be dipped into the stream directly if access is not an issue, otherwise using either a pole or by hanging the sterile bottle from a bridge using rope. If sample is to be collected directly from the stream (i.e. using a kayak or wading), the ambient water sample will be collected at a depth of 0.30 m (1 ft) for streams deeper than 1.5 ft or at 1/3 of the depth for shallow streams (depth < 1.5

ft). If the sample cannot be collected directly from the stream, the ambient water sample will be collected from the top 1 foot below water surface. An aliquot of the collected sample will be poured into bottles (as described in Table B.1) for the required analyses. All samples collected will be stored in an ice chest at 4ºC and transported to the respective laboratories within the required holding times.

Stream sediment and streambank soil samples will be collected either using a Ponar or Ekman dredge from a bridge or kayak, or a stainless steel spoon or post-hole digger directly from the streambank. All equipment will be scrubbed with ambient water and a brush and rinsed thoroughly with ambient water before and after each sediment collection. Approximately a liter of shallow, unconsolidated sediment will be collected from each sampling location and placed into sterile sample containers. All samples collected will be stored in an ice chest at 4ºC and transported to the respective laboratories within the required holding times.

Flow measurement will be performed as described in Chapter 3 of TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003) with modification as detailed in this section.

Flow measurement will be collected with either a Marsh McBirney electronic meter (with bridge board and weight or wading rod) or an acoustic doppler profiler on a line towed boat configuration (RiverCat®) (See Attachment 1 for SOP of the latter). In the event of flow or velocity regimes which may endanger field team safety, flow measurement procedures will be modified. During dangerous conditions, surface water velocity will be measured at the water surface at the thalweg or mid channel using a float and stopwatch to measure time of travel over a specified distance. This data will be used to make order of magnitude flow estimates for modeling purposes only (not for submittal to TRACS). Cross section depths will be measured as indicated in TCEQ SWQM Chapter 3 to calculate flow.

Sample Volume, Container Types, Minimum Sample Volume, Preservation Requirements, and Holding Time Requirements.

Table B.1 Field Sampling and Handling Procedures

Parameter	**Matrix**	**Container**	**Preservation**	**Sample Volume**	**Holding Time**
Orthophosphate-P	water	pre-cleaned polypropylene bottles	to be analyzed in the field or filtered in the field and stored at 4ºC	5 mL or 20 mL if taken to the lab	NA or 48 hours with preservation
Ammonia-N	water	pre-cleaned polypropylene bottles	to be analyzed in the field or pH<2 with H_2SO_4	5 mL	NA or 48 hours with preservation

Parameter	Matrix	Container	Preservation	Sample Volume	Holding Time
TSS	water	pre-cleaned LDPE bottle	4°C, dark	400 mL	7 days
TOC	water	Pre-cleaned amber glass jars with teflon seal	4º C, dark, pH<2 with H_2SO_4	40 mL	28 days
E. coli, IDEXX Colilert	water	Sterile Whirlpak bags or sterile polypropylene bottles with sodium thiosulfate	4°C, dark	400 mL	6 hrs, plus 2 lab hrs
Enterococci	water	Sterile Whirlpak bags or sterile polypropylene bottles with sodium thiosulfate	4°C, dark	400 mL	6 hrs, plus 2 lab hrs
E. coli, IDEXX Colilert	sediment	Sterile wide-mouth glass or plastic jar	4°C, dark	250 mL	6 hrs, plus 2 lab hrs
Enterococci	sediment	Sterile wide-mouth glass or plastic jar	4°C, dark	250 mL	6 hrs, plus 2 lab hrs
Total solids	sediment	wide-mouth glass jar	4°C, dark	250 g	7 days
Volatile solids	sediment	wide-mouth glass jar	4°C, dark	250 g	7 days
Moisture Content	sediment	wide-mouth glass jar	4°C, dark	250 g	7 days
Grain size analysis	sediment	Pint glass jars with teflon liners	N/A	500 g	28 days

Sample Containers

Sample containers are purchased pre-cleaned for conventional parameters and are disposable. Sterile Whirl-pak bags, cubitainers, or 120 mL bottles will be used for bacteriological samples and will have 1% sodium thiosulfate tablets added. Certificates of sample container lots are maintained in a notebook by the University of Houston/Parsons Water and Infrastructure or by the laboratory, if they provide the containers.

Processes to Prevent Cross Contamination

Procedures outlined in the TCEQ *SWQM Procedures Manual* (December 2003) describe the necessary steps to prevent cross-contamination of samples. These include such things as direct collection into sample containers when possible. Field QC samples (equipment and field blanks) as discussed in Section B5 will be collected to verify that cross-contamination has not occurred. Specifically, water quality samples will be collected in sterile polypropylene bottles. A new bottle will be used to collect water quality samples at each location.

Documentation of Field Sampling Activities

Field sampling activities are documented on field data sheets as presented in Appendix C. Flow work sheets, multi-probe calibration records, and records of bacteria analyses (if applicable) are part of the field data record. For all visits, station ID, location, sampling time, sampling date, sampling depth, preservatives added to samples and sample collector's name/signature are recorded. Values for all measured field parameters are recorded. Detailed observational data are recorded including water appearance, weather, biological activity, stream uses, unusual odors, specific sample information, missing parameters, days since last significant rainfall, and flow severity.

Recording Data

For the purposes of this section and subsequent sections, all personnel follow the basic rules for recording information as documented below:

1. Legible writing in indelible, waterproof ink with no modifications, write-overs or mark-outs;
2. Correction of errors with a single line followed by an initial and date; and
3. Closeouts on incomplete pages with an initialed and dated diagonal line.

Deviations from Sampling Method Requirements or Sample Design, and Corrective Action

Examples of deviations from sampling method requirements or sample design include but are not limited to such things as inadequate sample volume due to spillage or container leaks, failure to preserve samples appropriately, contamination of a sample bottle during collection, storage temperature and holding time exceedance, sampling at the wrong site, etc. Any deviations will invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. It is the responsibility of the University of Houston Project Manager, in consultation with the Project QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the TMDL Project Manager both verbally and in writing in the project progress reports and by completion of a corrective action report (CAR).

Corrective Action Reports (CARs) document: root cause(s); programmatic impact(s); specific corrective action(s) to address any deviations; action(s) to prevent recurrence; individual(s) responsible for each action; the timetable for completion of each action; and the means by which completion of each corrective action will be documented. CARs will be included with project 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 TCEQ immediately both verbally and in writing.

B3 Sample Handling and Custody

Chain-of –Custody – The COC system described in this QAPP replaces the "tag" system as described in the SWQM Manual.

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

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

1. Date and time of sample collection
2. Site identification
3. Sample matrix
4. Number of containers
5. Preservative used or if the sample was filtered
6. Analyses required
7. Name of collector
8. Custody transfer signatures and dates and time of transfer
9. Name of laboratory admitting the sample
10. Bill of lading (if applicable)

The Chain of Custody will be attached to the Field Data Sheets.

Sample Labeling

Samples are labeled on the container (or on a label) with an <u>indelible</u>, waterproof marker. Label information includes the site identification, the date and time of sampling, analysis to be performed, and preservative added (if applicable).
Samples collected during this investigation will be labeled with the TCEQ five digit station number (or TBD-01, etc) as listed in the sample station list in Appendix A (Work Plan).

Sample Handling

<u>Water Sample Collection</u>
Aliquots of the water sample will be poured into sterile Whirlpak bags or sterile polypropylene bottles with sodium thiosulfate ($Na_2S_2O_3$) for EC/EN analysis, LDPE bottles for TSS analysis, an amber glass jar for TOC (when appropriate), and two small HDPE bottles for field analysis of PO_4 and ammonia. All preservation of samples will take place within 15 minutes (i.e., field filtering of the PO_4 sample, acid addition if necessary, and placing the samples on ice). The TOC water sample will be acidified within 15 minutes of sample collection using H_2SO_4 to lower the

pH to below 2. Each TOC sample will be tested with pH-sensitive paper after acid is added to assure that the pH meets the preservation requirements. Samples for EC, EN, TSS, and TOC will be immediately placed on ice.

Field Measurements

Field data such as pH, DO, conductivity, temperature, and depth of probe readings may be useful in interpreting the conditions of the water system, such as influence of runoff or tide, the presence or absence of algae blooms, or the stratification of the water column. Instantaneous field measurements in water will be collected with a multiprobe water quality measurement device (YSI 6920 or similar). The unit (including all probes) will be calibrated as described in Chapter 8 of the *SWQM Procedures Manual* (December 2003) daily before use. DO may be calibrated more than once per day because it is highly dependent upon temperature and barometric pressure. Post calibration will be completed after every day of use to assess drift in the probe's readings. Detailed calibration records will be kept in the calibration logbook, recording information as required in Appendix E of the *SWQM Procedures Manual* (December 2003).

To collect probe data, the YSI Multi-probe instrument will be immersed in the water from a bridge or will be deployed by wading into the stream. If the water in the stream is not deep enough to fully immerse all probes, the bottle used to collect water quality samples will be employed to collect water into a bucket to take YSI readings as described in the *SWQM Procedures Manual* (December 2003). The bucket will be rinsed with ambient water twice before immersing the YSI probe. The bucket will be placed in the shade and the probe will be given at least one minute to equilibrate before recording the probe readings.

Analysis for PO_4 and NH_3 will be completed in the field, as long as the holding time for EC is not in danger of being exceeded. The sample for PO_4 will be filtered within 15 minutes of sample collection, prior to analysis. Otherwise, the nutrient samples will be preserved per Table B.1 and transported back to the UH laboratory for analysis.

Flow Measurement

Flow measurements will be performed to allow development of a model to assist the TMDL process. Flow severity will be recorded for each sample location during each sampling event. as detailed in Chapter 3 of TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003).

Flow measurements will be performed as described in Chapter 3 of TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003) with modification as detailed in this section.

Flow measurement will be collected with either a Marsh McBirney electronic meter (with bridge board and weight or wading rod) or an acoustic doppler profiler on a line towed boat configuration (RiverCat®) (See Attachment 1 for SOP of the latter). In the event of flow or velocity regimes which may endanger field team safety, flow measurement procedures will be modified. During dangerous conditions, surface water velocity will be measured at the water surface at the thalweg or mid channel using a float and stopwatch to measure time of travel over a specified distance. This data will be used to make order of magnitude flow estimates for modeling purposes only (not for submittal to TRACS). Cross section depths will be measured as indicated in TCEQ SWQM Chapter 3 to calculate flow. Flow from outfall structures will be measured by documenting the length of time to fill a graduated beaker.

Off-Site Laboratory Sample Transport and Custody Procedures

Samples that may be analyzed by an off-site laboratory include TSS, volatile solids, total solids, moisture content, and TOC. These samples will be sealed and carried in ice chests from the point of collection to the selected laboratory. Alternatively, a courier service will be called to pick up the cooler. Custody (using a sealed cooler and custody seal) will be transferred to the courier who will then transfer custody to the selected laboratory upon arrival. The laboratory data manager will receive a copy of the field log format and will log in the samples at the laboratory including both time of collection and time of reception of each sample, as well as the temperature measured. pH measurements will be taken from the samples to be analyzed for TOC and ammonia, and the value will be recorded in the logbook; if pH exceeds 2, the sample will be discarded. Samples will then be transferred to the cold room and stored at a temperature less than or equal to 4°C.

EC/EN in Water Sample Handling

Sterile Whirlpak bags or polypropylene bottles containing sodium thiosulfate ($Na_2S_2O_3$) will be used to collect the EC/EN samples to prevent interference by chlorine residual. Ample air space for shaking will be left at the top of the bag or bottle, in accordance with Section 9000 Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998 (American Public Health Association, 1998). A TCEQ sample collection data sheet will be filled out for each station (Appendix C). Samples will be sealed and carried in ice chests from the point of collection to the UH laboratory. The laboratory receiver will receive a copy of the field log and will log in the samples at the laboratory including both time of collection and time of reception of each sample. Samples must be received at the lab no later than 6 hours after collection. If the time of reception exceeds the 6 hour criterion, the samples will be considered unacceptable and this exceedance will be noted in the lab notebook. The laboratory receiver will also record the temperature of the temperature tester, a bottle containing DI water, packed with the samples. The temperature protocol considers sample temperatures exceeding 4°C as unacceptable. However, with ambient water samples in south Texas measuring near 20 °C at collection and transport times of less than an hour, the temperature may exceed the 4°C criterion, in which case the lab receiver will document the presence of significant ice on the cooler and the temperature blank temperature in the lab logbook and accept the samples at actual arrival temperature.

Sample preparation (reagent addition, pouring into tray and sealing) will be initiated within eight hours after sample collection. Three different dilutions will be prepared for each sample (1:1, 1:10, and 1:100, or as determined after looking at historical data for each location) using sterilized de-ionized water and at least two replicates will be prepared of each dilution. The SM 9223B EC Colilert® Quanti-tray® 2000 Method and the ASTM D6053 *Enterococcus* Enterolert® Quanti-tray® 2000 Method will be followed for laboratory procedures and data reporting in addition to the *SWQM Procedures Manual* (December 2003). Briefly, the Colilert-24/Enterolert reagent will be added to the prepared dilutions and shaken. Once the reagent has dissolved completely, the sample will be poured into a Quanti-Tray® 2000 and sealed. Sealed samples will be placed in an incubator at 35ºC for EC analysis and at 41ºC for EN analysis. The starting incubation time and temperature will be recorded in the lab logbook. Minor excursions of ± 0.5ºC are considered within the acceptable range of fluctuation for the incubator. Larger excursions will invalidate the sample results. When daily samples are not being run, a daily log of incubator temperature will be maintained. If sampling ceases for more than 1 week, the temperature log will be suspended until 1 week prior to the next sampling event.

Samples will be removed from the incubator after 24 hours and not more than 28 hours of incubation. The time at which the samples are removed from the incubator will be recorded in the lab logbook as well as the temperature at the time of sample removal. If the incubation time exceeds 28 hours, the negative wells will be considered negative (per CRP SOP) and the positive wells will be considered invalid and the samples discarded. Counting will be initiated as soon as all the dilutions from one sample are removed from the incubator. The number of positive cells for color and fluorescence will be noted in the laboratory notebook in addition to any observations regarding the trays.

<u>EC/EN in Sediment</u>
A review of methods for bacterial analysis of solids such as sediment was conducted and is briefly summarized in Attachment 2 to the QAPP. The procedures reviewed reflect different approaches and requirements for their special project needs, but all share common elements. All start with a solid sample and by dilution create a liquid sample for conventional bacterial analysis. Given the sediment characteristics in the area and the need for EC analyses, the following procedures will be employed.

Sediment sample bottles used for sample collection will have been weighed in the laboratory prior to use and the weight will be noted on the bottle. Samples of a known volume (as indicated by a mark the collection bottle) will be obtained.

Samples must be received at the lab no later than 6 hours after collection. If the time of reception exceeds the 6 hour criterion, the samples will be considered unacceptable and this exceedance will be noted in the lab notebook. The laboratory receiver will also record the temperature of the temperature tester, a bottle containing DI water packed with the samples. The temperature protocol considers sample temperatures exceeding 4ºC as unacceptable.

Three dilutions will be prepared for each sediment sample. The first and second will be prepared by putting approximately 1.0 and 0.1 g, respectively, of sediment with a sterilized spoon into the IDEXX bottles and filling with 100 mL of sterilized deionized (DI) water. The third bottle will be prepared by serial dilution. These three IDEXX bottles then contain sediment at approximately 1:100, 1:1,000 and 1:10,000 dilutions (sediment:water). The bottles will then be processed and incubated for EC/EN analyses following the same procedures described above in the "EC/EN in Water" section. The EC/EN concentrations in sediment will be given in a mass-based concentration (MPN/100 g dry wt), using the total solids content of the sediment sample.

<u>Total solids, volatile solids, and Moisture Content (%) in sediment</u>
Approximately a liter of shallow, unconsolidated sediment will be collected from each sampling location and placed in a plastic tub stainless steel bowl. At least three grab samples will be collected to generate the necessary sample volume. From the material in the tub, subsample will be placed in 250 mL glass jars. In transferring to the jars, the mud will be forced through a filter of solar screen with a roughly one millimeter mesh to remove any large particles. The screen will be rinsed thoroughly using bayou water before and after every use. The collected samples will be stored in an ice chest and transported to the respective laboratories within the required holding times. The collected samples will then be analyzed in the laboratory following the SM 2540 G procedures.

Failures in Chain-of-Custody and Corrective Action

All failures associated with chain-of-custody procedures as described in this QAPP are immediately reported to the University of Houston Project Manager. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc. The University of Houston Project Manager, in consultation with the Parsons Water and Infrastructure Project Manager will determine if the procedural violation may have compromised the validity of the resulting data. Any failures that have reasonable potential to compromise data validity will invalidate data, and the sampling event should be repeated. The resolution of the situation will be reported to the TCEQ TMDL Project Manager in the project progress report. Corrective action reports will be maintained by the Project QAO and submitted to TCEQ TMDL Project Manager along with the project progress report.

B4 Analytical Methods

The analytical methods are listed in Table A7.1 of Section A7. Procedures for laboratory analysis will be in accordance with the most recently published edition of *Standard Methods for the Examination of Water and Wastewater*, the latest version of the TCEQ *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue* (December 2003), 40 CFR 136, or other reliable procedures acceptable to TCEQ. Exceptions to this include analyses and sample matrices for which no regulated methods exist, or where EPA has not approved any method with adequate sensitivity for TMDL data requirements. In this project, these methods include bacterial analyses in sediment samples. In this case, sediment samples will be suspended in water and analyzed following approved water methods. The procedure to transfer sediment samples to water are discussed in Section B3-Sample Handling. In addition, orthophosphate and ammonia will be analyzed using HACH methods because they are field methods, fast, and easy to complete. The orthophosphate method is EPA approved (equivalent to EPA 365.2). Ammonia data will only be used to screen the presence of raw sewage. The drawbacks of using the HACH methods are that the reporting limits are higher than those obtained from lab analyses and that the sensitivity (MDL) of the method cannot be documented. Data for these two parameters will not be reported to TRACS.

Laboratories collecting data under this QAPP are, at a minimum, compliant with ISO/IEC Guide 25. Copies of laboratory SOPs are retained by UH and are available for review by the TCEQ. Laboratory SOPs are consistent with EPA requirements as specified in the method.

Standards Traceability

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

Analytical Method Modification

Only data collected under approved analytical methodologies as specified in this QAPP will be submitted to the TCEQ. Requests for method modifications will be documented on form TCEQ-10364, the *TCEQ Application for Analytical Method Modification*, and submitted for approval to the TCEQ Quality Assurance Section. Approval by the TCEQ will be granted or denied based on review of the application, specifically the section documenting an initial demonstration of method equivalency conducted by the laboratory. Work will only begin after the modified procedures have been approved.

Failures or Deviations in Analytical Methods Requirements and Corrective Actions

Failures in analytical methods requirements involve, but are not limited to such things as instrument malfunctions, failures in calibration, blank contamination, quality control samples outside QAPP defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst, then they will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to the Laboratory Supervisor, who will make the determination and notify the Project QAO. If the analytical system failure may compromise the sample results, the resulting data will not be reported to the TCEQ as part of this study. The nature and disposition of the problem is reported on the data report that is sent to the University of Houston Project Manager. The University of Houston Project Manager will include this information in the CAR and submit with the Progress Report that is sent to the

TCEQ TMDL Project Manager.

B5 Quality Control

Sampling Quality Control Requirements and Acceptability Criteria

The minimum Field QC Requirements are outlined in the *SWQM Procedures Manual* (December 2003). Specific requirements are outlined below. Field QC Samples are reported with the data report (See Section A9 and C2).

Field Equipment Blank - Field equipment blanks are required for samples when collected using sampling equipment. An equipment blank is a sample of reagent water poured into a sample bottle, or poured over or pumped through a sampling or analysis device. It is collected in the same type of container as the environmental sample, preserved in the same manner and analyzed for the same parameter. The analysis of equipment blanks should yield values less than the RL. When target analyte concentrations are very high, blank values must be less then 5% of the lowest value of the batch. If Field Equipment Blanks are consistently less than the reporting limit, a set of Field Equipment Blanks are submitted with every tenth sample. If less than 10 samples are collected in a month, submit one set of blanks per month. If contamination is detected in field equipment blanks, blanks are required for every sample until the problem is resolved.

Field splits - A field split is a single sample subdivided by field staff immediately following collection and submitted to the laboratory as two separate, identified samples according to procedures specified in the SWQM Procedures Manual. Split samples are preserved, handled, shipped, and analyzed identically and are used to assess variability in all of these processes. Field splits apply to conventional samples only and are collected on a 10% basis or one per batch whichever is greater. The precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$\mathbf{RPD = \{ (X_1 - X_2) / \langle (X_1+X_2)/2 \rangle \} * 100}$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the collection and analytical system. If it is determined that meaningful quantities of constituent (i.e., > RL) were measured and analytical variability can be eliminated as a factor, then variability in field split results will primarily be used as a trigger for discussion with field staff to ensure samples are being handled in the field correctly. Some sample results or batches of samples may be invalidated based on the examination of all extenuating information. Professional judgement during data validation will be relied upon to interpret the results and take appropriate action. The qualification (i.e., invalidation) of data will be documented on the Data Summary. Deficiencies will be addressed as specified in this section under Failures in Quality Control and Corrective Action.

For microbiolgical analyses, the method to be used for calculating precision is the one outlined in Standard Methods 20th Edition section 9020 B.8.b.

$$\mathbf{FRPD_{bacteria} = (log\ X_1 - log\ X_2)}$$

The $FRPD_{bacteria}$ should be lower than the performance criterion of $3.27\Sigma R_{log}/n$, where R_{log} is the difference in the natural log of splits for the first 15 positive (i.e. both samples are greater than the detection limit) split samples. If the result for X_1 or X_2 is less than the detection limit, then the value of 1 will be added to ½ the detection limit before calculating the logarithm. The performance criterion should be updated periodically by recalculating using the most recent set of 15 positive split analyses.

Performance control limits for analytical measurements are specified in Table A.1. Performance limits for field splits are defined in Section B5.

Final acceptance will be performed by the PIs. Any results not meeting requirements will be omitted from the data analysis and conclusions will not be made based on these data.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

Detailed laboratory QC requirements are contained within each individual method and laboratory quality assurance manuals (QAMs). The minimum requirements that all participants abide by are stated below. Lab QC sample results are reported with the laboratory data report (see Section C2 and A9). These QC requirements also pertain to orthophosphate and ammonia samples that are analyzed in the field.

Lab QC samples are prepared and analyzed in batches, which are defined as follows:

Batches are environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Laboratory duplicate - Laboratory duplicates are used to assess precision. A laboratory duplicate is prepared by splitting aliquots of a single sample (or a matrix spike or a laboratory control standard) in the laboratory. Both samples are carried through the entire preparation and analytical process. Laboratory duplicates are run at a rate of one preparatory (if applicable) and analytical batch. Acceptability criteria are outlined in Table A.1 of Section A7.

Precision is calculated by the relative percent deviation (RPD) of duplicate results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X_1 and X_2, the RPD is calculated from the following equation:

$$\mathbf{RPD = \{ (X_1 - X_2) / \langle (X_1 + X_2)/2 \rangle \} * 100}$$

A bacteriological duplicate is considered to be a special type of laboratory duplicate and applies when bacteriological samples are run in the field as well as in the laboratory. Bacteriological duplicate analyses are performed on samples from the sample bottle on a 10% basis. Results of bacteriological duplicates are evaluated by calculating the logarithm of each result and determining the range of each pair as outlined in Standard Methods 20th Edition section 9020 B.8.b.

For bacteria, the RPD should be lower than the performance criterion of 3.27 $\Sigma R_{log}/n$, where R_{log} is the difference in the natural log of duplicates for the first 15 positive (i.e. both samples are greater than the detection limit) duplicate samples. If the result for X_1 or X_2 is less than the detection limit, then the value of 1 will be added to ½ the detection limit before calculating the logarithm. The performance criterion should be recalculated periodically using the most recent set of 15 positive duplicate analyses.

Performance limits and control charts are used to determine the acceptability of duplicate analyses.

<u>Laboratory Control Standard (LCS)/Laboratory Control Standard Duplicate (LCSD)</u>-
LCS/LCSD pairs are analyte-free water samples spiked with the analyte of interest prepared from standardized reference material. The LCS/LCSD pairs are spiked into laboratory pure water at a level less than or equal to the mid-point of the calibration curve for each analyte. They are carried through the complete preparation and analytical process. The LCS/LCSD pairs are used to document the bias of the method due to the analytical process. Bias can be assessed by measuring the percent recovery of LCSs and LCSDs, and precision can be assessed by comparing the results of LCS/LCSD pairs. LCS/LCSD pairs are run at a rate of one each per batch. Acceptability criteria for bias are laboratory specific and usually based on results of past laboratory data (i.e., control charts). Precision and bias criteria for LCS/LCSD pairs are specified in Table A1. Laboratory-specific control limits and charts are calculated and maintained by laboratory staff on a periodic basis.

Bias of LCSs and LCSDs is expressed by percent recovery (%R) where SR is the observed spiked sample concentration, and SA is the spike added:

$$\mathbf{\%R = \lceil SR/SA \rfloor * 100}$$

The mean bias of LCS/LCSD pairs is expressed by $\%R_{mean}$, where $\%R_{LCS}$ is the percent recovery of the LCS and $\%R_{LCSD}$ is the percent recovery of the LCSD:

$$\mathbf{\%R_{mean} = (\%R_{LCS} + \%R_{LCSD})/2}$$

Precision between LCS/LCSD pairs is expressed by relative percent difference (RPD). For LCS/LCSD results, X_1 and X_2, the RPD is calculated from the following equation:

$$\mathbf{RPD\text{-}\{(X_1\text{-}X_2)/<(X_1+X_2)/2>\}*100}$$

<u>Matrix spikes (MS)</u>- A matrix spike is an aliquot of sample spiked with a known concentration of the analyte of interest. Percent recovery of the known concentration of added analyte is used to assess accuracy of the analytical process. The spiking occurs prior to sample preparation and analysis. Matrix spike samples are routinely prepared and analyzed at a rate of 5% of samples processed or one per batch whichever is greater. The MS is spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. The MS is used to document the accuracy of a method due to sample matrix and not to control the analytical process. Percent Recovery (%R) is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike. MS recoveries are indicative of matrix-specific biases and are plotted on control charts maintained by the laboratory. Measurement performance specifications for matrix spikes are not specified in this document, and MS data should be evaluated on a case-by-case basis.

The formula used to calculate percent recovery, where %R is percent recovery; SSR is the observed spiked sample concentration; SR is the sample concentration; and, SA is the spike added; is:

$$\mathbf{\%R = \langle (SSR - SR)/SA \rangle * 100}$$

<u>AWRL /Reporting Limit Verification</u> - The laboratory's reporting limit will be at or below the AWRL. To demonstrate ongoing ability to recover at the reporting limit, the laboratory will analyze a calibration standard (if applicable) at or below the reporting limit on each day samples are analyzed. Two acceptance criteria will be met or corrective action will be implemented. First, calibrations including the standard at the reporting limit will meet the calibration requirements of the analytical method. Second, the instrument response (e.g., absorbency, peak area, etc.) for the standard at the reporting limit will be treated as a response for a sample by use of the calibration equation (e.g, regression curve, etc.) in calculating an apparent concentration of the standard. The calculated and reference concentrations for the standard will then be used to calculate percent recovery (%R) at the reporting limit using the equation:

$$\mathbf{\%R = CR/SA * 100}$$

where CR is the calculated result and SA is the actual or reference concentration for the standard. Recoveries must be within 75-125% of the reference concentration.

When daily calibration is not required (e.g., EPA Method 624), or a method does not use a calibration curve to calculate results, the laboratory will analyze a check standard at the reporting limit on each day samples are analyzed. The check standard does not have to be taken through sample preparation, but must be recovered within 75-125% of the reference concentration for the standard. The percent recovery of the check standard is calculated using the following equation in which %R is percent recovery, SR is the sample result, and SA is the reference concentration for the check standard:

$$\%R = SR/SA * 100$$

If the calibration (when applicable) or the recovery of the calibration or control standard is not acceptable, corrective actions (e.g., re-calibration) will be taken to meet the specifications before proceeding with analyses of samples.

<u>Method Blank</u>- A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in the sample processing and analyzed with each batch. The method blank is carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the laboratory's reporting limit. For very high level analyses, blank value should be less then 5% of the lowest value of the batch or corrective action will be implemented.

<u>Additional method specific QC requirements</u> - Additional QC samples are run (e.g., positive controls, negative controls, media blanks, etc) as specified in the methods. The requirements for these samples, their acceptance criteria, and corrective action are method-specific.

Failures in Quality Control and Corrective Action

Sampling QC excursions are evaluated by the University of Houston/Parsons Water and Infrastructure Project Managers, in consultation with the Project QAO. In that differences in field duplicate sample results are used to assess the entire sampling process, including environmental variability, the arbitrary rejection of results based on pre-determined limits (e.g. FRPD > 20%) is not practical. Therefore, the professional judgement of the Project QAO will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Notations of field duplicate excursions and blank contamination are noted in the quarterly report and the final QC Report.

Corrective action will involve identification of the cause of the failure where possible. Response actions will typically include re-analysis of questionable samples. In some cases, a site may have to be re-sampled to achieve project goals.

Laboratory measurement quality control failures are evaluated by the laboratory staff. The disposition of such failures and conveyance to the TCEQ are discussed in Section B4 under Failures or Deviations in Analytical Methods Requirements and Corrective Actions.

B6 Instrument/Equipment Testing, Inspection and Maintenance

All sampling equipment testing and maintenance requirements are detailed in the TCEQ *SWQM Procedures Manual* (December 2003).

Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Acceptance criteria are detailed in the supplier's purchasing manual. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the Project Team Field Supervisor, or designee.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory QAM(s). Instruments requiring daily or in-use testing may include, but are not limited to, water baths, ovens, autoclaves, incubators, refrigerators, and laboratory pure water. Critical spare parts for essential equipment are maintained to prevent downtime. Testing and maintenance records are available for inspection by the TCEQ.

B7 Instrument/Equipment Calibration and Frequency

Field equipment calibration requirements are contained in the TCEQ *SWQM Procedures Manual* (December 2003). Post calibration error limits and the disposition resulting from error are adhered to. Data not meeting post-error limit requirements invalidate associated data collected subsequent to the pre-calibration and are not submitted to the TCEQ.

Detailed laboratory calibrations are contained within the QAM(s). The laboratory QAM identifies all tools, gauges, instruments, and other sampling, measuring, and test equipment used for data collection activities affecting quality that must be controlled and, at specified periods, calibrated to maintain bias within specified limits. Calibration records are maintained and are available for inspection by the TCEQ. Equipment requiring periodic calibrations include, but are not limited to, thermometers, pH meters, balances, incubators, turbidity meters, and analytical instruments.

B8 Inspection/Acceptance of Supplies and Consumables

The procurement of supplies, equipment and services is controlled to ensure that specifications are met for the high quality and reliability required for each laboratory task.

Each new batch of field and laboratory supplies for UH and Parsons Water and Infrastructure are tested before use to verify that they function properly and are not contaminated. The laboratory QAM provides additional details on acceptance requirements for laboratory supplies and consumables.

B9 Non-direct Measurements

Only data collected directly under this QAPP will be submitted to the SWQM portion of the

TRACS database. Sampling conducted by the TCEQ, the USGS, and Texas Clean Rivers Program partners is not covered under this QAPP and will not be reported to the TCEQ Data Manager by the University of Houston. However, data collected by the above organizations that meet the data quality objectives of this project may be useful in satisfying the data and informational needs of the TMDL. The collection and qualification of the TCEQ and USGS data are addressed in the TCEQ *Surface Water Quality Monitoring QAPP*. The collection and qualification of the Texas CRP data are addressed in the *Texas Clean Rivers Program QAPP*. No acquired or non-direct measurement data will be submitted under this QAPP.

Stream flow data collected by the USGS may be used to assist in estimating loads of bacteria. These data will be obtained from the USGS web site. These data are considered provisional for some time after their collection, generally until the publication of the annual water summary. Because the intended use of the data is only to explore the potential magnitude of bacteria loads in runoff, these data will be satisfactory. If these data were to be used to set permit limits or load allocations, the flow measurements will only be used once the provisional qualifier has been removed.

B10 Data Management

Data Management Protocols are addressed in the Data Management Plan which is in Appendix E of this document.

References

American Public Health Association. Standard Methods for the Examination of Water and Wastewater (20th Edition). 1998.

TCEQ. 2004 (or most recent version). *Data Management Reference Guide, Surface Water Quality Monitoring*.

TCEQ. 2003 (or most recent version). *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Document No. RG-415 (December 2003).

Note: when references are made to documents that are not attached to the QAPP, the Project Manager of the University of Houston assumes responsibility for compliance of the documentation with the QAPP requirements.

C1 Assessments and Response Actions

The following table presents the types of assessments and response action for data collection activities applicable to the QAPP.

Table C.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring, Oversight, etc.	Continuous	University of Houston Project Manager	Monitoring of the project status and records to ensure requirements are being fulfilled. Monitoring and review of contract laboratory performance and data quality.	Report to TCEQ in Quarterly Report. Ensure project requirements are being fulfilled.
Laboratory Inspections	Dates to be determined by the TCEQ lab inspector	TCEQ Laboratory Inspector	Analytical and quality control procedures employed at the UH laboratory and the contract laboratory	30 days to respond in writing to the TCEQ to address corrective actions
	Annually	Project QAO		Implements corrective action. Report sent to TCEQ Project Mgr.
Monitoring Systems Audit	Dates to be determined by the TCEQ	TCEQ QAS	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Field sampling, handling and measurement; facility review; and data management as they relate to the TMDL Project.	30 days to respond in writing to the TCEQ to address corrective actions
	Annually	Project QAO	Field sampling, handling and measurement; facility review; and data management as they relate to the TMDL Project.	Implements corrective action. Report sent to TCEQ Project Mgr.

Corrective Action

The University of Houston Project Manager is responsible for implementing and tracking corrective action procedures as a result of audit findings. Records of audit findings and corrective actions are maintained by both the TCEQ TMDL Program and the Project QAO. Corrective action documentation will be submitted to the TCEQ TMDL Project Manager with the progress report.

If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in the TCEQ QMP and in agreements or contracts between participating organizations.

C2 Reports to Management

Laboratory Data Reports

Laboratory data reports contain the results of all specified QC measures listed in section B5, including but not limited to field equipment blanks, trip blanks, field blanks, field splits, laboratory duplicates, laboratory control standards, matrix spikes, AWRL/reporting limit verification, laboratory equipment blanks, and method blanks. This information is reviewed by the Project QAO and compared to the pre-specified acceptance criteria to determine acceptability of data before forwarding to the University of Houston Project Manager. This information is available for inspection by the TCEQ.

Reports to UH Project Management

Parsons Water and Infrastructure will provide the training records, original COCs, field data sheets, field log books, field equipment calibration/maintenance logs, and bacteriological sample field sample logs to the Project QAO for retention at UH for the time specified in Table A.2 (Project Documents and Records).

The laboratories will provide data reports containing the results of all specified QC measures listed in section B5, including but not limited to field equipment blanks, trip blanks, field blanks, field splits, laboratory duplicates, laboratory control standards, matrix spikes, AWRL/reporting limit verification, laboratory equipment blanks, and method blanks. This information is reviewed by the Project QAO and compared to the pre-specified acceptance criteria to determine acceptability of data before forwarding to the University of Houston Project Manager. This information is available for inspection by the TCEQ.

Reports to TCEQ Project Management

The reports detailed in this section are contract deliverables and are transferred to the TCEQ in accordance with contract requirements.

Quarterly Progress Report - Summarizes the University of Houston/Parsons Water and Infrastructure's activities for each task; reports problems, delays, and corrective actions; and outlines the status of each task's deliverables.

Monitoring Systems Review Checklist and Report of Significant Corrective Actions - Following the annual audits performed by the University of Houston/Parsons Water and Infrastructure, the monitoring systems audit checklist along with recommendations and responses are sent to the TCEQ project manager in the quarterly progress report.

Reports by TCEQ Project Management

Contractor Evaluation - The University of Houston participates in a Contractor Evaluation by the

TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Financial Administration Division, Procurements and Contracts Section.

D1 Data Review, Verification and Validation

For the purposes of this document, verification means the processes taken to confirm by examination and provision of objective evidence that specified QAPP/project requirements, including documentation and technical criteria, have been fulfilled. Validation means those processes taken independently of the data-generation processes to confirm by examination and provision of objective evidence of the quality control acceptability of all the processes involved in the production of environmental data. Integrity means the processes taken to assure that no falsified data will be reported.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives which are listed in Section A7. Only those data which are supported by appropriate quality control data and meet the data quality objectives defined for this project will be considered acceptable, and will be reported to the TCEQ for entry into the SWQM portion of the TRACS database.

The procedures for verification and validation of data are described in Section D2, below. The Project Field Supervisor is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Supervisor is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity. The University of Houston Data Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. The Project QAO is responsible for documented validation of a minimum of 10% data for each task. Finally, the University of Houston Project Manager, with the concurrence of the Parsons Water and Infrastructure Project Principal, is responsible for validating that all data to be reported meet the objectives of the project and are suitable for reporting to TCEQ.

D2 Verification and Validation Methods

All field and laboratory data will be reviewed, verified and validated to ensure they conform to project specifications and meet the conditions of end use as described in Section A7. The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation and verification of the data each task generates or handles throughout each process. The field and laboratory tasks ensure the verification of raw data, electronically generated data, and data on chain-of-custody forms and hard copy output from instruments.

Verification, validation and integrity review of data will be performed using self-assessments and peer review, as appropriate to the project task, followed by technical review by the manager of the task. The data to be verified (listed by task in Table D.1) are evaluated against project specifications (Section A7) and are checked for errors, especially errors in transcription, calculations, and data input. Potential outliers are identified by examination for unreasonable data, or identified using computer-based statistical software. If a question arises or an error or potential outlier is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues which can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the task manager consults with higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected. The performance of these tasks is documented by completion of the data review checklist (Appendix F) by the UH Data Manager.

The University of Houston Project Manager and the Project QAO are each responsible for validating that the verified data are scientifically valid, legally defensible, of known precision, accuracy, integrity, meet the data quality objectives of the project, and are reportable to TCEQ. One element of the validation process involves evaluating the data again for anomalies. The Project QAO or Project Manager may designate other experienced water quality experts familiar with the water bodies under investigation to perform this evaluation. Any suspected errors or anomalous data must be addressed by the manager of the task associated with the data, before data validation can be completed.

A second element of the validation process is consideration of any findings identified during the annual monitoring systems audit conducted by the Project QAO or TCEQ QAS assigned to the project. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. Finally, the University of Houston Project Manager, with the concurrence of the Project QAOs, validates that the data meet the data quality objectives of the project and are suitable for reporting to TCEQ.

D3 Reconciliation with User Requirements

The data quality objectives described in Section A7 of this document are deemed to be consistent with and support the intended use of data set forth in the same section. Data will be evaluated continuously by the University of Houston/Parsons Water and Infrastructure representatives during the life-term of the project to ensure that they are of sufficient quality and quantity to meet the project goals. If the data do not meet the goals specified in Section A7, they will not be transferred to the TCEQ for upload to the statewide database to ultimately be used in decision-making, however, they will be included in all the reports to TCEQ. The evaluation of these data for decision-making is not part of this QAPP.

No decisions will be made by the project team based on the data collected. These data, and data collected by other organizations (e.g., USGS, TCEQ, etc.), may be subsequently analyzed and used by the TCEQ for TMDL development, stream standards modifications, permit decisions, and water quality assessments. Data which do not meet requirements will not be submitted to the SWQM portion of TRACS nor will be considered appropriate for any of the uses noted above.

Table D.1 Data Review, Verification, and Validation Procedures

Data to be Verified	**Field Task**[1]	**Laboratory Task**[2]	**Project Data Manager Task**[3]
Sample documentation complete; samples labeled, sites identified	✔	✔	
Field QC samples collected for all analytes as prescribed in the TCEQ SWQM Procedures Manual	✔		
Standards and reagents traceable	✔	✔	
Chain of custody complete/acceptable	✔	✔	
Sample preservation and handling acceptable	✔	✔	
Holding times not exceeded	✔	✔	
Collection, preparation and analysis techniques consistent with SOPs and QAPP	✔	✔	✔
Field documentation (e.g. biological, stream habitat) complete	✔		
Instrument calibration data complete	✔	✔	
Bacteriological records complete[4]	✔	✔	
QC samples analyzed at required frequencies	✔	✔	✔
QC results meet performance and program specifications	✔	✔	✔
Analytical sensitivity (RLs) consistent with QAPP		✔	✔
Results, calculations, transcriptions checked	✔	✔	
Laboratory bench-level review performed		✔	
All laboratory samples analyzed for all parameters		✔	
Corollary data agree	✔	✔	✔
Nonconforming activities documented	✔	✔	✔
Outliers confirmed and documented; reasonableness check performed			✔
Dates formatted correctly			✔
Depth reported correctly			✔
TAG IDs correct			✔
TCEQ ID number assigned			✔
Valid Parameter codes			✔
Source codes 1 and 2 and program code used correctly			✔
Time based on 24-hour clock			✔
Absence of transcription error confirmed	✔	✔	✔

Data to be Verified	**Field Task[1]**	**Laboratory Task[2]**	**Project Data Manager Task[3]**
Absence of electronic submittal errors confirmed	✔	✔	✔
Sampling and analytical data gaps checked (e.g., all sites for which data are reported are on the monitoring schedule)	✔	✔	✔
Field QC results attached to data review checklist			✔
Verified data log submitted			✔
10% of data manually reviewed			✔

[*] The University of Houston Project Manager/Project QAO will monitor only 10% of data for QA/QC purposes. All other entities are required to inspect 100% of the data prior to approval.

[1] Field tasks completed by UH/Parsons field supervisor and staff
[2] Laboratory tasks completed by UH/Parsons laboratory supervisor and staff
[3] Database tasks completed by Data manager
[4] This task may be completed by field or laboratory

Appendix A. Monitoring Plan

Introduction

Segments 1101 (Clear Creek Tidal), 1101B (Chigger Creek), 1102 (Clear Creek Above Tidal), 1102A (Cowarts Creek), 1102B (Mary's Creek/North Fork Mary's Creek), and 2425C (Robinson's Bayou) have been identified in the 303(d) list as impaired due to elevated levels of fecal coliform (FC) that can negatively impact contact recreation. The overall project will result in the completion of a Total Maximum Daily Load (TMDL), which will be submitted to TCEQ for approval by the Commission. In addition, the project will also provide several allocation scenarios which the TCEQ will use in the development of an implementation plan in support of the TMDL.

The objectives of the Clear Creek TMDL project include: (i) an assessment of the E. coli and fecal pathogen levels and trends in the Clear Creek watershed based on historical data, (ii) an assessment of major sources and fate and transport of E. coli and fecal contamination in the target water bodies based on historical and current data, (iii) development of a sampling plan and quality assurance project plan to collect current data, (iv) an assessment of the methods that may be used to determine the components of the TMDL equation, and (v) participation in the stakeholder project.

As part of the TMDL project, the University of Houston and Parsons Water and Infrastructure will collect additional field data on concentrations of fecal pathogens in the segments of concern to assess sources and current contamination levels and trends. This QAPP addresses those monitoring activities.

Monitoring and Data Collection

The listed Clear Creek Segments have been and continue to be monitored for a range of conventional water quality parameters. The monitoring data have been analyzed and indicate that a number of the segments exhibit exceedances of the pathogen standards relatively frequently (Table 1).

The main reason for monitoring in this TMDL project is to understand and document the sources of these elevated bacteria levels so that development of appropriate control measures can be accomplished. The monitoring program includes four major components: (1) Monitoring of *E. coli* and Enterococci in the project segments, (2) Searches for dry-weather discharges in both sewered and unsewered areas, (3) Sediment sampling, and (4) Flow measurements within the creek and its tributaries. These will be detailed in the following discussion.

Table 1. Exceedances of Indicator Standards for Stations in the Project Area

Location ID	TCEQ Short Description	Segment	USGS Station	Reason to Include	*E Coli*				Enterococci			
					Geo Mean MPN/100ml	Single Sample >394		% of Exceedance of Single Sample Criteria	Geo Mean MPN/100ml	Single Sample >200		% of Exceedance of Single Sample Criteria
						# Exceedances	# Samples			# Exceedances	# Samples	
11425	COWART CREEK AT FM 518	1102B		Furthest downstream station on Cowart Ck	N/A	N/A	N/A		127	5	15	33
11448	CLEAR CREEK TIDAL AT FM528	1101	USGS 08077600 active 2005	Downstream of mounth of Cowart Ck	128	2	11	18	244	11	26	42
11450	CLEAR CREEK AT FM 2351	1102	USGS 08077540 inactive since 1997	Only Station located on trib to Turkey Ck	131	4	16	25	268	19	38	50
11451	CLEAR CREEK AT COUNTRY CLUB R	1102		Located along woody land region of Clear Crk	93	3	10	30	7500	3	3	100
11452	CLEAR CREEK AT TELEPHONE RD	1102	USGS 08077000 inactive since 1993	Upstream of junction with trib of Clear Ck	196	3	12	25	N/A	N/A	N/A	
16473	MARYS CREEK AT MARYS CROSSING	1102B		To monitor downstream portion of Mary's Ck	N/A	N/A	N/A		N/A	N/A	N/A	
16486	ROBINSONS BAYOU AT WEBSTER	2425		Located at upstream end of Robinson Bayou	87	2	9	22	684	16	19	84
16493	CHIGGER CREEK AT FM528 BRIDGE	1101B		To monitor downstream portion of Chigger Ck	130	4	11	36	301	13	24	54
16572	CLEAR CK TDL AT ROBINSONS BAY	1101		Located downstream on Robinsons Bayou	193	1	2	50	15	2	20	10
16575	CLEAR CK TDL AT WALTER HALL	1101		Fair amount of eColi data, public access	21	0	5	0	75	10	30	33
16576	CLEAR CREEK TIDAL AT BROOKDALE	1101		Upstream of Magnolia Creek	N/A	N/A	N/A		88	8	26	31
16577	CLEAR CK TDL AT CHALLENGER PK	1101		most eColi data in area, public access	56	1	12	8	192	9	26	35
16611	MAGNOLIA CREEK UPSTM OF FM518	1101		Only Station on Magnolia Creek	N/A	N/A	N/A		N/A	N/A	N/A	
16678	COWART CREEK AT BAKER ROAD	1102A		Only one Station on Cowert Creek	N/A	N/A	N/A		N/A	N/A	N/A	
16985	CLEAR CK TDL AT NASSAU WWTP	1101		Downstream end of Clear Creek	N/A	N/A	N/A		N/A	N/A	N/A	
17068	HICKORY SLOUGH ROBINSON DRIVE	1102		No other Stations chosen on this tributary	N/A	N/A	N/A		N/A	N/A	N/A	
17069	TURKEY CREEK DIXIE FARM ROAD	1102		Only station located on Turkey Creek	N/A	N/A	N/A		N/A	N/A	N/A	
17071	MUD GULLEY DIXIE FARM ROAD	1102		Monitor Tributary into Clear Ck	N/A	N/A	N/A		N/A	N/A	N/A	
17074	CLEAR CREEK AT BARRY ROSE	1102		Located along wetland region of Clear Crk	N/A	N/A	N/A		N/A	N/A	N/A	
17076	CLEAR CREEK AT STONE ROAD	1102		Located at inlet of tributary into Clear Ck	N/A	N/A	N/A		N/A	N/A	N/A	
17079	CLEAR CREEK AT SH 28 BRIDGE	1102		To monitor west portion of Clear Creek	N/A	N/A	N/A		N/A	N/A	N/A	
TBD-01	MARY'S CR AT HWY35	1102B		To monitor upstream portion of Mary's Ck	N/A	N/A	N/A		N/A	N/A	N/A	
TBD-02	CHIGGER CR AT HWY35	1101B		undeveloped upstm of here (background)	N/A	N/A	N/A		N/A	N/A	N/A	
TBD-03	UNNAMED TRIB <E OF MAGNOLIA CR>	1101		Urban creek without WWTP	N/A	N/A	N/A		N/A	N/A	N/A	
TBD-04	TRIBUTARY OF CHIGGER CREEK	1101B		No other Stations chosen on this tributary	N/A	N/A	N/A		N/A	N/A	N/A	
TBD-05	CHIGGER CK WEST OF HWY35	1101B		Monitor upstream portion of Chigger Ck	N/A	N/A	N/A		N/A	N/A	N/A	

Notes:
N/A - data have not been obtained at these proposed sampling locations
[green shading] Geometric Mean exceeds the WQ Criteria (126 MPN/dL for EC and 35 MPN/dL for EN)

1. *E. Coli* and Enterococci Monitoring

The TCEQ has adopted the use of *E. coli* (EC) and Enterococci (EN) concentrations as pathogen indicators for current and proposed Texas water quality standards. Clear Creek and its tributaries have been designated for contact recreation use and must meet the standards that have been set for this use. While historical data exist for the tidal segments of Clear Creek, less data are available for much of the non-tidal segments and many of the tributaries. Thus, in this TMDL, samples will be collected to determine concentrations of *E. coli* and Enterococci in Clear Creek and its tributaries during dry-weather conditions. As specified by the TCEQ, the fresh water segments, 1101B (Chigger Creek), 1102 (Clear Creek Above Tidal), 1102A (Cowarts Creek), and 1102B (Mary's Creek/North Fork Mary's Creek), will be sampled for *E. coli*; the marine segments, 1101 (Clear Creek Tidal) and 2425C (Robinson Bayou), will be sampled for Enterococci. Preliminary locations for sampling are included in Figure 2 in Appendix B. However, it is noted that the monitoring and data collection program is dynamic and may change as data are collected and analyzed. If the monitoring and data collection program is to change, TCEQ project management will be notified, and if necessary, the QAPP will be updated accordingly. In addition to EC and Enterococci, the samples will be tested for standard water quality parameters. A list of parameters to be measured as well as laboratory methods to be used is presented in Table A.1 of Section A7. Sampling sites and schedules are presented in Appendix B.

2. Assessment of Dry Weather Discharges

In dry weather, essentially most of the flow in Clear Creek is theoretically from point source discharges. The Galveston County Health District completed a study in 2001 to "identify and eliminate illicit connections in the Clear Creek Watershed" (Wright 2001). The 2001 study from Galveston County will be used as the starting point for this component of the monitoring plan. All data, maps, findings, and reports from the 2001 study will be obtained and updated on the basis of field reconnaissance and survey. In addition, all other counties encompassing the Clear Creek segments in this TMDL will be contacted for stream geometry data, models, and information on outfalls and drainage infrastructure. Finally, and during the field reconnaissance activities for this component, dry-weather discharges from outfalls will be noted and recorded, and the magnitude of the flow will be determined.

3. Sediment Sampling

For this component, sediments at up to 20 locations within the Creek and its tributaries will be sampled to be analyzed for EC or EN and physical parameters. A list of parameters to be measured as well as laboratory methods to be used is presented in Table A.1 of Section A7. Sampling sites and schedules are presented in Appendix B. As much as possible, sediment samples will be collected at the same locations where water sampling will be conducted, however sediment locations may change once reconnaissance has been conducted. In addition, up to 10 sediment samples will be collected along a cross section and analyzed separately to assess potential differences between the banks and the main channel. The transect site will be selected once reconnaissance has been completed. If the monitoring and data collection program is to change, TCEQ project management will be notified, and if necessary, the QAPP will be updated accordingly. The site will be one that is easy to access, not concrete-lined, with significant presence of organic soils (silty clays not sands), and with a depth not higher than 4 ft.Finally, TSS data for the watershed will be gathered to investigate possible correlations with flow and EC/EN levels.

4. Flow Measurements

A review of the historical data indicated that there are no flow measuring gages in the watershed. Thus, during water sample collection for EC and EN flow and velocity measurements will be made at up to 20 stations. Flow measurements will be performed to allow development of a model to assist the TMDL process. Flow will be measured at the sampling locations listed on Table 3 of Appendix B, or as close to the sample location as possible taking into account stream access and sampling crew safety. Section B2 - Field Sampling Procedures and Attachment 1 present SOPs for flow sampling.

Flow severity will be recorded for each sample location during each sampling event. as detailed in Chapter 3 of TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003). See Table A.1 of Section A7.

Data Analysis

The product of the sampling activities will be a quantification of EC and EN in water and sediment from the Clear Creek watershed as well as conventional field parameters and physical parameters. These data will be used to assess current levels and trends of fecal indicators and to evaluate potential sources of contamination to the Clear Creek, and possible correlations between bacterial counts and other chemical parameters. These data will ultimately be used to set-up and calibrate a fate and transport model for EC/EN in Clear Creek.

Data Submittal

Most of the data collected will be appropriate for inclusion in the TRACS database as representing ambient conditions in water bodies, while other types of data (i.e. Ammonia-N and orthophosphate levels, sediment transect bacteria concentrations, and flow) will support project activities but will not become part of TRACS. Table 2 includes a list of data to be collected as well as whether it will be submitted to the TRACS database.

Appendix E outlines the requirements for data submittal to the TRACS database.

Schedule

Testing will begin once the QAPP is approved and will continue through August 2005. A report describing the testing procedures and results will be prepared two months after testing is finished or as specified in the approved work order. Figure 1 depicts the proposed timeline for the work to be completed in this QAPP.

Table 2. Summary of data to be collected by task

PARAMETER	UNITS	To be included into TRACS?				
		1	2	3 - stream	3 - transect	4
Field parameters						
pH	pH units	Y	NA	NA	NA	NA
DO	mg/L	Y	NA	NA	NA	NA
Conductivity	uS/cm	Y	NA	NA	NA	NA
Turbidity	NTU	Y	NA	NA	NA	NA
Temperature	◦ C	Y	NA	NA	NA	NA
Orthophosphate-P	mg/L	N	NA	NA	NA	NA
Ammonia-N	mg/L	N	NA	NA	NA	NA
Flow	cfs	NA	N	NA	NA	Y
Flow severity	days	NA	NA	NA	NA	Y
Conventional and Bacteriological Parameters						
TSS	mg/L	N	NA	NA	NA	NA
TOC in water	mg/L	Y	NA	NA	NA	NA
TOC in sediment	mg/L	NA	NA	Y	N	NA
E. coli, IDEXX Colilert	MPN/dL	Y	NA	NA	NA	NA
E. coli, IDEXX Colilert	MPN/100g	NA	NA	Y	N	NA
Enterococci, IDEXX Enterolert	MPN/dL	Y	NA	NA	NA	NA
Enterococci, IDEXX Enterolert	MPN/100g	NA	NA	Y	N	NA
Total solids	%	NA	NA	Y	N	NA
Volatile solids	%	NA	NA	Y	N	NA
Moisture content	%	NA	NA	Y	N	NA
Sediment particle size, clay	% dry weight	NA	NA	Y	N	NA
Sediment particle size, silt	% dry weight	NA	NA	Y	N	NA
Sediment particle size, sand	% dry weight	NA	NA	Y	N	NA

Y = Yes; N = No;   NA = not applicable (parameter will not be measured)

Figure 1. Monitoring Plan Timeline

COMPONENT	2004-2005											
	Sep	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1. Monitoring of EC and Enterococci in water												
2. Dry-weather discharge reconaissance												
3. Monitoring of EC and Enterococci in sediment												
4. Flow measurements												

NOTE: Sampling will not begin until final approval of QAPP is received.

References

McElyea, Bob. "A Comparison Between Fecal Coliform, *E. coli*, and Enterococci as Bacterial Indicators in Southeast Texas Surface Waters", Texas Commission on Environmental Quality, Austin, TX. March, 2003.

Wright, Jean. "Identifying and Eliminating Illicit Connections in the Clear Creek Watershed" (2001). Prepared for the Galveston County Health District, Galveston, Texas. http://www.clearcreekcleanup.org/newlook2001/file01/wright.htm.

TCEQ. 2000. Texas Surface Water Quality Standards. §307.1-307.10. Adopted by the Commission: July 26, 2000; Effective August 17, 2000 as the state rule. Austin, Texas.

TCEQ. 2003 (or most recent version). *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment and Tissue*. Texas Commission on Environmental Quality, Document No. RG-415 (December 2003).

Appendix B. Sampling Process Design and Monitoring Schedule

Sample Design Rationale

The sample design is based on the program requirements of the Total Maximum Daily Load Program. The TCEQ, and the University of Houston/Parsons Water and Infrastructure through contract with the TCEQ, has been tasked with providing data and information to characterize water quality conditions, to identify the presence or absence of impairments of designated water body uses, and to support water quality modeling, site-specific water quality standard revisions, the load allocation, and other TMDL data and information needs. As part of the TMDL stakeholder involvement process, the University of Houston coordinates closely with the TCEQ and other TMDL participants to ensure an adequate water monitoring strategy to supply informational needs for modeling, assessment, load allocation, and decision-making.

Site Selection Criteria

Station Selection Considerations for Water Sampling
Sampling station selection in this study is based on a careful review of the locations exhibiting historically elevated concentrations, possible sources of high concentrations, areas with undetermined levels of bacteria, and model input data requirements. Most of these stations will be located at historical TCEQ sampling locations. The sampling stations are recommended based on the following factors:

1. Reference Conditions - Understanding the background concentrations and variability in bacteria concentrations is critical to interpreting monitoring data. Although bacteria sources are ubiquitous, it is possible to exclude areas that do not have WWTPs. Data from the background stations are used to describe normal reference levels, which in turn forms the basis on which the other stations are to be evaluated.
2. Historical Sampling Locations – In an effort to obtain comprehensive sets of data, historical sites, sites used in previous studies and previously monitored by the TCEQ, will be used as often as possible. The data derived from these sites will add to the work of previous studies and allow a continuous temporal picture of bacteria concentrations in the Clear Creek Watershed.
3. Potential Sources - In areas where bacteria levels are known to be elevated, sampling stations will continue to assess the severity of contaminant levels.
4. Spatial Distribution - Because the study area covers over 200 $miles^2$ and includes many different environments, sampling stations have been located to represent the diversity in the watershed.
5. Add-on opportunities - Stations may also be located on a case by case basis if they address a specific question or there is the potential to complement work being done elsewhere.

Station Selection Considerations for Sediment Sampling
Station final selection for stream and streambank sediment sampling will be based upon the following: spatial representation of both urban and non-urban sections using GIS , stations

with exceedances of bacteria standards in historical data, review of existing literature similar to and including a Galveston County Health District study completed in 2001 to "identify and eliminate illicit connections in the Clear Creek Watershed" (Wright 2001), and field team reconnaissance.

The number of discrete samples for the sediment transect will depend upon access to the streambed and stream banks, land use, and assessment of potential for bacteria loading to the creek. It is anticipated that samples will be collected from: centerline of the creek, one on each bank just above the waterline at low flow, and several from both stream banks at prudent distances from the waterline (some from above the average flood level, some inside the flood level). When creek width is appropriate (e.g. greater than 10 feet), additional discrete samples may be collected in the streambed at equal distances from the centerline and each bank.

Monitoring Sites

Fecal indicator bacteria in water will be sampled at up to twenty five stations located in the main stem and main tributaries to Clear Creek as shown in Figure 2. In addition, stream and streambank sediment samples will be collected at up to twenty representative stations in the watershed and five to ten discrete cross sectional samples will be collected along a transect for one of these sampling station.

Table 3 presents monitoring sites and frequencies for the period June/2005 to August/2005.

Critical vs. non-critical measurements

All data collected for the TCEQ TMDL Program and entered into the SWQM portion of the TRACS database are considered critical.

References

Wright, Jean. "Identifying and Eliminating Illicit Connections in the Clear Creek Watershed" (2001). Prepared for the Galveston County Health District, Galveston, Texas. http://www.clearcreekcleanup.org/newlook2001/file01/wright.htm.

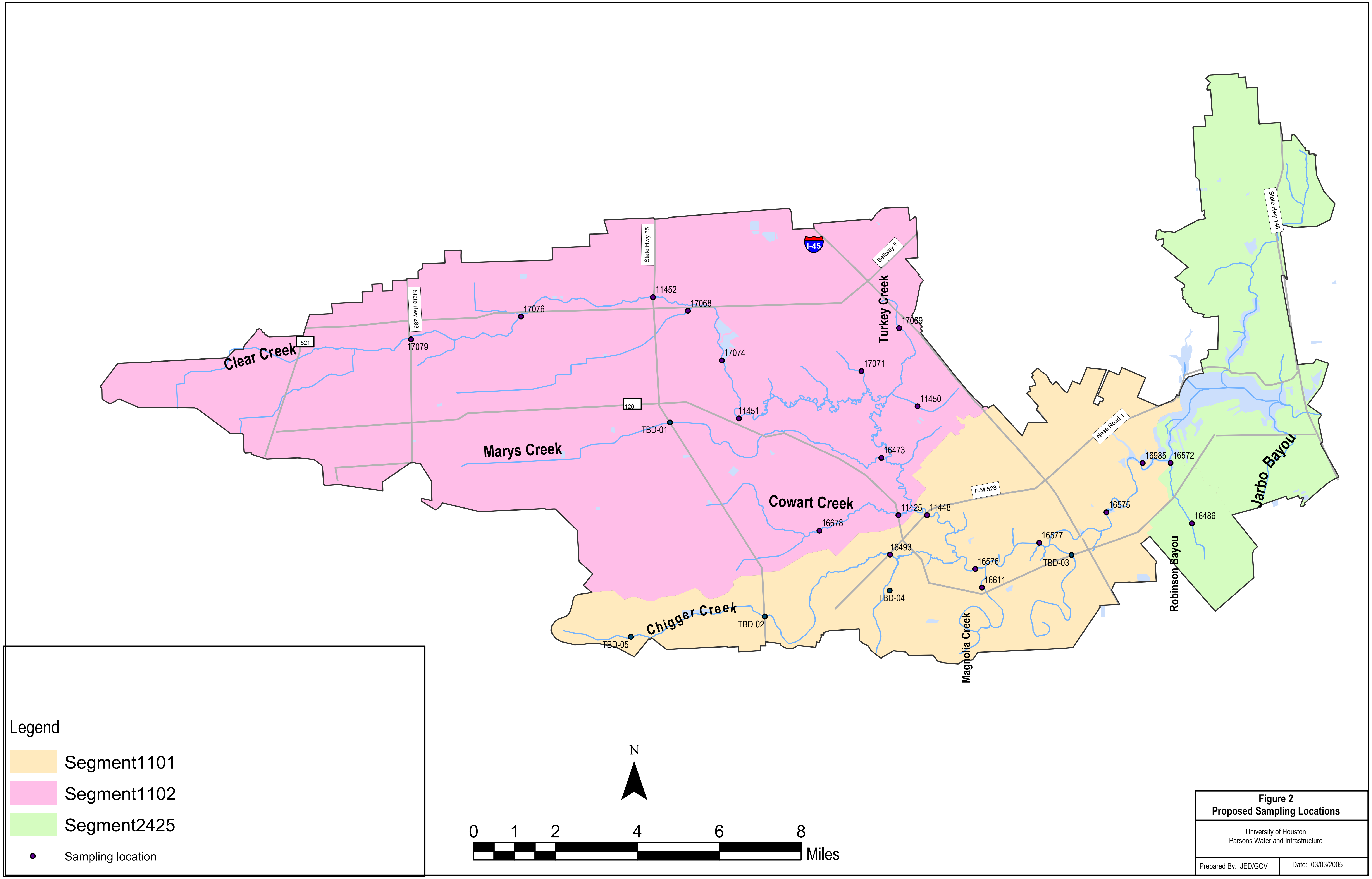

Figure 2
Proposed Sampling Locations

University of Houston
Parsons Water and Infrastructure

Prepared By: JED/GCV | Date: 03/03/2005

Table 3. Monitoring Sites and Frequencies
Basin: San Jacinto River Basin
Segment ID: 1101, 1101B, 1102, 1102A, 1102B, 2425

Sampling Component	Location ID	Potential Alternate Stations	TCEQ Short Description	Segment	Start Date[a]	End Date	SC1	SC2	Prog. Code[b]	Monitoring frequencies: Field parameters[c,d]	Conventional parameters[c,e]	Flow[f]	*E. Coli* in water[c]	*Enterococci* in water[c]	Moisture content[g]	Solids Content[g]	Volatile Solids[g]	TOC[g]	*E. Coli* in sediment[g]	*Enterococci* in sediment[g]
1&4	11425		COWART CREEK AT FM 518	1102B	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	11448		CLEAR CREEK TIDAL AT FM528	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1			1						
	11450		CLEAR CREEK AT FM 2351	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	11451	nearby station	CLEAR CREEK AT COUNTRY CLUB R	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
	11452		CLEAR CREEK AT TELEPHONE RD	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	16473		MARYS CREEK AT MARYS CROSSING	1102B	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	16486		ROBINSONS BAYOU AT WEBSTER	2425	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1		1						
	16493	16472	CHIGGER CREEK AT FM528 BRIDGE	1101B	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	16572		CLEAR CK TDL AT ROBINSONS BAY	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1			1						
	16575		CLEAR CK TDL AT WALTER HALL	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1			1						
	16576		CLEAR CREEK TIDAL AT BROOKDALE	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1			1						
	16577	11447	CLEAR CK TDL AT CHALLENGER PK	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1			1						
	16611	or Magnolia Ck	MAGNOLIA CREEK UPSTM OF FM518	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1		1						
	16678		COWART CREEK AT BAKER ROAD	1102A	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
	16985		CLEAR CK TDL AT NASSAU WWTP	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1		1						
	17068		HICKORY SLOUGH ROBINSON DRIVE	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	17069		TURKEY CREEK DIXIE FARM ROAD	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	17071		MUD GULLEY DIXIE FARM ROAD	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
	17074		CLEAR CREEK AT BARRY ROSE	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	17076		CLEAR CREEK AT STONE ROAD	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
	17079		CLEAR CREEK AT SH 28 BRIDGE	1102	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	TBD-01		MARY'S CR AT HWY35	1102B	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
	TBD-02		CHIGGER CR AT HWY35	1101B	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
	TBD-03	near confl to Clr Ck	UNNAMED TRIB <E OF MAGNOLIA CR>	1101	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1		1						
	TBD-04		TRIBUTARY OF CHIGGER CREEK	1101B	6/1/2005	8/31/2005	UH	UH	TQ	1	1	1	1							
	TBD-05		CHIGGER CK WEST OF HWY35	1101B	6/1/2005	8/31/2005	UH	UH	TQ	1	1		1							
3-In-stream	11425		COWART CREEK AT FM 518	1102B	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	11448		CLEAR CREEK TIDAL AT FM528	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	11450		CLEAR CREEK AT FM 2351	1102	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	11452		CLEAR CREEK AT TELEPHONE RD	1102	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	16486		ROBINSONS BAYOU AT WEBSTER	2425	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	16493	16472	CHIGGER CREEK AT FM528 BRIDGE	1101B	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	16572		CLEAR CK TDL AT ROBINSONS BAY	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	16575		CLEAR CK TDL AT WALTER HALL	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	16576		CLEAR CREEK TIDAL AT BROOKDALE	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	16577	11447	CLEAR CK TDL AT CHALLENGER PK	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	16611	or Magnolia Ck	MAGNOLIA CREEK UPSTM OF FM518	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	16678		COWART CREEK AT BAKER ROAD	1102A	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	16985		CLEAR CK TDL AT NASSAU WWTP	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	17069		TURKEY CREEK DIXIE FARM ROAD	1102	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	17076		CLEAR CREEK AT STONE ROAD	1102	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	TBD-01[h]		MARY'S CR AT HWY35	1102B	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	TBD-02[h]		CHIGGER CR AT HWY35	1101B	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	TBD-03[h]	near confl to Clr Ck	UNNAMED TRIB <E OF MAGNOLIA CR>	1101	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1		1
	TBD-04[h]		TRIBUTARY OF CHIGGER CREEK	1101B	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
	TBD-05[h]		CHIGGER CK WEST OF HWY35	1101B	6/1/2005	8/31/2005	UH	UH	TQ						1	1	1	1	1	
3-transect	TBD		Location to be determined	TBD	6/1/2005	8/31/2005	UH	UH	TN						1[i]	1[i]	1[i]	1[i]	1[i]	

Notes:
TBD- to be defined following submittal of Station Location request form (SLOC)
[a] Start date is tentative and contingent upon QAPP approval
[b] TQ data will generally be includedin TRACS with the exception of ammonia, orthophosphate, and flow data. TN data are not-ambient data that will not be used for assessment purposes
[c] Up to 25 locations will be sampled for water
[d] Field parameters include temperature, DO, pH, conductivity, and flow severity
[e] Conventional parameters include TSS, turbidity, orthophosphate, Ammonia-N, and TOC
[f] Up to 20 flow measurements will be made, some are at locations other than identified stations
[g] Up to 20 locations will be sampled for sediment, some may be at locations other than identified stations
[h] A SLOC request will be submitted once GPS readings are completed during reconnaissance activities
[i] Five to ten independent samples will be collected along the transect

Appendix C. Field Data Reporting Form

FIELD DATA SHEETS
FECAL PATHOGENS STUDY

Total Maximum Daily Load for Fecal Pathogens in Clear Creek

TCEQ Contract No. 582-0-80121/ Work Order No. 582-0-80121-09

Sampler(s)

Date	Time	Station ID/ Sample ID	Location	DO	pH	Temp.	Conduct.	Turbidity	Flow	Flow Severity[1]	Depth	NH_3-N	PO_4^--P	Observations[2]

[1] 1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry
[2] Water appearance, depth of sample measurement, weather, biological activity, stream uses, unusual odors, specific sample information, missing parameters, days since last significant rainfall, and flow severity if applicable.

Appendix D. Chain-of Custody Form

CHAIN OF CUSTODY RECORD

University of Houston
Dept. of Civil & Environmental Engineering
4800 Calhoun Road
Houston, Texas 77204-4003
(713) 743-6515

PARSONS
8000 Centre Park Drive, Suite 200
Austin, Texas 78754
(512) 719-6000

Laboratory Name
Laboratory Address
Laboratory Phone Number

PROJECT NAME/LOCATION
TMDL for Fecal Pathogens in Clear Creek

CARRIER
☐ Federal Express
Other ____________

TCEQ Contract No. 582-0-80121/
Work Order No. 582-0-80121-09

AIRBILL OR CARRIER ID#

SAMPLER(S):

PRESERVATIVE

ANALYSIS REQUIRED

Date	Time	Sample ID/Desc.	Sample Type	Matrix	Sample Depth	NUMBER OF CONTAINERS	EC	EN	TSS	TOC	Total Solids	Volatile Solids	Bulk density	Grain size analysis			REMARKS

Relinquished by: Date Time *(Signature)*	Relinquished by: Date Time *(Signature)*	Relinquished by: Date Time *(Signature)*
Received by: Date Time *(Signature)*	Received by: Date Time *(Signature)*	Received by: Date Time *(Signature)*

Appendix E. Data Management Plan

Field measurements and sample data collection for water and sediment are performed according to the SWQM Procedures Manual (RG-415).

Personnel

Ron Stein is responsible for managing this project for the TCEQ. He will be responsible for receiving the data and database review checklist from Jennifer Davis-Senftleber of the University of Houston, reviewing the database review checklist for completeness, and conveying the data in the required format to Kerry Niemann, TCEQ-TMDL Data Manager.

The MDM&A data manager analyzes data for completeness and inconsistencies and prepares a data validation/verfication summary report as the data is submitted to Information Resources for loading into the SWQM portion of the TRACS database.

Dr. Hanadi Rifai is responsible for managing the project for the University of Houston. She is responsible for ensuring that data are managed by the University of Houston and its subcontractors according to this data management plan and QAPP.

Mel Vargas is responsible for managing the water quality data for Parsons Water and Infrastructure and ensuring that the data comply with this QAPP. He will submit the evaluated data to the University of Houston.

Sandra de las Fuentes, the Project QAO, is responsible for reviewing the quality data from University of Houston/ Parsons Water and Infrastructure and the laboratories and performing all quality control checks on the data (Data validation checklist). If applicable, data will be sent back to the data loader for corrections. Once data have been corrected and the data validation is approved, she will be responsible for converting the data to the required format, archiving the data, backing up the data, and transferring the data to the UH Project Manager for approval. Once approval from the project manager is received, the QAO will send the final QA-evaluated field data and sample analysis results in approved electronic format to Ronald Stein of the TCEQ.

Curt Burdorf, the project field supervisor, is responsible for ensuring that the water and sediment sampling activities are conducted according to this QAPP. He will ensure that field data sheets are transmitted to the project data loader and the samples and COC forms are sent to the laboratories.

The UH/NWDLS/A&B Labs/Eastex/Acetech Project Representatives are responsible for ensuring that the data resulting from laboratory analyses for this project are managed according to the lab QMPs and this QAPP. They will sent laboratory results in electronic and hard copy to the University of Houston.

Jennifer Davis-Senftleber, the project data loader, is responsible for entering the information on the field data sheets into an electronic system. She will also incorporate analytical data from the labs into the database.

Monica Suarez, the data manager, is responsible for reviewing the quality data from University of Houston/ Parsons and the laboratories and performing all quality control checks on the data (Data validation checklist). If applicable, data will be sent back to the data loader for corrections. Once data have been corrected and the data validation is approved, she will be responsible for converting the data to the required format, archiving the data, backing up the data, and transferring the data to the UH Project Manager for approval. Once approval from the project manager is received, the data manager will sent final QA-evaluated field data and sample analysis results in approved electronic format to Ron Stein of the TCEQ.

Systems Design

Data will be entered into, stored in, and transmitted between personal computers operating on Microsoft Windows 98/2000/XP and using common commercially-available software. Microsoft Access 2000 or 2002 will be used as the databases and data files created by these software programs will be transmitted between computers via e-mail. The TCEQ database hardware and software are described elsewhere and available from the TCEQ Data Manager. Files submitted to TCEQ will be provided as pipe-delimited, ASCII files exported from Microsoft Access 2000.

Data Dictionary

The fields of the data dictionary can be reviewed in the *Data Management Reference Guide*, Chapter 7 (Data Reporting). The fields are described under the subheadings, “Event file structure: and “Results file structure.” The document is available at: http://www.tnrcc.state.tx.us/water/quality/data/wqm/wdma/dmrg/2003dmrg.html.

Table 4 outlines the codes that will be used when submitting data under this QAPP.

Table 4. Codes used for Data Submittal

Name of Monitoring Entity	Tag ID prefix	Source Code 1	Source Code 2	Program Code
University of Houston	UH	UH	UH	TQ/TN[a]
Parsons Water & Infrastructure	UH	UH	PE	TQ/TN[a]

[a] **TQ** will be used for ambient data usable for general water quality assessments (i.e., in-stream water and sediment), while **TN** will be used for non-ambient data not to be used for general water quality assessments (i.e., sediment transect)

Parameter codes for data collected under this project are included in Table A.1 of section A7.

Data Management Plan Implementation – Implementation of the data management plan is displayed graphically on Figure 3. Field data will be recorded on field data reporting forms, then conveyed to Jennifer Davis-Sentfleber, who will enter them into a database file. All values in the electronic file will be compared to the paper forms after entry. Field data forms will be maintained at the University of Houston for five years.

The results of analytical tests at the University of Houston and NWDLS/Acetech/Eastex/A&B Laboratories will be provided in paper or electronic form, then entered into an electronic database maintained at UH by Jennifer Davis-Senftleber. After this operation, each value in the database is compared to the value on paper for accuracy.

If any calculations are made, at least 10% will be checked by hand for accuracy. Monica Suarez will convert the electronic file to Corel Paradox format for the TCEQ, and following manual accuracy checks, archive copies of each file to CD-ROM format. The ASCII text file, along with a database review checklist, will be then transferred to the TCEQ Project Manager by e-mail. After approving the database review checklist, the TCEQ Project manager will convey the file to the TCEQ Data Manager. The TCEQ Data Manager will run the TCEQ automated screening procedure on the file to check for errors and outliers, then forward the results to the TCEQ Project Manager. Upon approval of the TCEQ Project Manager, the TCEQ Information Resources staff will add this data to the SWQM portion of the TRACS database.

Quality Assurance/Control - See Section D of this QAPP.

Migration/Transfer/Conversion - Data will be entered into the Access 2000 database from field data sheets or by importing the data from a spreadsheet or text file that has been supplied by other project participants or laboratories. Data entered from the field sheets will be compared to the value of the paper for accuracy. Before importing data from electronic files, a backup of the primary UH database will be made. The files will be imported into the database and then the database will be compared with the backup version to ensure that no data were lost. The backup database will then be destroyed to ensure that there is no confusion regarding the current version of the database.

Backup/Disaster Recovery – Data files stored on the network servers at the University of Houston, Parsons Water and Infrastructure, NWDLS/Acetech/Eastex/A&B Laboratories, and TCEQ computer systems are routinely backed up. After a summary report is produced at the University of Houston, it will then be saved to a CD-ROM for distribution and archive at the University of Houston offices. Copies of the field data reporting forms and laboratory paper records will be maintained, at the University of Houston and the laboratories, respectively, for a period of five years as additional insurance against data loss. Additionally, backups of the database will be made by the data manager every month data are entered and stored on permanent media (zip disk or CD-ROM) at UH to guard against data loss due to accidental erasure or file corruption.

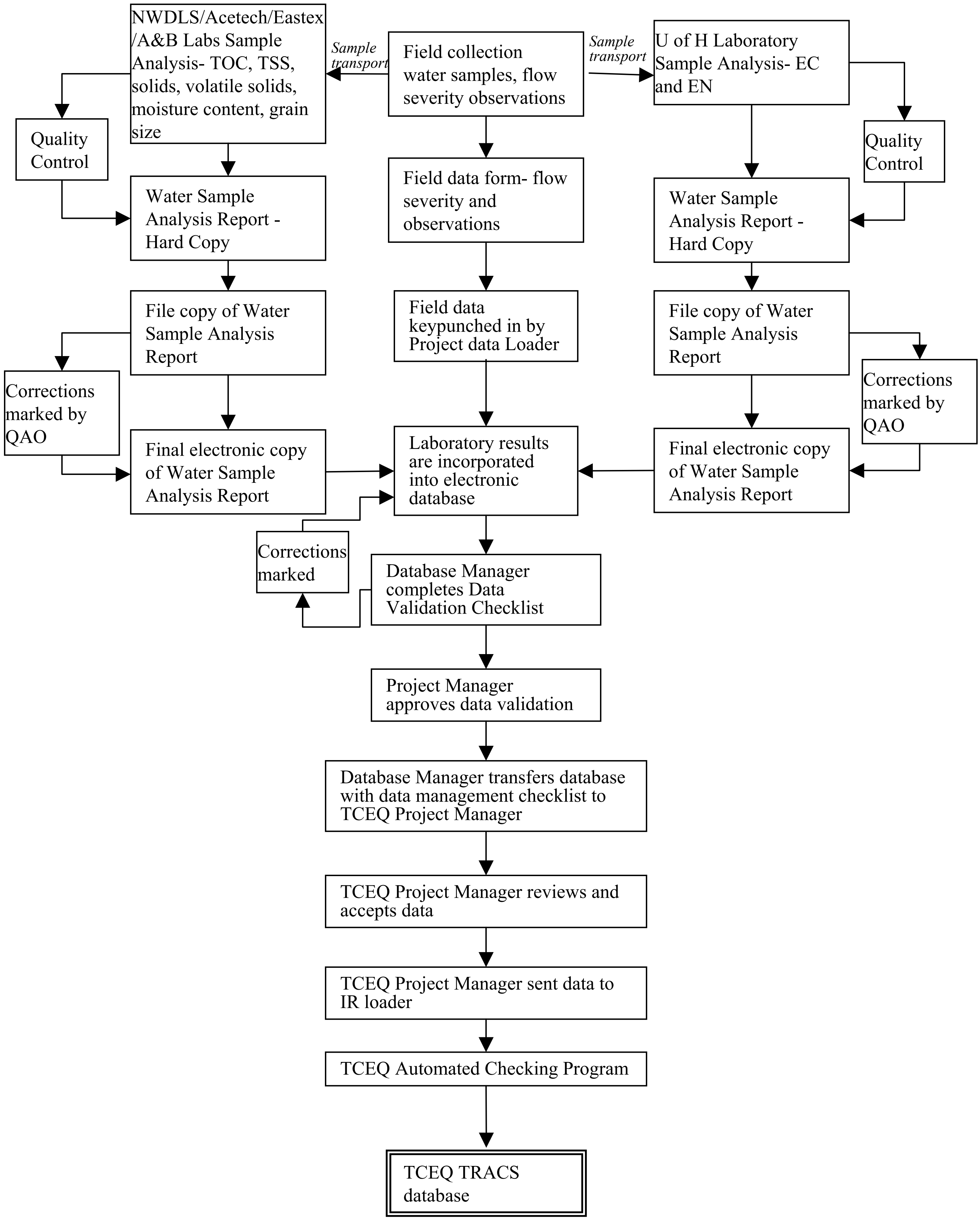

Figure 3. Data Management Plan

Archives/Data Retention - Complete original data sets are archived on permanent media (zip disk or CD-ROM) and retained on-site by UH for a retention period specified in the original QAPP approved by the TCEQ Project Manager.

Information Dissemination - Project updates will be provided to the TMDL Project Manager in progress reports and the information will be made available at stakeholder meetings. Environmental data collected as part of the project described in this QAPP will be accessible to the general public from the SWQM portion of the TRACS database once the data has undergone the QA/QC protocol described herein.

References

TCEQ. 2004 (or most recent version). *Data Management Reference Guide, Surface Water Quality Monitoring* (December 2004).

TCEQ. 2003 (or most recent version). *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue*. Document No. RG-415. (December 2003).

Appendix F. Data Review Checklists

DATA QUALITY REVIEW CHECKLIST FOR WATER AND SEDIMENT DATA

Data Format and Structure **✔, ✘, or N/A**

A. Is the file in the correct format (e.g. ASCII pipe delimited)? ________
B. Are there any duplicate Tag Id numbers? ________
C. Are the Tag prefixes correct? ________
D. Are all Tag Id numbers 7 characters? ________
E. Are TCEQ station location (SLOC) numbers assigned? ________
F. Are sampling Dates in the correct format, MM/DD/YYYY? ________
G. Is the sampling Time based on the 24 hour clock (e.g. 13:04)? ________
H. Is the Comment field filled in where appropriate (e.g. unusual occurrence, sampling problems, unrepresentative of ambient water quality)? ________
I. Source Code 1, 2 and Program Code used correctly and are valid? ________
J. Is the sampling date in the Results file the same as the ones in the Events file? ________
K. Values represented by a valid parameter code with the correct units and leading zeros? ________
L. Are there any duplicate parameters for the same Tag Id? ________
M. Are there any invalid symbols in the Greater Than/Less Than (GT/LT) field ________
N. Are there any tag numbers in the Results file that are not in the Events file? ________
O. Have confirmed outliers been identified? (preferably with a “1" in the verify flg field)________

Data Quality Review

A. Are all the values reported at or below the appropriate AWRL? ________
B. Have the outliers been verified? ________
C. Checks on correctness of analysis or data reasonableness performed? ________
e.g.:Is orthophosphorus less than total phosphorus?
D. Have at least 10% of the data in the data set been reviewed against the field and laboratory data sheets? ________
E. Are all STORET codes in the data set listed in the QAPP? ________
F. Are all stations in the data set listed in the QAPP? ________

DATA REVIEW CHECKLIST (contd.)

Documentation Review

A. Are blank results acceptable as specified in the QAPP? ________
B. Were control charts used to determine the acceptability of field duplicates? ________
C. Were there any failures in sampling methods and/or deviations from sample design requirements that resulted in unreportable data? If yes, explain on next page ________
D. Were there any failures in field and laboratory measurement systems that were not resolvable and resulted in unreportable data? If yes, explain on next page. ________

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

____
____
____
____
____
____
____
____

Date Submitted to TCEQ: ________________________________
TAG Series: ________________________________
Date Range: ________________________________
Data Source: ________________________________
Comments (attach README.TXT file if applicable): ________________________________
____
____

University of Houston Data Manager Signature: ________________________________

Date: ________________________________

Appendix G. Database Review Checklist

This checklist is part of the QA/QC and should be used by the TMDL University of Houston/Parsons Water and Infrastructure database managers and other entities handling the monitoring data in order to review data processing methods before submittal to the TCEQ. This checklist applies to data collected under a quality assurance project plan and is confined to only those items, which the data manager routinely reviews.

Field Data Review	✓, ✗, or N/A
A. QC samples (field duplicates) collected for all analytes as prescribed in the TCEQ SWQM Procedures Manual?	________
B. Are field duplicate and blank results acceptable?	________
C. Are field QC results attached to this review?	________
D. Field documentation includes the following:	
(1) Identification of individual(s) collecting sample(s)?	________
(2) Sample ID number and site location?	________
(3) Sample collection date, depth, and time?	________
(4) Site observations (i.e. weather, unusual flow, etc)?	________
(5) Unusual occurrences that may affect water quality?	________
(6) Sample collection problems?	________
E. Chain of custody record properly filled out and available for review?	________

Data Format and Structure	
A. Are there any duplicate *Tag Id* numbers?	________
B. Are the *Tag* prefixes correct?	________
C. Are all *Tag Id* numbers 7 characters?	________
D. Are TCEQ station location (SLOC) numbers assigned?	________
E. Are sampling *Dates* in the correct format, DD/MM/YYYY?	________
F. Is the sample *Depth* greater than 0.3 meters?	________
G. Is the *Comment* field filled in where appropriate?	________
H. *Source Code 1, 2* and *Program Code* used correctly?	________
I. Is the sampling date in the *Results* file the same as the one in the *Events* file?	________
J. Values represented by a valid parameter (*STORET*) code with the correct units?	________
K Are there any duplicate measurements for the same *Tag* and *STORET*?	________
L. Are there any invalid symbols in the Greater Than/Less than (*GT/LT*) field?	________
M. Are there any measurements in the *Results* file that are not in the *Events* file?	________
N. Is the sampling *Time* based on the 24 hour clock (e.g. 13:04)?	________

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

DATABASE REVIEW CHECKLIST (cont'd)

Data Quality Review		**✓, ✗, or N/A**
O.	Holding times confirmed?	_______
P.	RLs consistent with those in the QAPP?	_______
Q.	Outliers confirmed and documented?	_______
R.	Documentation (verified error log) provided to TCEQ?	_______
S.	Checks on correctness of analysis or data reasonableness performed?	_______
T.	For FC densities that are too few or too numerous to count, are the values reported as < or > the applicable minimum or maximum value?	_______
U.	Have at least 10% of the data in the database been reviewed against the data sheets?	_______

Explain any answers that may indicate a problem with the data (attach another page if necessary):

____

____

____

Date Submitted to TCEQ: ___________________________

TAG Series: ____

Date Range: ____

Data Source: _______________________________________

Comments (attach README.TXT file if applicable):

Data Manager Signature: ____ Date: ____________

Appendix H. Example letter to document adherence to the QAPP

TO: Subcontractor

FROM: Hanadi Rifai
University of Houston

RE: QAPP for *Total Maximum Daily Loads for Fecal Pathogens in the Clear Creek Watershed*

Please sign and return this form by __(*date*)__ to:

Civil and Environmental Engineering
4800 Calhoun Rd., Room N107D
Houston, TX 77204-4003

I acknowledge receipt of the QAPP for Fecal Pathogens in Clear Creek for 2005. I understand the QAPP describes quality assurance, quality control, and other technical activities that I must implement to ensure the results of work performed will satisfy stated performance criteria.

________________________________ _______________

Subcontractor Signature Date

ATTACHMENT 1 - STANDARD OPERATIONAL PROCEDURES (SOPs) FOR FLOW MEASUREMENTS USING RIVER SURVEYOR

This section describes the procedures for the collection of flow measurements and velocity profiles using a SonTek Acoustic Doppler Profiler interconnected with the RiverSurveyor software. This standard operating procedures document (SOP) is a slight modification of the one developed by Grace Chen from The Texas Parks and Wildlife Department to maintain consistent data collection procedures, and to ensure the quality of the data collected.

INTRODUCTION

The ADP we are operating has an acoustic frequency of 1.5 MHz, which is designed for deep water. To ensure the best quality of measurement, the operator has to stick with the minimum and maximum limits for particular parameters listed below as closely as possible.

Profiling Range (min - max)	*Cell Size (min-max)*	*Blanking Distance (min)*	*Number of Cells (min-max)*
0.8 - 15 m	0.25 - 4.0 m	0.4 m	1 - 100

PREPARE DATA COLLECTION AT EACH SURVEY SITE

Two tasks need to be performed once the crew arrives at the survey site. They are:

1. Calibrate Compass
   a. Use the SonUtils Program
   b. Establish communication between the systems by selecting a com port and specifying the Baud rate (eg. 9600).
   c. Click the control panel **Compass Calibration** to open the dialog box
   d. Click **Start** from the dialog box
   e. **Drive** the boat through two full loops and rock the boat to vary the pitch and roll as much as practical
   f. Click **Stop** and examine the calibration scores (eg., H9V9M4)
   g. Determine whether the scores are satisfactory. Otherwise, change some settings and redo the calibration.

2. Conduct preliminary surveys across the transect to gather information on
   a. The **depth of the transducer** below the waterline (in meters)
   b. The **maximum depth** of the transect (in meters)
   c. Representative **salinity** along the transect
   d. **Distances** between the start/end points to the nearest bank (in meters)

SELECT RIVER SURVEYOR SETTINGS

1. Open the RiverSurveyor software by clicking Start | Program | SonTek| RiverSurveyor
2. Establish connection by clicking Com Port 1 and Baud 9600 (in most cases)
3. Specify preferences for the file
   - Click **File | Configuration** to open a dialog box for Program Configuration
   - Complete the dialog by specifying preferential settings, e.g., choose **metric units**.
4. Choose system settings through user setup dialog
   - Click **ADP Configuration | User Setup**
   - Supply the following inputs to complete the dialog box
     - File Naming System: Automatic
     - File Name: give a name less than 5 characters
     - Averaging Interval: 5 seconds
     - Profiling Range: solicit suggestions from the **Profile Assistant**
       - § Click **Show Profile Assistant**
       - § Enter the expected **maximum depth** of the transect
       - § Click **Transfer Values**
       - § Adjust the suggested values for Number of Cells, Cell Size, and Blanking Distance as fit
     - Enter the **depth** of the transducer below the waterline
     - Coordinate System: **ENU** (East-North-UP)
     - Bottom Track: **Yes**
     - Magnetic Declination: Varies with survey sites
     - Sound Speed Settings
       - § **Temperature Mode**: Measured (by the internal device)
       - § Enter **Salinity** (ppt) measured using a YSI sonde
     - Click **OK** to accept the selections

MODIFY DISPLAY SETTINGS

Although the default display settings seem to provide adequate information for monitoring the progress of the program, one can modify the settings by checking on or off particular contents listed under the View menu.

BEGIN DATA COLLECTION

1. Click **Play** or **F6** to start data collection without recording
2. **Move the boat** into the position where you want to start the transect
3. Make sure the indicator lights for ADP and Bottom Track displayed in the status bar are green and the software is receiving valid data.
4. **Measure the distance** from the starting point to the bank, if necessary.

START RECORDING DATA

1. Click **Record** or **F7** - Data recording begins immediately and the file name will be displayed on the top of the screen.
2. Enter the distance from the closest bank into the **Start Distance** dialog box
3. **Linger** at the start point (as well as the end point) for about 5 seconds to ensure sufficient number of valid cells are recorded.
4. Move the boat across the transect slowly. Ideally, the boat speed should be slower than the flow velocity, although it is often hard to maintain the ideal condition in tidal streams.
5. Monitor the **number of valid cells** from the **discharge data** tabular display and prepare to stop the boat as the # of valid cell decreases.
6. Stop the vessel when you are sufficiently close to the riverbank yet still have two valid cells.
7. Accurately measure the distance from the ADP to the riverbank, if necessary.
8. Click **Record** or **Alt + F7** and enter the distance into the **Edge Distance** dialog box.
9. The discharge data across the cross section should be well recorded by now.

IF COMPARISONS OF DATA ACROSS THE SAME TRANSECT ARE WANTED

1. Allow the system to keep running in **Play** mode.
2. **Position** the boat into the new start point
3. Click **Record or F7** and enter the distance into the **Start Distance** dialog box again to start another transect.
4. Stop the vessel and click **Record** or **Alt + F7** and enter the distance to the **Edge Distance** dialog box as the boat reaches the other end of the transect.
5. These procedures can be repeated for the third or fourth time along the same transect.

FINISH A SITE

1. Click the **Stop** button or **F5** to conclude the study of a particular site.

PREVIEW DATA

1. Load a RiverSurveyor ADP data file (.adp) by clicking **File | Open**.
2. Compute summary data for the loaded file by clicking **Processing |Discharge Computation**.
3. Open the summary data by clicking **File | Discharge Summary** and evaluate whether the discharge data are recorded as expected.
4. Data can be previewed by **PlayBack** or **export** the file into ASCII format.

ATTACHMENT 2
REVIEW OF SEDIMENT EC MEASUREMENT PROCEDURES

A review of methods for bacterial analysis of solids such as sediment was conducted and briefly summarized below. Essentially all methods require the solid material to be diluted into a volume of water and enumeration made with conventional water analysis techniques. This could either be with a membrane filter, an MPN method, or counting colonies on a petri dish. However, since membrane filter methods are very sensitive to solids blanketing of the filter, the MPN method is preferred. Since the IDEXX Colilert and IDEXX Enterolert methods are MPN methods and are being used for water samples, they are the logical choice for the sediment samples.

The following sections briefly summarize other procedures.

Review of "Microbiological Methods for Monitoring the Environment, Water and Wastes", EPA/600/8-78/017, by EPA (1978)

This document includes procedures to process water samples with high solids (Section 1.3.1) and dry solid samples (Section 1.3.2). These procedures involve the blending of the samples using a Waring-type blender at 5,000 RPM for no more than 30 seconds. The procedures also involve dilution of samples using buffered dilution water. For water samples with high solids, a 1:1, 1:2 dilution ratio or more was recommended. For dry solid samples, a 1:10 dilution ratio was recommended. If necessary, serial dilutions were allowed and each bottle containing diluted samples should be shaken vigorously about 25 times in 7 seconds before subsequent dilution. The document also indicates that serial dilutions are usually prepared in succeeding ten-fold volumes called "decimal dilutions."

Review of City Of Houston 69th Street Wastewater Quality Control Laboratory Standard Operating Procedure -- Multiple-Tube Fermentation Procedure For Fecal Coliform

These procedures are used for wastewater sludge samples, both class A and B. In brief summary, a sterilized 100 mL beaker is placed on the top-loaded balance and tared to zero. A 1:10 dilution is obtained by weighing 10 gm of sludge into the beaker, then dilute to 100 g with buffered dilution water. The beaker is then removed from the balance and stirred to mix the sample. Two additional dilutions are made from this dilution. The three dilutions are used in the MPN FC procedure, SM 9221 E.

Review of procedures adopted by Stillmeadow Lab for analyzing sediment samples for Harris County Flood Control District

The methodology described used by Stillmeadow was based on general microbiological techniques and on The Difco Manual, 11th edition, 1998. The collected sediment samples were frozen upon receipt. When ready for use the samples were thawed. About 10-20 grams of a subsample was weighed into a sterile 50 mL centrifuge tube. The subsamples were then diluted to the 30 mL mark (Dilution 0) with sterile water and vortexed to thoroughly mix and suspend the solids. A 1:10 dilution (Dilution 1) was made immediately after mixing by removing 1.0 mL with a pipette and transferring to a sterile 15 mL tube containing 9.0 mL sterile water. Dilution 1 was further diluted by 1:10 by following the same procedure to make Dilution 2 and so on. Various dilutions were applied to specific media on petri dishes. Positive colonies on the dish surface were enumerated.

Review of methods used by An, J-J, D H Kampbell and G P Breidenbach, 2002, Escherichia coli and total coliforms in water and sediment at lake marinas. Env. Pollution 120 771-778. an EPA-supported study on Lake Texoma.

Total coliform and EC in sediment were determined by spreading suitable dilutions on eosin methylene blue (EMB) plates that select for gram negative bacteria. An aliquot equal to 1.5 gm dry sediment was placed in a 40 mL glass vile and 15-mL of sterile RO water added. Vials closed and rolled on a low profile roller at 8 rpm for 1 hr to suspend sediment. This became the 1:10 dilution. Further 10-fold dilutions were made from this. The dilutions were spread on the EMB plates with a sterile L shaped rod. Plates incubated for 2 days at 36 degrees C and colonies counted with a colony counter, if the number was between 30 and 300 colonies. Those with green metallic sheen were counted as EC.

References

An, J-J, D H Kampbell and G P Breidenbach, 2002, *Escherichia coli* and total coliforms in water and sediment at lake marinas. Env. Pollution 120 771-778. an EPA-supported study on Lake Texoma.

City of Houston Public Works and Engineering Department. (1999). “Greens Bayou Intensive Survey and Wasteload Evaluation Final Report.” Prepared for the Texas Clean Rivers Program, Houston-Galveston Area Council, Houston, TX.

City Of Houston 69th Street Wastewater Quality Control Laboratory Standard Operating Procedure -- Multiple-Tube Fermentation Procedure For Fecal Coliform

Stillmeadow Lab. “Procedures adopted by Stillmeadow Lab for analyzing sediment samples for Harris County Flood Control District”

US EPA. "Microbiological Methods for Monitoring the Environment, Water and Wastes", EPA/600/8-78/017, by EPA (1978)