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

Development of a Watershed Protection Plan for Cedar Bayou

TSSWCB Project Number 10-08
Revision No. 2

Monitoring Quality Assurance Project Plan

Texas State Soil and Water Conservation Board

Prepared by:
Houston-Galveston Area Council
3555 Timmons Lane, Suite 120
Houston, TX 77027

Effective Period: Upon EPA Approval through August 31, 2015
(With annual revisions required)

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

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A1 APPROVAL PAGE

Quality Assurance Project Plan (QAPP) for the Development of a Watershed Protection for Cedar Bayou

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Name: Pam Hickman
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Signature:___________________________________Date:_____________

Name: Daniel Bowen
Title: Eastex QAO

Signature:___________________________________Date:_____________

A2 TABLE OF CONTENTS

Appendices

A3 DISTRIBUTION LIST

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

U.S. Environmental Protection Agency Region 6
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Name: Dr. George Guillen
Title: EIH Project Manager

List of Acronyms

ACS	American Chemical Society
AWRL	Ambient Water Reporting Limit
BMP	Best Management Practice
CAR	Corrective Action Report
CFS	Cubic Feet Per Second
COC	Chain of Custody
CRP	Clean Rivers Program
CWA	Clean Water Act
DO	Dissolved Oxygen
DMR	Discharge Monitoring Report
EIH	Environmental Institute of Houston
EPA	Environmental Protection Agency
GBEP	Galveston Bay Estuary Program
GIS	Geographic Information System
GPS	Global Positioning System
H-GAC	Houston-Galveston Area Council
LCS	Laboratory Control Sample (formerly Laboratory Control Standard)
LCSD	Laboratory Control Sample Duplicate
LOQ	Limit of Quantitation (formerly Reporting Limit)
NELAC	National Environmental Laboratory Accreditation Conference
NPS	Nonpoint Source
PM	Project Manager
QA	Quality Assurance
QC	Quality Control
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
RPD	Relative Percent Difference
SLOC	Station Location Form
SM	Standard Methods for Examination of Water and Wastewater, 20th edition
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
WPP	Watershed Protection Plan
WWTF	Wastewater Treatment Facility
TWQI	Texas Water Quality Inventory

A4 PROJECT/TASK ORGANIZATION

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

U.S. Environmental Protection Agency Region 6

Henry Brewer, EPA Project Officer

> Responsible for overall performance and direction of the project at the federal level. Ensures that the project assists in achieving the goals of the Clean Water Act (CWA). Reviews and approves the QAPP, project progress, and deliverables.

Texas State Soil and Water Conservation Board (TSSWCB)

Ashley Wendt, TSSWCB Project Manager (PM)

> Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with the project. Develops lines of communication and working relationships between H-GAC and TSSWCB. Tracks deliverables to ensure that tasks are completed as specified in the contract. Responsible for ensuring that project deliverables are submitted on time and are of acceptable quality and quantity to achieve project objectives. Participates in the development, approval, implementation, and maintenance of the QAPP. Assists the TSSWCB QAO in technical review of the QAPP. Responsible for verifying that the QAPP is followed by H-GAC, EIH, and Eastex. Notifies the TSSWCB QAO of particular circumstances that may adversely affect the quality of data derived from the collection and analysis of samples. Enforces corrective action.

Mitch Conine, TSSWCB QAO

> Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TSSWCB participants. Responsible for verifying that the QAPP is followed by project participants. Assists the TSSWCB Project Manager on issues related to Quality Assurance (QA). Determines that the project meets the requirements for planning, QA/QC, and reporting under the CWA Section 319 program. Coordinates reviews and approvals of QAPPs and amendments or revisions. Monitors implementation of corrective actions. Coordinates and conducts audits of field and laboratory systems and procedures.

Houston-Galveston Area Council (H-GAC)

Justin Bower, H-GAC PM

Responsible for ensuring tasks and other requirements in the contract are executed on time and are of acceptable quality. Monitors and assesses the quality of work. Coordinates attendance at conference calls, training, meetings, and related project activities with the TSSWCB. Responsible for verifying the QAPP is followed and the project is producing data of known and acceptable quality. Ensures adequate training of data collection personnel and supervision of all monitoring and data collection activities. Complies with corrective action requirements.

Jean Wright, H-GAC QAO, H-GAC Field Supervisor

Responsible for coordinating development and implementation of the QA program. Responsible for writing and maintaining the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. 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 coordinating with the TSSWCB QAO to resolve QA-related issues. Notifies the contractor Project Manager and TSSWCB Project Manger of particular circumstances which may adversely affect the quality of data. Responsible for validation and verification of all data collected according with procedures listed in this document and acquired data procedures after each task is performed. Coordinates the research and review of technical QA material as well as data related to water quality monitoring system design and analytical techniques. Conducts laboratory inspections; develops, facilitates, and conducts monitoring systems audits. Responsible for supervision of all aspects of the 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 are appropriately trained as specified in Sections A6 through A8.

William Hoffman, H-GAC Data Manager

Responsible for acquisition, verification, and transfer of data to the TSSWCB. Oversees data management for the study. Performs data quality assurances prior to transfer of data to TSSWCB. Responsible for transferring data to the TSSWCB in the acceptable format. Ensures data are submitted according to work plan specifications. Provides the point of contact for the TSSWCB PM to resolve issues related to the data.

Eastex Environmental Laboratory, Inc.

Pam Hickman, Laboratory Director, Eastex Environmental Laboratory

Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for ensuring that 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 operation, ensuring that all QA/QC requirements are met, and documentation related to the analysis is completely and accurately reported. Enforces corrective action, as required. Develops and facilitates monitoring systems audits. Responsible for producing quality analytical data for all samples. Maintains verification of procedures establishing the level of quality. Responsible for sending data and chain of custody (COC) forms to EIH for delivery to H-GAC.

Daniel Bowen, Eastex Environmental Laboratory QAO

Monitors the implementation of the QAM and the QAPP within the laboratory to ensure complete compliance with QA objectives as defined by the contract and in the QAPP. Conducts internal audits to identify potential problems and ensure compliance with written SOPs. Responsible for supervising and verifying all aspects of the QA/QC in the laboratory. Performs validation and verification of data before the report is sent to the contractor. 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 QAO. Checks training, competency, and re-training of technicians. Resolves out-of-control issues. Conducts internal lab audits.

Environmental Institute of Houston (EIH) University of Houston Clear Lake (UHCL)

Dr. George Guillen, EIH Project Manager, Field Supervisor and QAO

Responsible for meeting the requirements of the contract between H-GAC and the Environmental Institute of Houston (EIH) by implementing project requirements, the QAPP, and QAPP amendments and appendices. Ensures project oversight is consistent with QAPP requirements and communicates project status to H-GAC Project Manager. Notifies H-GAC Project Manager and/or the H-GAC QAO of circumstances that may adversely affect quality of data derived from collection and analysis of samples. Helps coordinates basin planning activities and works with basin partners. Responsible for ensuring that proper methods and protocols are followed during sample collection and that field data are properly reviewed, verified and submitted to H-GAC in a timely manner.

Jenny Oakley, Data Manager & Field QAO

Responsible for entering data in spreadsheets, reviewing and verifying data with field operations and with contract laboratory personnel. Performs required QA/QC checks on data and ensures results are acceptable for submission to H-GAC. Trains all field monitoring personnel and is responsible for ensuring that proper methods and protocols are followed during sample collection.

Figure A4.1a-Organization Chart

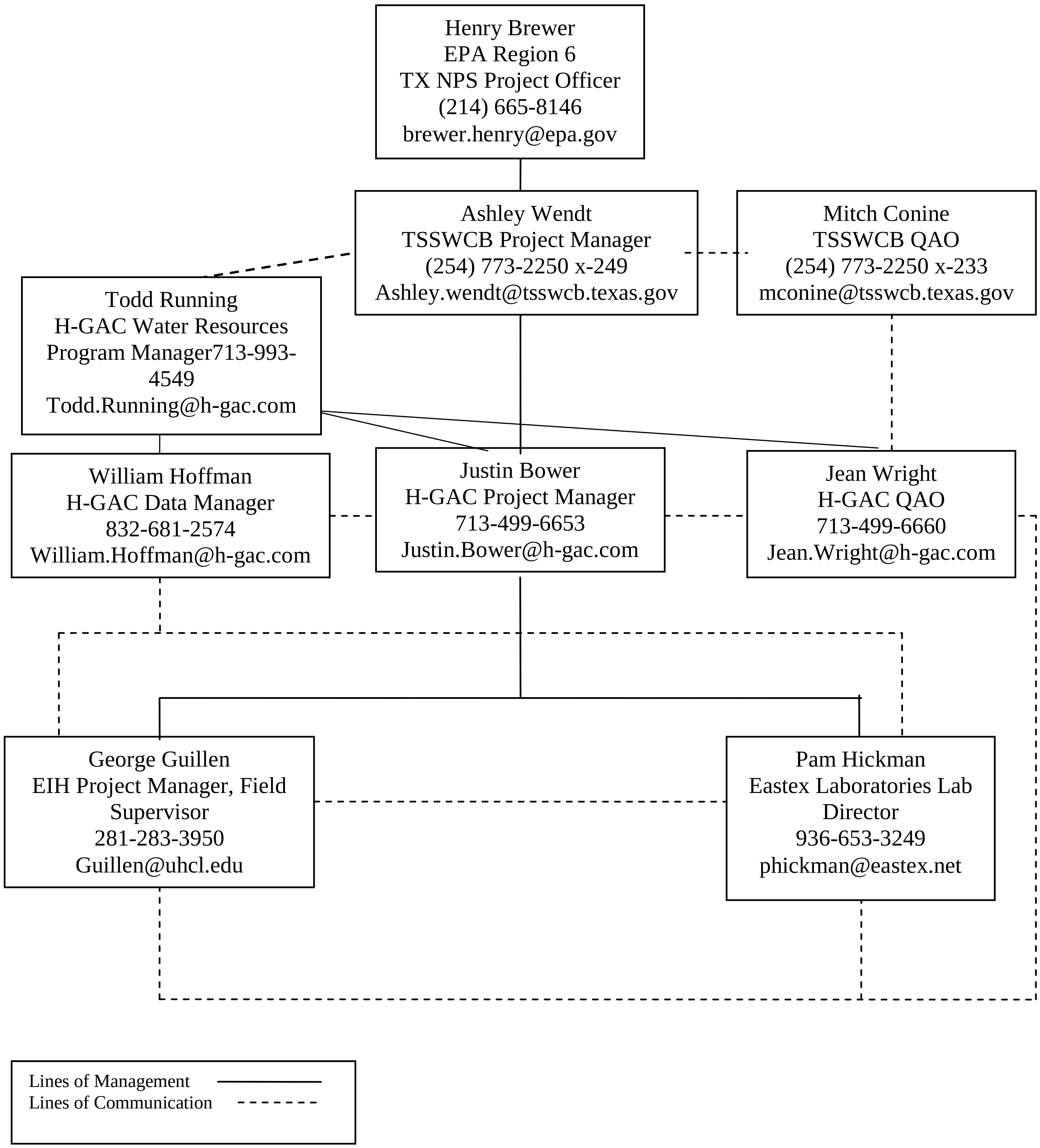
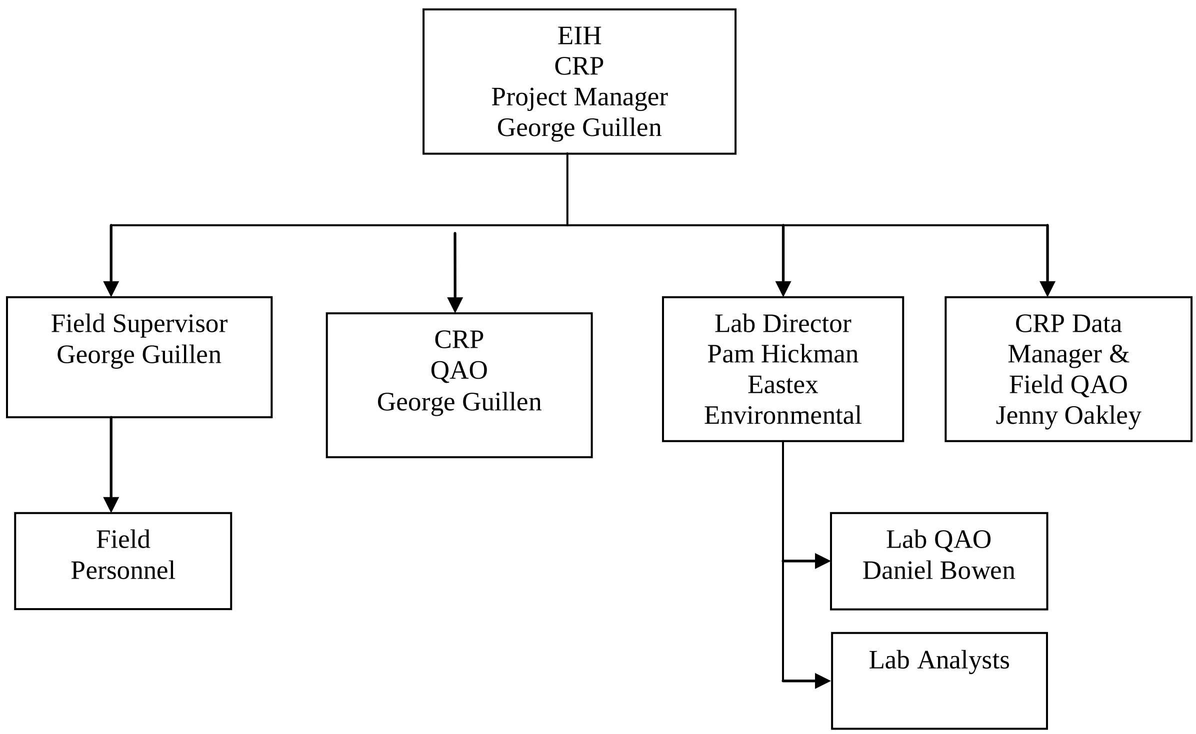


Figure A4.1b. The Environmental Institute of Houston (EIH) at the University of Houston - Clear Lake (UHCL) Organizational Chart.



A5 PROBLEM DEFINITION/BACKGROUND

The purpose of this project is to work with federal, state and local agencies to coordinate a stakeholder driven process for development of a watershed protection plan for the Cedar Bayou watershed which will satisfy the EPA's nine element guidance for watershed-based plans.

The Cedar Bayou watershed drains approximately 200 square miles. Cedar Bayou flows south from its headwaters in Liberty County to form the majority of the boundary between Harris, Liberty and Chambers Counties. Cedar Bayou is comprised of two stream segments as defined by the Texas Commission on Environmental Quality (TCEQ). Stream segment 0902 is Cedar Bayou Above Tidal, which flows from a point 7.4 kilometers (4.6 miles) upstream of FM 1960 in Liberty County (northwest of the City of Dayton) to a point 2.2 kilometers (1.4 miles) upstream of Interstate 10 in Chambers/Harris County (due west of the City of Mont Belvieu). Segment 0901 is Cedar Bayou Tidal, which flows from a point 2.2 kilometers (1.4 miles) upstream of IH 10 in Chambers/Harris County (due west of the City of Mont Belvieu) to the confluence with Galveston Bay 1.0 kilometer (0.6 mile) downstream of Tri-City Beach Road in Chambers County (southeast of the City of Baytown).

The top third of the watershed is primarily comprised of agricultural and low density residential uses, and undeveloped areas. Most of the Bayou and its network of drainage tributaries are channelized or bermed, and range in size from a small, ephemeral drainage ditch to a shallow creek. The middle third of the watershed includes large portions of undeveloped land and some agricultural and residential uses. The Bayou in this section has a thick riparian buffer zone in many areas, widens and deepens, and maintains consistent flow. The bottom third of the watershed includes suburban areas and dense urban and industrial uses. Historically, the lower portion of the watershed has been a locus for commodities and petrochemical industry activity. This section of the Bayou continues to widen, becoming a small river, and then a series of interconnected lakes prior to its confluence with Upper Galveston Bay.

Regional growth projections point to a continued rapid increase of population for Harris County and its adjacent counties through 2035. In the Cedar Bayou watershed, much of that growth is expected to occur in and adjacent to existing urban and suburban areas, and along major transportation corridors. Additionally, the lower reaches of Cedar Bayou serve a large volume of barge traffic, which is expected to increase with the proposed development of a barge terminal. In the upper portions of the watershed, significant portions of the Bayou and its tributaries have been modified in path and channel characteristics, and natural drainage has been replaced throughout much of the bayou with an intricate series of drainage ditches, canals, and channelized tributaries.

In the 2008 Texas Water Quality Inventory (TWQI) and 303(d) List, Cedar Bayou Above Tidal (0902) is listed as impaired for macrobenthic communities. Cedar Bayou Tidal (0901) is listed as non-supporting of the contact recreation standard due to elevated levels of indicator bacteria, and is also impaired for PCBs and Dioxin in edible fish tissue. In the 2010 Integrated Report for Clean Water Act Sections 305(b) and 303(d), the same impairments exist, with the exception of a delisting of Segment 0902 for impaired macrobenthic communities. However, the 2010 Integrated Report also indicates that Segment 0902 has concerns for impaired macrobenthic communities and depressed dissolved oxygen, while Segment 0901 has a concern for chlorophyll-*a*.

Cedar Bayou Tidal is part of the Houston Ship Channel and Upper Galveston Bay Total Maximum Daily Load (TMDL) project for Dioxin and Polychlorinated Biphenyls (PCBs) in Fish Tissue. Additionally, the TMDL for Upper Galveston Bay (Segment 2421), currently being addressed in the Upper Gulf Coast Oyster Waters TMDL Implementation Plan, is potentially affected by flow from the Bayou. Some aspects of nonpoint source (NPS) pollution are being addressed by the City of Baytown and the Joint Task Force (Harris County, Harris County Flood Control District, the City of Houston, and the Texas Department of Transportation (TXDOT) through their respective TPDES storm water permits, which include areas in the Harris County portions of the watershed. Cedar Bayou supports appreciable recreational activity, including boating, swimming, and fishing, which could be impacted by these water quality impairments. Cedar Bayou is also a tributary to the Galveston Bay system, thus these contaminants potentially impact a wide range of economic and ecological interests even beyond their watershed of origin. To that end, H-GAC sought CWA §319(h) grant funding from the EPA through the TSSWCB for the development of a watershed protection plan for Cedar Bayou, resulting in this project.

Currently H-GAC, through the Clean Rivers Program, has ambient monitoring data from four stations (11115, 11117, 11118, and 11123) in the watershed. Sites 11115 and 11118 have data from as early as 1995. Sites 11117 and 11123 have data starting from 2007. All four stations are being monitored by H-GAC. Increased ambient monitoring, monitoring of storm flow events, monitoring of dissolved oxygen levels, and biological assessment of macrobenthic communities is necessary to support the development of the Cedar Bayou Watershed Protection Plan.

Data collected as a result of these sampling efforts will be used to support the decisions of stakeholders during the WPP development process by: expanding the number of ambient monitoring sites to broaden the range of data collected for the watershed; monitoring and assessing changes to bacteria concentrations and dissolved oxygen levels; refining load duration curves developed from historical data; evaluating pollutant conditions in specific storm flow events; calibrating and validating quantitative analysis of the tidal mixing processes between Cedar Bayou and the Galveston Bay system; supporting evaluation of the cumulative impact of pollutant loading on stream health and biological communities; and supporting a causal evaluation of the macrobenthic invertebrate impairment in the non-tidal portion of the watershed.

The purpose of this QAPP is to clearly delineate H-GAC's QA policy, management structure, and procedures which will be used to implement the QA requirements necessary to verify and validate the monitoring effort through this project. The QAPP is reviewed by the TSSWCB and EPA to help ensure that data generated for the purposes described above are scientifically valid and legally defensible. This process will ensure that data, developed under this QAPP and submitted to TSSWCB, TCEQ, and EPA, have been collected and managed in a way that guarantees its reliability and therefore can be used as deemed appropriate by the TSSWCB and EPA.

A6 PROJECT/TASK DESCRIPTION

The primary focus of this CWA §319(h) funded project[1] is to support the development of a watershed protection plan for the Cedar Bayou Watershed through monitoring and data analysis. In this project, H-GAC will evaluate water quality and potential sources of contamination through a range of monitoring efforts, including: routine ambient monitoring; automated storm flow monitoring; review of wastewater treatment facility (WWTF) effluent data[2]; 24-hour dissolved oxygen (DO) monitoring; and biological monitoring (benthic macroinvertebrate, nekton and habitat assessment).

H-GAC will provide assessment activities through the end of FY14 (9/30/14) at ten (10) watershed sites (CB1/11109, CB2/11111, CB3/11115, CB4/21079, CB5/11117, CB6/11118, CB7/21080, CB8/11120, CB9/11123, and CB10/21081) in the Cedar Bayou watershed (see Figure A6.1). Four (4) of the sites (CB3/11115, CB5/11117, CB6/11118, and CB9/11123) are existing Clean Rivers Program (CRP) sites where routine ambient monitoring is conducted on a quarterly basis under H-GAC's Texas Clean Rivers Program Regional Monitoring Activities QAPP. The remaining six (6) sites (CB1/11109, CB2/11111, CB4/21079, CB8/11120, CB7/21080, and CB10/21081) were identified based on the Site Selection Methodology is provided in this document along with photos of all ten sites, as Appendix E. A map of all ten (10) sampling sites is included below as Figure A6.1. During FY15[3], H-GAC will continue to monitor the four CRP sites on a quarterly basis, and will contract EIH to monitor the remaining 6 sites on a quarterly basis.

H-GAC will monitor for a wide array of parameters under this monitoring effort. Pollutants or impairments of specific concern include those for which Cedar Bayou Segments 0901 and 0902 are listed as impaired on the 2008 303(d) list. These include bacteria (*E. coli* and Enterococcus) and biological assessments relevant to impaired macrobenthic communities. Additional constituents or indicators of concern are nutrients, chlorophyll-*a*, and depressed dissolved oxygen. All are listed as concerns in the 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d).

[1] The initial funding for this project has been provided by the TSSWCB under the 319(h) grant fund referenced earlier. Additional matching (state) funding is provided by the Galveston Bay Estuary Program (GBEP) Contract 12-22310. The SOW for the GBEP contract includes identical tasks to the original TSSWCB contract, including all tasks and objectives related to monitoring activities. Funding from both of these grant sources will be used toward work under the Project.

[2] This task will be covered under the Modeling QAPP for this project. It is being mentioned here to indicate the array of data that will be considered under the project as a whole. If additional effluent data is required, this QAPP will be amended to include a monitoring task for this source.

[3] From final approval of Revision 2 of this QAPP through 8/31/15.

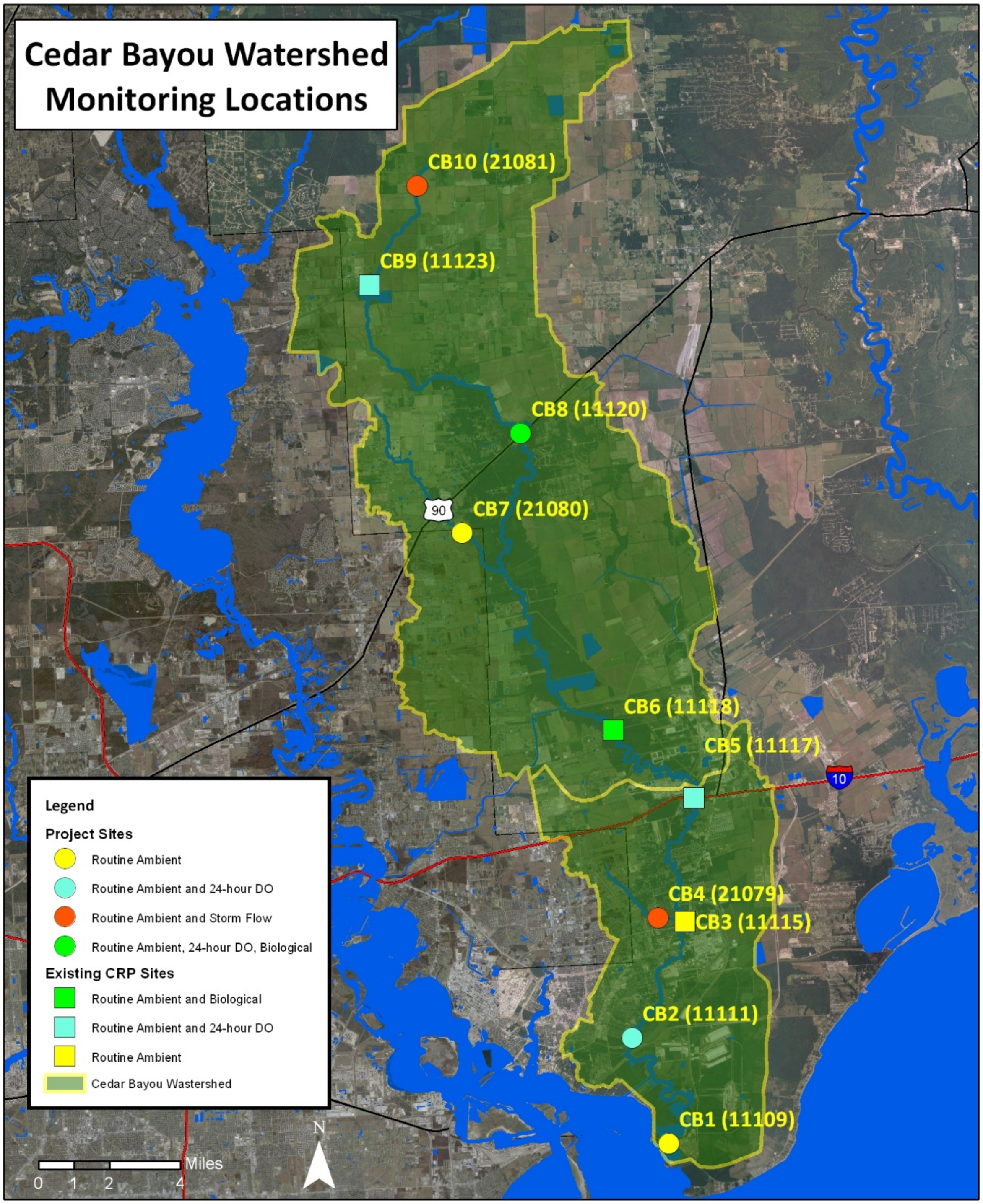


Figure A6.1 Location of Monitoring Sites.

Historical SWQMIS Data Evaluation

H-GAC will retrieve all historical data in the Surface Water Quality Monitoring Information System (SWQMIS) for the watershed and conduct an analysis for trends and variability, both spatially and temporally. See modeling QAPP for further discussion.

Routine Ambient Monitoring

In this project, H-GAC, in conjunction with EIH, will conduct routine ambient monitoring at six (6) sites monthly and at four (4) sites twice per quarter year, collecting field, conventional, flow, and bacteria parameter groups. Four of the sites are the existing CRP sites in the watershed. The sampling period will extend over 24 months and the total number of sample events scheduled for collection is 208. Sampling through this effort will complement existing monitoring regimes such that routine water quality monitoring is conducted monthly at ten (10) sites in the Cedar Bayou watershed. Currently, routine ambient monitoring is conducted quarterly at four (4) stations by H-GAC (CB3/11115, CB5/11117, CB6/11118, and CB9/11123) through the Clean Rivers Program under the H-GAC's Texas Clean Rivers Program Regional Monitoring Activities QAPP. Under this effort, these stations would be sampled monthly (adding two additional sampling events on top of the current quarterly sampling event under the CRP, to be collected by EIH). Field parameters to be sampled are pH, temperature, conductivity, and dissolved oxygen. Conventional parameters to be sampled are total suspended solids, turbidity, sulfate, chloride, nitrate+nitrite nitrogen, ammonia nitrogen, total kjeldahl nitrogen, chlorophyll-*a*, total hardness, and total phosphorus. H-GAC and EIH will also collect flow and bacteria (*E. coli* and Enterococcus) data. Subsequent to this sampling program, H-GAC will continue to sample the 4 CRP sites on a quarterly basis and engage EIH to sample the remaining 6 sites on a quarterly basis.

Storm Flow Monitoring

H-GAC will conduct automated storm flow monitoring at two (2) locations (CB4/21079 and CB10/21081) during four (4) storm events annually collecting a selection of the field, conventional, flow and bacteria parameter groups collected during ambient monitoring, as described in Table A7.1d..This monitoring effort is designed to characterize water body conditions during runoff periods. ISCO samplers meeting all applicable TSSWCB and EPA requirements will be deployed for this purpose. Depending on meteorological conditions and funds availability, additional sites may be identified for storm flow monitoring in a future revision of this document. The sampling period extends over 24 months and the total number of storm events is four (4), resulting in sixteen (16) sampling events. Depending on meteorological conditions, seasonal variation in storm events will be captured. Monitoring will be aimed at capturing first flush or during the hydrograph period of rising flow. A qualifying storm event (i.e, an event for which data may be reported) must be preceded by at least 72 hours without rainfall. Subsequent to the initial sampling period, H-GAC will continue automated sampler collection events through 8/31/15. The number of events will be up to 4 for each sampler, for a total of up to 8 events.

Effluent Data Review and Monitoring

H-GAC will compile the last five (5) years of self-reported effluent discharge data from TPDES permittees in the watershed as reported in Discharge Monitoring Reports (DMRs). H-GAC will assess the value of this data with respect to the pollutants of interest to this project. If self-reported data from TPDES permittees is not sufficient to characterize the point source contribution to pollutant loading for the water body, H-GAC will engage EIH to conduct effluent monitoring at selected WWTFs collecting field, conventional, flow, and bacteria parameter groups as described in the preceding paragraphs. EIH will also collect effluent parameter groups (effluent parameters are BOD_5, $CBOD_5$ and COD). The sampling period will extend over a maximum of 24 months with the maximum of 16 samples being collected. H-GAC will contract with an NELAC-accredited laboratory who will conduct sample analysis. While coordination between TPDES permittees and the TCEQ Regional Office will be required, neither H-GAC nor TSSWCB shall submit WWTF data to TCEQ for use in permit compliance and enforcement; rather, WWTF data will only be used to estimate pollutant loadings from wastewater discharges and to assist TPDES permittees in improving management and operations as part of the WPP development and implementation.

24-hour DO Monitoring

H-GAC and EIH will conduct 24-hour DO monitoring at four (4) mainstem sites (CB2/11111, CB5/11117, CB8/11120, and CB9/11123) monthly during the index period collecting field and flow parameter groups as described in preceding paragraphs. The sampling period extends over 8 months during the index period between March 15 and October 15, and the samples will be collected during the index period in 2012 and 2013 The total number of sample events scheduled for collection through this subtask is 64 (4 sites for 8 months, for 2 years.). The field parameters to be collected are pH, temperature, conductivity and dissolved oxygen. Flow, including flow severity, will be measured once during each deployment.

Biological Monitoring

EIH will conduct biological monitoring (benthic macroinvertebrate and habitat assessment) at two (2) main stem sites (CB6/11118 and CB8/11120) twice per year for 2 years to assess the cumulative impact of pollutant loading on stream health and biological communities.

Table A6.1 describes the tasks and schedule for work plan activities related to water quality monitoring efforts.

Table A6.1. Schedule of Milestones.

Task #	Description	Start Date	End Date
2	**Quality Assurance**		
2.1	Develop monitoring and modeling QAPPs	Nov. 1 2010	May 31, 2012
2.2	Implement QAPPs	June 1, 2012	Aug. 31, 2015
5	**Surface Water Quality Monitoring**		
5.1	Conduct routine ambient monitoring	May 1, 2011	Aug. 31, 2015
5.2	Storm flow monitoring	May 1, 2011	Aug. 31, 2015
5.3	Compile and evaluate effluent data[a]	Nov. 1 2010	Oct. 31, 2014
5.4	Conduct 24-hour DO monitoring	May 1, 2011	Oct. 31, 2014
5.5	Conduct biological assessments	May 1, 2011	Oct. 31, 2014
5.6	Transfer data to TSSWCB for SWQMIS	May 1, 2011	Aug. 31, 2015

[a] The data evaluation described in this task is handled under the modeling QAPP for this project. If effluent data is insufficient to characterize this source, the QAPP will be amended to include effluent monitoring.

Constraints in meeting this work schedule include approval of the QAPP and unexpected extreme variability in weather conditions that preclude sampling. See Section B1 for sampling design and monitoring pertaining to this QAPP.

A7 QUALITY OBJECTIVES AND CRITERIA

The goal of this project is to support the development of a watershed protection plan (WPP) for Cedar Bayou by conducting a series of water quality evaluations, including routine ambient monitoring, automated storm flow monitoring, effluent data analysis and monitoring, 24-hour DO monitoring and biological monitoring of benthic macroinvertebrates and habitat assessment. The data gathered under these efforts will be used to support modeling for the Cedar Bayou Watershed Protection Plan development process, and help to inform stakeholder decisions.

The purpose of collecting routine ambient monitoring under this project is to support watershed modeling and stakeholder decision-making as part of the WPP process, and to provide ongoing monitoring data. As part of coordination between TSSWCB and H-GAC, H-GAC will provide routine ambient water quality data to TSSWCB on a quarterly basis for inclusion in TCEQ's SWQMIS. Routine water quality monitoring is needed for conducting water quality assessments in accordance with TCEQ's *Guidance for Assessing and Reporting Surface Water Quality in Texas*.

The purpose of conducting storm water monitoring under this project is to characterize storm flow conditions. The sites and methods described in this QAPP were selected to ensure that the data resulting from this effort are representative of water quality conditions during runoff events. Information regarding storm flow conditions will be used to support watershed modeling and inform stakeholder decision-making as part of the WPP process.

The purpose of evaluating effluent is to characterize the point source contribution of WWTFs in the watershed[4].

24-hour DO monitoring is required to be measured to determine compliance with aquatic life use designations and support biological modeling. Two (2) of the 24-hour deployments at site CB8/11120 will be conducted with the biological monitoring activities at that site each year.

The goal of the biological monitoring is to collect environmental data describing the physical, chemical, and biological characteristics of each of designated site. This data will be used to inform decisions in the development of the Cedar Bayou Watershed Protection Plan regarding impaired macrobenthic communities in Segment 0902, Cedar Bayou Above Tidal. Additionally, this data will support causal evaluation of the macrobenthic invertebrate impairment.

Biological and Diel data (24-hour monitoring) are collected as biased sampling. Both sets of data are collected primarily during the TCEQ's defined Index and Critical periods during stable, unscoured flow conditions, ideally when the flow is at or just above, the 7Q2 for the particular stream. If flow conditions are not stable or do not reflect baseline conditions, the sampling will

[4] WWTF effluent sampling may be completed under a future revision of this QAPP, pending review of discharge monitoring report data from dischargers in the watershed. If WWTF effluent sampling is required after review of that data, this QAPP will be amended to include it.

be delayed until a minimum of two weeks of normal flow has occurred. Data will be assigned a BS program code representing biased-season monitoring when submitted to TSSWCB for submittal to the TCEQ.

EIH will perform biological monitoring complete with vouchering of individual, representative fish species collected during seining and shocking efforts. Fish data collected by seining will be kept separate from fish data collected by shocking. Collected aquatic invertebrates will be preserved and stored. Habitat assessment and Diel data along with field parameters and observations, water chemistry and bacteriological samples and flow will be collected when biological monitoring is performed. All biological monitoring will be performed according to TCEQ's *Surface Water Quality Monitoring Procedures Manual, Volume 1(RG-415, October 2008)* and *Volume 2 (RG-416, June 2007)* plus the applicable updates to Volume 1.

- Fish collection methods will include both seining and electrofishing. All fish data will be collected and submitted by collection type (seining or shocking). If unable to employ multiple gear types, effort will be increased accordingly using the available gear. To accurately obtain information on the composition and integrity of the fish community, all collected fish will be identified and enumerated to prevent selectivity.
- Benthic macroinvertebrates will be collected using the rapid bioassessment protocols (RBPs) approved by TCEQ. The qualitative collection methods employed will include 5-minute kicknets and snag sampling. At least one representative of each benthic macroinvertebrate taxon collected will be preserved and retained as a voucher specimen. There are no plans to sample depositional habitats such as pools.
- Habitat assessments will be conducted by completing the 3 TCEQ assessment forms:
    - Stream Physical Characteristics Worksheet – Part I;
    - Summary of Physical Characteristics of Water Body – Part II; and
    - Habitat Quality Index (HWI) – Part III.

The measurement performance specifications to support the project objectives are specified in Table A7.1b. The representative data collected during this project will be submitted to SWQMIS via H-GAC or the TSSWCB.

The non-direct measurements in this project comprise CRP ambient monitoring data and USGS flow gage data. See Section B9 for further discussion.

Quantitative and qualitative information regarding measurement of direct data are provided below in Tables A7.1a-A7.1d

Table A7.1a – Routine Ambient Monitoring Measurement Performance Specifications

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	LOQ CHECK STANDARD %Rec	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	LAB
Field Parameters										
pH	units.u	water	EPA 150.1 and TCEQ SOP, V1	00400	NA*	NA	NA	NA	NA	Field
DO	mg/L	water	SM 4500-O G and TCEQ SOP, V1	00300	NA*	NA	NA	NA	NA	Field
Specific Conductance	µS/cm	water	EPA 120.1 and TCEQ SOP, V1	00094	NA*	NA	NA	NA	NA	Field
Salinity	PPT	water	SM 2520 and TCEQ SOP, V1	00480	NA*	NA	NA	NA	NA	Field
Temperature	°C	water	SM 2550 B and TCEQ SOP V1	00010	NA*	NA	NA	NA	NA	Field
Total water depth	meters	water	TCEQ SOP V2	82903	NA*	NA	NA	NA	NA	Field
Secchi Depth	meters	water	TCEQ SOP V1	00078	NA*	NA	NA	NA	NA	Field
Turbidity, Observed (if no secchi)	1-low 2-medium 3-high	water	TCEQ	88842	NA*	NA	NA	NA	NA	Field
Water Clarity (if no secchi)	1-excellent 2-good 3-fair 4-poor	water	TCEQ	20424	NA*	NA	NA	NA	NA	Field
Days since last significant rainfall	days	NA	TCEQ SOP V1	72053	NA*	NA	NA	NA	NA	Field
Present Weather	1-clear 2-partly cloudy 3-cloudy 4-rain 5-other	NA	NA	89966	NA*	NA	NA	NA	NA	Field
Flow, Instantaneous**	cfs	water	TCEQ SOP V1	00061	NA*	NA	NA	NA	NA	Field
Flow measurement method**	1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler	water	TCEQ SOP V1	89835	NA*	NA	NA	NA	NA	Field
Flow severity	1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry	water	TCEQ SOP V1	01351	NA*	NA	NA	NA	NA	Field
Water Color	1-brownish 2-reddish 3-greenish 4-blackish 5-clear 6-other	water	TCEQ	89969	NA*	NA	NA	NA	NA	Field
Water Odor	1-sewage 2-chemical 3-rotten egg 4-musky 5-fishy 6-none 7-other	water	TCEQ	89971	NA*	NA	NA	NA	NA	Field
Wind Intensity	1-calm 2-slight 3-moderate	NA	NA	89965	NA*	NA	NA	NA	NA	Field

	4-strong									
Water Surface	1-calm 2-ripples 3-waves 4-whitecap	water	TCEQ	89968	NA*	NA	NA	NA	NA	Field

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	LOQ CHECK STANDARD %Rec	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	LAB
Conventional and Bacteriological Parameters										
TSS	mg/L	water	SM 2540 D	00530	4	1	NA	NA	NA	Eastex
Sulfate	mg/L	water	ASTM D516	00945	5	5	70-130	20	80-120	Eastex
Chloride	mg/L	water	SM 4500 Cl^- C	00940	5	5	70-130	20	80-120	Eastex
Chlorophyll-a, spectrophotometric method	µg/L	water	EPA 446.0	32211	3	3	NA	20	80-120	Eastex
E. coli, IDEXX Colilert	MPN/ 100 mL	water	Colilert-18****	31699	1	1	NA	0.5***	NA	Eastex
enterococcus, IDEXX Enterolert	MPN/ 100 mL	water	Enterolert	31701	10*****	10	NA	0.5***	NA	Eastex
Ammonia-N, total	mg/L	water	SM 4500 NH3-D or G	00610	0.1	0.1	70-130	20	80-120	Eastex
Nitrate/nitrite-N, total	mg/L	water	SM 4500-$NO3_3$ F	00630	.05	.02	70-130	20	80-120	Eastex
Total Kjeldahl Nitrogen	mg/L	water	SM 4500-Norg C and SM 4500-NH3 B	00625	0.2	0.2	70-130	20	80-120	Eastex
O-phosphate-P, field filter <15 min.	mg/L	water	SM 4500-P E or F	00671	.04	.02	70-130	20	80-120	Eastex
Hardness, Total (mg/L as CACO3)	mg/L	water	SM 2340 C	00900	5	5	NA	20	80-120	Eastex
Turbidity, Lab Nephelometric Turbidity Units, NTU	NTU	water	SM 2130B	82079	0.5	0.5	NA	NA	NA	Eastex
Total phosphorus-P	mg/L	water	SM 4500-P E	00665	.06	.02	70-130	20	80-120	Eastex

*Reporting to be consistent with SWQM guidance and based on measurement capability.

**This information will be acquired from USGS gage stations where located at or in close proximity to sampling sites or through direct measurement by EIH staff.

*** Based on a 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 MPN/100mL or >10 organisms/100mL.

**** E.coli samples analyzed by IDEXX Colilert-18 should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 48 hours.

*****Enterococcus samples should be diluted 1:10 or all waters.

References for Table A7.1a:

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, 1998.

TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2008 (RG-415).

TCEQ SOP, V2 - TCEQ Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data, 2007 (RG-416)

American Society for Testing and Materials (ASTM) Annual Book of Standards, Vol. 11.02: Method ASTM D516 – 90 (Reapproved in 1995); Method ASTM D 6503 – 99 (Reapproved in 2005)

Table A7.1b – 24-hour DO Measurement Performance Specifications

24-hour Dissolved Oxygen Monitoring Parameters									
Parameter	**Units**	**Method**	**Parameter Code**	**AWRL**	**Limit of Quantitation (LOQ)**	**LOQ CHECK STANDARD %Rec**	**PRECISION (RPD of LCS/LCSD)**	**Bias % Rec LCS**	**Lab**
24-Hr D.O. Avg.	mg/l	TCEQ SOP, V1	89857	NA	NA	NA	NA	NA	field
Max Daily DO	mg/l	TCEQ SOP, V1	89856	NA	NA	NA	NA	NA	field
Min Daily DO	mg/l	TCEQ SOP, V1	89855	NA	NA	NA	NA	NA	field
# DO measurements during 24-Hrs	# meas.	TCEQ SOP, V1	89858	NA	NA	NA	NA	NA	field
24-Hr Avg water Temperature	°Celsius	TCEQ SOP, V1	00209	NA	NA	NA	NA	NA	field
Max Daily water Temperature	°Celsius	TCEQ SOP, V1	00210	NA	NA	NA	NA	NA	field
Min Daily water Temperature	°Celsius	TCEQ SOP, V1	00211	NA	NA	NA	NA	NA	field
# water temp measurements during 24-Hrs	# meas.	TCEQ SOP, V1	00221	NA	NA	NA	NA	NA	field
24-Hr Avg Spec Conductance	µS/cm	TCEQ SOP, V1	00212	NA	NA	NA	NA	NA	field
24-Hr Max Spec Conductance	µS/cm	TCEQ SOP, V1	00213	NA	NA	NA	NA	NA	field
24-Hr Min Spec Conductance	µS/cm	TCEQ SOP, V1	00214	NA	NA	NA	NA	NA	field
# Spec Conductance measurements during 24-Hrs	# meas.	TCEQ SOP, V1	00222	NA	NA	NA	NA	NA	field
Max Daily pH	Standard units	TCEQ SOP, V1	00215	NA	NA	NA	NA	NA	field
Min Daily pH	Standard units	TCEQ SOP, V1	00216	NA	NA	NA	NA	NA	field
# pH measurements during 24-Hrs	# meas.	TCEQ SOP, V1	00223	NA	NA	NA	NA	NA	field
24-Hr Salinity Avg	ppt	TCEQ SOP, V1	00218	NA	NA	NA	NA	NA	field
Max Daily Salinity	ppt	TCEQ SOP, V1	00217	NA	NA	NA	NA	NA	field
# salinity measurements during 24-Hrs	# meas.	TCEQ SOP, V1	00220	NA	NA	NA	NA	NA	field

Table A7.1c –Biological Monitoring Measurement Performance Specifications

Physical Habitat				
PARAMETER	**UNITS**	**METHOD**	**PARAMETER CODE**	**LAB**
Streambed slope over evaluated reach	m/Km	TCEQ SOP, V2	72051	NA
Approximate drainage area above the most downstream transect	km^2	TCEQ SOP, V2	89859	NA
Stream Order	#	TCEQ SOP, V2	84161	NA
Length of stream	km	TCEQ SOP, V2	89860	NA
Lateral transects made	#	TCEQ SOP, V2	89832	NA
Average stream width	meters	TCEQ SOP, V2	89861	NA
Average stream depth	meters	TCEQ SOP, V2	89862	NA
Instantaneous stream flow	cfs	TCEQ SOP, V2	00061	NA
Flow measurement method	1 = gage 2 = electric 3 = mechanical 4 = weir/flume 5 = Doppler	TCEQ SOP, V2	89835	NA
Habitat Flow Status	1 = no flow 2 = low 3 = moderate 4 = high	TCEQ SOP, V2	89848	NA
Maximum pool width at time of study	meters	TCEQ SOP, V2	89864	NA
Maximum pool depth in study area	meters	TCEQ SOP, V2	89865	NA
Total stream bends	#	TCEQ SOP, V2	89839	NA
Well-defined stream bends	#	TCEQ SOP, V2	89840	NA
Moderately defined stream bends	#	TCEQ SOP, V2	89841	NA
Poorly defined stream bends	#	TCEQ SOP, V2	89842	NA
Riffles	#	TCEQ SOP, V2	89843	NA
Dominant substrate	1 = clay, 2 = silt, 3 = sand, 4 = gravel, 5 = cobble, 6 = boulder, 7 = bedrock, 8 = other	TCEQ SOP, V2	89844	NA
Avg. % of substrate gravel size or larger	%	TCEQ SOP, V2	89845	NA
Avg. % instream cover	%	TCEQ SOP, V2	84159	NA
Stream Cover Types	#	TCEQ SOP, V2	89929	NA
Avg. % stream bank erosion potential	%	TCEQ SOP, V2	89846	NA
Avg. stream bank slope	degrees	TCEQ SOP, V2	89847	NA
Avg. width natural riparian vegetation	meters	TCEQ SOP, V2	89866	NA
Avg. % trees as riparian vegetation	%	TCEQ SOP, V2	89849	NA
Avg. % shrubs as riparian vegetation	%	TCEQ SOP, V2	89850	NA
Avg. % grass as riparian vegetation	%	TCEQ SOP, V2	89851	NA
Avg. % cultivated fields as riparian vegetation	%	TCEQ SOP, V2	89852	NA
Avg. % other as riparian vegetation	%	TCEQ SOP, V2	89853	NA
Avg.% tree canopy coverage	%	TCEQ SOP, V2	89854	NA
Overall Aesthetics	1 = wilderness 2 = natural 3 = common 4 = offensive	TCEQ SOP, V2	89867	NA

Physical Habitat				
PARAMETER	**UNITS**	**METHOD**	**PARAMETER CODE**	**LAB**
Texas Ecoregion Code	#	TCEQ SOP, V2	89961	NA
Land development impact	1 = unimpacted 2 = low 3 = moderate 4 = high	TCEQ SOP, V2	89962	NA

Benthics - Freshwater - RBA (Qualitative)					
PARAMETER	**UNITS**	**MATRIX**	**METHOD**	**PARAMETER CODE**	**LAB**
Benthic Data Reporting Units	1= number of individuals in sub-sample; 2 = number of individuals/ft^2; 3 = number of individuals/m^2; 4 = total number in sample.	Water	TCEQ SOP, V2	89899	NA
Kicknet Effort, area kicked	m^2	Water	TCEQ SOP, V2	89903	NA
Kicknet Effort, minutes kicked	minutes	Water	TCEQ SOP, V2	89904	NA
Debris and Shoreline Sampling Effort, minutes picked	minutes	Water	TCEQ SOP, V2	89905	NA
Number of individuals in benthic sample	#	Water	TCEQ SOP, V2	89906	NA
Benthic Sampler	1=Surber, 2=Ekman, 3=kicknet, 4=Petersen, 5=Hester-Dendy	Water	TCEQ SOP, V2	89950	NA
Undercut bank at sample point	%	Water	TCEQ SOP, V2	89921	NA
Overhanging brush at sample point	%	Water	TCEQ SOP, V2	89922	NA
Gravel substrate at sample point	%	Water	TCEQ SOP, V2	89923	NA
Sand substrate at sample point	%	Water	TCEQ SOP, V2	89924	NA
Soft bottom at sample point	%	Water	TCEQ SOP, V2	89925	NA
Macrophyte bed at sample point	%	Water	TCEQ SOP, V2	89926	NA
Snags and brush at sample point	%	Water	TCEQ SOP, V2	89927	NA
Bedrock at sample point	%	Water	TCEQ SOP, V2	89928	NA
Benthic Organisms, None Present	NA	Water	TCEQ SOP, V2	90005	NA
Mesh Size, any net or sieve, average bar (diagonal measurement) for benthic collection	cm	NA	TCEQ SOP, V2	89946	NA
Stream Order	#	NA	TCEQ SOP, V1	84161	NA
Ecoregion (Texas Ecoregion Code)	#	NA	TCEQ SOP, V1	89961	NA
Total Taxa Richness, Benthos	#	Water	TCEQ SOP, V2	90055	NA
EPT Index, Abundance	#	Water	TCEQ SOP, V2	90008	NA
Biotic Index (HBI)	NA	Water	TCEQ SOP, V2	90007	NA
Chironomidae	%	Water	TCEQ SOP, V2	90062	NA
Dominant Taxon, Benthos	%	Water	TCEQ SOP, V2	90042	NA
Dominant FFG	%	Water	TCEQ SOP, V2	90010	NA
Predators	%	Water	TCEQ SOP, V2	90036	NA
Ratio of Intolerant:Tolerant taxa, Benthos	NA	Water	TCEQ SOP, V2	90050	NA
Total Trichoptera as Hydropsychidae	%	Water	TCEQ SOP, V2	90069	NA
Non-insect taxa	#	Water	TCEQ SOP, V2	90052	NA
Collector-gatherers	%	Water	TCEQ SOP, V2	90025	NA

Total number as Elmidae	%	Water	TCEQ SOP, V2	90054	NA

Nekton- Freshwater

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	LAB
Nekton, none captured	NA	Water	TCEQ SOP, V2	98005	NA
Electrofishing effort, duration of shocking	Seconds	Water	TCEQ SOP, V2	89944	NA
Seining effort	# of Hauls	Water	TCEQ SOP, V2	89947	NA
Combined length of seine hauls	meters	Water	TCEQ SOP, V2	89948	NA
Seining effort, duration	minutes	Water	TCEQ SOP, V2	89949	NA
Seine Minimum Mesh Size, net average bar, Nekton	in	Water	TCEQ SOP, V2	89930	NA
Seine Maximum Mesh Size, net average bar, Nekton	in	Water	TCEQ SOP, V2	89931	NA
Net length	meters	Water	TCEQ SOP, V2	89941	NA
Electrofishing method	1 = boat 2 = backpack 3 = tote barge	Water	TCEQ SOP, V2	89943	NA
Area seined	m^2	Water	TCEQ SOP, V2	89976	NA
Stream Order	#	NA	TCEQ SOP, V1	84161	NA
Ecoregion (Texas Ecoregion Code)	#	NA	TCEQ SOP, V1	89961	NA
Total number fish species	#	Water	TCEQ SOP, V2	98003	NA
Total native cyprinid species, fish	#	Water	TCEQ SOP, V2	98032	NA
Total benthic invertivore species, ish	#	Water	TCEQ SOP, V2	98052	NA
Total benthic species, fish	#	Water	TCEQ SOP, V2	98053	NA
Total sunfish species	#	Water	TCEQ SOP, V2	98008	NA
Total intolerant fish species	#	Water	TCEQ SOP, V2	98010	NA
Tolerant individuals (excluding Western Mosquitofish), fish	%	Water	TCEQ SOP, V2	98070	NA
Omnivore individuals, fish	%	Water	TCEQ SOP, V2	98017	NA
Invertivore individuals, fish	%	Water	TCEQ SOP, V2	98021	NA
Piscivore individuals, fish	%	Water	TCEQ SOP, V2	98022	NA
Total Individuals seining	#	Water	TCEQ SOP, V2	98039	NA
Total Individuals electrofishing	#	Water	TCEQ SOP, V2	98040	NA
Individuals/seine haul	#	Water	TCEQ SOP, V2	98062	NA
Individuals/minute electrofishing	#	Water	TCEQ SOP, V2	98069	NA
Individuals as non-native species	%	Water	TCEQ SOP, V2	98033	NA
Individuals w/ disease/anomalies	%	Water	TCEQ SOP, V2	98030	NA

References for Table A7.1c:

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, 1998.

TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2008 (RG-415).

TCEQ SOP, V2 - TCEQ Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data, 2007 (RG-416)

American Society for Testing and Materials (ASTM) Annual Book of Standards, Vol. 11.02: Method ASTM D516 – 90 (Reapproved in 1995); Method ASTM D 6503 – 99 (Reapproved in 2005)

Table A7.1d – Automated Storm Flow Monitoring Measurement Performance Specifications

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	LOQ CHECK STANDARD %Rec	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	LAB
Field Parameters*										
Rainfall	In	water	TCEQ SOP VI	46529	NA	NA	NA	NA	NA	Field
Days since last significant rainfall	days	NA	TCEQ SOP V1	72053	NA*	NA	NA	NA	NA	Field
Storm Event Flow	Gallons	water	TCEQ SOP VI	50052	NA	NA	NA	NA	NA	Field
Flow, Instantaneous	cfs	water	TCEQ SOP V1	00061	NA*	NA	NA	NA	NA	Field
Flow measurement method	1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler	water	TCEQ SOP V1	89835	NA*	NA	NA	NA	NA	Field

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	LOQ CHECK STANDARD %Rec	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	LAB
Conventional and Bacteriological Parameters										
TSS	mg/L	water	SM 2540 D	00530	4	1	NA	NA	NA	Eastex
E. coli, IDEXX Colilert	MPN/ 100 mL	water	Colilert-18***	31699	1	1	NA	0.5**	NA	Eastex
Holding time, *E. coli*, IDEXX Colilert	Hours	Water	NA	31704	NA	NA	NA	NA	NA	Eastex
enterococcus, IDEXX Enterolert	MPN/ 100 mL	water	Enterolert	31701	10****	10	NA	0.5**	NA	Eastex
Ammonia-N, total	mg/L	water	SM 4500 NH3-D or G	00610	0.1	0.1	70-130	20	80-120	Eastex
Nitrate/nitrite-N, total	mg/L	water	SM 4500-$NO3_3$ F	00630	.05	.02	70-130	20	80-120	Eastex
Total Kjeldahl Nitrogen	mg/L	water	SM 4500-Norg C and SM 4500-NH3 B	00625	0.2	0.2	70-130	20	80-120	Eastex
Total phosphorus-P	mg/L	water	SM 4500-P E	00665	.06	.02	70-130	20	80-120	Eastex

*Reporting to be consistent with SWQM guidance and based on measurement capability.
** Based on a 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 MPN/100mL or >10 organisms/100mL.
***E.coli samples analyzed by IDEXX Colilert-18 should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 24 hours because this project is based on research and is not regulatory in nature. Refrigerated automated samplers will be used for all sample collection.
****Enterococcus samples should be diluted 1:10 or all waters.

References for Table A7.1a:

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, 1998. (note, the 21st edition may be cited if it becomes available)

TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, 2012 (RG-415).

TCEQ SOP, V2 - TCEQ Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data, 2007 (RG-416)

Automated Storm Water Sampling on Small Watersheds. 2003 American Society of Agricultural Engineers ISSN 0883-8542. Vol. 19(6):667-674. R.D. Harmel, K.W.King, R.M. Slade.

Practical Guidance for Discharge and Water Quality Data Collection on Small Watersheds. 2006 American Society of Agricultural and Biological Engineers ISSN 001-2351. Vol 49(4): 937-948. R.D. Harmel, K.W. King, B.E. Haggard, D.G. Wren, and J.M. Sheridan.

Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar condition, conform to themselves. It is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions, and is an indication of random error. Laboratory precision is assessed by comparing replicate analyses of laboratory control standards in the sample matrix (e.g., deionized water) or sample/duplicate pairs in the case of bacterial analysis. Precision results are plotted on quality control (QC) charts that are based on historical data and used during evaluation of analytical performance. Performance specifications for laboratory control standard/laboratory control standard duplicate pairs are defined in Table A7.1. 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. Control limits for field splits are defined in Section B5.

Bias

Bias is a statistical measurement of correctness and includes multiple components of systematic 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 prepared with verified and known amounts of analytes and by calculating percent recovery. Results are compared against measurement performance specifications and used during evaluation of analytical performance. Project control limits for laboratory control standards are specified in Table A7.1.

Representativeness

The data collected as routine grabs and storm samples will be considered representative of the target population or phenomenon to be studied. The representativeness of the data is dependent on 1) the sampling locations, 2) the flow regime during sample collection, 3) the number of years sampling is performed, and 4) the sampling procedures. Site selection and sampling of pertinent media (i.e., water) and use of only approved analytical methods will assure that the measurement data represent the population being studied at the site. Although data may be collected during varying regimes of weather and flow, data collection will be targeted toward both ambient conditions and storm events, representing water quality at high and low flow conditions.

For the automated storm sampling, site selection, the appropriate sampling regime, the sampling of all pertinent media according to TCEQ SOPs, and use of only approved analytical methods will help assure that the measurement data accurately represent each storm event in its entirety as well as typical annual rainfall patterns at the site. Storm flow monitoring will be completed during rainfall events so only storm event pollutant loads can be quantified. Samples will be collected from the sites during 4 significant rainfall events annually. Each sampling event must be preceded by at least 72 hours of dry weather (no rainfall). Flow-interval or flow weighted sampling will demonstrate the loading through the rise and fall of the hydrograph. However, due to the maximum holding time for bacteria, samples cannot be held for more than 12 hours on site. Therefore every monitoring event will be limited to only 12 hours. Rate of change, based either on flow or rainfall gauge, will be the trigger mechanism to start collecting samples. All automated samplers will be calibrated prior to collecting any water samples.

The goal for meeting total representation of the water body will be tempered by the funding available. To assure that the measurement data represents the conditions of the Cedar Bayou watershed, site selection was determined by field reconnaissance and review of aerial photos (see Appendix E).

According to TCEQ's *Surface Water Quality Monitoring Procedures Manual, Volume 2 (RG-416, June 2007),* biological organisms are collected and identified in a manner that, in most cases, permits an assessment of community composition and integrity. Bioassessment data should be collected during summertime critical conditions. The belief that if the criteria are met during these conditions, it would be expected that the criteria would be met during other seasons as well.

Comparability

Confidence in the comparability of data sets for this project and for water quality assessments is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP. 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 Section B10 on Data Management.

Completeness

The completeness of the data is basically a relationship of how much of the data is 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 that 90% data completion is achieved.

Limit of Quantitation

Uniform limits of quantitation (LOQs) are not specified for the NPS program due to the variety of types of data collected. However, because surface water data are being collected for the purpose of comparison to the Texas Surface Water Quality Standards (TSWQS), the Ambient Water Reporting Limits (AWRLs) do apply and have been added to table A7.1.

The AWRL establishes the reporting specification at **or below** which data for a parameter must be reported to be compared with freshwater screening criteria. The AWRLs specified in Table A7.1 are the program-defined reporting specifications for each analyte and yield data acceptable for the TCEQ's water quality assessment. A full listing of AWRLs can be found at http://www.tceq.texas.gov/waterquality/clean-rivers/qa/index.html. The limit of quantitation is the minimum level, concentration, or quantity of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The following requirements must be met in order to report results to the CRP:

- The laboratory's LOQ for each analyte **must be at or below the AWRL** as a matter of routine practice

- The laboratory must demonstrate its ability to quantitate at its LOQ for each analyte by running an LOQ check standard for each analytical batch of CRP Samples analyzed.

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

A8 SPECIAL TRAINING/CERTIFICATION

All field personnel receive training in proper sampling and field analysis as necessary. Before actual sampling or field analysis occurs, they will demonstrate to the QA Officer (or designee) their ability to properly calibrate field equipment and perform field sampling and analysis procedures. Field personnel training is documented and retained in the personnel file and will be available during a monitoring systems audit.

Global Positioning System (GPS) equipment may be used as a component of the information required by the Station Location (SLOC) request process for creating the certified positional data that will ultimately be entered into the TCEQ's SWQMIS database. Any positional data obtained by Nonpoint Source Program grantees using a Global Positioning System will follow the TCEQ's OPP 8.11 and 8.12 policy regarding the collection and management of positional data.

Positional data entered into SWQMIS will be collected by a GPS certified individual with an agency approved GPS device to ensure that the agency receives reliable and accurate positional data. Certification can be obtained in any of three ways: completing a TCEQ training class, completing a suitable training class offered by an outside vendor, or by providing documentation of sufficient GPS expertise and experience. Contractors must agree to adhere to relevant TCEQ policies when entering GPS-collected data.

In lieu of entering certified GPS Coordinates, positional data may be acquired with a GPS and verified with photo interpolation using a certified source, such as Google Earth or Google Map. The verified coordinates and map interface can then be used to develop a new SLOC.

Contractors and subcontractors must ensure that laboratories analyzing samples under this QAPP meet the requirements contained in section 5.4.4 of the NELAC standards (concerning Review of Requests, Tenders and Contracts).

EIH personnel also received additional training when they attended TCEQ's Biological Monitoring Training Course conducted in Austin in June 2010. EIH's field QAO (or their designee) evaluates and documented each employee's demonstration of capabilities for their personnel files. These records are shared with H-GAC and made available during the routine monitoring systems audit.

Table A8.1 Designated Trainer for each Contractor and Subcontractor

Local Partner Agency	Designated Trainer
Environmental Institute of Houston	George Guillen
Houston-Galveston Area Council	Jean Wright

A9 DOCUMENTS AND RECORDS

Hard copies of all field data sheets, general maintenance (GM) records, COCs, laboratory data entry sheets, field data entry sheets, calibration logs, and corrective action reports (CARs) will be archived by H-GAC for at least five years. In addition, H-GAC will archive electronic forms of all project data for at least five years. Electronic data is stored in folders on the H-GAC servers. H-GAC backs up the data on their servers on daily and weekly bases. Examples of GM and field data sheets are presented in Appendix A, a COC form in Appendix B, and a CAR form in Appendix C.

Quarterly progress reports will be produced electronically for the TSSWCB and will note activities conducted in connection with audits of the water quality monitoring program, items or areas identified as potential problems, and any variations or supplements to the QAPP. CARs will be utilized when necessary (Appendix C). CARs will be maintained in an accessible location for reference at H-GAC. CARs that result in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in an update or amendment to the QAPP when appropriate.

Individuals listed in Section A3 will be notified of approval of the most current copy of the QAPP by the H-GAC project manager. The H-GAC project manager will make the most recent version of the QAPP available to all entities listed in Section A3 of this QAPP. Current copies of the QAPP will be kept on file for all individuals on the distribution list.

The final project report will be produced electronically and as a hard copy and all files used to produce the final report will be saved electronically by H-GAC for at least five years.

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

Laboratory Documentation

The laboratory will document sample results clearly and accurately. Information about each sample will include the following to aid in interpretation and validation of data:

- A clear identification of samples analyzed for the project including station information
- Date and time of sample collection
- Identification of preservation and analysis methods used
- Sample results, units of measurement, and sample matrix
- Information on QC failures or deviations from requirements that may affect the quality of results or is necessary for verification and validation of data

Table A9.1 Project Documents and Records

Document/Record	Location	Retention (yrs)	Format
QAPPs, amendments and appendices	TCEQ / H-GAC	7 years	Electronic & Paper
QAPP, distribution documentation	H-GAC	7 years	Paper
Field training records	H-GAC	7 years	Paper
Field notebooks or data sheets (see Appendix B for examples of field data sheets)	H-GAC	7 years	Paper
Field equipment calibration/maintenance logs	H-GAC	7 years	Paper
Field instrument printouts	H-GAC	7 years	Paper
Field SOPs	H-GAC	7 years	Electronic & Paper
Chain of custody records (see Appendix B for example)	H-GAC	7 years	Paper
Laboratory Quality Manuals	Eastex Lab	7 years	Current version – electronic & paper; prior versions paper only
Laboratory training records	Eastex Lab	7 years	Paper
Laboratory SOPs	Eastex Lab	7 years	Current version – electronic & paper; prior versions paper only
Laboratory instrument printouts	Eastex Lab	7 years	Paper
Laboratory data reports/results	Eastex Lab	7 years	Paper
Laboratory equipment maintenance logs	Eastex Lab	7 years	Paper
Laboratory calibration records	Eastex Lab	7 years	Paper
Corrective Action Documentation (see Appendix D for example)	H-GAC	7 years	Electronic & Paper

QAPP Revision and Amendments

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

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

B1 SAMPLING PROCESS DESIGN (-OR-EXPERIMENTAL DESIGN)

The sample design rationale for the five sampling efforts, including extended ambient monitoring in FY 2015, is intended to evaluate ambient water quality throughout the watershed, 24-hour DO levels, and biology and habitat related to impaired macrobenthic communities. The purpose of these evaluations is to support the development of a watershed protection plan for the Cedar Bayou Watershed.

Monitoring sites for each of these five sampling efforts are provided in tables B.1a (routine ambient monitoring), B.1b (24-hour DO monitoring), and B.1c (biological monitoring). For more information regarding monitoring locations, please refer to maps and descriptions in Appendix E, Site Selection methodology.

If at any time a site becomes inaccessible, field personnel will attempt to access the water body within 400 meters upstream of the designated sampling location, per *TCEQ Surface Water Quality Monitoring Data Management Reference Guide, Chapter 3*. If this is not possible, and the site is not expected to be accessible on a regular basis, the QAPP may be amended.

Routine Ambient Monitoring
H-GAC and EIH will monitor ten (10) sites in the Cedar Bayou Watershed on a monthly basis. They are referred to here by their project designations (CBx) with CRP site identifier appended if the site is a current, or a historical, monitoring site. Those sites without the secondary identifier are new sites identified specifically for this sampling effort.

Four (4) of the sites (CB3/11115, CB5/11117, CB6/11118, and CB9/11123) are existing CRP sites. For these sites, one (1) sample a quarter will be conducted under the existing CRP sampling regime (as per H-GAC's Texas Clean Rivers Program Regional Monitoring Activities QAPP). For these sampling events, the turbidity and hardness tests will be covered by this QAPP, while the rest of the tests will be covered under the existing CRP QAPP[5]. The other two (2) of the samples taken each quarter from these sites will be taken by EIH and will be covered under this QAPP.

Six (6) of the sites (CB1/11109, CB2/11111, CB4/21079, CB7/21080, CB8/11120, and CB10/21081) are not current CRP sites. These sites will be sampled monthly by EIH under this QAPP.

During the time period from the approval of Revision 2 of this QAPP through 8/31/15, sampling will consist of routine CRP sampling and quarterly sampling by EIH at the 6 additional project sites listed above.

At all sites, monitoring will include field parameters (pH, temperature, conductivity, and DO), conventional parameters (total suspended solids, turbidity, sulfate, chloride, nitrate+nitrite

[5] CRP does not routinely conduct hardness and turbidity tests described in the A7.1 tables of this QAPP.

nitrogen, ammonia nitrogen, total kjeldahl nitrogen, chlorophyll *a*, total hardness, orthophosphorus, and total phosphorus), flow (collected by gage, electric, mechanical or Doppler), and Bacteria parameters (*E. coli* and Enterococcus).

Table B.1a indicates the monitoring site locations and sampling frequencies.

Table B1.1a Routine Ambient Monitoring Site and Frequencies

Station ID	Site Description	Latitude Longitude (Datum NAD83)	Start Date[1]	End Date[1]	Sample Matrix	Sampling Frequency (per year)[2]
						Routine[a]
CB1/11109	Cedar Bayou Tidal at FM2354 (Tri City Beach Road)	29.679165 -94.92778	May 1, 2011	October 31, 2014	Water	8[a]/4[2]
CB2/11111	Cedar Bayou Tidal at Roseland Park	29.723127 -94.94279	May 1, 2011	October 31, 2014	Water	12/4[2]
CB3/11115	Cedar Bayou Tidal at Highway 146	29.77 -94.9161	May 1, 2011	October 31, 2014	Water	12/4[2]
CB4/21079	Cary Bayou at Raccoon Drive	29.772211 -94.928498	May 1, 2011	October 31, 2014	Water	12/4[2]
CB5/11117	Cedar Bayou Tidal at Interstate Highway 10	29.820873 -94.909785	May 1, 2011	October 31, 2014	Water	8[a]/4[2]
CB6/11118	Cedar Bayou Above Tidal at FM 1942	29.849159 -94947013	May 1, 2011	October 31, 2014	Water	12/4[2]
CB7/21080	Adlong Ditch at New Road	29.932771 -95.014321	May 1, 2011	October 31, 2014	Water	12/4[2]
CB8/11120	Cedar Bayou Above Tidal at Highway 90	29.972281 -94.98544	May 1, 2011	October 31, 2014	Water	8[a]/4[2]
CB9/11123	Cedar Bayou Above Tidal at FM 1960	30.03581 -95.054144	May 1, 2011	October 31, 2014	Water	8[a]/4[2]
CB10/21081	Cedar Bayou Above Tidal at County Road 624	30.075633 -95.029975	May 1, 2011	October 31, 2014	Water	12/4[2]

[1] These dates are delayed from the start dates as indicated in project work plan.
[2] The frequency for sampling during the period between the approval of Revision 2 of this QAPP and 8/31/15 will be quarterly for all sites.
[a] Routine samples are scheduled for collection 8 times a year for the existing CRP sites, and 12 times per year for the remaining sites, but fewer samples may be collected if flow is not present during scheduled routine monitoring. Sampling frequencies representing sampling under this sample design, and not the CRP QAPP. The CRP program will be conducting sampling not covered under this QAPP for 4 of the 12 events at these sites. However, they will be conducting individual tests (hardness, turbidity) during these 4 events that are not covered under the CRP QAPP. These individual tests are to be covered under this QAPP. However, they have not been counted as separate sampling events.

24-Hour DO sampling

EIH will conduct monthly 24-hour DO monitoring at four (4) sites on Cedar Bayou during the 8-month index period (3/15-10/15), for two years, resulting in 64 samples. The four (4) sites selected for DO monitoring will be CB2/11111, CB5/11117, CB8/11120, and CB9/11123.

At all four (4) sites, monitoring will include field parameters (pH, temperature, conductivity, and DO), and flow parameters (collected by gage, electric, mechanical or Doppler, including severity).

Table B.1b indicates the monitoring site locations and sampling frequencies for 24-DO sampling.

Table B1.1b 24-Hour DO Monitoring Sites and Frequencies

Station ID	Site Description	Latitude Longitude (Datum NAD83)	Start Date[1]	End Date[1]	Sample Matrix	Sampling Frequency (per year)
						24-Hour DO
CB2/11111	Cedar Bayou Tidal at Roseland Park	29.723127 -94.94279	May 1, 2011	October 31, 2014	Water	8
CB5/11117	Cedar Bayou Tidal at Interstate Highway 10	29.820873 -94.909785	May 1, 2011	October 31, 2014	Water	8
CB8/11120	Cedar Bayou Above Tidal at Highway 90	29.972281 -94.98544	May 1, 2011	October 31, 2014	Water	8
CB9/11123	Cedar Bayou Above Tidal at FM 1960	30.03581 -95.054144	May 1, 2011	October 31, 2014	Water	8

[1] These dates are delayed from the start dates as indicated in the attached work plan.

Biological Monitoring

EIH will conduct biological monitoring including evaluation of benthic macroinvertebrates and habitat assessments to assess the cumulative impact of pollutant loading on stream health and biological communities in the Above Tidal segment (0902) of Cedar Bayou. The monitoring will be conducted at two (2) sites (CB6/11118 and CB8/11120).

Monitoring will occur twice per year for a two year period, yielding four (4) total monitoring events for each site, and eight (8) monitoring events total.

Table B.1c indicates the monitoring site locations and sampling frequencies for 24-DO sampling.

Table B1.1c Biological Monitoring Sites

Station ID	Site Description	Latitude Longitude (Datum NAD83)	Start Date[1]	End Date[1]	Sample Matrix	Sampling Frequency (per year)
						Biological
CB6/11118	Cedar Bayou Above Tidal at FM 1942	29.849159 -94947013	May 1, 2011	October 31, 2014	Water	2
CB8/11120	Cedar Bayou Above Tidal at Highway 90	29.972281 -94.98544	May 1, 2011	October 31, 2014	Water	2

[1] These dates are delayed from the start dates as indicated in the attached work plan.

Automated Storm Flow Sampling

H-GAC will conduct automated storm flow monitoring to assess the water quality conditions during storm events in different areas of the watershed. The main parameters of concern are bacteria indicator species and nutrients. The monitoring will be conducted at two (2) sites (CB4/21079 and CB10/21081).

Monitoring will occur up to four times per year for up to a two year period, yielding a maximum of eight (8) total monitoring events for each site, and a maximum of sixteen (16) monitoring events total.

Samples will be collected by automated samplers triggered by a rise in water lebel, an increase in flow rate, rainfall significant enough to generate runoff, or a combination of these parameters occuring after at least a 72 hour dry period. ISCO refrigerated automatic samplers will be installed at each site. Water samples will be removed from ISCO units within 12 hours of the start of the event and will be transported to the Eastex Environmental lab for analysis.

Flow Logger

The 2150 area velocity flow meter measures liquid level and average stream velocity, and calculates the flow rate and total flow. The liquid level and velocity measurements are read from an attached area velocity sensor that is placed in the flow stream. Flow rate calculations are performed internally using the measured parameters from the AV Sensor.

The AV Sensor's internal differential pressure transducer measures the liquid level. The transducer is a small piezo-resistive chip that detects the difference of the pressures felt on the inner and outer face. The stainless steel outer diaphragm is exposed to the flow stream through the ports under the AV Sensor. The pressure felt on the outer diaphragm is transferred to the outer face of the transducer through a silicone fluid medium. The outer diaphragm and fluid isolate the sensitive transducer from direct exposure to the stream. The inner face of the transducer is exposed, or referenced, to the atmosphere through the internal vent tube that runs the full length of the AV Sensor's cable. The difference between the pressures exerted on the transducer is the hydrostatic pressure. Hydrostatic pressure is proportional to the level of the stream.

The AV Sensor measures average velocity by using ultrasonic sound waves and the Doppler effect. The Doppler effect states that the frequency of a sound wave (or other wave) passed from one body to another is relative to both their motions. As the two approach each other, the frequency increases; as they move apart, the frequency decreases. The AV Sensor contains a pair of ultrasonic transducers. One transducer transmits the ultrasonic sound wave. As the transmitted wave travels through the stream, particles and bubbles carried by the stream reflect the sound wave back towards the AV Sensor. The second transducer receives the reflected wave. Circuits internal to the module compare the frequencies of the sound waves and extract the difference. An increase or decrease in the frequency of the reflected wave indicates forward or reverse flow. The degree of change is proportional to the velocity of the flow stream.

Using measurements from the AV Sensor, the AV Module can calculate the flow rate. The AV Module supports many different flow rate conversion methods:

- Area Velocity
- Data Points
- Manning Formula
- Two-term Polynomial Equations
- Flumes

• Weirs

The flow meter electronically converts the level reading into a properly-scaled flow rate value. The flow meter has enough memory to store a high volume of data readings

Automated Sampler
Certain external instruments will enable or disable a sampler by sending a signal to the sampler's flow meter connector. A flow meter or flow logger will have a programmable sampler-enable feature that lets them enable or disable the sampler. Flow paced sampling operates a sampler by sending an electronic signal to the sampler after measuring a specified volume of liquid. The stored sampling data will be collected via computer software (see www.isco.com – Operating Manual for 2150 Model.).

Sites CB4 and CB10 are flow initiated samplers. Flow interval (flow weighted) samples of 300 mL will be collected once initiated by the flow meter and every 30,000 gallons thereafter. Samples will continue to be collected for a period of up to 12 hours or less if flow falls below the trigger level without likelihood of resuming. Both sites will require an initial "fine-tuning" period where data from several storm events will be evaluated to determine the sampler enable and sample aliquot pacing settings that will provide a high probability for success over the widest range in storm sizes possible. This evaluation will involve determining how much rainfall occurred, how much rise in water level was observed, and what volume of water passed the flow metering location during the storm. Once this information is known the flow meter and sampler can be programmed in the field.

Site Descriptions
Site CB4 is located in the City of Baytown in Harris County, on a tributary (Cary Bayou) to Cedar Bayou Tidal (0901). The site is located downstream of a variety of urban/suburban land uses including a public park. Additional description and site photos can be found in Appendix E.

Site CB10 is located in Liberty County, west of the City of Dayton, on the main stem of Cedar Bayou Above Tidal (0902). The site is located downstream of a variety of rural/agricultural land uses. Additional description and site photos can be found in Appendix E.

Table B.1d indicates the monitoring site locations and sampling frequencies for 24-DO sampling.

Table B1.1d Storm Flow Monitoring Sites

Station ID	Site Description	Latitude Longitude (Datum NAD83)	Start Date[1]	End Date[1]	Sample Matrix	Sampling Frequency (per year)
						Storm Flow
CB4/ 21079	Cary Bayou at Raccoon Drive	29.772211 -94.928498	May 1, 2011	August 31, 2015	Water	4
CB10/ 21081	Cedar Bayou Above Tidal at County Road 624	30.075633 -95.029975	May 1, 2011	August 31, 2015	Water	4

[1] These dates are delayed from the start dates as indicated in the attached workplan.

B2 SAMPLING METHODS

Field Sampling Procedures

Field sampling will be conducted according to procedures documented in the *TCEQ Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods 2012(RG-415) and Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (*RG-416),* unless otherwise specified in the specific sections for each sampling effort in the following paragraphs. For WWTFs, sampling will be conducted in accordance with the permit and approved methodology of the regulatory agency. Field QC samples are taken to verify that contamination has not occurred. Container types, expected sample volumes, preservation requirements, and holding time requirements are specified in Table B2.1a for routine samples. Requirements specific to biological monitoring are contained in Table B2.1b. Requirements specific to automated storm flow monitoring are contained in Table B2.1c.

Pre-cleaned, disposable sample containers for conventional parameters are provided by Eastex Environmental Lab, H-GAC's contract lab. Brown, poly, 4-liter cubitainers are used for chlorophyll-*a* samples and are also provided by the contract lab. The required preservation acid is added to the VOA containers (TOC) before being given to field personnel but the acid required to preserve the nutrients (ammonia, nitrate+nitrite, and total phosphorus) is added to the container in the field by field personnel. Disposable, sterile, 120 mL plastic bottles are used for bacteriological samples. The tubing used local to field filter orthophosphate phosphorus samples and metals is re-used. A contract lab (Eastex) cleans the tubing between each use by washing each piece with a 10 % nitric acid solution and a 10% Hydrochloric acid solution. Each tube is triple rinsed with D.I. water between and after the 2 acid washes, then hung and allowed to air dry. The lab individually packages each tube in a zip-lock style, plastic baggie and performs QC testing to assure that no contamination results from the washing procedure.

Table B2.1a Sample Storage, Preservation and Handling Requirements for Routine Samples

Parameter	Matrix	Container	Preservation	Sample Volume	Holding Time
TSS	water	Plastic	Cool to 4°C	200 mL***	7 days
Sulfate	water	Plastic	Cool to 4°C	100 ml******	28 days
Chloride	water	Plastic	Cool to 4°C	100 mL******	28 days
Chlorophyll-*a*	water	Brown plastic	Dark & iced before filtration; Dark & frozen after filtration	4 L	Filtered,48 hours; filtered & frozen , 28 days**
E. coli IDEXX Colilert	water	Sterile Plastic	Cool to 4°C	120 mL	6 hours*
Enterococcus IDEXX Enterolert	water	Sterile Plastic	Cool to 4°C	120 mL	6 hours*
Ammonia-N	water	Plastic	Cool to 4°C H_2S0_4 to pH <2	150 mL****	28 days

Parameter	Matrix	Container	Preservation	Sample Volume	Holding Time
Nitrate + nitrite-N	water	Plastic	Cool to 4°C, H_2SO_4 to pH <2	100 mL****	28 days
Total Kjeldahl Nitrogen	water	Plastic	Cool to 4°C, H_2SO_4 to pH <2	150 mL****	28 days
Ortho phosphate Phosphorus (field filtered < 15 min.)	water	Plastic	Cool to 4^oC	250 mL	48 hours
Phosphorus-P, total	water	Plastic	Cool to 4°C H_2S0_4 to pH <2	250 mL****	28 days

**E.coli* samples analyzed by SM 9223-B should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 24 hours.
** Contract lab will pick up sample and filter before 48 hours.
*** All Solids tests are collected in one 1-liter plastic cubitainer.
**** Three nutrient tests are collected from one 1-liter plastic cubitainer.
***** Two 40-ml VOA Vials are used to collect these samples.
****** One 500 mL plastic container is used to collect these two samples.

Biological Field Sampling Procedures

Benthic macroinvertebrate samples will be collected for qualitative analysis using Rapid Bioassessment Protocol (RBP) procedures. Macroinvertebrates attached to snags located in riffles and/or runs will be supplemented (and combined) with individuals collected using the standard D-frame kicknet method. Nekton samples will be collected using both seining and electrofishing techniques from all habitats present. All nekton sampling efforts will be processed and kept separate. Effort as "time fished over a fixed distance" will be recorded. Habitat characterization will comprise observations and measurements from at least 5 transects at each site. In addition, general qualitative observations about the entire reach where the biotic assessments were conducted will be recorded. Voucher specimens and photographs will be taken at each location on each sampling event.

Table B2.1b. Biological Sample Storage, Preservation, and Handling Requirements

Collected by Environmental Institute of Houston Analyzed at Eastex Environmental Laboratory					
Parameter	**Matrix**	**Container**	**Preservation**	**Sample Volume**	**Holding Time**
Nekton (Fish)		Plastic or glass	10% formalin, after 1 week wash and preserve in 70% ethyl alcohol, keep away from light and extreme temperatures	Variable	7 years
Benthic macroinvertebrates		Plastic or glass	preserve in 70% ethyl alcohol, keep away from light and extreme temperatures	Variable	7 years

Storm Flow Sampling Procedures

All field monitoring and sample collection will be conducted in accordance with the USDA National Water Quality Handbook and the TCEQ Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods (August 2012) except in regards to bacteria sampling and analysis. Both documents require bacteria samples to be collected as grab samples and not composites. For this project, every bacteria sample will be a composite sample collected by an auto sampler. From the first ’sip’ until the sample is retrieved for delivery to the lab, the composited bacteria sample will be held in a refrigerated unit. Sample temperatures will be verified at time of pick-up to confirm the samples were held within an acceptable temperature range of >0-<6°C. Both manuals also specify bacteria analyses be completed within 8 hours of the sample being collected. All composited bacteria samples will be delivered to the lab in ice and analyzed within 24 hours of collecting the first ‘sip’. These deviations from standard protocol are supported by two research papers referenced in the footnotes of table A7.1d. Since this is a research project with no regulatory component, a flow-weighted composite will best represent the storm load.

Table B2.1c. Storm Flow Storage, Preservation, and Handling Requirements

Parameter	Matrix	Container	Preservation	Sample Volume	Holding Time
TSS	water	Plastic	Cool to 4°C	200 mL**	7 days
E. coli IDEXX Colilert	water	Sterile Plastic	Cool to 4°C	120 mL	6 hours*
Enterococcus IDEXX Enterolert	water	Sterile Plastic	Cool to 4°C	120 mL	6 hours*
Ammonia-N	water	Plastic	Cool to 4°C H_2S0_4 to pH <2	150 mL***	28 days
Nitrate + nitrite-N	water	Plastic	Cool to 4°C, H_2SO_4 to pH <2	100 mL***	28 days
Total Kjeldahl Nitrogen	water	Plastic	Cool to 4°C, H_2SO_4 to pH <2	150 mL***	28 days
Phosphorus-P, total	water	Plastic	Cool to 4°C H_2S0_4 to pH <2	250 mL***	28 days

**E.coli* samples analyzed by SM 9223-B should always be processed as soon as possible and within 8 hours. When transport conditions necessitate delays in delivery longer than 6 hours, the holding time may be extended and samples must be processed as soon as possible and within 24 hours since the nature of this project is research and not regulatory..
** All Solids tests are collected in one 1-liter plastic bottle.
*** Four nutrient tests are collected from one 1-liter plastic bottle.

Sample Containers

Sample containers used in the automated samplers will be 4 – 2.5 gallon (9.5 liter) bottles with PTFE lined caps. All bottles will be washed with warm soapy water, rinsed with deionized water, and autoclaved prior to installation in units.

Recording Data

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

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

Deficiencies, Nonconformances and Corrective Action Related to Sampling Requirements

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render data unacceptable or indeterminate. Deficiencies related to sampling method requirements include, but are not limited to, such things as sample container, volume, and preservation variations, improper/inadequate storage temperature, holding-time exceedances, and sample site adjustments.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the H-GAC QAO. If the situation requires an immediate decision concerning data quality or quantity, the H-GAC Project Manager will be notified within 24 hours. The H-GAC Project Manager will notify the H-GAC QAO of the potential nonconformance. The H-GAC QAO will record and track the CAR to document the deficiency.

The H-GAC QAO, in consultation as appropriate with the H-GAC Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the H-GAC Project Manager in consultation with H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the H-GAC QAO.

CARs document: root cause(s), programmatic impact(s), specific corrective action(s) to address the deficiency, 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. The TSSWCB will be notified of inconsistencies that affect data quality within the quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to the TSSWCB immediately.

B3 SAMPLE HANDLING AND CUSTODY

Chain-of-Custody

Water quality data are generated in the field by H-GAC, EIH, and the Eastex analytical laboratory. A COC form is used to record sample identification parameters and to document the submission of samples from the field staff to the analytical laboratory staff. Each COC has space to record data for nine (9) separate samples. A copy of the COC is found in Appendix B. For samples collected by automated samplers that will be composited, a computer printout for each site showing aliquot volumes should be attached to the COC. For grab samples, a field data sheet for each site is attached to the COC. COCs and accompanying data sheets are kept by H-GAC in paper form for at least seven years.

Sample Tracking

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

The field staff member submitting the sample transfers possession of samples to a laboratory staff member. The field staff member and the laboratory staff member both sign and date the COC. A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is a record that documents the possession of the samples from the time of collection to receipt in the laboratory. The following information concerning the sample is recorded on the COC form (See Appendix B). The following list of items matches the COC form in Appendix B. For this project, all laboratory work will be done by Eastex Environmental Labs.

The following information concerning the sample is recorded on the COC form (See Appendix B).

1. Date and time of collection
2. Site identification
3. Sample matrix, indicated by test group code
4. Number of containers and container type ID designation
5. Preservative used or if the sample was filtered, indicated by test group code
6. Sample composite information (bottle numbers and ending time)
8. Analyses required, indicated by test group code
9. Name of collector
10. Custody transfer signatures and dates and time of transfer
11. Name of laboratory admitting the sample

Sample Labeling

Water samples are labeled with a waterproof label marked with an indelible marker and placed on the container. Label information from the field crew includes:

1. Station identification
2. Time of sampling (or bottle number for composited samples)
3. Date of sampling
4. Preservation (if applicable)
5. Designation of “field-filtered” as applicable
6. Sample type (i.e., analysis(es)) to be performed

These unique identifiers on the sample container can be matched with data on COC forms that are submitted to the laboratory, generally, the same day as samples are collected.

The field staff member documents on a field data sheet the station, date, time, location, and sample type and pertinent comments. These identifying data are copied in ink onto a COC. A unique sample identification number is assigned to water samples at the H-GAC office and written in indelible ink on a water-proof label on the container, and on the COC. The sample identification number, time, date and station location serves to match the sample with the data on the COC.

Sample Handling

All samples are collected according to TCEQ SWQM procedures. All water samples are iced in the field and submitted to the laboratory on ice the same day they are collected in the field or retrieved from an automated sampler.

Upon collection, H-GAC or EIH immediately immerses their samples in coolers containing ice. If a temperature blank is carried (it is not required), it shall be placed on top of the samples instead of buried in the ice. Samples are transferred to a lab courier who signs the chain of custody form and transports the samples to the lab. After the samples arrive, the lab personnel taking custody of samples will verify the samples are “in the process” of cooling to 4 °C before signing the COC. Internal sample handling, custody, and storage procedures for Eastex are described in the Quality Management Plans (QMP) kept on file with H-GAC. References for the Eastex lab procedures are listed in the Table B3.1.

Table B3. 1 Sample Handling References

MONITORING ENTITY	REFERENCE TO SAMPLE HANDLING
Environmental Institute of Houston	EIH has a Standard Operating Procedure (SOP) for Bacteria Samples and a Sample Handling SOP, August 2004; All biological collecting and sample handling will be performed according to TCEQ's *Surface Water Quality Monitoring Procedures Manual, Volume 2 (RG-416, June 2007).* Eastex Environmental Laboratory QM, Rev. 6, January 16, 2009, covers samples relinquished to the lab.
Houston-Galveston Area Council	H-GAC's Standard Operating Procedures (SOP) Manual for Conducting Surface Water Quality Monitoring references the most current *TCEQ Surface Water Quality Monitoring Procedures Manuals Volume 1 & 2* plus specific SOP's pertaining to H-GAC monitoring activities only. Eastex Environmental Laboratory QM, Rev. 6, January 16, 2009, covers samples relinquished to the lab

After samples are received at the laboratory, they are inventoried against the accompanying COC. Any discrepancies are noted at that time, remediated if possible, and the COC is signed for acceptance of custody. Sample numbers are then assigned and samples are checked for preservation *(as allowed by the specific analytical procedure).* Samples are then filtered or pretreated as necessary and placed in a refrigerated cooler dedicated to sample storage, where required.

The laboratory manager has the responsibility to ensure that all holding times are met (see Tables B2.1 and B2.2). Any problems will be documented with a corrective action report.

Deficiencies, Nonconformances and Corrective Action Related to Chain-of-Custody

Deficiencies are defined as unauthorized deviation from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render the data unacceptable or indeterminate. Deficiencies related to chain-of-custody include, but are not limited, to delays in transfer resulting in holding time violations; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the H-GAC Project Manager will be notified within 24 hours. The H-GAC Project Manager will notify H-GAC QAO of the potential nonconformance. The H-GAC QAO will record and track the CAR to document the deficiency.

The H-GAC QAO, in consultation as appropriate with the H-GAC Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the H-GAC Project Manager in consultation with H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the H-GAC QAO.

CARs document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency, 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. The TSSWCB will be notified of inconsistencies that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

B4 ANALYTICAL METHODS

The analytical methods, associated matrices, and performing laboratory are listed in Table A7.1 of Section A7. The authority for analysis methodologies is derived from the TSWQS (§307.1 - 307.10) in that data generally are generated for comparison to those standards and/or criteria. The Standards state that "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 *SWQM Procedures, Volume 1: Physical Methods for Water, Sediment, and Tissue*, 40 CFR 136, or other reliable procedures acceptable to the Executive Director."

Laboratories collecting data under this QAPP are compliant with the NELAC standards. Copies of laboratory QMs and SOPs are available for review by the TCEQ.

Standards Traceability

All standards used in the field and laboratory are traceable to verified and known amounts of analytes. Standards and reagent preparation is fully documented and maintained in a standards log book. The use of standards and reagents are documented when used in preparation and analytical logs. Each documentation includes traceability to purchased stocks, reference to the method of preparation, including concentration, amount used and lot number, date prepared, expiration date and preparer's initials or signature. The reagent bottle is labeled with concentration, date of preparation, expiration date, storage requirements, safety considerations, and a unique identifier that traces the reagent to the standards log book entry.

Analytical Method Modification

Only data generated using approved analytical methodologies as specified in this QAPP will be used as direct data for this project. Requests for method modifications will be documented and submitted for approval to the TSSWCB. Work using modified methods will begin only after the modified procedures have been approved.

Deficiencies, Nonconformances and Corrective Action Related to Analytical Methods

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render the data unacceptable or indeterminate. Deficiencies related to field and laboratory measurement systems include but are not limited to instrument malfunctions, blank contamination, quality control sample failures, etc.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the H-GAC Project Manager will be notified within 24 hours. The H-GAC Project Manager will notify the H-GAC QAO of the potential nonconformance. The H-GAC QAO will record and track the CAR to document the deficiency.

The H-GAC QAO, in consultation as appropriate with the H-GAC Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the H-GAC Project Manager in consultation with H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a Corrective Action Report, which is retained by the H-GAC QAO.

CARs document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency, 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. The TSSWCB will be notified of inconsistencies that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

B5 QUALITY CONTROL

Sampling Quality Control Requirements and Acceptability Criteria

Field Split - A field split is a single sample subdivided by field staff immediately following collection and submitted to the laboratory as two separately identified samples. This requirement applies to composited grab samples as well as single grab samples, but not to automated samples or bacteria samples. Field splits will be collected on a 10% basis for instream routine samples. The precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$RPD = (X_1-X_2)/[(X_1+X_2)/2]\ 100$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the sample handling and analytical system. If it is determined that elevated quantities of analyte (i.e., > 5 times the LOQ) were measured and analytical variability can be eliminated as a factor, then variability in field split results will be used to trigger discussions with field staff to ensure samples are being handled correctly in the field. Some individual sample results may be invalidated based on the examination of all extenuating information. The information derived from field splits is generally considered to be event specific and would not normally be used to determine the validity of an entire batch; however, some batches of samples may be invalidated depending on the situation. Professional judgment during data validation will be relied upon to interpret the results and take appropriate action. Deficiencies will be addressed as specified in this section under Deficiencies, Nonconformances, and Correction Action related to Quality Control.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

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

Detailed laboratory QC requirements and corrective action procedures are contained within the individual laboratory quality assurance manuals (QAMs). The minimum requirements that all participants abide by are stated below.

Limit of Quantitation (LOQ) - The laboratory will analyze a calibration standard (if applicable) at the LOQ on each day project samples are analyzed. Calibrations including the standard at the LOQ will meet the calibration requirements of the analytical method or corrective action will be implemented.

LOQ Check Standard- An LOQ check standard consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system at the lower limits of analysis. The LOQ check standard is spiked into the sample matrix at a level less than or near the LOQ for each analyte for each batch of samples that are run.

The LOQ check standard is carried through the complete preparation and analytical process. LOQ Check Standards are run at a rate of one per preparation batch. A preparation batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

The percent recovery of the LOQ 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:

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

Measurement performance specifications are used to determine the acceptability of LOQ Check Standard analyses as specified in Table A7.1.

As noted above, the LOQ check standard will be used for information in determining the performance of the measurement system at the lower limits of analysis and not as a sole criterion for determining overall data acceptability for a batch.

Laboratory Control Sample (LCS)- An LCS consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system. The LCS is spiked into the sample matrix at a level less than or near the midpoint of the calibration for each analyte. In cases of test methods with very long lists of analytes, LCSs are prepared with all the target analytes and not just a representative number, except in cases of organic analytes with multipeak responses.

The LCS is carried through the complete preparation and analytical process. LCSs are run at a rate of one per preparation batch. A preparation batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Results of LCSs are calculated by percent recovery (%R), which is defined as 100 times the measured concentration, divided by the true concentration of the spiked sample.

The following formula is used to calculate percent recovery, where %R is percent recovery; SR is the measured result; and SA is the true result:

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

Measurement performance specifications are used to determine the acceptability of LCS analyses as specified in Table A7.1.

Laboratory Duplicates- A laboratory duplicate is prepared by taking aliquots of a sample from the same container under laboratory conditions and processed and analyzed independently. A laboratory control sample duplicate (LCSD) is prepared in the laboratory by splitting aliquots of an LCS. Both samples are carried through the entire preparation and analytical process. LCSDs are used to assess precision and are performed at a rate of one per preparation batch. A preparation batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

For most parameters, precision is calculated by the RPD of LCS 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:

$$RPD = (X_1 - X_2)/[(X_1+X_2)/2] * 100$$

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 lab. 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.

Measurement performance specifications are used to determine the acceptability of duplicate analyses as specified in Table A7.1. The specifications for bacteriological duplicates in Table A7.1 apply to samples with concentrations > 20 org./100 mL.

Matrix spike (MS)- Matrix spikes are prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

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. Spiked samples are routinely prepared and analyzed at a rate of 10% of samples processed, or one per quality control batch whichever is greater. A quality control batch is defined as samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 10 environmental samples. The information from these controls is sample/matrix specific and is not used to determine the validity of the entire batch. The MS is spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. Percent recovery (%R) is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike.

The results from matrix spikes are primarily designed to assess the validity of analytical results in a given matrix and are expressed as percent recovery (%R). The laboratory shall document the calculation for %R. The percent recovery of the matrix spike is calculated using the following equation in which %R is percent recovery, SSR is the observed spiked sample concentration, SR is the sample result, and SA is the reference concentration of the spike added:

$$\%R = (SSR - SR)/SA * 100$$

Measurement performance specifications for matrix spikes are not specified in this document.

The results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine the internal criteria and document the method used to establish the limits. For matrix spike results outside established criteria, corrective action shall be documented or the data reported with appropriate data qualifying codes.

- Eastex uses matrix spike recovery limits of 80-120 for parameters where a spike solution is available. These recoveries are monitored with QC charts to help determine interferences or detect trends. Matrix spikes that fail to meet these guidelines are reanalyzed if possible. An alternate sample may be used to help determine whether the problem was specific to that sample. If matrix spikes are not achievable within 80-120 % recovery, then this recovery is flagged as exceeding the control limit on the QC report.

Method blank- A method blank is a sample of matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. The method 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 LOQ.

Deficiencies, Nonconformances and Corrective Action Related to Quality Control

Deficiencies are defined as unauthorized deviation from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render the data unacceptable or indeterminate. Deficiencies related to Quality Control include but are not limited to quality control sample failures.

Deficiencies are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory supervisor. The supervisor will forward the CAR to the QAO. If the situation requires an immediate decision concerning data quality or quantity, the H-GAC Project Manager will be notified within 24 hours. The H-GAC Project Manager will notify the H-GAC QAO of the potential nonconformance. The H-GAC QAO will record and track the CAR to document the deficiency.

The H-GAC QAO, in consultation as appropriate with the H-GAC Project Manager (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the H-GAC Project Manager in consultation with H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the H-GAC QAO.

CARs document: root cause(s); programmatic impact(s); specific corrective action(s) to address the deficiency, 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. The TSSWCB will be notified of inconsistencies that affect data quality with quarterly progress reports. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

All sampling equipment testing and maintenance requirements are detailed in the *TCEQ Surface Water Quality Monitoring Procedures Volumes 1 and 2*. Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within the laboratory's QM.

B7 INSTRUMENT/ EQUIPMENT CALIBRATION AND FREQUENCY

Field equipment calibration requirements are contained in the *TCEQ Surface Water Quality Monitoring Procedures*. 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 QM(s).

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

All supplies and consumables received by Eastex are inspected upon receipt for damage, missing parts, expiration date, and storage and handling requirements by appropriate laboratory personnel. Labels on reagents, chemicals, and standards are examined to ensure they are of appropriate quality, initialed by staff member and marked with receipt date. Volumetric glassware is inspected to ensure class ‘A’ grade where required.

Chemicals for analysis are tested by the supplier and meet or exceed American Chemical Society (ACS) certification, where applicable.

Acceptance criteria for such supplies and consumables, in order to satisfy the technical and quality objectives of this project, are documented in Eastex’s QMs.

B9 NON-DIRECT MEASUREMENTS

In addition to the data generated from the monitoring associated with this project, non-direct measurements will be acquired from the Clean Rivers Program, USGS flow gage data, and SWQMIS.

H-GAC is a partner in the Clean Rivers Program for the state of Texas. As such, they collect data for four (4) sites in the watershed on a regular basis for routine water quality assessment as part of the state's mandate for CWA §305(b) – Water Quality Inventory Report. These data are also used by Texas for consideration of water bodies to be added to their list of impaired water body segments, as described in CWA §303(d). The TCEQ monitors two sites in the watershed (sites 11111 and 11120) on a regular basis. Additional data obtained from CRP or the Texas Commission on Environmental Quality are from the SWQMIS database.

All data used for this project are collected in accordance with approved quality assurance measures under the state's Clean Rivers Program, Texas Commission on Environmental Quality, Texas Water Development Board, USDA, National Weather Service, Texas Stream Team, water quality sampling conducted under stormwater phase I and II permits in the watershed, or USGS.

Quality assured stream flow measurements will be collected from USGS stream gage stations as available.

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

B10 DATA MANAGEMENT

Data Management Process

Data is received by H-GAC directly from EIH and Eastex lab. The paragraph below gives a brief description of their data submission process.

When data is submitted to H-GAC, the data is saved in "Raw Data" folders. When H-GAC begins to process the data, it is saved into a "Working Data" folder. By changing the folder in which the data is saved, H-GAC always has the original data submittal in electronic format. Data is processed by H-GAC's Data Manager/SAS Operator and H-GAC's QAO before being provided to TSSWCB and thence to TCEQ. H-GAC's full data procedure, including data submitted to SWQMIS, is shown in the flow chart in Appendix D– H-GAC's Data Management Process and Flow Chart.

EIH performs data entry for only the field data collected by their program. The field QAO or the individual who collected the data inputs the data to an EXCEL spreadsheet. All supporting QA data is input to spreadsheets as well. The field QAO and the Project Manager review more than 10% of the data for accuracy, completeness, and reasonableness. A Data Review checklist is generated while data is being reviewed. Then it is submitted to H-GAC along with electronic data files hard copies of the field sheet and COC.

H-GAC receives lab data from Eastex Lab in hard copy and electronic versions. The data is typed into a new format in an EXCEL spreadsheet by either a temporary employee or the Data Manager and is saved in the "RAW Data" files. It is reviewed for accuracy and completeness by either the Data Manager (DM) or QAO (but not the person who performed the original data entry).

The DM begins the task of merging the field and lab data files. The merged file is saved in a "WORKING Data" file. When a dataset is fully merged, it will be provided to TCEQ.

H-GAC's Data Management Flow Chart describes the entire data management process. Data manipulation through the merging task will be the only part applicable to data collected under this QAPP.

Data Dictionary**-** Terminology and field descriptions are included in the SWQM Data Management Reference Guide, 2009 or most recent version. For the purposes of verifying which entity codes are included in this QAPP, a table outlining the entities that will be used when submitting data under this QAPP is included as Table B10.1 below.

Table B10.1 Monitoring Entity Identification

Name of Monitoring Entity	Tag Prefix	Submitting Entity	Collecting Entity
Houston-Galveston Area Council	I	TX	HG
Environmental Institute of Houston – University of Houston Clear Lake	I	TX	UI

Data Errors and Loss

H-GAC stores original electronic data is “Raw Data” files. These files are saved in the original format and other then changing the name of a file, remains unchanged. Any changes to a data file are saved in the “Working Data” folders. In these folders, data is merged, formatted, and converted to the correct reporting units before SAS processing begins. After SAS is applied, the files are stored in ACCESS tables. An ACCESS database is made for each data set. In this database there are several folders where all reports and modifications are documented. There is an INPUT folder, an OUTPUT folder, Draft Matrix tables which should show all the data as reformatted and ready to be converted into the EVENT/RESULTS format for the TSSWCB, and thence to TCEQ. All changes, validation, and verification actions on the data are documented in a Data Review Summary Report which accompanies each data set submittal.

Record Keeping and Data Storage

As each data set is processed by H-GAC, all hard copies of data and/or field forms are organized into packets. All correspondences or reports related to the data set are to be printed and placed in the packet of information. Including but not limited to the QAO review comments, the draft and final Data Summary Reports/Sheets. Any other documentation related to that specific data set is also to be attached. Each packet of information is placed in a file storage box for long term storage.

EIH and Eastex submit electronic data along with hard copies of field sheets and COC forms. Electronic data is stored in folders on the H-GAC network as “originals” and as copies for data management, verification, and validation. Daily and weekly backups are completed on H-GAC’s server. Hard copies are filed in filing cabinets or file boxes for use as needed. Data more than 2 years old may be sent for off-site storage according to H-GAC procedures. All data is maintained for at least seven (7) years by H-GAC and all sub-contractors.

Chain of Custody Forms

A COC form is used to record water sample identification parameters and to document the submission of samples from the field staff to the analytical laboratory staff (Appendix B). Each COC has space to record data for numerous separate samples. All entries onto the COC forms will either be typed or completed in ink, with any changes made by crossing out the original entry, which should still be legible, and initialing and dating the new entry. COCs are kept in three-ring binders or designated folder in the H-GAC office for at least seven years.

Data Verification/Validation

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

Data Handling

H-GAC maintains several networked computers to store and manage data. All computers are equipped with at least Windows XP and Office 2007 which includes MS Excel 2007 and MS Access 2007. The data manager's computer also includes Oracle 9 to assist with screening, management and reformatting the data to TCEQ's specifications. Additionally, the SAS software is available on the DM/SAS Operator's computer.

Hardware and Software Requirements

Hardware configurations are sufficient to run Windows XP, Office 2007, MS Excel 2007 MS Access 2007, SAS and Oracle 9 software in a networked environment. Specific hardware need to be configured to run WISKI and FLOWLINK software, but not necessarily in a networked environment. H-GAC information resources staff is responsible for assuring that hardware configurations meet the requirements for running current and future data management/database software as well as providing technical support.

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table presents the types of assessments and response actions for data collection activities applicable to this project (Table C1.1).

Table C1.1 Assessments and Response Requirements

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring, Oversight, etc.	Continuous	H-GAC Project Manager	Monitoring of the project status and records to ensure requirements are being fulfilled	Report to TSSWCB in Quarterly Report
Monitoring Systems Audit of H-GAC, EIH	Dates to be determined by TSSWCB (minimum of one per life of project)	TSSWCB QAO	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 NPS Project	30 days to respond in writing to the TSSWCB to address corrective actions
Laboratory Inspection	Dates to be determined by TSSWCB (minimum of one per life of project)	TSSWCB QAO	Analytical and quality control procedures employed at the Eastex laboratory.	30 days to respond in writing to TSSWCB to address corrective actions
Laboratory Management Review	Annually	H-GAC QAO	Conduct management reviews of the laboratory's quality system to ensure its effectiveness	Not applicable
Laboratory Internal Audits	Annually	Eastex Laboratory QAO	Conduct internal audits of the quality system to verify that activities comply with the quality system Standard	30 days to respond in writing to Lab QAO to address corrective actions
Site Visit	Dates to be determined by TSSWCB (minimum of one per each fiscal year during life of project)	TSSWCB PM	Status of activities. Overall compliance with work plan and QAPP	As needed

Corrective Action

The H-GAC Project Manager is responsible for implementing and tracking corrective action resulting from audit findings outlined in any internal or external audit report. The H-GAC QAO will maintain records of audit findings and corrective actions. Internal audit reports will be made available to the TSSWCB upon request.

C2 REPORTS TO MANAGEMENT

Reports to TSSWCB Project Management

Quarterly Progress Report

Summarizes H-GAC activities for each task; reports problems, delays, and corrective actions; and outlines the status of each tasks deliverables. Report written by the H-GAC project manager.

Monitoring System Audit Response

H-GAC will respond in writing to the TSSWCB within 30 days upon receipt of a monitoring system audit report to address corrective actions. Response written by the H-GAC QAO.

Laboratory System Audit Response

H-GAC will respond in writing to the TSSWCB within 30 days upon receipt of a laboratory system audit report to address corrective actions. Response written by the H-GAC/Eastex's laboratory QAO.

Final Project Report

Summarizes H-GAC's activities for the entire project period including a description and documentation of major project activities; evaluation of project results and environmental benefits; and a conclusion. Report written by or under the guidance of the H-GAC project manager with assistance from other staff members.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

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

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

The procedures for verification and validation of data are described in Section D2. The H-GAC Field Supervisor is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Manager is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity. The H-GAC QAO, DM and PM will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. The Eastex Laboratory QAO is responsible for validating a minimum of 10% of the data produced in each task. Finally, the H-GAC PM, with the concurrence of the H-GAC QAO and the H-GAC DM, is responsible for validating that all data collected and analyzed meet the objectives of the project.

All field and laboratory data will be reviewed and verified for integrity and continuity, reasonableness, and conformance to project requirements, and then validated against the project objectives and measurement performance specifications which are listed in Section A7. Data that are supported by appropriate quality control data and meet the measurement performance specifications defined for this project will be considered acceptable will be used in evaluating project objectives for the final report.

D2 VERIFICATION AND VALIDATION METHODS

All data will be verified to ensure they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to project specifications. 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 (Table D2.1). 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 laboratory 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 are evaluated against project performance specifications (Section A7) and are checked for errors, especially errors in transcription, calculations, and data input. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues that 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 H-GAC PM, DM and QAO are each responsible for validating that the verified data are scientifically valid, defensible, of known precision, accuracy, integrity, meet the data quality objectives of the project, and are reportable to TSSWCB. One element of the validation process involves evaluating the data again for anomalies. The manager of the task associated with the suspected data errors or anomalous data must address these issues before data validation can be completed.

A second element of the validation process is consideration of any findings identified during a laboratory or monitoring systems audit conducted by the TSSWCB QAO. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. Finally, the H-GAC PM, with the concurrence of the H-GAC QAO and H-GAC DM, validates that the data meet the data quality objectives of the project and are suitable for meeting project objectives for the TSSWCB.

Table D2.1: Data Review Tasks

Field Data Review	**Responsibility**
Field data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements	H-GAC QAO, DM and FS; EIH.
Post-calibrations checked to ensure compliance with error limits	H-GAC QAO, DM and FS; EIH.
Field data calculated, reduced, and transcribed correctly	H-GAC QAO, DM and FS; EIH.
Laboratory Data Review	
Laboratory data reviewed for conformance with data collection, sample handling and chain of custody, analytical and QC requirements to include documentation, holding times, sample receipt, sample preparation, sample analysis, project and program QC results, and reporting	Eastex Laboratory Manager and/or QAO
Laboratory data calculated, reduced, and transcribed correctly	Eastex Laboratory Manager and/or QAO
Reporting limits consistent with requirements for Ambient Water Reporting Limits.	Eastex Laboratory Manager and/or QAO
Analytical data documentation evaluated for consistency, reasonableness and/or improper practices	Eastex Laboratory Manager and/or QAO
Analytical QC information evaluated to determine impact on individual analyses	Eastex Laboratory Manager and/or QAO
All laboratory samples analyzed for all parameters	Eastex Laboratory Manager and/or QAO
Data Set Review	
Data reported has all required information as described in Section A7 of the QAPP	H-GAC QAO and DM
Confirmation that field and lab data have been reviewed	H-GAC QAO and DM
Data set (to include field and laboratory data) evaluated for reasonableness and if corollary data agree	H-GAC PM and QAO
Outliers confirmed and documented	H-GAC DM and PM
Field QC acceptable (e.g., field splits)	H-GAC QAO
Sampling and analytical data gaps checked and documented	H-GAC QAO, DM and PM
Verification and validation confirmed. Data meets conditions of end use and are reportable	H-GAC PM and QAO

D3 RECONCILIATION WITH USER REQUIREMENTS

Data produced in this project, and data collected by other organizations (e.g., USGS, TCEQ, etc.), will be analyzed and reconciled with project data quality requirements. Data meeting project requirements will be used by the TCEQ in SWQMIS for use in the development of the biennial *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*, stream standards modifications, and permit decisions as appropriate. Data which do not meet requirements will not be submitted to SWQMIS nor will be considered appropriate for any of the uses noted above.

References:

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, 1998.

American Society for Testing and Materials (ASTM) Annual Book of Standards, Vol. 11.02: Method ASTM D516 – 90 (Reapproved in 1995); Method ASTM D 6503 – 99 (Reapproved in 2005)

EPA, United States Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory, Office of Research and Development, US-EPA, Cincinnati, Ohio. EPA-600/4-79-020, Revised March 1983.

TCEQ, Texas Commission on Environmental Quality. Texas Surface Water Quality Standards, Chapter 307, Texas Administrative Code 307.1 - 307.10. Austin, Texas: TCEQ.

TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods ,2012 (RG-415).

TCEQ SOP, V2 - TCEQ Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data, 2007 (RG-416)

Appendix A. Field Data Reporting Forms

EIH Field Data Form

Environmental Institute of Houston - University of Houston Clear Lake

Clean Rivers Program Field Data/Sampling Sheet

Station ID:____________________Date:_________________ Time: arrive_____________ sample______________ depart_____________

Location:____ Lat:______________________ Long:______________________

Collected By:____

FIELD MEASUREMENTS (If < 1.5m deep - record @ 0.3m from surface; If ≥ 1.5m deep - perform profile @ 0.3m from bottom, @ middle, and @ 0.3m from surface)

	1	2	3	4	5
Temp (C)					
Conductivity (uS)					
Salinity (psu)					
DO (%sat)					
DO mg/L					
pH					
Depth (m)					

FIELD OBSERVATIONS

[ ] TOTAL DEPTH (m)

[ ] SAMPLING DEPTH (m)

[ ] % CLOUD COVER

[ ] WIND SPEED

[ ] WIND DIRECTION

[ ] AIR TEMP (C)

[ ] WATER ODOR 1-sewage 2-oily/chemical 3-rotten egg 4-musky 5-fishy 6-none 7-other

[ ] WATER SURFACE 1-calm 2-ripples 3-waves 4-whitecap

[ ] WIND INTENSITY 1-calm 2-slight 3-moderate 4-strong

[ ] WATER COLOR 1-brownish 2-reddish 3-greenish 4-blackish 5-clear 6-other

[ ] TIDE STAGE 1-low 2-falling ~~3-slack~~ 4-rising 5-high

[ ] PRESENT WEATHER 1-clear 2-partly cloudy 3-cloudy 4-rain 5-other

[ ] DAYS SINCE LAST SIG. RAINFALL

[ ] FLOW SEVERITY 1-no flow 2-low 3-normal 4-flood 5-high 6-dry

[ ] FLOW (cfs)

[ ] FLOW METHOD 1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler

[ ] SECCHI DISK (m)

[ ] RECREATIONAL USE 1=1° observed, 2=2° observed, 3=non-contact observed, 4=1° evidence, 5=2° evidence, 6=non-contact evidence, 7=no evidence

[ ] Primary Contact Rec. Observed (enter number of people)

[ ] Evidence of Primary Contact Rec. Observed 0= no evidence observed, 1= evidence observed

[ ] Forel-Ule Color

[ ] HACH Color Wheel HR / LR

WATER SAMPLES

☐ **FRESH** (Non-Tidal) ☒ **MARINE** (Tidal)

☐ *E. coli* ☒ *Enterococcus*

[ ] TURBIDITY (NTU) BOTTLE #______

[ ] CHL-A, AVG (µg/L) (1)_________(2)________(3)_________

[NO] Field Split Collected (yes/no)

Container	Preservative	Analysis Requested	Comments
1 x 1L - Plastic	Ice	TSS	
1 x 1L - Plastic	Ice, 2 mL H_2SO_4 added	NH_3, TPO_4, NO_2+NO_3	
1 x 500ml - Plastic	Ice, 1 mL H_2SO_4 added	TKN	
1 x 500ml - Plastic	Ice	Cl, SO_4 (fresh water only)	
1 x 4L - Plastic (amber)	Ice	Chlorophyll-*a* (select sites)	
1 x 100ml - Plastic	Ice, $Na_2S_2O_3$ tablet	Bacteria (Entero and/or *E. coli*)	

ADDITIONAL INFORMATION & REMARKS

Remarks:

* If site is dry, determine if there is any pool with 500m reach, If pool(s) exists (> 10 m in length and 0.4m deep) record: Lat ___________ Long__________ of largest pool
Maximum pool width_______(m), Maximum pool depth ______ (m), Pool length ________(m), and percent pool coverage in 500m reach ________%.

H-GAC Field Data Reporting form

H-GAC – Ambient Monitoring Data Sheet

Date: _______/_______/_______ Station: **TCEQ ID: # 11117 – Cedar Bayou tidal @ I-10 frontage road eastbound**

Time (military):______________ Samples Collected by:____

Total Water Depth at sampling location	meters		# of Days Since Last Significant Rainfall	
Sampling Depth	meters			
Water Temperature	°C			
Specific Conductance	µS/cm			
Salinity	‰			
pH	standard units			
Dissolved Oxygen	mg/L			

Secchi disk or tube	Observed Turbidity	Water Clarity	Water Color	Water Odor	Present Weather	Wind Intensity	Water Surface	Flow Severity	Tide Stage
								N/A	
meters	1 – low 2 – medium 3 – high	1 – excellent 2 – good 3 – fair 4 – poor	1 – brownish 2 – reddish 3 – greenish 4 – blackish 5 – clear 6 – other	1 – sewage 2 – oily/chemical 3 – rotten egg 4 – musky 5 – fishy 6 – none 7 – other	1 – clear 2 – partly cloudy 3 – cloudy 4 – raining 5 – other	1 – calm 2 – slight 3 –moderate 4 – strong	1 – calm 2 – ripples 3 – waves	1 – no flow 2 – low 3 – normal 4 – flood 5 – high 6 – dry	1 – low 2 – falling 3 – slack 4 – rising 5 – high

Flow	cfs	N/A
Flow Method	1 – gage 2 – electric 3 – mechanical 4 – weir/flume 5 – Doppler	N/A
Chlorine Residual		
Primary Contact, # of People Observed (1-10, >10)		
Evidence of Primary Contact, (1- Observed, 0 - Not Observed)		

Maximum Pool Width	meters	
Maximum Pool Depth	meters	
Pool Length	meters	
Percent Pool Coverage in 500 meter Reach	%	
Comments or Observation		

Fresh (non-tidal) _______

Marine (tidal) _______

Field Split? Yes____ No____

Containers	Preservatives	Analyses	Requested
1 x 1 L Plastic	Iced	TSS, Turbidity	✓
1 x 1 L Plastic	Iced, H_2SO_4	TKN, NH3, NO2+NO3, TPO4, hardness	✓
1 x 500 mL Plastic	Iced	CL, SO4 (fresh only)	N/A
1 x 100 mL Sterile Plastic	Iced	Bacteria: *E. coli* Enterococcus	✓ ✓
1 x 250 mL Plastic	Iced	O-PO4 (Field Filtered: Yes X No)	✓
1 x 4 L Amber Plastic	Iced	Chlorophyll *a*	✓

If no,
Date of last split:____________ Surveyor SN:________________________ Sonde SN:___________________________

Updated: January 3, 2013

Field Forms – H-GAC Stream Flow Measurement Form

H-GAC Surface Water Quality Monitoring Program

Stream Flow (Discharge) Measurement Form

Stream:____ Date:_______________

Station:____

Description:____

Time Begin:_____________ Time End:_____________ Meter Type:__________________________________

Observers:___________________________ Stream Width*:____________ Section Width (W):_____________

Observations:____

Section Midpoint (ft) (m)	Section Depth (ft) (m) (cm) (D)	Observational Depth** (ft)(m)	Velocity (V)		Flow (Q) (m^3/s) (ft^3/s) Q = (W)(D)(V)
			At Point (ft/s)(m/s)	Average (ft/s)(m/s)	

Biological Summary Packet Form

Elements of the Biological Data Summary Packet

Aquatic Life Monitoring and Habitat Assessment Checklist

Background Information

Name of water body:	

Segment number:		Station ID:	

On segment: Yes □ No □

Permit number, if applicable:_______________ Check monitoring objective: ALM □ ALU □ UAA □ RWA □

Historic Stream Characterization (circle one):

Intermittent   Intermittent with perennial pools sufficient to support significant aquatic life use   Perennial   Unknown

Basis for historic stream characterization (describe):

Current aquatic life use designation (if classified segment or site specific standard determined):

Exceptional □ High □ Intermediate □ Limited □

Current assessment status on the (year)__________ Water Quality Inventory, 305(b) Report:
Supported □ Partially Supported □ Not Supported □ Concern □ Not Assessed □

Data Entry

Field data entry (FDE) information: Date entered into FDE:
RTAG #: __________ (*TCEQ regional biologists only*)

Field data (*CRP partners only*):Tag #:

Objective for Aquatic Life Use Assessment

Is this water body supporting its designated uses? Yes ☐ No ☐ Reason:

Known or potential causes of aquatic life use concern or impairment:

Identify sources of pollution:

Point source: Yes ☐ No ☐ Identify:

Nonpoint source: Yes ☐ No ☐ Identify:

Ambient toxicity tests in water body? Yes ☐ No ☐

Results:

	Sediment Chronic	Sediment Acute	Water Chronic	Water Acute
Significant effect				
No significant effect				

Monitoring Information

Biological monitoring conducted during index period (03/15 to 06/30 and 10/01 to 10/15) and critical period (07/01-09/30).

Stream characterization event 1, date: _____________

Dry	Pools covering ________% of the _______ meters assessed	Flowing at ______ cfs (measured)

Describe conditions that may have adversely affected stream during each sampling event (for example, recent rains, drought, construction):

Note: If sampling event for a RWA, characterize the receiving stream upstream of the existing discharge point or downstream of the proposed discharge point.

Stream characterization event 2, date:______________

Dry	Pools Covering ________% of the _______ meters assessed	Flowing at ______ cfs (measured)

Describe conditions that may have adversely affected stream during each sampling event (for example, recent rains, drought, construction):

Nekton sampling event 1:

Minimum 15–minute (900 seconds) electrofishing: Yes ☐ No ☐
Minimum 6 seine hauls (or equivalent effort to sample 60 meters): Yes ☐ No ☐
Fish sampling conducted in all available habitat types: Yes ☐ No ☐
If no, please describe why:

Benthic macroinvertebrate sampling event 1:
Indicate method(s) used:

Rapid bioassessment : 5–minute kicknet ☐ snags ☐
Quantitative: Surber ☐ snags ☐ dredge ☐

Habitat assessment event 1:

TCEQ habitat protocols: Yes ☐ No ☐

Stream flow measurement event 1:

Instantaneous measurement: Yes ☐ No ☐
USGS gauge reading: Yes ☐ No ☐

Nekton sampling event 2:

Minimum 15-minute (900 seconds) electrofishing: Yes ☐ No ☐
Minimum 6 seine hauls (or equivalent effort to sample 60 meters): Yes ☐ No ☐
Fish sampling conducted in all available habitat types: Yes ☐ No ☐
If no, please describe why:

Benthic macroinvertebrate sampling event 2:
Indicate method(s) used:

Rapid bioassessment: 5-minute kicknet ☐ snags ☐
Quantitative: Surber ☐ snags ☐ dredge ☐

Habitat assessment event 2:

TCEQ habitat protocols: Yes ☐ No ☐

If no, flow, wetted channel width, photographs, description of bank conditions relative to first event, and description of canopy cover conditions relative to first event must be provided in this packet.

Stream flow measurement event 2:

Instantaneous measurement: Yes ☐ No ☐

USGS gauge reading: Yes ☐ No ☐

Assessment Results (Optional)

Fish community index event 1:

Exceptional ☐ High ☐ Intermediate ☐ Limited ☐

Fish community index event 2:

Exceptional ☐ High ☐ Intermediate ☐ Limited ☐

Benthic macroinvertebrate community index event 1:

Exceptional ☐ High ☐ Intermediate ☐ Limited ☐

Benthic macroinvertebrate community index event 2:

Exceptional ☐ High ☐ Intermediate ☐ Limited ☐

Habitat index event 1:

Exceptional ☐ High ☐ Intermediate ☐ Limited ☐

Habitat index event 2:

Exceptional ☐ High ☐ Intermediate ☐ Limited ☐

Benthic Forms – Macroinvertebrate Sample Tracking Log

EIH Benthic Macroinvertebrate Sample Tracking Log

Sample tracking log number:
Name of collector:
TCEQ Station ID:
Location description:
Date of collection:
Date entered in sample tracking log:
Date identification started:
Date identification completed:
Name of identifier:
Method of collection:

Sample tracking log number:
Name of collector:
TCEQ Station ID:
Location description:
Date of collection:
Date entered in sample tracking log:
Date identification started:
Date identification completed:
Name of identifier:
Method of collection:

Sample tracking log number:
Name of collector:
TCEQ Station ID:
Location description:
Date of collection:
Date entered in sample tracking log:

Date identification started:
Date identification completed:
Name of identifier:
Method of collection:

TCEQ-20231 (EIH rev 8/12/2010)

Benthic Forms – Macroinvertebrate Data Reporting Form

Texas Commission on Environmental Quality
Surface Water Quality Monitoring Program

Benthic Macroinvertebrate Data Reporting Form

RTAG# | REGION | EMAIL-ID: COLLECTOR

STATION ID | SEGMENT | SEQUENCE | DATA SOURCE

Station Description____

Composite - Most biological samples will be type Both

COMPOSITE SAMPLE

COMPOSITE CATEGORY: T=Time S=Space B=Both

M M D D Y Y Y Y — START DATE | H H M M — START TIME | . START DEPTH (SHALLOWEST) | M = meters F = feet

M M D D Y Y Y Y — END DATE | H H M M — END TIME | . END DEPTH (DEEPEST) | M = meters F = feet

PARAMETRIC DATA

Enter the codes and values appropriate for this sample. Code (<) if less than value, and (>) if greater than value, other wise leave this column blank. Continue if necessary, on additional worksheets. Codes to describe the benthic sampling effort are listed on the back. Benthic data must be submitted with a Habitat Assessment.

CODE	(<) or (>)	Value	Description

Benthic Macroinvertebrate Parameter Codes

NOTE: Measurements reported in metric units
**** Indicates Parameter Measured at Sample Point (e.g. riffle from which benthic sample is collected)**

Quantitative Benthic Sample Descriptors					
89899		Biological Data Reporting Units (Values: 1= number of individuals from sub-sample; 2 = number of individuals/ft^2; 3 = number of individuals/m^2; 4 = total number in kicknet)	89946		Mesh size, any net or sieve (diagonal measurements) for benthic collection (cm)
89901		Surber Sampler Effort, area sampled (m^2)	89961		Ecoregion (Texas Ecoregion Code)
89935		Ekman Sampler Effort, area sampled (m^2)	84161		Stream Order
89934		Petersen Sampler Effort, area sampled (m^2)	90005		Benthos Sampled--No Organisms Present
89933		Hester-Dendy Duration (days)	90055		Total Taxa (Taxa Richness), Benthos # Taxa
89950		Benthic Sampler (1=Surber, 2=Ekman, 3=kicknet, 4=Petersen, 5=Hester-Dendy)	90056		Total # of Diptera Taxa
89975		Area of snag surface sampled (m^2)	90057		Total # of Ephemeroptera Taxa
**89921		Percent undercut bank at sample point (%)	90058		Total # of Intolerant Taxa
**89922		Percent overhanging brush at sample point (%)	90060		EPT Taxa (% of communtiy)
**89923		Percent gravel substrate at sample point (%)	90062		Chironomidae (% of community)
**89924		Percent sand substrate at sample point (%)	90066		Tolerant Taxa (% of community), Benthos
**89925		Percent soft bottom at sample point (%)	90020		Benthic Grazers (% of community)
**89926		Percent macrophyte bed at sample point (%)	90025		Benthic Gatherers (% of community)
**89927		Percent snags and brush at sample point (%)	90030		Benthic Filterers (% of community)
**89928		Percent bedrock at sample point (%)	90067		Dominance (3 Taxa) (% of community)
RBAP Benthic Sample Descriptors					
89899		Biological Data Reporting Units (Values: 1= number of individuals from sub-sample; 2 = number of individuals/ft^2; 3 = number of individuals/m^2; 4 = total number in kicknet)	89946		Mesh size, sieve (diagonal measurements) (cm)
89950		Benthic Sampler (1=Surber, 2=Ekman, 3=kicknet, 4=Petersen, 5=Hester-Dendy)	89961		Ecoregion (Texas Ecoregion Code)
89902		Dip Net Effort, area swept (m^2)	84161		Stream Order

89903		Kicknet Effort, area kicked (m^2)	90005		Benthos Sampled--No Organisms Present
89904		Kicknet Effort, minutes kicked (min.)	90055		Total Taxa (Taxa Richness), Benthos, # Taxa
89905		Snags and Shoreline Sampling Effort, minutes picked	90008		EPT Taxa Abundance (# Taxa)
89906		Number of individuals in benthic RBA sub-sample (∀ 100)	90007		Biotic Index (HBI)
89950		Benthic Sampler (1=Surber, 2=Ekman, 3=kicknet, 4=Petersen, 5=Hester-Dendy)	90062		Chironomidae (% of community)
**89921		Percent undercut bank at sample point (%)	90042		Dominant Taxon, Benthos (% of community)
**89922		Percent overhanging brush at sample point (%)	90010		Dominant Functional Feeding Group (% of community)
**89923		Percent gravel substrate at sample point (%)	90036		Benthic Predators (% of community)
**89924		Percent sand substrate at sample point (%)	90050		Ratio of Intolerant: Tolerant Taxa
**89925		Percent soft bottom at sample point (%)	90069		% of Total Trichoptera as Hydropsychidae
**89926		Percent macrophyte bed at sample point (%)	90052		Total # Non-insect Taxa
**89927		Percent snags and brush at sample point (%)	90025		Benthic Collector-Gatherers (% of community)
**89928		Percent bedrock at sample point (%)	90054		% of Total # as Elmidae (% of community)

Benthic Forms – Metrics and Scoring for Kick Samples

Texas Commission on Environmental Quality
Surface Water Quality Monitoring Program

Metrics and Scoring for Kick Samples
Rapid Bioassessment Protocol
Benthic Macroinvertebrates Worksheet

Stream Name:				
Date:		**Collectors:**		
Location:				
County:		**Ecoregion Number:**		
Type of Assessment:	UAA	ALA	ALM	RWA

Metric	Value	Score
1. Taxa Richness		
2. EPT Taxa Abundance		
3. Biotic Index (HBI)		
4. % Chironomidae		
5. % Dominant Taxon		

6. % Dominant FFG		
7. % Predators		
8. Ratio of Intolerant:Tolerant Taxa		
9. % of Total Trichoptera as Hydropsychidae		
10. # of Non-Insect Taxa		
11. % Collector-Gatherers		
12. % of Total Number as Elmidae		
Aquatic Life Use Point Score Ranges:	Exceptional: High: Intermediate: Limited:	> 36 29-36 22-28 < 22
Total Score:		
Aquatic Life Use:		

Benthic Forms – Metrics and Scoring for Surber Samples

Texas Commission on Environmental Quality
Surface Water Quality Monitoring Program

Metrics and Scoring for Surber Samples
Benthic Macroinvertebrates by Bioregion:
Central, East, or North

Stream Name:						
Date:		**Collectors:**				
Location:						
County:		**Ecoregion #:**				
Type of Assessment:	UAA		ALA	ALM	RWA	

Metric	**Value**	**Score**
1. Total Taxa		
2. Diptera Taxa		
3. Ephemeroptera Taxa		
4. Intolerant Taxa		
5. % EPT Taxa		

6. % Chironomidae		
7. % Tolerant Taxa		
8. % Grazers		
9. % Gatherers		
10. % Filterers		
11. % Dominance (3 Taxa)		
Aquatic Life Use Point Score Ranges:	Exceptional: High: Intermediate: Limited:	> 40 31-40 21-30 < 21
Total Score:		
Aquatic Life Use:		

TCEQ-20153 (Rev. 05/13/2004) Page 1 of 1

Benthic Forms – Macroinvertebrate Laboratory Bench Sheet

EIH Benthic Macroinvertebrate Laboratory Bench Sheet	
Sample tracking log number:	
Name of identifier:	
Location of collection:	Method of collection:
Date of collection:	
Date entered in sample tracking log:	
Date identification/enumeration started:	
Date identification/enumeration completed:	

Scientific Name	Number of Individuals

TCEQ-20232 (rev. 10/21/2005)

Nekton Forms – Fish Sample Tracking Log

EIH Fish Sample Tracking Log

Sample tracking log number:		TCEQ Station ID:		
Location description:				
Collector(s):				
Identifier(s):				
Date				
Collected:	Entered into Log:	Transferred to EtOH:	Identified:	
Method of Collection				
# of Seine hauls:	Electrofishing (seconds):	Gill net duration:		Other:

Sample tracking log number:	TCEQ Station ID:
Location description:	

Collector(s):			
Identifier(s):			
Date			
Collected:	Entered into Log:	Transferred to EtOH:	Identified:
Method of Collection			
# of Seine hauls:	Electrofishing (seconds):	Gill net duration:	Other:

Sample tracking log number:		TCEQ Station ID:	
Location description:			
Collector(s):			
Identifier(s):			
Date			
Collected:	Entered into Log:	Transferred to EtOH:	Identified:
Method of Collection			
# of Seine hauls:	Electrofishing (seconds):	Gill net duration:	Other:

TCEQ-20235 (EIH rev. 8/12/2010)

Nekton Forms – Biological Scoring Worksheet

Quantitative Biological Scoring for Evaluating Aquatic Life Use Subcategories Regional Criteria Worksheets for Fish

Ecoregions 33 & 35

Stream Name:		Location:		Date:	
Collector:			County:		
No. seine hauls:		Electrofishing effort (min):			
Metric Category	**Intermediate Totals for Metrics**		**Metric Name**	**Raw Value**	**IBI Score**
	Drainage basin size (km^2)				
Species richness and composition	Number of fish species		Number of fish species		
	Number of native Cyprinid species		Number of native Cyprinid species		
	Number of benthic invertivore species		Number of benthic invertivore species		
	Number of sunfish species		Number of sunfish species		
	Number of intolerant species		Number of intolerant species		
	Number of individuals as tolerants[a]		% of individuals as tolerant species[a]		
Trophic composition	Number of individuals as omnivores		% of individuals as omnivores		
	Number of individuals as invertivores		% of individuals as invertivores		
	Number of individuals as piscivores		% of individuals as piscivores		
Fish abundance and condition	Number of individuals (seine)		Number of individuals in sample		
	Number of individuals (electrofishing)		Number of individuals/seine haul		
	Number of individuals in sample		Number of individuals/min electrofishing		
	# of individuals as non-native species		% of individuals as non-native species		
	# of individuals with disease/anomaly		% of individuals with disease/anomaly		
			Index of biotic integrity numeric score:		

	Aquatic life use:
This data should be incorporated with water quality, habitat, and other available biological data to assign an overall stream score.	

[a] Excluding western mosquitofish

Ecoregion 34

Stream Name:		**Location:**		**Date:**	
Collector:			**County:**		
No. seine hauls:		**Electrofishing effort (min):**			
Metric Category	**Intermediate Totals for Metrics**		**Metric Name**	**Raw Value**	**IBI Score**
	Drainage basin size (km^2)				
Species richness and composition	Number of fish species		Number of fish species		
	Number of native Cyprinid species		Number of native Cyprinid species		
	Number of benthic invertivore species		Number of benthic invertivore species		
	Number of sunfish species		Number of sunfish species		
	Number of intolerant species		Number of intolerant species		
	Number of individuals as tolerants[a]		% of individuals as tolerant species[a]		
Trophic composition	Number of individuals as omnivores		% of individuals as omnivores		
	Number of individuals as invertivores		% of individuals as invertivores		
Fish abundance and condition	Number of individuals (seine)		Number of individuals in sample		
	Number of individuals (electrofishing)		Number of individuals/seine haul		
	Number of individuals in dample		Number of individuals/min electrofishing		
	# of individuals as non-native species		% of individuals as non-native species		
	# of individuals with disease/anomaly		% of individuals with disease/snomaly		
			Index of biotic integrity numeric score:		
			Aquatic life use:		
This data should be incorporated with water quality, habitat, and other available biological data to assign an overall stream score.					

[a] Excluding western mosquitofish

Nekton Forms – Fish Laboratory Bench Sheet

EIH Fish Laboratory Bench Sheet

Sample tracking log number:

Name of identifier:

Location of collection: Method of collection:

Date of collection:

Date entered in sample tracking log:

Date identification/enumeration started:

Date identification/enumeration completed:

Scientific Name	Number of Individuals

TCEQ-20236 (rev. 10/21/2005)

Nekton Forms – Species Collection Report

						Page 1 of ____	
EIH SPECIES-COLLECTION REPORT							
Permittee Name(s):			**Scientific Collection Permit Number:**				
Common Name *or* Scientific Name	**Date of Collection**	**County *or* Location Where Collected**	**No. Caught and Released**	**No. Collected (live take)**	**No. Salvaged**	**No. Incidental Mortalities**	**Disposition of Specimens**

If specimens were donated, please attach list of recipients of all donated specimens.

Definitions:

No. Caught and Released—self-explanatory; **No. Collected (live take)**—number kept to ID in lab or as voucher specimens; **No. Salvaged**—number counted as a result of a fish kill, by-catch, etc.; **No. Incidental Mortalities**—number killed during collection activities; **Disposition of Specimens**—self-explanatory

TCEQ-20234 (rev. August 2008)

Nekton Forms – TCEQ Nekton Data Reporting Form

Texas Commission on Environmental Quality
Surface Water Quality Monitoring Program

Nekton Data Reporting Form

RTAG# | REGION | EMAIL-ID: | COLLECTOR

STATION ID | SEGMENT | SEQUENCE | DATA SOURCE

Station Description____

Composite - Most biological samples will be: Both

COMPOSITE SAMPLE

COMPOSITE CATEGORY: T=Time S=Space B=Both

M M D D Y Y Y Y — START DATE
H H M M — START TIME
START DEPTH (SHALLOWEST) .
M = meters
F = feet

M M D D Y Y Y Y — END DATE
H H M M — END TIME
END DEPTH (DEEPEST) .
M = meters
F = feet

PARAMETRIC DATA

Enter the codes and values appropriate for this sample. Code (<) if less than value, and (>) if greater than value, other wise leave this column blank. Continue if necessary, on additional worksheets. Codes to describe the nekton sampling effort are listed on the back. Nekton data must be submitted with a Habitat Assessment.

CODE	(<) or (>)	Value	Description

NEKTON SAMPLES					
98005		Nekton, None Captured	98003		Total # Fish Species (Richness)
89944		Electrofishing Effort, Duration of Shocking (sec.)	98008		Total # of Sunfish Species (except bass)
89947		Seining Effort (# of Seine Hauls)	98010		Total # of Intolerant Fish Species
89948		Combined Length of Seine Hauls (meters)	98070		% of Individuals as Tolerant Species (excluding Western Mosquitofish)
89949		Seining Effort, Duration (min.)	98017		Omnivore Individuals (% of community)
89930		Minimum Seine Mesh Size, net average bar (inches)	98021		Insectivore/Invertivore Individuals (% of community)
89931		Maximum Seine Mesh Size, net average bar (inches)	98022		Piscivore Individuals (% of community)
89941		Net Length (meters)	98039		Total # of Individuals, Seining
89943		Electrofishing Method (1= boat, 2=backpack, 3=tote barge)	98040		Total # of Individuals, Electrofishing
89976		Area Seined (m^2)	98062		# of Individuals per Seine Haul
89961		Ecoregion (Texas Ecoregion Code)	98069		# of Individuals per Minute Electrofishing
98032		Total # of Native Cyprinid Species	98052		Total # of Benthic Invertivore Species
98033		Individuals as Non-Native Species (% of community)	98053		Total # of Benthic Species (catfish, suckers, and darters)
98030		Individuals with Disease / Anomalies (% of community)			
Additional Parameters					
89942		Net or Hook & Line Effort, Duration in Water (hrs)	89951		Cooling Water Intake Screen (1=revolving, 2=static)
89945		Castnetting Effort (# of casts)	89940		Intake Screen Collection, Duration (min.)

89907		Trawl, Otter, Duration (min.)	89953		Trawl, Otter, Width (meters)

Habitat Forms – Habitat Assessment Worksheet (I)

Page 1 of ___	**Part I - Stream Physical Characteristics Worksheet**				
Observers:		Date:	Time:		
Weather conditions:					
Stream:		Stream segment no.			
Location of site:			Length of reach:		
Observed stream uses:					
Stream type (circle one): **perennial** or **intermittent w/ perennial pools**					
Stream bends:	No. well defined	No. moderately defined		No. poorly defined	
Aesthetics (circle one):	**(1) wilderness**	**(2) natural**	**(3) common**	**(4) offensive**	
Channel obstructions or modifications:			No. of riffles		
Channel flow status (circle one):	**high**	**moderate**	**low**	**no flow**	
Riparian vegetation (%):	**Left Bank**	**Right Bank**	Maximum Pool Depth:		
Trees			Maximum Pool Width:		
Shrubs			**Notes**		
Grasses or forbs					
Cultivated fields					

Other		

Site map:

Part I - Stream Physical Characteristics Worksheet (continued)

Date: **Stream Name:**

Location of transect	Stream width (m)	Left bank slope (°)	Left bank erosion potential (%)	Stream Depths (m) at Points Across Transect Thalweg Depth:											Right bank slope (°)	Right bank erosion potential (%)	Tree canopy (%)	
																	Total	
	Habitat type (circle one) **Riffle Run** **Glide Pool**		Dominant substrate type			Dominant types riparian vegetation: Left bank: Right bank:										% Gravel or larger	CL CR	
Macrophytes (circle one) **Abundant Common** **Rare Absent**	Algae (circle one) **Abundant Common** **Rare Absent**		Width of natural buffer vegetation (m) LB: RB:		Instream cover types:											% Instream cover	LB RB	

C-24 Location of transect	Stream width (m)	Left bank slope (°)	Left bank erosion potential (%)	Stream depths (m) at points across transect Thalweg depth:											Right bank slope (°)	Right bank erosion potential (%)	Tree canopy (%)	
																	Total	
	Habitat type (Circle One) **Riffle Run** **Glide Pool**		Dominant substrate type			Dominant types riparian vegetation: Left bank: Right bank:										% Gravel or larger	CL CR	
Macrophytes (circle one) **AbundantCommon** **Rare Absent**	Algae (circle one) **AbundantCommon** **Rare Absent**		Width of natural buffer vegetation (m) LB: RB:		Instream cover types:											% Instream cover	LB RB	

Location of transect	Stream width (m)	Left bank slope (°)	Left bank erosion potential (%)	Stream depths (m) at points across transect Thalweg depth:	Right bank slope (°)	Right bank erosion potential (%)	Tree canopy (%)

																Total	
	Habitat type (circle one) **Riffle Run** **Glide Pool**		Dominant substrate type			Dominant types riparian vegetation: Left bank: Right bank:									% Gravel or larger	CL	
																CR	
Macrophytes (circle one) **AbundantCommon** **Rare Absent**	Algae (circle one) **AbundantCommon** **Rare Absent**		Width of natural buffer vegetation (m) LB:	RB:	Instream cover types:										% Instream cover	LB	
																RB	

Page 3 of ___

Part I - Stream Physical Characteristics Worksheet (continued)

Date: **Stream Name:**

Location of transect	Stream width (m)	Left bank slope (°)	Left bank erosion potential (%)	Stream Depths (m) at Points Across Transect Thalweg Depth:											Right bank slope (°)	Right bank erosion potential (%)	Tree canopy (%)	
																	Total	
	Habitat type (circle one) **Riffle Run** **Glide Pool**		Dominant substrate type			Dominant types riparian vegetation: Left bank: Right bank:										% Gravel or larger	CL	
																	CR	
Macrophytes (circle one) **Abundant Common** **Rare Absent**	Algae (circle one) **Abundant Common** **Rare Absent**		Width of natural buffer vegetation (m) LB:	RB:	Instream cover types:											% Instream cover	LB	
																	RB	

Location of transect	Stream width (m)	Left bank slope (°)	Left bank erosion potential (%)	Stream depths (m) at points across transect Thalweg depth:											Right bank slope (°)	Right bank erosion potential (%)	Tree canopy (%)	
																	Total	
	Habitat type (Circle One)		Dominant substrate type			Dominant types riparian vegetation:										% Gravel or	CL	

	Riffle **Run** **Glide** **Pool**			Left bank:	larger	CR	
Macrophytes (circle one) **AbundantCommon** **Rare** **Absent**	Algae (circle one) **AbundantCommon** **Rare** **Absent**	Width of natural buffer vegetation (m) LB:	RB:	Instream cover types:	% Instream cover	LB	
						RB	

Location of transect	Stream width (m)	Left bank slope (°)	Left bank erosion potential (%)	Stream depths (m) at points across transect Thalweg depth:											Right bank slope (°)	Right bank erosion potential (%)	Tree canopy (%)	
																	Total	
	Habitat type (circle one) **Riffle** **Run** **Glide** **Pool**		Dominant substrate type			Dominant types riparian vegetation: Left bank: Right bank:										% Gravel or larger	CL	
																	CR	
Macrophytes (circle one) **AbundantCommon** **Rare** **Absent**	Algae (circle one) **AbundantCommon** **Rare** **Absent**		Width of natural buffer vegetation (m) LB:	RB:		Instream cover types:										% Instream cover	LB	
																	RB	

Habitat Forms – Habitat Assessment Worksheet (II and III)

Texas Commission on Environmental Quality
Surface Water Quality Monitoring Program

Habitat Assessment Worksheet B Part II of III

Part II - Summary of Physical Characteristics of Water Body Using information from all of the transects and measurements in Part I and other sources, report the following general characteristics or averages for the entire reach:			
Stream Name		**Date**	
Physical Characteristics		**Value**	
Stream bed slope over evaluated reach (from USGS map; elevation change in meters/reach length in meters)			
Approximate drainage area above the transect furthest downstream (from USGS or county highway map in km^2)			
Stream order			
Length of stream evaluated (in meters or kilometers)			
Number of lateral transects made			
Average stream width (in meters)			
Average stream depth (in meters)			
Instantaneous stream flow (in ft^3/sec)			
Indicate flow measurement method			
Channel flow status (high, moderate, low, or no flow)			
Maximum pool width (in meters)			
Maximum pool depth (in meters)			
Total number of stream bends			
Number of well defined bends			
Number of moderately defined bends			
Number of poorly defined bends			
Total number of riffles			
Dominant substrate type			
Average percent of substrate gravel sized or larger			
Average percent instream cover			
Number of stream cover types			
Average percent stream bank erosion potential			
Average stream bank slope (in degrees)			
Average width of natural buffer vegetation (in meters)			
Average riparian vegetation percent composition by: (total to equal 100%)			

Trees	
Shrubs	
Grasses and Forbes	
Cultivated fields	
Other	
Average percent tree canopy coverage	
Overall aesthetic appraisal of the stream	

Texas Commission on Environmental Quality
Surface Water Quality Monitoring

Habitat Assessment Worksheet B Part III of III

Part III - Habitat Quality Index

Habitat Parameter	Scoring Category			
Available Instream Cover	**Abundant** >50% of substrate favorable for colonization and fish cover; good mix of several stable (not new fall or transient) cover types such as snags, cobble, undercut banks, macrophytes	**Common** 30-50% of substrate supports stable habitat; adequate habitat for maintenance of populations; may be limited in the number of different habitat types	**Rare** 10-29.9% of substrate supports stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed	**Absent** <10% of substrate supports stable habitat; lack of habitat is obvious; substrate unstable or lacking
Score__________	4	3	2	1
Bottom Substrate Stability	**Stable** >50% gravel or larger substrate; gravel, cobble, boulders; dominant substrate type is gravel or larger	**Moderately Stable** 30-50% gravel or larger substrate; dominant substrate type is mix of gravel with some finer sediments	**Moderately Unstable** 10-29.9% gravel or larger substrate; dominant substrate type is finer than gravel, but may still be a mix of sizes	**Unstable** <10% gravel or larger substrate; substrate is uniform sand, silt, clay or bedrock
Score__________	4	3	2	1
Number of Riffles	**Abundant** ≥ 5 riffles	**Common**	**Rare**	**Absent**

To be counted, riffles must extend >50% the width of the channel and be at least as long as the channel width		2-4 riffles	1 riffle	No riffles
Score_________	4	3	2	1
Dimensions of Largest Pool	**Large** Pool covers more than 50% of the channel width; maximum depth is >1 meter	**Moderate** Pool covers approximately 50% or slightly less of the channel width; maximum depth is 0.5-1 meter	**Small** Pool covers approximately 25% of the channel width; maximum depth is <0.5 meter	**Absent** No existing pools; only shallow auxiliary pockets
Score__________	4	3	2	1
Channel Flow Status	**High** Water reaches the base of both lower banks; < 5% of channel substrate is exposed	**Moderate** Water fills >75% of the channel; or <25% of channel substrate is exposed	**Low** Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed	**No Flow** Very little water in the channel and mostly present in standing pools; or stream is dry
Score_________	3	2	1	0

Part III - Habitat Quality Index (continued)

Habitat Parameter	Scoring Category			
Bank Stability	**Stable** Little evidence (<10%) of erosion or bank failure; bank angles average <30 ☐	**Moderately Stable** Some evidence (10-29.9%) of erosion or bank failure; small areas of erosion mostly healed over; bank angles average 30-39.9 ☐	**Moderately Unstable** Evidence of erosion or bank failure is common (30-50%); high potential of erosion during flooding; bank angles average 40-60 ☐	**Unstable** Large and frequent evidence (>50%) of erosion or bank failure; raw areas frequent along steep banks; bank angles average >60 ☐
Score__________	3	2	1	0
Channel Sinuosity	**High** ≥ 2 well-defined bends with deep outside areas (cut banks) and shallow inside areas (point bars) present	**Moderate** 1 well-defined bend or ≥ 3 moderately-defined bends present	**Low** <3 moderately-defined bends or only poorly-defined bends present	**None** Straight channel; may be channelized
Score___________	3	2	1	0
Riparian Buffer Vegetation	**Extensive** Width of natural buffer is >20 meters	**Wide** Width of natural buffer is 10.1-20 meters	**Moderate** Width of natural buffer is 5-10 meters	**Narrow** Width of natural buffer is <5 meters
Score___________	3	2	1	0
Aesthetics of Reach	**Wilderness** Outstanding natural beauty; usually wooded or unpastured area; water clarity is usually exceptional	**Natural Area** Trees and/or native vegetation are common; some development evident (from fields, pastures, dwellings); water clarity may be slightly turbid	**Common Setting** Not offensive; area is developed, but uncluttered such as in an urban park; water clarity may be turbid or discolored	**Offensive** Stream does not enhance the aesthetics of the area; cluttered; highly developed; may be a dumping area; water clarity is usually turbid or discolored
Score___________	3	2	1	0
Total Score_____________ **HABITAT QUALITY INDEX**				

26 - 31	**Exceptional**
20 - 25	**High**
14 - 19	**Intermediate**
≤ 13	**Limited**

Habitat Forms – TCEQ Habitat Data Reporting Forms

Texas Commission on Environmental Quality
Surface Water Quality Monitoring Program

Habitat Data Reporting Form

RTAG# ______ REGION ______ EMAIL-ID: ______ COLLECTOR

STATION ID ______ SEGMENT ______ SEQUENCE ______ DATA SOURCE

Station Description ____

Composite - habitat events will be Both

COMPOSITE SAMPLE

COMPOSITE CATEGORY: ___ T=Time S=Space B=Both

M M D D Y Y Y Y — START DATE
H H M M — START TIME
START DEPTH (SHALLOWEST) ___ . ___
M = meters
F = feet

M M D D Y Y Y Y — END DATE
H H M M — END TIME
END DEPTH (DEEPEST) ___ . ___
M = meters
F = feet

HABITAT DESCRIPTORS					
NOTE: All measurements reported in metric units					
72051			89844		Dominant substrate type (1=clay, 2-silt, 3=sand, 4=gravel, 5=cobble, 6=boulder, 7=bedrock, 8=other)
89859			89845		Average percent of substrate gravel size (> 2mm) or larger (%)
89860		Streambed slope over evaluated reach (from USGS map; elevation change in meters/reach	84159		Average percent instream cover (%)

		length in kilometers multiplied by 1000)			
89832		Approximate drainage area above the most downstream transect from USGS map (km^2)	89929		Number of Stream Cover Types
89861		Average stream width (m)	89846		Average percent stream bank erosion potential (%)
89862		Average stream depth (m)	89847		Average stream bank angle (degrees)
00061		Instantaneous stream flow (ft^3/sec)	89866		Average width of natural riparian vegetation (m)
89835		Indicate flow measurement method 1=Flow Gage Station, 2= Electronic, 3=Mechanical, 4=Weir/Flume, 5=Doppler Note: Use either 74069 or 00061, not both	89849		Average percent trees as riparian vegetation (%)
			89850		Average percent shrubs as riparian vegetation (%)
89848		Channel Flow Status 1=no flow, 2=low, 3=moderate, 4=high	89851		Average percent grasses and forbs as riparian vegetation (%)
89864		Maximum pool width at time of study (m)	89852		Average percent cultivated fields as riparian vegetation (%)
89865		Maximum pool depth in study area (m)	89853		Average percent other as riparian vegetation (%)
89839		Total number of stream bends	89854		Average percent tree canopy coverage (%)
89840		Number of well defined stream bends	89867		Aesthetics (1=wilderness, 2=natural, 3=common, 4=offensive)
89841		Number of moderately defined stream bends	84161		Stream Order
89842		Number of poorly defined stream bends	89961		Ecoregion (Texas Ecoregion Code)
89843		Total number of riffles	89962		Land Development Impact (1=unimpacted, 2=low, 3=moderate, 4=high)

Appendix B. Chain of Custody Form

Chain of Custody Form

EASTEX ENVIRONMENTAL LABORATORY, INC.

P. O. Box 859
Coldspring, Texas 77331
(409) 653-3249 • (281) 350-4080

P. O. Box 631375
Nacogdoches, Texas 75963-1375
(409) 569-8879 • Fax (409) 569-8951

REPORT TO:	INVOICE TO:
(1) Company	(2) Company
Address	Address
Attn.	Attn.
Phone #	Phone #
Fax #	Fax #
	P.O. #
Sampler's Name (please print)	Sampler's Signature

(8) ANALYSIS REQUESTED

Project Number	(3) Project Name									(7) Containers			
(4) Sample ID	Date	Time	(5) C/G	DO	PH	Cl2	Flow	Temp	(6) Matrix	#Con	Size	Type	Pres

Relinquished By: (Signature)	Received By: (Signature)	Date	Time
Relinquished By: (Signature)	Received By: (Signature)	Date	Time

Remarks:

Received Iced: Yes / No

LAB USE ONLY

Checked In By: (Signature)	Date	Time	Logged In By:	Date	Time

White Copy-Follows Samples
Yellow Copy-Laboratory
Pink Copy-Client Copy

SEE BACK FOR INSTRUCTIONS

Appendix C. Corrective Action Report

Deficiency / Nonconformance / Corrective Action Report		
Report No.:	Issued by:	Date Issued:

Description of deficiency	
Is the deficiency a nonconformance and why? (If yes, complete report. If no, indicate the date of closure.)	
Root cause of nonconformance	
Programmatic impact of nonconformance to include impact on existing TRACS data.	
Does the seriousness of the nonconformance require immediate reporting to the TCEQ? If so, to whom and when was it report?	.
Corrective action to address the nonconformance and prevent its recurrence.	
Proposed completion date for each action	
Individual(s) responsible for each action	
Method of Verification	
Date "Correction Action Report" Closed	

Appendix D. H-GAC's Data Management Process & Flow Chart

H-GAC's Data Management Process & Flow Chart

1. When the data manager receives field and laboratory data from individual local partners, all electronic files are saved in the partner's 'Raw Data' folder. The data may be in the form of Excel spreadsheets, Access tables, scanned field data collection forms, or files downloaded directly from field instrumentation. If data summary checklists have been submitted as electronic files, they are also stored in this folder. Hard copies of data, data summary checklists, calibration records, or other physical data are filed for subsequent data entry by H-GAC staff and for reference during the data review and validation process. In addition, receipt of the data is documented in the "CRP Data Tracking" database, currently found at Q:\CE\Clean Rivers\DATA\Data\CRP Data Tracking.accdb.

   No modifications or corrections are made to files in the raw data folders.

2. Raw data files are then copied to the partner's "Working Data" folder. All modifications to the data prior to SAS processing are performed on the files in the "Working Data" folder. Compilation of the submitted data, where necessary, is performed by the H-GAC data manager. This may involve manual data entry into an Access data entry form, re-formatting of Excel or Access tables, and other data management tasks as needed. In addition, identifying information such parameter names in the raw data files replaced by TCEQ parameter codes (specific information is found below). Because the measurement performance specifications found in the A7.1 table may vary from one QAPP to another, The working data file must not include data collected under two different QAPPs. The file may, however, contain information from more than one month within the fiscal year covered by an individual QAPP.

3. Field and laboratory data for specific sample sites (monitoring stations) are combined where necessary to create one record containing all observations made at the sample site. Because combination of field and laboratory records is most efficiently performed by by joining two Access tables on a common unique field, Excel tables may be imported into an Access 2003 database. In most cases, data are joined on equivalent monitoring station ID, sample date, and end depth values. If not already present in the datasets, the TCEQ monitoring station ID must be added, and the format of the date field must be consistent in the files to be combined.

   a. Note 1: this step is not necessary for City of Houston HHS and Harris County datasets.

   b. Note 2: The electronic data submitted by Eastex Laboratory must be transposed before combination with corresponding field data. This is most efficiently accomplished using SAS PROC TRANSPOSE.

4. The fields (columns) in the compiled dataset are renamed and reformatted to comply with SWQM data management guidelines. Consult the most recent version of the “Data Management Reference Guide for Surface Water Quality Monitoring “ for further information .

5. The fields containing sample site, sample date, sample time, and sample depth are renamed STATION_ID, ENDDATE, ENDTIME, and ENDDEPTH respectively.

6. The parameter names used by the partner are replaced by the TCEQ parameter code. Precede the code number with an “S” to ensure that the data is read into SAS files as text data.

    a. Example: The field or column for dissolved oxygen must be relabeled “S00300” prior to SAS processing.

7. The units of measurement as reported by the partner may not comply with SWQM guidelines. In most cases the SAS code will make the conversion to the correct units. If it is discovered that the code for conversion has not been written or is incorrect, or if the partner does not report the results consistently, manual conversion of the units may be necessary. In many cases, the SAS code will flag any records reported in the wrong units for other reasons (below or above screening values, for example), and the correction can be made using SAS.

8. If the SAS code does not include an algorithm for reformatting dates and times, the data manager ensures that these data are formatted as mm/dd/yyyy and hh:mm respectively.

9. Any parameters that are not included in the A7.1 table for the partner should be removed from the dataset. In most cases, the SAS code will simply omit the parameter from inclusion in the final datasets. It is preferable to modify the SAS code if unwanted parameters appear in the final dataset.

    Note: While references appear in this document to modification of the SAS code, these are for expository purposes only. The code should only be modified by a person who is very familiar with SAS programming in general, and the CRP processing code in particular.

10. When a database table(s) or Excel spreadsheet containing all field and laboratory data has been compiled and reformatted as described above, it is saved to the SAS input folder within the “SAS Data Processing” folder (currently at Q:\CE\Clean Rivers\DATA\SAS_Data_Processing) as an Access 2002-2003 database or an Excel 97-2003 file. Note that the version of SAS (9.1.2) in use at H-GAC cannot import or export Office 2007 file types. The input file should be renamed to include a code identifying the partner and the date range of the data.

11. As part of SAS processing, tables containing laboratory –specific quantitation limits, TCEQ minimum and maximum screening values, and site name / monitoring station ID correspondences are imported for comparison to the partner data. At the beginning of the period under which a specific QAPP is applicable, the data manager ensures that the tables containing this information correspond (where applicable) to the A7.1 tables. The data manager updates these tables at other times as needed.

12. The data manager modifies the SAS program used for the partner's most recent dataset for processing of the current data.

    a. Open and save the SAS program with the same name as the new input file.

    b. Find all references to input and output files within the program, and replace them with the name of the new input file.

    c. Save changes to the program.

    d. Run the program through the step where "Flagged_Records_1" is created.

13. The SAS program creates a new Access database in the "Access" folder within the "SAS Data Processing" folder. The database should have the same name as the input file.

    a. The database contains at least two tables: The "Input_Data_Matrix" that contains all data in the input file, and the "Flagged_Records_1" table.

14. The data manager updates the "CRP Data Tracking" database to include the date of initial SAS processing.

15. The "Flagged_Records_1" table identifies questionable data that must be investigated by the data manager. The table is generated from comparisons against screening levels to identify outliers, quantitation limit tables to identify improperly reported data, and a variety of other comparisons. The program includes algorithms to identify the following:

    a. Reported values beyond TCEQ screening limits (outliers)
    b. Values reported as negative numbers
    c. Illegal values (e.g.,, results for qualitative parameters that are not in the range of allowed values)
    d. Reported orthophosphate that exceeds the reported total phosphate
    e. Total constituents below dissolved constituent
    f. TDS/conductance ratio outside 0.55-0.70
    g. TDS less than total hardness
    h. Nitrate+nitrite concentration is less than nitite concentration

i. TDS less than chloride and sulfate;
j. Inconsistent observed turbidity and water clarity results
k. Inconsistent water surface and wind intensity results

16. The data manager is responsible for reviewing each flagged record against available raw data, data submittal checklists from the partner agency, instrument calibration records, and so forth, and where necessary obtaining additional information from the partner agency in order to determine the appropriate action to be taken. The flagged records table contains a variety of fields for documenting the disposition of the problem. In summary, a flagged record is accepted (on the basis of verification by the data manager), replaced with a corrected value, or deleted. A code is entered into the "Action" column, the "Verification Method" code is entered, and the initials of the responsible party are entered in the "Verified By" column.

    a. "Verification Method" codes currently in use are DR (document review) and PJ (professional judgment).

17. At present, there is a subset of data quality problems that cannot be identified or corrected using the flagged records table. It may be necessary to make changes to the input file to correct some errors and inconsistencies identified during subsequent review by the data manager or quality assurance officer.

18. All written communications with the staff of partner agencies that are made during the data verification process are printed and retained with the final data package that is retained by H-GAC. Records of telephone conversations are also retained..

19. Before changes are made to each data set, the data manager creates a "Data Summary Report/Sheet" for that specific data set. The data summary report is created from the most recent data summary report for that partner agency, and saved with the name of the current data set. All changes to the data and/or action taken on the data set are documented in this report. In addition, summary narratives discussing missing data, outliers that were verified and accepted, explanations of variations in reporting the data, failure to meet A7.1 LOQs, and so forth are also included. Pertinent information from the data submittal checklist submitted by the partner agency is also included in the final report. This report is submitted to TCEQ with each data set.

20. The data submittal checklist submitted by the partner agency is reviewed for the following, at minimum:

    a. If the quality control information included in the report indicates that data has been reported that did not meet the measurement performance specifications of the A7.1 tables, it will be removed from the dataset. The removal will be noted on the “Data Summary Report/Sheet.”

b. If the quality control information included in the report indicates that data has been reported that did not meet method-specific quality control criteria, the impact on data useability will be evaluated. Data may be removed from the dataset if legal defensibility is questionable. The removal will be noted on the “Data Summary Report/Sheet.”

c. The post-calibration error limits in the partner agency’s data submittal checklist shall be checked against requirements, as well as raw calibration records if available.

d. Reports of missing data, and the reasons that the data is missing (QC failure, spilled sample, could not sample site, etc.)

21. The SAS program is re-run following action on all flagged records. The flagged records table is read back into the process, and a variety of new tables and files are created. The most important of these are the “Draft_Data_Matrix” and the pipe-delimited text files that are submitted directly to TCEQ.

    a. The portion of the SAS code that assigns TAG ID numbers is edited prior to generating the second group of tables and files.

22. The data manager queries a subset of data from the “Draft_Data_Matrix” table and reviews it against hard-copy raw data to check for random transcription errors. A sufficient number of records are selected so that when added to the flagged records previously evaluated, at least ten percent of submitted data has been verified against raw data. The query results are printed and retained with the data package as a record of data review.

23. The data manager creates and views a totals query of the “Draft_Data_Matrix” table to identify missing records that have not been addressed in the data summary report.

24. The data manager completes the draft data summary report, and updates the “CRP Data Tracking” database with the date the draft was completed.

25. The summary report is submitted to the quality assurance officer (QAO). The “Draft_Data_Matrix” and draft summary are reviewed by the QAO , who identifies all values that, in the QAO’s judgment, are unreasonable, are unverified outliers, or are otherwise questionable. Written comments and concerns are returned to the data manager for further investigation and correction of the dataset (where warranted). Newly identified discrepancies are investigated, and documented on the data summary report.

26. The data manager reviews the written comments, takes the appropriate action, and documents any additional actions on the data summary report.. In most cases, the SAS program will be run at least one more time, although a new flagged records table is not routinely created. In the event there has been extensive modification of the input dataset, a new flagged records table may be created. The written comments from the quality assurance officer, with annotations by the data manager, are retained with the data package as a record of data review and modification (where applicable). The date of data summary report approval is added to the "CRP Data Tracking" database.

27. The text files created by the SAS program and the final data summary report are then submitted to TCEQ by the data manager. The data is first submitted to the SWQMIS (database) validation algorithm to obtain a validation report; the files are then emailed to the CRP Project Manager at TCEQ.

    a. The data manager copies the event and result files to the desktop.
    b. Each file is edited to remove the header line (field names).
    c. The data manager logs into the SWQMIS system, and submits the files and data summary report as described in the SWQMIS user's guide (http://www.tceq.state.tx.us/assets/public/compliance/monops/water/wqm/swqmis_users_guide.pdf , retrieved 8/10/2010).
    d. If the system identifies validation errors, upload is canceled and the validation errors are investigated and corrected. In some cases this may involve editing the text files only. If this option is selected, document changes to text files appropriately. It may be most convenient to document minor changes to the text files in the "Comments" section of the appropriate record in the "CRP Data Tracking" database.
    e. When no validation errors are found, the upload is completed, and a validator report is created and saved report (with a unique file name) as an html file.
    f. The data manager reviews the validator report to identify remaining discrepancies between the dataset, data summary report, and A7.1 table requirements that may have been missed. The appropriate actions, to include resubmission of the data to obtain a revised validator report, are performed.
    g. The text files, data summary report, and validator report are e-mailed to the CRP Project Manager.
    h. The validator report is saved in the "Data Review and Submission Docs" folder at Q:\CE\Clean Rivers\DATA\Data\Data Review and Submission Docs."

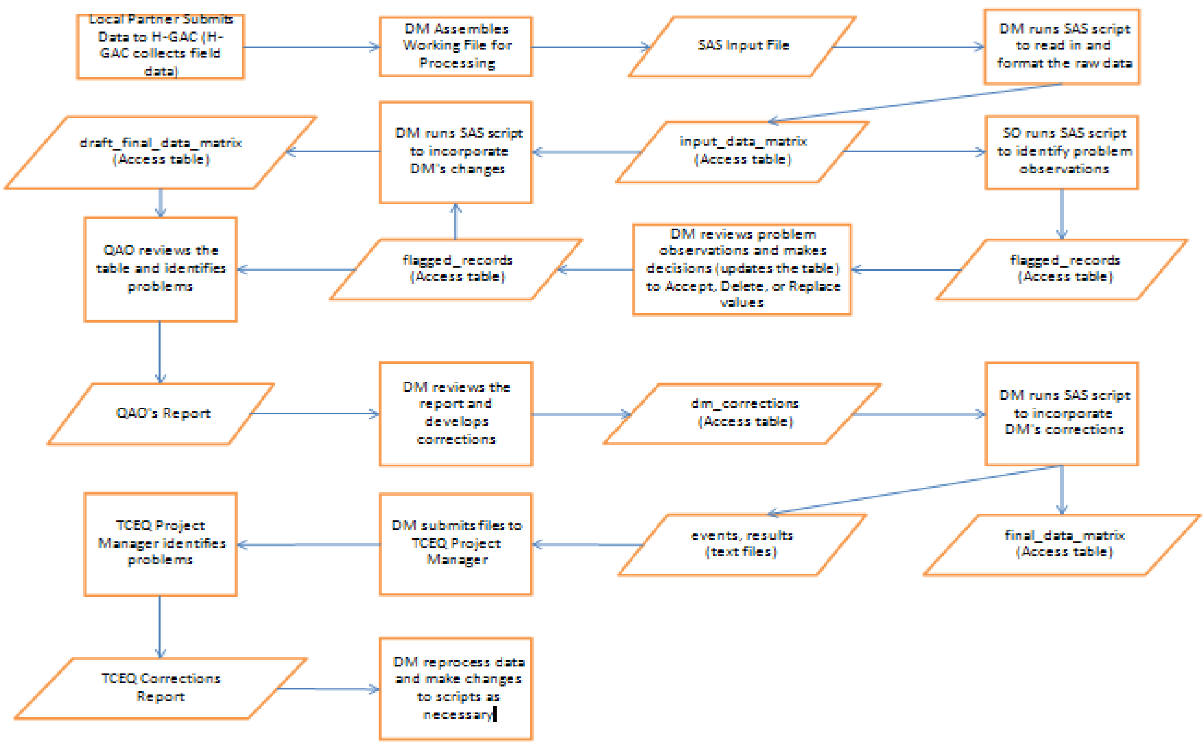
28. The data manager updates the "CRP Data Tracking" database to include the date the files were sent to TCEQ, and add hyperlinks to the data summary and validator reports.

29. If the CRP Project Manager identifies further problems with the dataset, the appropriate action is taken and revised datasets or data correction requests (where appropriate) are submitted. Written communications with the CRP project manager are printed and

retained on file with the data package to serve as a record of validation and modification of the dataset.

30. When the dataset is accepted by TCEQ and loaded into SWQMIS, the data manager updates the “CRP Data Tracking” database to include the acceptance date.

31. All data management activities are documented in an Access database maintained by the Data Manager. The database contains details of receipt, processing, submission, and acceptance by TCEQ, and includes hyperlinks to raw and final datasets, data summary reports, and data validation reports.



Appendix E. Site Selection Methodology

Cedar Bayou Watershed Protection Plan

Sampling Site Selection Methodology

Introduction

As part of Task 5 (Surface Water Quality Monitoring) of Contract 10-08), the Development of a Watershed Protection Plan for Cedar Bayou, with the Texas State Soil and Water Conservation Board (TSSWCB), H-GAC has evaluated the potential of various sampling sites throughout the project area. Unlike more traditional river basins, Cedar Bayou's system of relatively small tributaries is largely shaped and diverted by development, and its area contains a web of drainage ditches and irrigation/water supply canals. To best account for the complex hydrology of the watershed, the evaluations were made based on existing and developed information from a wide array of sources. A map and photos of the proposed sites are included in this document.

Purpose

The purpose of the evaluation was to select sites for a variety of surface water quality monitoring events, as spelled out in Task 5 of Contract 10-08. The sites were to be selected for suitability, accessibility, and potential to accurately reflect sources and conditions in the watershed.

Data Reviewed

The data sources that were considered in this evaluation include:

- Existing and developed GIS data, including hydrologic data, topography, land use, road network, population projections, and other relevant layers.
- Other existing mapping products, including Key Maps, USGS topographic quarter-quads, Google Earth/Google Maps.
- Clean Rivers Program and TCEQ data on existing and historical sampling sites
- General discussion of historic and current land uses and areas of the watershed with H-GAC staff members and other watershed stakeholders, including the City of Baytown, the City of Mont Belvieu, Harris County, Liberty County, Chambers County, and members of the Friends of Cedar Bayou United (a local community organization).

Selection Methodology

The selection process for the proposed sites was based on finding sites that were relatively accessible were representative of the different land uses of the watershed, considered the input of tributaries, were aligned with potential sources of contamination (as identified thus far), were matched to impairments, and sought an overall balance in spatial distribution with existing sites. The following steps were taken by H-GAC staff in evaluating potential sites.

1) **Preliminary GIS development –** As part of Task 4, H-GAC is creating a comprehensive GIS inventory of the watershed. However, site selection occurred concurrent to the creation of the GIS, so a preliminary inventory was used to aid site selection. While this was preliminary information, it was not expected that the broad siting concerns will be

greatly impacted by localized changes to the data in final development (ground truthing, etc.) The primary aspects considered under the preliminary development were:

a. ***Watershed outline*** **–** H-GAC reviewed three different data sources for watershed delineation, including Harris County Flood Control District (HCFCD) data, CRP watershed data, and USGS HUC 10 and HUC 12 watershed data. None of the three boundaries were an exact match. However, preliminary review of potential outline indicated that the final watershed boundary was likely within the range represented by superimposing all three datasets. Therefore, all three were plotted to indicate the total potential range. The USGS HUC 12 subwatersheds (6 HUC12s; single HUC10) were used as the preliminary subwatershed boundaries to aid in balancing sites between general areas of the watershed (i.e., to ensure that the sites were targeted to meaningful subdivisions of the watershed, the HUC12 subwatersheds were used as a general guide.) Following the completion of the GIS inventory development process, a different boundary (The HCFCD data) was used. However, all sites fall well within the overlap between these two boundary layers. The areas of discrepancy do not appreciably impact the site location decisions. For ease of reference, the Site Map in this document used the HUC 12 subwatersheds referenced in this methodology.
b. ***Stream Network*** **–** Existing H-GAC data sets were used for this purpose.
c. ***Land Use/Land Cover*** **–** H-GAC used 2008 National Land Cover Data, existing H-GAC 2008 land use dataset, and aerial imagery to provide multiple looks at land use/land cover.
d. ***Road Network*** - *H*-GAC used our existing STARMAP transportation network.
e. ***Existing Sites*** **–** H-GAC used our Clean Rivers Program sampling site locations data set, which includes current and historic sampling sites.

2) Inclusion of Additional Mapping Data – In addition to the preliminary GIS, H-GAC used Key Maps of Harris, eastern Chambers, and southwestern Liberty County to fill in any gaps (names of tributaries, gaps in hydrology layers coverage, etc) not reflected. This allowed us to name several tributaries or figure out uncertain pieces that were not readily visible on aerial or stream network datasets. The combination of these first two steps was an understanding of the total stream network for the watershed.

3) **Consideration of Spatial Distribution, Existing Sites –** Project staff mapped existing sites as they compared to subwatersheds, and noted what subwatersheds had or did not have sampling sites. All of the existing sites are located in areas that are conducive to the goals of the sampling efforts. The four existing sites are fairly evenly distributed, representing four of the six HUC 12 subwatersheds. All are main channel sites. That left

two large areas of the watershed (The two HUC 12 watersheds representing the headwaters and the central portions of the watershed) in need of sites.

4) **Consideration of Accessibility –** Accessibility to the Bayou and its tributaries was the next consideration in site location. In the southern/mouth and northern/headwaters areas of the watershed, there are several road crossings for the channel and its tributaries. However, road crossings are less frequent in the three central portions of the waterway. Project staff documented each road crossing throughout the watershed, and made quick evaluations of aerials and discussion with sampling staff as to the potential accessibility of the waterway. With the exception of the central reach of the watershed (middle two subwatersheds), many accessible sites were initially found in all subwatersheds. Throughout most of the watershed, access to the creek is direct, without large slope or bank issues. In the central most subwatersheds, access is limited by lack of major east-west roads and large undeveloped tracts. However, suitable alternatives were identified.

5) Evaluation of Land Uses – Project staff evaluated, within subwatersheds and on the whole, the groupings of representative land uses in the watershed. The watershed is fairly cleanly divided between an urbanized southern portion (Baytown area), a suburban/industrial area north of this, a large undeveloped center characterized by a few large industrial users and reservoirs, and a primarily rural/agricultural headwaters. The existing sites are adequately distributed as to account for the urban, suburban, and undeveloped/industrial land uses, but potential agricultural impact in the north was not well covered. Additionally, some existing sites were not well sited to consider the total output of a subwatershed (located at the start or middle of the subwatershed, or neglecting tributaries). In selection of sites for on tributaries, project staff concentrated on isolating areas dominated by certain land uses whenever possible, in addition to other standing goals. The final result was a recommendation that rural/agricultural uses in the north, undeveloped/industrial areas in the middle, and the tidal wetlands/industrial areas in the south needed better representations, along with a few key tributaries.

6) Selection of Applicable Tributaries – As stated, Cedar Bayou’s watershed is characterized by a moderate number of small tributaries derived from drainage of developed or agricultural areas rather than larger, distinct natural waterways. In consideration of the tributaries and their potential contributions to the main channel, project staff evaluated the length and probable drainage area by identifying probable hydrologic boundaries (road networks without obvious culverts, intercepting roadway drainage, etc). Most of the tributaries were minor ditches or gullies that were likely to be intermittent in flow. Also, many of the small tributaries in the southern portion of the watershed drained areas that were homogenous in character. However, this left a few larger tributaries that drained area of interest, especially in the middle and upper watershed. These tributaries were identified for potential monitoring sites.

7) **Consideration of Potential Sources and Impairments –** As indicated in the 2008 TWQI, the impairments and concerns in the watershed are not evenly distributed. Additionally, groupings of potential sources of contaminants, as identified from land use data, information from local partners, and preliminary site visits are relatively specific to spatial location. In preliminary selection of sites, the need to evaluate reductions and the impact of potential best management practices (BMPs) on water quality were considered in relation to the potential source locations. Project staff also considered the previously stated goal of keeping some sampling efforts tied to the same sites (e.g. to the greatest practicable extent, staff attempted to keep the biological, DO and stormwater sites tied to the proposed ambient sites.) While WWTP effluent will be considered in addition to ambient sampling, the location of plants was considered, but not deemed to be spatially significant in siting decisions (i.e. it was most often attributed to other uses, like urbanized areas) or not of sufficient scale to be considered singly.

8) **Synthesis –** In bringing all of the previous steps together, priorities were set to help determine final selection. Accessibility was a primary limiting factor, but enough sites were identified for all other considerations, that accessibility did not lead to compromise of any other goal. Staff started by identifying areas that had one or more considerations indicating a gap or lacking coverage. The most identifiable need was better coverage of the northern areas, which addressed land use, spatial distribution, major tributaries, and potential sources. This general process of seeking greatest potential combination of consideration was largely handled through discussion and informal consideration of the relative merits of many sites. Because source identification (especially with the aid of local knowledge) is not yet complete, project staff took conservative approach of identifying large general areas of grouped sources (industrial complexes, large agricultural rural areas, etc) rather than parcel-level considerations. Spatial proximity to other sites was a final consideration.

   Twenty potential sites were selected (in addition to the existing four sites) as potential candidates for the 10 final sites. Five sites were weeded out by staff as being redundant, poorly located in relation to other sites, or unlikely to provide meaningful data in consideration of the watershed as a whole. The only gap identified in potential sites was a way to adequately isolate industrial contributions on tributaries (based on lack of large/perennial tributaries). However, as the industrial areas are fairly discretely located in certain areas, upstream and downstream locations on the main stem will serve as comparison points.

Final Proposed Site Descriptions

The following sites were selected, as described in the rationale below. Note that the site designations given are project-specific and don't reflect CRP or other naming conventions. However, where existing or historical sites exist, the site reference number is also given. The sites are described in order from south to north. Subwatershed names reflect the USGS HUC 12 subwatersheds. Please refer to the Site Map in this document for spatial locations. While the HUC12 subwatersheds were used as general tools for spatially distributing site choices, the USGS watershed boundary may be replaced in the GIS inventory development process with the Harris County Flood Control District's watershed and subwatershed boundaries. For the purpose of easy reference, the HUC 12 subwatersheds are displayed on the Site Map. Their use in the process was not meant to indicate that they were used as rigid dividing lines, but rather, as a justifiable manner in sites could be compared to large, general areas of the watershed.

Site CB1: 11109 *Main stem at FM 2354* - This site is located at the last publically accessible point prior to confluence with the Galveston Bay. It is located downstream of the entire watershed, a large urban and industrial area, and adjacent to a large landfill and proposed barge terminal site. It is also adjacent in a shipping lane used for both recreational and barge traffic. (Cedar Point Lateral subwatershed, tidal influence)

Site CB2: 11111 *Main stem at Roseland Park*- This site is located at Roseland Park, and represents the last stretch of the Bayou before it widens to the series of small lakes that precede the confluence with the Bay. This stretch is directly adjacent to the urbanized area of Baytown, and is an area of high recreational activity (primarily subsistence and recreation fishing form the park banks, and recreational watercraft operation). The proposed barge terminal is directly across the river from this point. It is also downstream of some urban neighborhoods with canals (and thus greater potential of human contact with the water) and a small marina. (Cedar Point Lateral subwatershed, tidal influence)

Site CB3: 11115 *Existing CRP site, Main Stem, at Highway 146* – This site is the only publically accessible crossing point in the 10 mile stretch between CB 2 and CB5. Give the variation in land uses between these points, and the introduction of flow from Horsepen Bayou, McGee Bayou, and Carey Bayou, an intermediate site was identified to be necessary. Additional inputs from Baytown storm water, direct runoff from suburban and urban uses, and inputs from Saw gully and other tributaries occur downstream as land use continues to transition to denser urban an industrial areas. This site also is approximately halfway between CB2 and CB5. While it is very close to CB4/21079, CB4/21079 is a tributary rather than a main stem site. (Cedar Point Lateral Subwatershed, tidal influence).

Site CB4: 21079 *Cary Bayou at Raccoon Drive (bridge).* – This site is on one of the larger tributaries in the southern reach, and represents suburban and low-density urban land uses. It is the last location prior to the confluence of the tributary with the main stem, and is also downstream from two small but popular park areas with expected high pet contributions. According to local information it is usually flowing, but is largely driven by drainage, making it a good storm event site as well as an ambient site. It is very close to Site CB3, but was included because the tributary is likely to be characteristic of the area, because it is downstream of some unique land uses (parks) and because it was a rare publically accessible point. (Cedar Point Lateral subwatershed, tidal influence)

Site CB5: 11117 ***Existing CRP site, Main Stem at IH10 Bridge –*** This site represents the upper aspects of the tidal reach, and is the most accessible site downstream of a large industrial area in the lower central watershed. A moderate gully tributary enters the waterway directly upstream of this site, but is not easily accessible, and too proximate to this existing site for consideration. (Ellis Branch subwatershed, tidal influence)

Site CB6: 11118 ***Existing CRP site, Main Stem at FM 1942 Bridge –*** This site is the last accessible site downstream of a largely undeveloped section upstream. This section is characterized by moderately thick wooded riparian buffers, and light development. Several industrial reservoirs are located in this area. This area is expected to be a probable source of much of the wildlife concentration in the area, as it represents some of the better habitat for larger species (deer, feral hogs, etc) from preliminary evaluation. This site will also serve well as a biological assessment site, in comparison with sites further north in the watershed. (Ellis Branch subwatershed, but primarily serves to monitor the Cedar Bayou Lake subwatershed, above tidal)

Site CB7: 21080 ***Adlong Ditch at New Road –*** This site is located on one of three similar medium sized tributaries that enter the main stem in very close proximity to the Main stem at Runneberg road. As all three are very similar in character and land uses (a mix of small scale agricultural, diffuse residential development, light commercial and undeveloped areas), this largest water body of the three was chosen. It is expected that this will be indicative of the impacts of land uses in the upper middle part of the watershed, and will serve as good comparison with the downstream site, which follows a largely undeveloped section. (Red Bud Lake subwatershed, above tidal)

Site CB8: 11120 ***USGS gage, Main stem at US90 –*** This site is located on one of the primary east-west intercepts of the Bayou, and is close to the northernmost reach of the mostly wooded central riparian corridor, and the southernmost reach of the rural/suburban north. It is downstream of several large industrial reservoirs. This is an existing bio-monitoring site, and will be retained as such under this sampling effort. (Red Bud Lake subwatershed, above tidal)

Site CB9: 11123 ***Existing CRP Site, Main stem at FM 1960 –*** This existing site is located on a major east-west intercept, north of a large reservoir system, at the end of a fairly homogenous stretch of rural/agricultural area. (Seaburg Reservoir subwatershed, above tidal)

Site CB10: 21081 ***Main stem at County Road 624-*** This site is located on the last stretch of the main stem that is Cedar Bayou proper before it splits into increasingly shallower and smaller drainage gullies that drain the rest of the northern part of the watershed. This site should represent the inputs of most of the North Dayton Oil Field subwatershed. Land use in this area is fairly consistent, and therefore further sites north of this site are not necessary. Additionally, diminishing waterway size and lack of consistent flow would make upstream sites problematic. . (Seaburg Reservoir subwatershed, above tidal)

DO, Stormwater, Biological and WWTF effluent Sampling Sites

As part of Task 5, H-GAC is tasked with conducting automated monitoring of two (2) locations during storm flow conditions, 24 hour monitoring of DO at four (4) main stem sites, biological monitoring at two (2) main stem sites, and WWTF effluent monitoring as necessary based on existing data. WWTF effluent monitoring is plant specific and potentially unnecessary, and thus not considered in this site selection methodology. H-GAC is working with TCEQ on formal transition of related DMRs and sanitary sewer overflow (SSO) data concurrently with this site methodology consideration.

H-GAC recommends that one of the storm flow sites be tied to a proposed tributary site, and one to a main stem site. To cover the greatest degree of land uses, and greatest degree of potential change in flow, H-GAC recommends sites CB4/21079 (Cary Bayou/North Baytown, for urban/suburban flush) and site CB10/21081, which would represent most of the storm flow from the agricultural/rural northern watershed. Even though CB10/21081 is a main stem site, the waterway at that location is small enough, with a large enough drainage area upstream, that storm flow will have an appreciable impact, allowing for meaningful data.

For 24 hour DO sites, H-GAC proposes using (CB2/11111, CB5/11117, CB8/11120, and CB9/11123 as they are accessible, main stem sites, with good distribution throughout the watershed and good representation of different areas of land use. Additionally they are equally split between the Tidal and Above Tidal segments of the Bayou.

For biological monitoring, H-GAC proposes sites CB8/11120 (which is an existing bio-monitoring site) and site CB6/11118. It is expected that conditions further north in the watershed are not likely to normally support the conditions necessary for this monitoring, given the degree to which the waterway banks and channel have been modified. As noted in field reconnaissance, CB6/11118 (located at highway 1942 in the Above Tidal portion of the watershed) is in the last stretch of the segment of the watershed listed for impaired macrobenthic communities. The existing site at CB8/11120 is accessible, has previously been used as a bio site, and is the last main stem site (mostly due to inaccessibility) prior to the lower two subwatersheds and Tidal portion.

Evaluation

Evaluation of the proposed sites was conducted between staff members, and also with external review. Project staff met with Clean Rivers Program staff at H-GAC to informally discuss the suitability of some locations. Additionally, H-GAC staff presented the proposed sites at the last meeting of the Clean Rivers Program Coordinated Monitoring Meeting for the H-GAC region. Staff received feedback from local partners and state regulators/project managers regarding proposed sites. This feedback led to the relocating of two sites to more suitable locations. Staff then conducted additional field reconnaissance resulting in the slight relocation of two sites, as reflected in the current descriptions. TSSWCB reviewed and approved these site selections. The final site selection and related detail will be included in the monitoring QAPP for the Cedar Bayou Watershed project, as approved by the TSSWCB.

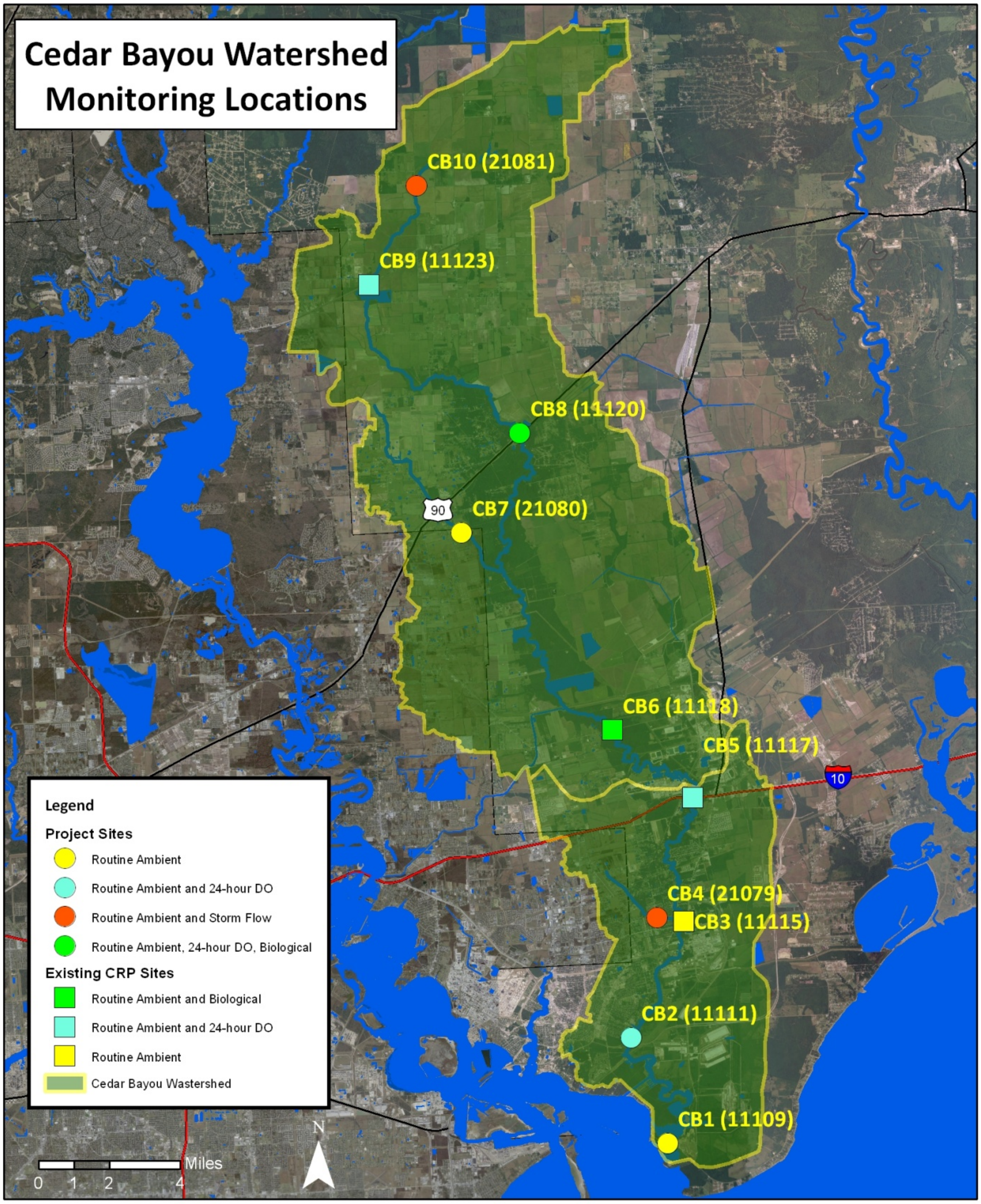
The table below is a quick reference summary chart for site locations and monitoring categories.

Cedar Bayou Monitoring Sites Summary Table

	Stream order	Current CRP sites 4x	Mainstem	Tidal AU	Routine ambient sampling 12x	BF auto storm	BS 24hrDO	Biological
CB1/11109	1		X	X	X			
CB2/11111	2		X	X	X		X	
CB3/11115	3	X	X	X	X			
CB4/21079	4			X	X	X		
CB5/11117	5	X	X	X	X		X	
CB6/11118	6	X	X		X			X
CB7/21080	7				X			
CB8/11120	8		X		X		X	X
CB9/11123	9	X	X		X		X	
CB10/21081	10		X		X	X		
		4	**8**	**4**	**10**	**2**	**4**	**2**

Site Map

The following map reflects the USGS HUC 10 watershed boundary. During the ongoing GIS inventory development, the boundary is likely to change to a more precise version developed by the Harris County Flood Control District. However, all sites represented fall within both boundary. Discrepancies between the two boundaries do not impact the factors that went into the site selection.


Cedar Bayou Watershed
Monitoring Locations
CB10 (21081)
CB9 (11123)
CB8 (11120)
90
CB7 (21080)
CB6 (11118)
CB5 (11117)
10
CB4 (21079)
CB3 (11115)
CB2 (11111)
CB1 (11109)
Legend
Project Sites
Routine Ambient
Routine Ambient and 24-hour DO
Routine Ambient and Storm Flow
Routine Ambient, 24-hour DO, Biological
Existing CRP Sites
Routine Ambient and Biological
Routine Ambient and 24-hour DO
Routine Ambient
Cedar Bayou Wastershed
N
Miles
0 1 2 4

Site Photos

The following photos are taken from two field reconnaissance trips undertaken by H-GAC staff. They are presented in order from the bottom of the watershed to the top.

CB1/11109 – FM2354 at Cedar Bayou (mainstem)

Upstream

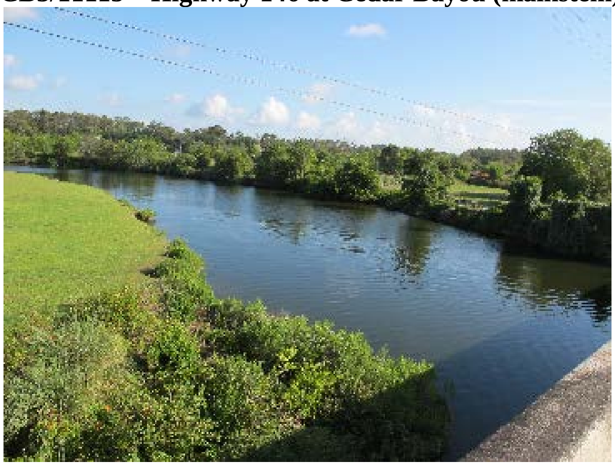
Downstream

CB2/11111 – Main stem at Roseland Park

Upstream

Downstream

CB3/11115 – Highway 146 at Cedar Bayou (mainstem)



Upstream

Downstream

CB4/21079 – Raccoon Drive at Cary Bayou (tributary)

Upstream

Downstream

CB5/11117 – Interstate 10 at Cedar Bayou (mainstem)

Upstream

Downstream

CB6/11118 – FM 1942 at Cedar Bayou (mainstem)

Upstream

Downstream

CB7/21080 – New Road at Adlong Ditch (tributary)

Upstream

Downstream

CB8/11120 – Highway 90 at Cedar Bayou (mainstem)

Upstream

Downstream

CB9/11123 – FM 1960 at Cedar Bayou (mainstem)

Upstream

Downstream

CB10/21081 – County Road 624 at Cedar Bayou (mainstem)

Upstream

Downstream