Appendix A: Quality Assurance Project Plan

A1 Approval Page

By signing this document, signatories acknowledge their respective organizations' awareness of and commitment to requirements contained in this Quality Assurance Project Plan (QAPP) in accordance with roles and responsibilities as described in Section A4 Project/Task Organization.

Texas Commission on Environmental Quality (TCEQ)

Office of Water
Water Quality Planning Division
Planning and Implementation Section

_____   Date
Sarah Bernhardt, Ph.D., Program Manager
Galveston Bay Estuary Program (GBEP)

_____   Date
Lisa Marshall, Project Manager (PM)
GBEP

_____   Date
Michelle Krause, Quality Assurance Officer (QAO)
GBEP

Office of Compliance and Enforcement
Monitoring Division
Laboratory and Quality Assurance (QA) Section

_____   Date
Sharon Coleman, TCEQ QA Manager

Houston-Galveston Area Council (H-GAC)

_____
Paniz Miesen, PM   Date
H-GAC

_____
Jean Wright, QAO   Date
H-GAC

_____
Bill Hoffman, Clean Rivers Program (CRP) Data Manager   Date
H-GAC

_____
Will Merrell, GIS Data Manager   Date
H-GAC

Eastex Environmental Laboratory (Eastex)

_____ Date: _____
Pam Hickman
Eastex Lab Manager

_____ Date: _____
Daniel Bowen
Lab

A2 Table of Contents

List of Acronyms

BIG	Bacteria Implementation Group
C&E	Community and Environmental Planning
CAR	Corrective Action Report
COG	Council of Governments
CFU	Colony-Forming Unit of Bacteria
CRP	Clean Rivers Program
CSDGM	Content Standards for Digital Geospatial Metadata
DM	Data Manager
EPA	Environmental Protection Agency
FDC	Flow Duration Curve
FGDC	Federal Geographic Data Committee
GPS	Global Positioning System
GBEP	Galveston Bay Estuary Program
H-GAC	Houston-Galveston Area Council
IDDE	Illicit Discharge Detection and Elimination
I-Plan	Implementation Plan
LDC	Load Duration Curve
LU/LC	Land Use/Land Cover
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NELAP	National Environmental Laboratory Accreditation Program
OSSF	Onsite Sewage Facility
PM	Project Manager
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manual (or Manager)
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
QMP	Quality Management Plan
SOP	Standard Operating Procedure
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TNI	The NELAC Institute
TNRIS	Texas Natural Resources Information System
Top2	Top 2 Most Impaired/Top 2 Least Impaired Lists
Top5	Top 5 Most Impaired/Top 5 Least Impaired Lists
Top10	Top 10 Most Impaired/Top 10 Least Impaired Lists
TSWQS	Texas Surface Water Quality Standards
USGS	United States Geological Survey
WWTF	Wastewater Treatment Facility

A3 Distribution List

TCEQ
P.O. Box 13087
Austin, Texas 78711-3087

Sharon Coleman, TCEQ QA Manager
(512) 239-6340

GBEP
17041 El Camino Real, Suite 210
Houston, TX 77058

Lisa Marshall, GBEP PM
 (281) 486-1244

Michelle Krause, GBEP QAO
 (281) 486-1246

H-GAC
P.O. Box 22777
Houston, TX 77227

Paniz Miesen, PM	Jean Wright, QAO
(832) 681-2579	(713) 499-6660
Bill Hoffman, Data Manager	Will Merrell, GIS Data Manager
(832) 681-2574	(832) 681-2551

Eastex Environmental Laboratory (Eastex)
P.O. Box 1089
Coldspring, TX 77331

Pam Hickman
Laboratory Manager

Daniel Bowen
Laboratory

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

Teresita Mendiola
Region 6 Project Officer
(214) 665-7144

The H-GAC QAO will provide copies of this project plan and any amendments or revisions of this plan to each person on this distribution list and to each sub-tier participant other than TCEQ and EPA staff. The H-GAC QAO or PM will provide documentation of this transmittal to the TCEQ GBEP Project Manager within two weeks of QAPP approval. This documentation will be maintained as part of the H-GAC's quality assurance records and as part of the TCEQ project file.

The TCEQ GBEP Project Manager is responsible for providing copies of the project plan and any amendments or revisions of this plan to TCEQ and EPA staff. Copies must be provided within two weeks of QAPP approval, and documentation of this transmittal will be available for review and maintained as part of the TCEQ project file.

A4 Project/Task Organization

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

GBEP

Sarah Bernhardt, Ph.D.
GBEP Program Manager
The TCEQ GBEP Program Manager is responsible for supervising the TCEQ's GBEP Team. Oversees the development of QA guidance for the GBEP Team to ensure it is within pertinent frameworks of the TCEQ. Reviews and/or approves all GBEP projects, QA audit responses, QAPPs, agency Quality Management Plans (QMPs), corrective action reports (CARs), work plans, and contracts. Enforces corrective action where QA protocols are not met. Ensures GBEP personnel are fully trained.

Lisa Marshall
GBEP PM
The TCEQ GBEP PM is responsible for ensuring that the project delivers data of known quality and quantity on schedule to achieve project objectives. PM is the primary point of contact between the H-GAC and the TCEQ. Tracks and reviews deliverables to ensure that tasks in the work plan are completed as specified in the contract. Reviews and approves QAPPs and any amendments or revisions and ensures proper distribution of approved/revised QAPPs to TCEQ participants and the EPA. Responsible for verifying that the QAPP is followed by the H-GAC. Notifies the TCEQ GBEP and GBEP Program Manager of significant project nonconformances and corrective actions taken as documented in CARs and/or quarterly progress reports (QRPs).

Michelle Krause
GBEP QAO
GBEP reviews and approves QAPPs and any amendments or revisions. Responsible for verifying that the QAPP is followed by the H-GAC. Assists the GBEP Program Manager and GBEP PM on QA-related issues. Prepares and distributes annual audit plans. Conveys QA problems to appropriate TCEQ management. Monitors implementation of corrective actions. Coordinates and conducts audits. Ensures maintenance of QAPPs and audit records for the GBEP program.

HOUSTON-GALVESTON AREA COUNCIL (H-GAC)

Paniz Miesen
H-GAC PM
The H-GAC PM is responsible for ensuring that all tasks and other requirements in the contract are executed on time and with the quality assurance/quality control requirements as defined by the contract and in the project QAPP; assessing the quality of subcontractor/participant work; submitting accurate and timely deliverables to the TCEQ GBEP PM; and coordinating attendance at conference calls, trainings, meetings, and related project activities with the TCEQ. Responsible for verifying that the QAPP is distributed and followed by the H-GAC (including all subcontractors and/or sub-tier project participants). Coordinates C&E staff assigned to conduct the desk reviews, groundtruthing field activities, sampling, and data acquisition for this project.

Jean Wright
H-GAC QAO
Responsible for coordinating development and implementation of the H-GAC's QA program. Responsible for writing and maintaining QAPPs, annual updates, and amendments, and monitoring their implementation. 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 compiling and submitting the QA report. Responsible for coordinating with the GBEP to resolve QA-related issues. Notifies the H-GAC PM and GBEP PM of particular circumstances which deviate from requirements in the QAPP and may adversely affect the quality of data. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts assessments of participating organizations during the life of the project as noted in Section C1. Coordinates and monitors nonconformances and corrective actions. Also implements or ensures implementation of corrective actions needed to resolve nonconformances noted during assessments.

Bill Hoffman
H-GAC Data Manager
Responsible for the acquisition, verification, and transfer of data to the H-GAC PM. Oversees data management for the project. Provides the point of contact for the H-GAC PM to resolve issues related to the data and assumes responsibility for the correction of any data errors. Coordinates with H-GAC GIS Data Manager on use of data for GIS analysis.

Will Merrell
H-GAC GIS Data Manager
Responsible for the GIS data acquisition, interpretation, and analysis as well as providing technical guidance needed for the preparation of the project QAPP. Will oversee all GIS data processing, GIS and/or GPS data review, data analysis, incorporation of data into Basin 11 database, and will make sure the minimum requirements/ objective/data are met. H-GAC GIS Data Manager will work with H-GAC PM to address any GIS issues or concerns.

Eastex Environmental Laboratory (Eastex)

Pam Hickman
Laboratory Director - Eastex Environmental Laboratory (Contract Lab)
Responsible for producing quality analytical data for samples collected and submitted by H-GAC. Maintains verification of procedures establishing the level of quality. Responsible for sending data and COC forms to H-GAC within time specified in contract.

Daniel Bowen
Eastex Lab
Checks training, competency, and re-training of technicians. Performs verification and validation procedures to confirm quality data is issued to clients. Performs other QA/QC duties and checks associated with lab activities. Resolves out-of-control issues. Conducts internal lab audits.

Other Project Partners
Local governments, consultants, non-profits and other local and regional stakeholders (e.g. City of Houston Public Works, Bayou Preservation Association), particularly those involved in the Bacteria Implementation Group (BIG) may be invited to participate as part of a technical advisory work group. The work group will voluntarily assist the H-GAC project team with local knowledge of local conditions and may be asked to lend support in the field. Project partners will work alongside and not independent of H-GAC staff. Local partners will be determined during desk reviews and will be identified in reports.

Figure A4.1 Organization Chart
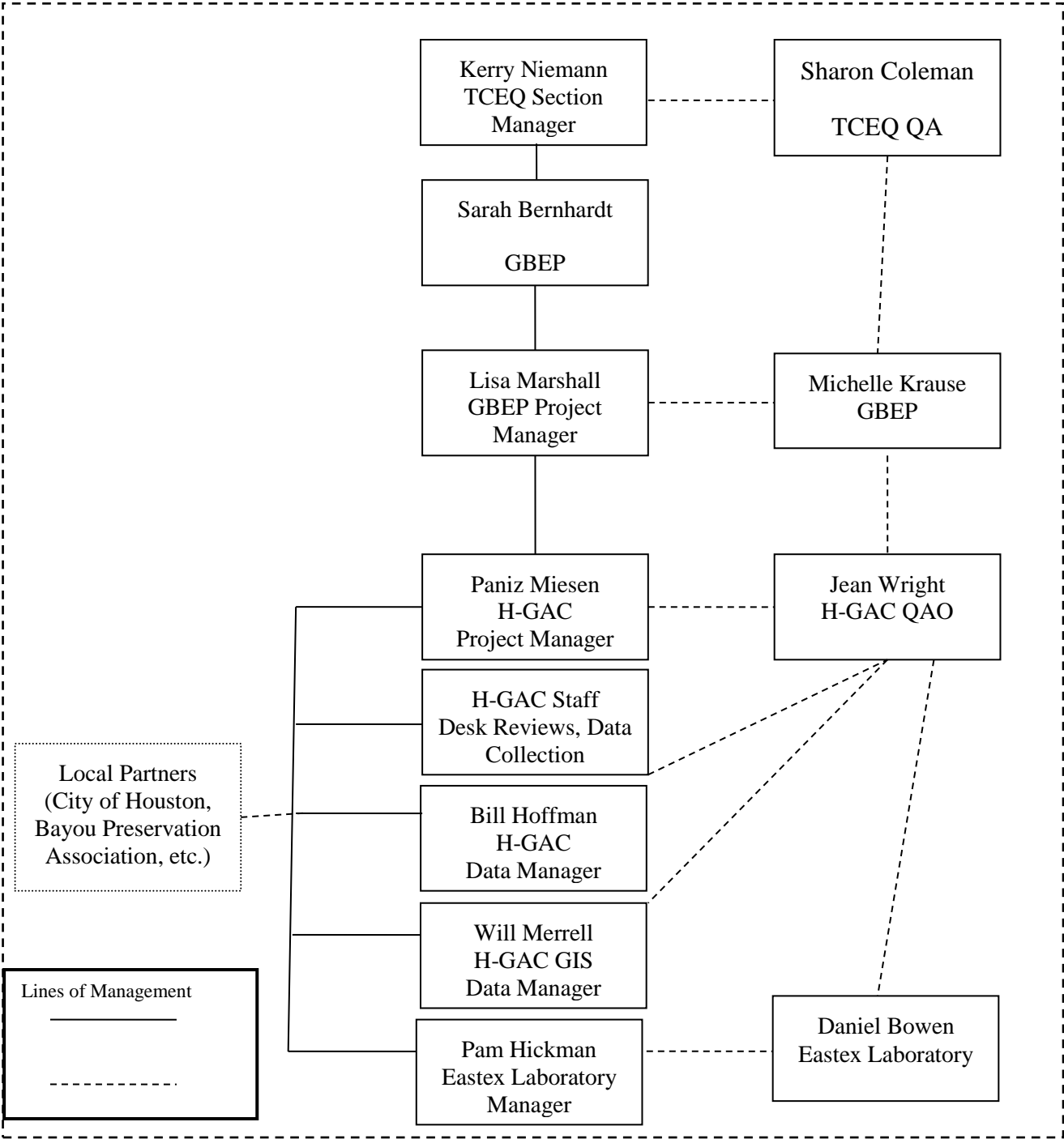
A5 Problem Definition/Background

The Bacteria Implementation Group (BIG) was formed in 2008, following the completed Total Maximum Daily Load (TMDL) study, to develop an implementation plan (I-Plan) that addresses the elevated levels of bacteria in 72 bacteria-impaired segments in the region. The BIG project area drains to Galveston Bay, where a sizeable area of the Bay's oyster producing waters are restricted to recreational harvest by the Texas Department of State Health Services due to elevated bacteria levels. Figure A5.1 presents the BIG project area map. Contact recreation is the primary impairment or concern identified in this BIG region and will be the focus of this project. The contact recreation standard uses indicator bacteria (*E. coli* and Enterococcus) as surrogates for the potential presence of human pathogens. Bacteria is known to come from a variety of sources (anthropogenic and wildlife) and is associated with land cover/land uses which include but are not limited to agriculture and urban development run-off and wastewater conveyance and treatment.

This project will address the Non-point Source and Point Source action plans of the Galveston Bay Plan, a Comprehensive Conservation Management Plan of the Galveston Bay Estuary Program. Illicit discharges were found by the BIG to be a potential source of bacteria impacting area streams. This project will identify potential bacteria discharges and seek to eliminate them by working with local jurisdictions.

The Houston-Galveston Area Council (H-GAC) is a Council of Governments (COG), the regional authority for the Gulf Coast State Planning Region, and has been actively involved in regional water quality planning and public outreach activities since the 1970's. H-GAC is a member of the BIG and has tracked bacteria levels to develop the Top Ten Most/Top Ten Least Impaired Lists (Top 10 Lists), "Most Wanted" (i.e. those impaired assessment units (AUs) with the highest geometric means relative to the state standards for bacteria) and "Most Likely to Succeed" (i.e. impaired AUs with the lowest geometric means relative to the state standards for bacteria). A project map that includes the Top 10 Lists can be found in Figure A5.1. Tables of the Top 10 Lists can be found in Appendix F.

H-GAC C&E staff will address ten targeted watersheds (five each from the Top 10 Lists) by prioritizing the watersheds through desk reviews, groundtruthing, identifying elevated sources of bacteria in the field through sample collection and analysis, and reporting those elevated bacteria sources to local jurisdictions where the sources were found. H-GAC will not correct the sources but will work with those jurisdictions to remove the sources. This project will demonstrate improved water quality and document the value of a prioritized watershed approach for correcting bacteria sources. Long-term AU water quality will be evaluated using CRP ambient monitoring not subject to this project. Results will be shared with BIG partners and other municipalities, particularly Municipal Separate Storm Sewer System (MS4) operators, through presentations and print material to encourage prioritization during Illicit Discharge Detection and Elimination (IDDE) programs.

The purpose of this QAPP is to clearly delineate H-GAC's QA policy, management, structure, and procedures which will be used to acquire the needed data from the identified sources and to complete the data analysis and land cover/land use comparisons. Data and results derived from this project will be used to increase understanding of water quality impairments and concerns and the source of those impairments or concerns. Results from this project may also be used by the TCEQ to address implementation of the Galveston Bay Plan and support future implementation projects to reduce bacteria to meet contact recreation standards in the Galveston Bay Watershed.
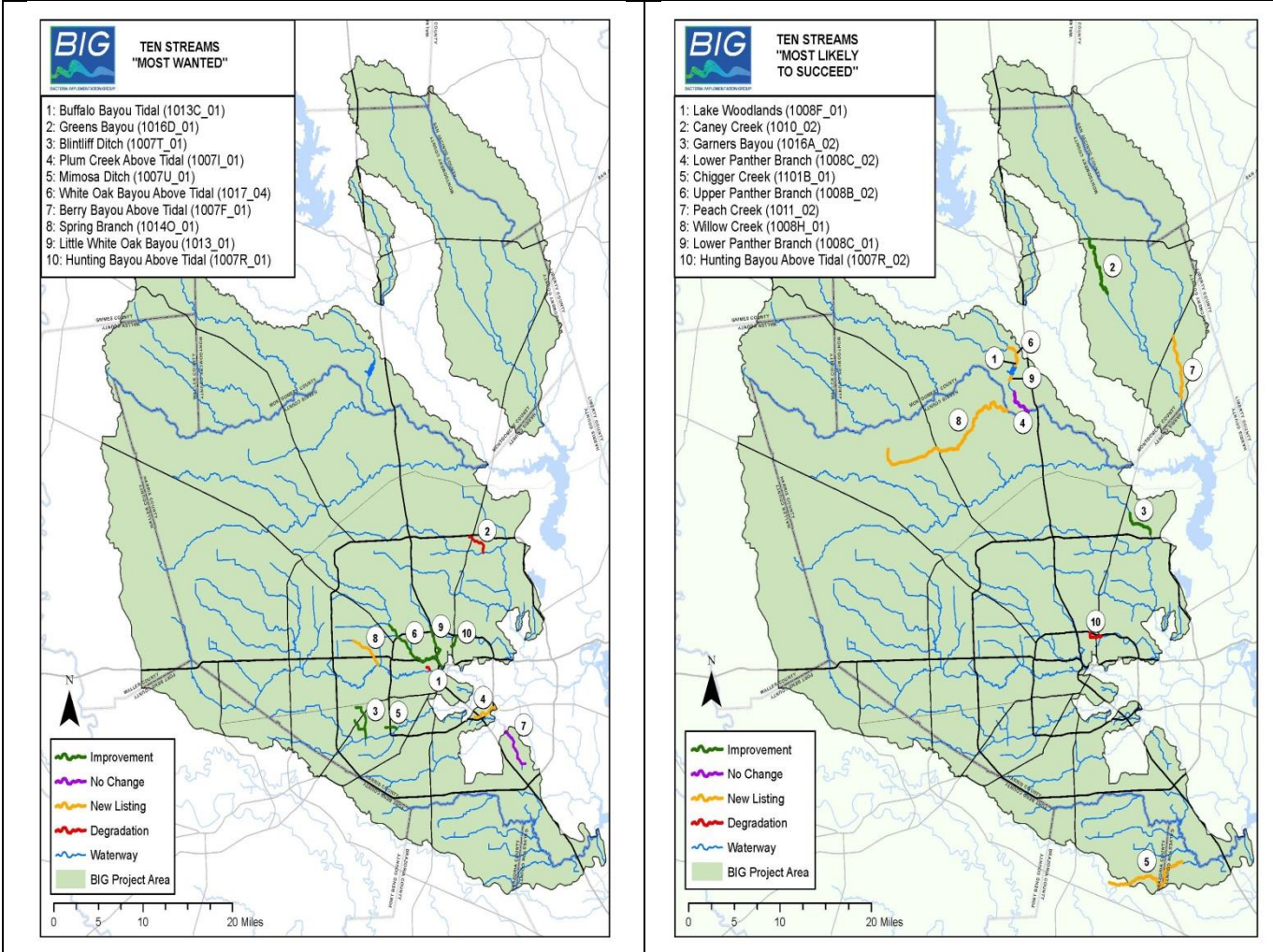
Figure A5.1 Project map depicting the BIG project area and Top Ten "Most Wanted" and Top Ten "Most Likely to Succeed" listed AUs.

A6 Project/Task Description

This project will use data collected through both direct and non-direct means. To simplify and monitor progress, this project has been split into three phases. Figure A6.1 delineates the three phases through a project flow chart and describes the tasks contained within. A project timeline has been provided with Figure A6.2. A more detailed and updated project work plan can be found in Appendix A.

Phase I

In Phase I of the project, H-GAC will conduct an initial desk review, Desk Review 1, of the Top 10 Lists to prioritize this list and pare it down to create a top five list for each top ten list. H-GAC will then conduct a more thorough desk review, Desk Review 2, to refine these lists one step further. The resulting prioritized list of two from each top 5 lists will then be subjected to ground truth analysis.

During Phase I, local project partners will be invited to participate in a technical work group to share their extensive knowledge of subject AUs. Local partners might be asked to participate alongside H-GAC in surveys of the selected AUs. The goal is to remove sources of bacteria in waterways and catchment areas which local partners might have jurisdiction. Developing trust and input by local partners will potentially facilitate future follow up actions to remove sources by these partners in Phase III of the project. Involvement of local partners will be detailed in project reports provided to the TCEQ.

During Desk Review 1, an assessment unit spreadsheet will be created which will contain at minimum, AU descriptions, monitoring station ID(s), location of monitoring stations, bacteria concentration (geometric mean), WWTF outfall locations, and stormwater outfall locations for the Top 10 lists. GIS will be used to capture aerial imagery for the AUs and conduct general geospatial analysis to determine accessibility. Previously collected quality assured ambient monitoring data from H-GAC and its partners (through CRP), TCEQ SWQM Program, and the U.S. Geological Survey (USGS) will be gathered during this part of Phase I. All data collected by TCEQ regional personnel are covered under the SWQM Program QAPP. The impaired watersheds will also be prioritized based on the I-Plan's recommendation under the Geographic Priority Framework for five criteria: Bacteria Level, Accessibility, Use Level, Implementation Opportunities, and Future Land Use Changes. If other criteria are determined as this project develops, those criteria will be written into the Final Report and made into a recommendation to the BIG for revision of the BIG I-Plan. The Top 10 Lists will be pared down to create preferential top five most and top five least (Top 5) lists for further review.

Under Desk Review 2, H-GAC will further refine the AU spreadsheet by defining the size of each AU catchment, completing AU bacteria trends using historical data beginning with January 1, 2003, and if sufficient data is available, complete load duration curves (LDCs) for the Top 5 Lists. GIS will be used to complete land use/land cover analysis (LU/LC), consider potential sources, and evaluate further the accessibility to AU and catch basin. Completed analysis should be able to prioritize the Top 5 Lists down to the top two most and top two least (Top 2) lists.

LDCs for the AUs will be calculated where feasible, should sufficient historic bacteria data and flow data be available. LDC and Flow Duration Curves (FDCs), a precursor in developing LDCs, will be calculated and plotted for bacteria in each selected AU. An LDC is a graphical illustration that shows the corresponding relationship between contaminant loadings and stream flow conditions in the AU. While sometimes considered as models, FDCs and LDCs are not in the truest sense models. Further they do not require calibration to measured data nor do they require validation to measured data, thus obviating these tasks of typical model development and coverage of these tasks by a QAPP. An LDC is a simple and effective first-step methodology to obtain data-based evaluations of the general relationship of concentrations to flow conditions, and allows for vary basic comparisons between LU/LC data.

LDCs assist in determining patterns in pollution loading (point sources, nonpoint sources, erosion, etc.) depending on the streamflow conditions. Based on the observed patterns, specific management measures can be implemented that target a particular kind of pollutant source. Another main advantage of the LDC method is that it can also be used to evaluate the current impairment by determining the percent of samples that exceed the standard.

The final step in Phase I will be to complete an AU Intensive Study by conducting ground truth analysis of the Top 2 Lists. Ground truth analysis will entail performing windshield surveys of the AU catchment area and waterway reconnaissance surveys where the AUs and tributaries are walked. Windshield and waterway reconnaissance will be conducted using established data collection forms and checklist developed by H-GAC. Example field data sheets and expected survey data collected can be found in Appendix C. Additionally, during the walks, bacteria screening samples will be collected at potential outfalls and suspected effluents to quickly establish areas of the AUs for follow-up monitoring during Phase II. Field staff will track the windshield survey and walks using GPS handheld devices to log the path traveled and collect waypoints for screening sample collection locations, additional outfall structure locations, potential sources, and other project relevant observations for follow-up during Phase II and Phase III. Photographs will also be taken to document observations.

During the initial waterway surveys, H-GAC will document pipe outfalls with dry weather effluent discharges. All outfalls emitting effluent during dry weather will be screened for bacteria by collecting samples for processing at H-GAC. H-GAC will follow Texas Stream Team (TST) protocols for collecting and analyzing screening bacteria samples as established in the TST procedures manual, chapter 4, and using Coliscan Easygel method. The excised portion of procedure manual specific to TST bacteria samples can be found in Appendix D. TST is a quality assured voluntary monitoring program managed by joint collaboration between the Meadows Center for Water and the Environment at Texas State University, the TCEQ, and EPA. H-GAC is the lead for TST activities in the region and staff is certified to train and audit TST volunteers. Samples will be handled within the required holding time as documented in the TST procedures manual. Bacteria screening will help prioritize areas within the AUs for further bacteria analysis during Phase II. A Preliminary Action Report documenting the results of Phase I will be created at the end of Phase I (See Appendix A, Project Work Plan).

Phase II
Bacteria samples and field parameters will be collected following the established policies and procedures of the CRP during Phase II. H-GAC is the CRP lead agency for the San Jacinto River Basin (Basin 10) and three associated coastal basins – the Trinity-San Jacinto (Basin 9), the San Jacinto-Brazos (Basin 11), and the Brazos-Colorado (Basin 13), which covers all of the BIG project area. Monitoring will be used to firmly establish bacteria concentrations found during bacteria screening and to further refine source identification and aid in tracking the source(s) of the impairment up the tributaries and ditches to the greatest extent practicable. H-GAC will monitor the prioritized AUs during wet weather and dry weather conditions by returning to suspected waypoints plotted during Phase I that exhibited elevated levels of bacteria.

PROJECT FLOW CHART

PHASE 1

Top Ten/Least Ten Lists

AU Spreadsheet

Review Analysis

GIS Aerial Image Review

Top Five/Least Five

AU Spreadsheet Refinement

Review Analysis

GIS LU/LC Source Identification

Prioritized Top Two/Least Two

Revise Prioritized Top Two/Least Two

AU Windshield and Waterway Reconnaissance

Desk Review 1
AU Spreadsheet: Develop spreadsheet on each AU containing (description, monitoring station ID(s), location, bacteria concentration/AU, # WWTF outfalls, WWTF locations, #stormwater outfalls, stormwater outfall locations).
GIS: Gather Aerial Images for AU review and analysis to determine accessibility
Decision: Using spreadsheet, aerial imagery and stakeholder

Desk Review 2
AU Spreadsheet Refinement: Size of AU catchment, bacteria trends, calculate LDC (if possible)
GIS: Consider LU/LC and Aerial Images for AU review and analysis. Add GIS data layers. Consider potential sources, evaluate AU and catch basin for access and ability to track potential bacteria sources into the catchment area to highest extent practical.
Decision: Using spreadsheet, GIS and stakeholder experience, to cut down Top 5/Least 5 lists to 2 AUs from each list for further study.

AU Intensive Study: Conduct on the ground and via vehicle observation of the selected AUs. Reconnaissance should GPS outfalls with flow, observe any releases during dry weather, assess bank and access points, note specific LU/LC, identify potential sources of bacteria, and note potential pollution sources. Map routes using GPS. Collect bacteria screening samples for analysis at H-GAC to direct future monitoring events under Phase 2.

Preliminary Action Report -6/30/2016

PHASE 2

No

Conduct NELAP Testing?

Yes

Sample Collection

Data Analysis and Source Identification

Sample Collection Decision: Do screening samples suggest a problem? If yes, then recommend AU for additional bacteria sample collection and analysis at a NELAP laboratory. If no, then conduct a second observation round with the next AU on the Top 5/Least 5 lists.

Sample Collection: Collect bacteria samples and field measurements (Temperature, Conductivity, pH, D.O., Secchi, and observations) along AU at outfalls and sub tributary confluences. Sites selected based on reconnaissance and results from bacteria screening samples. Bacteria samples collected in Phase 2 will be analyzed at a NELAP laboratory. Location of sample will be reviewed, permits and the LU/LC studied to identify potential sources.

Source Identification Report - 12/31/2016

PHASE 3

No

Elevated Bacteria Found?

Yes

Report Analysis to Local Authority

Authority Reports

Follow Up Monitoring

Final Report

Final Data Analysis

Elevated Bacteria: Locations found with elevated bacteria concentrations will be reported, along with potential sources, to the local jurisdictional authority for investigation.

Agency Action Report - 4/30/2017. Local jurisdiction reports any findings and any corrective actions taken.

Monitoring: Follow up monitoring will be conducted at locations identified with elevated conditions post authority investigations to access any change to condition.
Analysis: Complete final data analysis.
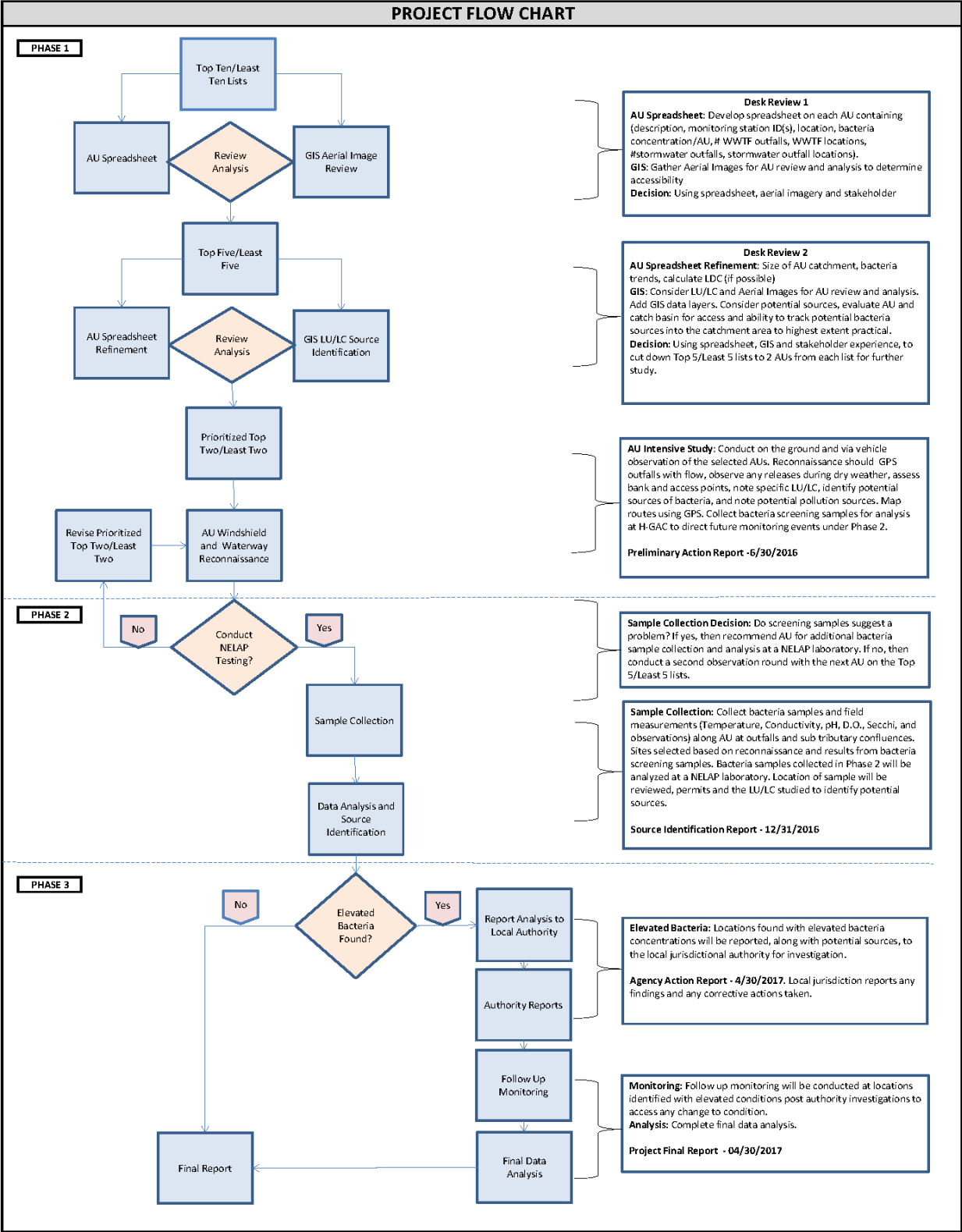
Project Final Report - 04/30/2017

Figure A6.1 Project flow chart delineating phases and tasks.

All sampling and laboratory analysis methods are specified in H-GAC's Texas CRP FY 2016-2017 Regional Monitoring Activities Quality Assurance Project Plan (QAPP) as well as all past TCEQ approved QAPPs, revisions, and amendments. The collection and qualification of the Texas CRP data collected in the H-GAC region are addressed in the H-GAC's CRP QAPP found at http://www.h-gac.com/community/water/rivers/data/regional-quality-assurance-project-plan.aspx. All bacteria samples and conventional field parameters collected will follow this plan. Sample field data sheets can be found in Appendix C. Bacteria samples collected during Phase II will be analyzed at a NELAP certified laboratory and will be processed within the required holding time as noted in footnotes to Table A7.1b on page 22. Bacteria samples will be analyzed using IDEXX Colilert method.

The locations with high concentrations of bacteria will then be identified and plotted with GPS for use during Phase III. A Source Identification Report will document the results of Phase II (See Appendix A, Project Work Plan).

Phase III
In Phase III of the project, H-GAC will direct any project findings to the appropriate jurisdiction for further investigation. Additionally, any potential sources identified through the desk review and field ground truth analysis will be directed to local jurisdictions. H-GAC will not have any role in removing or remediating any bacteria source, determining the specific type of action needed or taken, nor providing project funding to local jurisdictions for implementing any identified action. H-GAC will not nor has the authority to require any action be taken by the local jurisdiction.

H-GAC will attempt to track implementation carried out by the local jurisdiction by documenting any remedial actions carried out to remove or modify the elevated effluent sources. Once sources have been reported as corrected, H-GAC will collect follow-up bacteria samples at locations where elevated bacteria concentrations were found to determine if the corrective action(s) resulted in improved water quality. All bacteria samples collected during Phase III will be analyzed at a NELAP certified laboratory. A final report will be created at the end of Phase III and will be used to document results from Phase III and summarized the entire project. (See Appendix A, Project Work Plan)

Data Collection, Acquisition, and Analysis
While much of the project addressed in this QAPP will require collection of direct measurements of data (i.e. windshield and water way reconnaissance, bacteria sample collection and analysis, and conventional parameters using a calibrated datasonde), this project will also require the acquisition of existing water quality data collected through other projects and the potential use of said data for purposes other than those for which the data were originally collected.

Non direct data will be gathered from the CRP program, TCEQ Field Ops, and the USGS who also collect or have collected ambient water quality data, including bacteria, through routine monitoring or during special studies. Only non-direct measured data collected after January 1, 2002 will be used in this project. The acquired data will include all bacteria data and associated field parameters collected with a calibrated datasonde. All acquired water quality data stored in SWQMIS was collected under approved QAPPs.

Routine ambient water quality data collected by CRP partners as well as the TCEQ are stored with other types of data in TCEQ's Surface Water Quality Monitoring Information System (SWQMIS) database. SWQMIS data are available from the TCEQ "Surface Water Quality Viewer" site (http://www.tceq.state.tx.us/gis/surface-water-quality-viewer). Data undergoes rigorous validation and verification processes outlined in applicable QAPPs.

H-GAC routinely acquires GIS data sets from reliable sources such as USGS, Texas Natural Resources Information System (TNRIS), TCEQ, US Census Bureau, COGs, and other local, regional, state, and federal organizations or governments. A complete list of files and sources is provided in Appendix 5 of H-GAC's C&E Data Management Plan (The Plan) found in Appendix B of this document. Using geospatial software, H-GAC's Community and Environmental Planning Department (C&E) develops, stores and/or maintains new created GIS data sets generated for this project. Data sets being used in this project include but are not limited to the following:

- 1996, 2001, 2006, 2011 and 2015 land cover/land use/aerial imagery data sets (exist in 5 year intervals only)
- 2016 CRP stream network and station datasets
- "H-GAC_15_County_Soils_2012_w_taxonomy" 2015 soils data layer
- elevation
- impervious/pervious cover
- EPA's Nitrogen and Phosphorus Data Access Tool (based on HUC 8's)
- USGS HUC 8 and USGS HUC 12 layers
- run-off curve number
- other databases as deemed necessary.

Bacteria trends will be assessed using a variety of parametric and non-parametric methods. If more than fifteen percent of the bacterial data in the analytical unit of interest are censored, survival analysis (SAS PROC LIFEREG) will be applied. H-GAC will use SAS General Linear Model (PROC GLM) to evaluate nominal variables and interactions between variables as appropriate. Discriminant analysis will be used to test correlations and classifications. Canonical correlation and Pearson/Spearman/Kendall correlation matrices may be included for reference.

H-GAC will control the Type I error rate by applying a significance level of 0.05 in all statistical tests. The applicable null hypothesis will be rejected if the p-value of the statistical test is below 0.0545. Where feasible, H-GAC will calculate the statistical power and Type II error rate for all tests. Data will be evaluated to ensure the assumptions of specific statistical tests are met. For parametric tests, data transformations will be employed as needed. If parametric tests are not appropriate due to the nature of the data, semi-parametric or nonparametric tests will be applied. No data will be disqualified on a statistical basis alone. Because all data that might be considered an "outlier" was confirmed as correct prior to inclusion in SWQMIS, outliers will not be removed but will be included in analysis using statistical tests that are insensitive to outliers.

Maps developed will be for illustrative purposes. Geospatial data utilized in maps may include land use, land cover, elevation, pervious/impervious cover, precipitation, soil type, run-off curve numbers, ecoregion, TCEQ monitoring station location, TCEQ permitted WWTF outfall, on-site sewage facilities (OSSFs), USGS gage location, city/county/state boundary, stream hydrology, reservoir, drought, road, watershed, municipal separate storm sewer system, urbanized area, basin, railroad, recreational area, area landmark, aerial photography. Park information may also be used to develop informative maps of the study area.

To assist with this project, H-GAC also maintains a centralized geospatial warehouse of both tabular (non-geographic) and spatial (geographic) datasets. Geographical Information System (GIS) staff in the C&E capture, manipulate, analyze, store and display spatially referenced data and associated metadata to support a wide variety of applications ranging from sites assessments, environmental planning, urban planning, and spatial analysis.

H-GAC will work to facilitate general education and outreach concerning IDDE and bacteria impairments across the watershed to raise the general awareness, but particularly with MS4s. H-GAC will also support watershed management, water quality issues, and options available to stakeholders to address water quality impairments during future watershed planning initiatives. The project, including any analysis, conclusions and recommendations, will be documented in a final report.

The Final Report will be written detailing the results of all data analysis, comparisons and correlation testing. A draft report will be due April 30, 2017. A final report will be due May 31, 2017 following receipt of TCEQ comments to the draft. Results from this project may be used by TCEQ for further implementation of the Galveston Bay Plan and help develop additional watershed action planning projects.

A project timeline can be found in Figure A6.2. The work to be performed and the products to be produced are described in detail in the project work plan (see Appendix A).

QAPP ANNUAL Revision

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 90 days of significant changes, whichever is sooner. The revision must be submitted to the TCEQ for approval 120-90 days before the last approved version expires. 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 certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP, including any amendments, and a copy of new, signed approval pages for the QAPP.

Amendments TO THE QAPP

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address nonconformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the H-GAC's PM to the TCEQ GBEP PM in writing using the GBEP QAPP Amendment form (Appendix H). The GBEP PM will consult with the GBEP QAO to determine if the changes are substantive or eligible for the expedited amendment process. The changes are effective immediately upon approval by the H-GAC PM, the GBEP PM and QAO, and TCEQ QA Manager. Amendments to the QAPP and the reasons for the changes will be documented. Copies of the approved QAPP Amendment form will be distributed to all individuals on the QAPP distribution list by the H-GAC.

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

Top 5/Least 5

Quarter	Quarter One			Quarter Two			Quarter Three			Quarter Four			Quarter One			Quarter Two			Quarter Three		
Task 1 — Project Administration	Project Communication and Drafting PR			Project Communication and Drafting PR			Project Communication and Drafting PR			Project Communication and Drafting PR			Project Communication and Drafting PR			Project Communication and Drafting PR			Project Communication and Drafting PR		
Month	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17
Paniz Miesen	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Todd Running	*	*	*	*	*	*	*	*	*	X	*	X	X	*	*	X	*	*	X	*	X
Jeff Teabel	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Stephanie Beckford	*	*	*	X	*	*	*	*	*	X	*	*	X	*	*	X	*	*	X	*	*
Virgie Hall	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
David Waller	*	*	*	X	*	*	X	*	*	X	*	*	X	*	*	X	*	*	X	*	X
Task 2 — QAPP	Draft QAPP		QAPP Approval	QAPP Monitoring												QAPP Update	QAPP Monitoring				
Paniz Miesen	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Jean Wright	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bill Hoffman	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Thushara Ranatunga	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Task 3 — Desk Review and Survey: Data Acquisition, Summarization and Analysis			Identify Existing Datasets			Acquire, Process, Create Databases, Process, Analyze Datasets														
Paniz Miesen				X	X	X	X	X	X	X	X										
Bill Hoffman				X	X	X	X	X	X	X	X										
Thushara Ranatunga				X	X	X	X	X	X	X	X										
Will Merrell				X	X	X	X	X	X	X	X										
Rachel Fields				X	X	X	X	X	X	X	X										
Task 4 — NELAP Bacteria Samples: Data Collection, Summarization and Analysis										Collect, Process, Analyze Bacteria Samples (NELAP)									Follow Up Sample Monitoring		
Paniz Miesen										X	X	X	X	X	X	X	X	X	X		
Bill Hoffman										X	X	X	X	X	X	X	X	X	X		
Thushara Ranatunga										*	*	*	*	*	*	*	*	*	*		
Will Merrell										X	X	X	X	X	X	X	X	X	X		
Rachel Fields										X	X	X	X	X	X	X	X	X	X		
Task 5 — Reporting and Outreach				Outreach: Local Jurisdictions, Watershed Stakeholder Groups, etc.																	
Paniz Miesen				*	*	*	X	X	*	*	*	*	*	*	*	*	*	*	*	X	X
Rachel Fields				*	*	*	X	X	X	X	*	*	*	*	*	*	*	*	*	X	X
Time Line	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17
Results/Deliverables				Progress Report, FSRs			Progress Report, FSRs			Progress Report, FSRs			Progress Report, FSRs			Progress Report, FSRs			Progress Report, FSRs	Progress Report	Progress Report
		QAPP (draft)		Revised QAPP						Preliminary Action Report						QAPP Update (Draft)			Source Identification Report	Draft Final Report & Agency Action Report	Final Report

Figure A6.2 Project Timeline.

A7 Quality Objectives and Criteria

Existing data from other sources will be acquired and used as described in Section B9. Data will also be collected directly for this project.

The purpose of the water quality monitoring described in this QAPP is to collect bacteria samples in impaired AUs found in the BIG project area, identify potential sources of bacteria, work with local jurisdictions to remove or remediate sources of bacteria and observe improved water quality. H-GAC will have control over any data collected and observable information gathered, but does not have any control over how that information is received or acted upon by the local jurisdiction once notified.

This project is an example of systematic watershed monitoring, which is defined by sampling that is planned for a short duration (1 to 2 years) and is designed to: screen waters that would not normally be included in the routine monitoring program, monitor at sites to check the water quality situation, and investigate areas of potential concern. Due to the limitations regarding these data (e.g., not temporally representative, limited number of samples), the data will be used to determine whether any locations have values exceeding the TCEQ's water quality standards for bacteria.

Bacteria samples will be collected as screening samples during Phase I and follow-up laboratory samples used to confirm any elevated bacteria levels. Screening bacteria samples will be collected and analyzed following methods established by the TST. Follow-up bacteria samples, field parameters, and observations will be collected following procedures established under the CRP. Bacteria samples will be processed at a NELAP certified lab. The list of field parameters can be found in Table A7.1.

The measurement performance specifications to support the project objectives for a minimum data set are specified in Tables A7.1a and b below.

Ambient Water Reporting Limits (AWRLs)

AWRLs establish the reporting specification at or below which data for a parameter must be reported to be compared with freshwater screening criteria. AWRLs for field measurements as presented in Table A7.1a are considered not applicable (NA) and measurement performance will be consistent with SWQM guidance and standard measurement capability. The AWRLs specified in Table A7.1b are the program-defined reporting specifications for each analyte and yield data acceptable for TCEQ water quality assessment. The limit of quantitation (LOQ) 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.

Table A7.1a - Field Measurement Performance Specifications for Routine Systematic and Biased Flow Monitoring Events

PARAMETER	UNITS	MATRIX	METHOD	PARA-METER CODE	AWRL	LOQ	LOQ CHECK STD %Rec	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Lab
Temperature	ºC	water	SM 2550 and TCEQ SOP, V1	00010	NA	NA	NA	NA	NA	Field
Specific Conductance	µS/cm	water	EPA 1201 and TCEQ SOP, V1	00094	NA	NA	NA	NA	NA	Field
pH	standard units	water	EPA 150.1 and TCEQ SOP, V1	00400	NA	NA	NA	NA	NA	Field

PARAMETER	UNITS	MATRIX	METHOD	PARA-METER CODE	AWRL	LOQ	LOQ CHECK STD %Rec	PRECISION (RPD of LCS/LCS dup)	BIAS (%Rec. of LCS)	Lab
DO	mg/L	water	SM 4500-O G. and TCEQ SOP, V1	00300	NA	NA	NA	NA	NA	Field
Transparency, Secchi Disc	meters	water	TCEQ SOP, V1	00078	NA	NA	NA	NA	NA	Field
Days since precipitation event	days	other	TCEQ SOP V1	72053	NA	NA	NA	NA	NA	Field
Wind Intensity (1=calm, 2=slight,3=mod, 4=strong)	No Unit	other	NA	89965	NA	NA	NA	NA	NA	Field
Present Weather (1=clear,2=ptcldy, 3=cldy,4=rain, 5=other)	No Unit	other	NA	89966	NA	NA	NA	NA	NA	Field
Water Color (1=brownish, 2=reddish,3=greenish,4=blackish, 5=clear,6=other)	No Unit	water	NA	89969	NA	NA	NA	NA	NA	Field
Water Odor (1=sewage,2=oily/ chemical,3=rotten egg,4=musky, 5=fishy,6=none, 7=other)	No Unit	water	NA	89971	NA	NA	NA	NA	NA	Field
Water clarity (1=excellent,2=good,3=fair,4=poor)	No Unit	water	NA	20424	NA	NA	NA	NA	NA	Field
Turbidity, observed (1=low,2=medium, 3=high)	No Unit	water	NA	88842	NA	NA	NA	NA	NA	Field
Algae Cover	No Unit	other	NA	NA	NA	NA	NA	NA	NA	Field
Primary contact, observed activity (# of people observed)	# of people observed	other	NA	89978	NA	NA	NA	NA	NA	Field
Evidence of primary contact recreation (1=observed, 0=not observed)	No Unit	other	NA	89979	NA	NA	NA	NA	NA	Field

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, (or most recent version)
- TCEQ SOP, V1 - TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue, August 2012 or most recent editions (RG-415)

H-GAC does not anticipate this data being submitted to SWQMIS; however, all results will be provided to GBEP PM who will consult with TCEQ's Data Management Section. If deemed appropriate, the following requirements must be met in order to report results to the TCEQ SWQMIS:

- 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 sample for each batch of samples analyzed.

provided in tables found in Section A7 and discussed in Section B5.

A8 Special Training/Certification

No special certifications are required to collect or evaluate water quality data for this project. However, all employees involved in this project will have the proper experience and educational credentials to understand the relevant issues and concepts. Plus, employees involved in each phase of the project have received additional training to be or already are proficient in using the equipment necessary to conduct field sampling under CRP, TST or to evaluate data using software required to complete each task.

- *SAS (Statistical Analysis Software) – college or vendor training to accomplish necessary water quality data analyses.*
- *GIS software – college or vendor trained and experienced in geospatial concepts and use of H-GAC GIS software.*
- *Map/Photo interpretation training and/or experience and understanding of cartographic concepts.*
- *Remote Sensing software – training and/or experience in remote sensing concepts and H-GAC software.*
- *Geospatial metadata – college or workshop training recommended.*
- *"A Guidance Manual for Identifying and Eliminating Illicit Connections to Municipal Separate Storm Sewer Systems (MS4)," prepared by the Galveston County Health District, Pollution Control Division, August 2002.*

Personnel conducting work associated with this project are deemed qualified to perform their work through educational credentials, specific job/task training, required demonstrations of competency, and internal and external assessments.

Laboratories are NELAP-accredited as required. Records of educational credentials, training, demonstrations of competency, assessments, and corrective actions are retained by project manager or designee and are available for review.

A9 Documents and Records

All GIS datasets generated by H-GAC have been fully documented as to original source, quality, and history per Federal Geographic Data Committee (FGDC) compliant metadata. Similarly, outside sources obtained and used by H-GAC will require FGDC-compliant metadata as provided by the source agency. Datasets without a known history and documented quality will be noted as provisional and used only when noted as such. Metadata will be completed for any modifications to outside sources, or integration of outside sources with agency datasets. Metadata formats possibly included html, xml, or txt.

The document and records that describe, specify, report, or certify activities, requirements, procedures, or results for this project are listed. H-GAC sends hard copies to off-site storage 2 years after the contract is closed. Otherwise, they are kept on-site for easy access.

Table A9.1a Project Documents and Records for H-GAC

The documents and records that describe, specify, report, or certify activities are listed In Table A9.1. All records are kept for a minimum of seven years after the end of the project.

Table A9.1 Project Documents and Records for H-GAC

Document/Record	Location	Retention*	Format
QAPPs, amendments and appendices	H-GAC	7 years	Paper/ Electronic
QAPP distribution documentation	H-GAC	7 years	Paper
Desk Review paperwork	H-GAC	7 years	Paper
Data Analysis - including SAS, GIS, LDC	H-GAC	7 years	Electronic
Field data sheets	H-GAC	7 years	Paper
Field instrument print outs	H-GAC	7 years	Electronic
Field staff training records	H-GAC	7 years	Paper
Field equipment calibration/maintenance logs	H-GAC	7 years	Paper
Chain of custody records	H-GAC	7 years	Paper
Field SOPs	H-GAC	7 years	Paper
Data Quality Review Checklist for Bacteria testing using Easygel	H-GAC	7 years	Paper
Corrective Action Documentation	H-GAC	7 years	Paper/Electronic

*Retention period in paper format/electronic format.

Table A9.1 Project Documents and Records for Eastex Lab

Document/Record	Location	Retention*	Format
QAPPs, amendments and appendices	H-GAC	7 years	Paper/ Electronic
Chain of custody records	Eastex and/or H-GAC	7 years	Paper
Laboratory QA Manuals	Eastex	7 years	Paper
Laboratory SOPs	Eastex	7 years	Paper
Laboratory data reports/results	Eastex	7 years	Paper
Laboratory staff training records	Eastex	7 years	Paper
Instrument printouts	Eastex and/or H-GAC	7 years	Paper
Laboratory equipment maintenance logs	Eastex	7 years	Paper
Laboratory calibration records	Eastex	7 years	Paper
Corrective Action Documentation	Eastex and/or H-GAC	7 years	Paper

*Retention period in paper format/electronic format.

All H-GAC records, including notebooks, binders, and electronic files of technical staff, will be archived by H-GAC for at least seven years after the end of the project. Electronic data are stored on individual computers and on the network servers. The network servers are backed up nightly. After one week, data tapes are sent off-site to an electronic storage warehouse where they are held for 8 weeks. At the end of that 8 week period, the tapes are sent back to H-GAC to be re-used to back-up the servers again and the cycle begins again. In the event of a catastrophic systems failure, the tapes can be used to restore the lost data. Data generated on the day of the failure may be lost, but can be reproduced from raw data in most cases.

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

Laboratory Test Reports

Test/data reports from the laboratory will document the test results clearly and accurately. Reporting of the data will follow standard formats and protocols for *TNI Volume 1 Module 2 Section 5.10* and include the information necessary for the interpretation and validation of data.

Eastex is the contract lab for H-GAC's monitoring program. The final lab data for H-GAC's program are submitted by Eastex directly to H-GAC's Data Manager. It is reformatted as needed and reviewed prior to use. Eastex lab reports include the following information.

1) The title "Test Report" or other identifying statement (the lab offers several report formats);
2) Name and address of laboratory, and phone number with name of contact person;
3) A unique identification number and the total number of pages, with all pages sequentially numbered;
4) Name and address of client;
5) Description and unambiguous identification of the sample(s) including the client identification code (i.e. station information);
6) Identification of results for any sample that did not meet sample acceptance requirements;
7) Date of receipt of sample, date and time of sample collection, sample matrix, and time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to 48 hours (including holding time for SM9223-B);
8) Identification of the test method used plus its LOQ;
9) Reference to sampling procedure (grab or composite);
10) Any deviations from, additions to or exclusions from SOPs, and any conditions that may have affected the quality of results, and including the use and definitions of data qualifiers;
11) Measurements, examinations and derived results, supported by tables, graphs, sketches and photographs as appropriate, and any failures identified; identification of whether data are calculated on a dry weight or wet weight basis; identification of the reporting units such as µg/l or mg/kg;
12) Clear identification of all test data provided by outside sources, such as subcontracted laboratories, clients, etc.;
13) Clear identification of numerical results with values below the Reporting Limit, and
14) Identification of accreditation status per analysis.

If H-GAC receives any Eastex summary reports without all the above information, it is still available upon request.

Electronic Data

Should TCEQ wish to upload data from this project to SWQMIS, H-GAC will submit data to the GBEP/TCEQ in the event/result format specified in TCEQ's 2016 Data Management Reference Guide (DMRG) (https://www.tceq.texas.gov/assets/public/waterquality/dma/dmrg/dmrg_complete.pdf).

B1 Sampling Process Design

Data sample collection and analysis will be completed in all three phases of this project. Additionally, data will be acquired as non-direct measurements. All non-direct measurements will be discussed under B9.

Phase I

The basis for sample design is the BIG's Top Ten "Most Wanted" Streams and the Top Ten "Most Likely" Stream Lists where the bacteria concentration, ten AUs with highest concentration for "Most Wanted" and ten AUs with concentration just above standard, is used to rank the AUs for the BIG project area. The most recent ranking of the Top Ten Lists can be found in Appendix E. The rationale for using these two lists include:

- addressing a ranking from the BIG, therefore implementing an activity of the BIG I-Plan,
- AUs with the highest geometric mean concentration afford the opportunity to find and address bacteria sources, and
- AUs with the lowest concentration offer an opportunity to remove or remediate a source that might eventually take that AU off the state's impaired waters listing.

Starting from these two lists, H-GAC will complete two separate desk reviews to pare the lists down to two AUs from each of the Top Ten Lists. The project flow chart, Figure A6.1 on page 15, delineates this process, the three project phases and describes the tasks contained within.

Data will be collected from the Top2 List AUs through two methods: surveys and sample collection. H-GAC will conduct AU windshield and waterway surveys. Field data sheets have been created for conducting the reconnaissance and gathering observable data. The data sheets can be found in Appendix C. The purpose of the surveys is to identify outfalls with effluent discharges, observe physical characteristics of the waterway, bank habitat characteristics, confirm land cover uses within the AU catchment basin, and identify potential sources of pollution upstream of effluent discharges that have been identified with elevated levels of bacteria. The routes for the surveys will be tracked using GPS and interesting observation waypoints will be logged using GPS. The manual for the Garmin GPS units can be found in Appendix F. The forms and the information logged into GPS will then translated into GIS for each AU and catchment area for latter analysis. Photographs will also be taken to document observations.

During the waterway surveys H-GAC staff will also collect bacteria screening samples at outfalls exhibiting discharges during dry weather. The expectation is that only WWTFs should emit a discharge during dry weather. Sample locations will be identified using GPS and logged into the GPS for use in reporting and to potentially return to the location in later phases of the project. The screening samples will assist project staff in tracking potential sources back to their origin or to the furthest extent possible. Samples will then be taken to H-GAC and processed using TST procedures, Chapter 4, using Coliscan Easygel (Appendix D). Outfalls where samples were found to be elevated will then be confirmed during Phase II. Results from Phase I will be summarized in the Preliminary Action Report.

Phase II

During Phase II, H-GAC staff will return to outfall locations at least once during dry and wet weather conditions, using GPS data collected in Phase I, within the selected AUs that were found to have elevated levels of bacteria. During wet weather events, not all outfall locations will be monitored due to inaccessibility. Monitoring will be conducted during or immediately after a rainfall event that has created runoff, preferably preceded by a 72-hour antecedent dry period. Wet weather sampling events may also

occur in the absence of a 72-hour antecedent dry period if trace rains with a total accumulation of less than 0.25 inches has occurred prior to sampling.

Bacteria samples and field measures using a calibrated datasonde will be taken at those locations. H-GAC will collect the samples following H-GAC's Texas CRP FY 2016-2017 Regional Monitoring Activities QAPP. Following appropriate sample and chain of custody procedures, the samples will be analyzed at Eastex Laboratory, a NELAP certified laboratory using procedures for IDEXX Colilert found in the CRP QAPP. Results from the processed samples and from surveys conducted in Phase II will be summarized in the Source Identification Report.

Phase III
Where elevated bacteria samples were found in Phase II, local jurisdictions will be alerted. Information passed along will include: locations of the samples taken, bacteria concentrations found, and potential bacteria sources identified. H-GAC will work with the local jurisdictions that were notified and document any actions taken by the local jurisdictions to remove or remediate sources of bacteria. Once actions have been taken, H-GAC will return to the location of the elevated samples to conduct follow-up bacteria sample collection to determine if the actions taken improved water quality. H-GAC will collect samples following H-GAC's Texas CRP FY 2016-2017 Regional Monitoring Activities QAPP. Following appropriate sample and chain of custody procedures, the samples will be analyzed at a NELAP certified laboratory using procedures found in the CRP QAPP.

B2 Sampling Methods

Field Sampling Procedures

Field sampling and data collection will be conducted according to procedures documented in the most current version of the *TCEQ SWQM Procedures, Volume 1*. Specifications outlined in Table B2.1 reflect additional requirements for sampling for the project and/or provide additional clarification.

Table B2.1 Sample Storage, Preservation and Handling Requirements for H-GAC Bacteria Samples.

Parameter	Matrix	Container	Preservation	Sample Volume	Holding Time
E. coli IDEXX Colilert	water	Sterile Plastic w/ sodium thiosulfate	Cool to <6°C but not frozen	120 mL	8 hours[1]
E. coli Coliscan Easygel	water	Sterile Plastic w/ sodium thiosulfate	Cool to <6°C but not frozen	120 mL	6 hours[2]

[1] *E.coli* samples analyzed by Colilert 18 should always be processed as soon as possible and within 8 hours, but no more than 24 hours.
[2] *E.coli* samples analyzed by Coliscan Easygel should always be processed as soon as possible and within 6 hours.

Sample Containers

Certificates from sample container manufacturers are maintained in a notebook by Eastex Lab as appropriate. Information about the various sample containers is described below.

All sample containers are provided to H-GAC by their contract lab, Eastex. The lab performs and tracks required QC procedures for all bottles purchased.
- Sterile, sealed, 120 mL plastic, disposable bottles with a sodium thiosulfate tablet added, are used for bacteriological samples.

Processes to Prevent Contamination

Procedures in the *TCEQ SWQM Procedures* outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field QC samples (identified in Section B5) are collected to verify that contamination has not occurred.

Documentation of Field Sampling Activities

Field sampling activities are documented on field data sheets (see Appendix C). The following will be recorded for all visits:
- station ID
- sampling date
- sampling time
- sampling depth
- sample collector's name/signature
- values for all field parameters, including flow and flow severity
- detailed observational data, where appropriate, including:
  o water appearance
  o weather
  o biological activity
  o algal growth
  o unusual odors
  o pertinent observations related to water quality or stream uses (i.e., exceptionally poor water quality conditions; stream uses such as swimming, boating, fishing, irrigation pumps)
  o watershed or in stream activities (i.e., bridge construction, livestock watering upstream)
- missing parameters (i.e., when a scheduled parameter or group of parameters is not collected)

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

Sampling Method Requirements or Sample Processing Design Deficiencies and Corrective Action

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

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

B3 Sample Handling and Custody

Sample Tracking

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

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The Chain of Custody (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 C).

- date and time of collection,
- site identification,
- sample matrix, indicated by the test group code,
- number of containers and container type ID designation,
- preservative used or if the sample was filtered, indicated by test group code,
- analyses required, indicated by the test group code,
- name of collector,
- custody transfer signatures and dates and time of transfer,
- name of laboratory accepting the sample.

Sample Labeling

Samples from the field are labeled on the container with an indelible marker. Label information includes:

- site identification
- date of sampling
- time of sampling
- preservative added, if applicable

Sample Handling

After collection of samples is complete, sample containers are immediately stored in an ice chest for transport to the Eastex laboratory. Ice chests remain in the possession of the field technician or in the locked vehicle until being delivered to the lab. After submission to the Eastex laboratory, the samples remain in the log-in room until log-in is completed, then they are stored in the refrigeration unit or given to an analyst for immediate analysis. Only authorized laboratory personnel handle samples received by the laboratory. Eastex Environmental Laboratory Quality Manual (QM), most current version, addresses samples relinquished to the lab.

Sample Tracking Procedure Deficiencies and Corrective Action

All deficiencies associated with COC procedures and described in this QAPP are immediately reported to the H-GAC PM or QAO. These include such items as delays in transfer resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; and broken or spilled samples. The H-GAC PM, in consultation with the GBEP PM and H-GAC QAO, will determine if the procedural violation may have compromised the validity of resulting data. Any failures that have reasonable potential to compromise data quality will invalidate data and the sampling event should be repeated, if feasible. The resolution of the situation will be reported to the GBEP PM in the project progress report. CARs will be prepared by the H-GAC personnel and summarized by the H-GAC PM for submittal to the GBEP PM for inclusion with project progress report.

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

B4 Analytical Methods

The analytical methods, associated matrices, and performing laboratories are listed in Tables A7.1 a and b of Section A7. The procedures for laboratory analysis shall be in accordance with the most recently published edition of Standard Methods for the Examination of Water and Wastewater, the latest version of the TCEQ Surface Water Quality Monitoring (SWQM) Procedures, 40 CFR Part 136, or other reliable procedures acceptable to the TCEQ.

Laboratories analyzing bacteria data, except for screening bacteria tests, under this QAPP are compliant with the TNI Standards, at a minimum. Copies of laboratory quality assurance manual (QAM) and SOPs are available for review by the TCEQ, upon request.

Standards Traceability

All standards used in the field and laboratory are traceable to certified reference materials. Standards preparation is fully documented and maintained in a standards log book. Each documentation includes information concerning the standard identification, starting materials, including concentration, amount used and lot number; date prepared, expiration date and preparer's initials/signature. Reagent bottles are labeled to trace the reagent back to preparation. Tables A7.1a and b, Measurement Performance Specifications, list the methods to be used for field and laboratory analyses.

Deficiencies, Nonconformances and Corrective Action Related to Quality Control

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP or other applicable documents. Nonconformances are deficiencies which affect quantity and/or 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, and QC sample failures.

Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff and reported to the pertinent field or laboratory supervisor who will notify the H-GAC PM. A Corrective Action Report to document the deficiency is written for each deficiency.

The H-GAC PM, in consultation with the GBEP PM and H-GAC QAO (and other affected individuals/organizations), will determine whether the deficiency could affect data quality. If it is determined the 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 a nonconformance does exist, the H-GAC Project Manager, in consultation with the GBEP PM and the H-GAC QAO, will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented in the CAR (see Appendix E).

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

B5 Quality Control

Sampling Quality Control Requirements and Acceptability Criteria

The minimum field QC requirements, and program-specific laboratory QC requirements, are outlined in SWQM Procedures.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria

Batch
A batch is defined as environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAP-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 25 hours. An **analytical batch** is composed of prepared environmental samples (extract, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

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

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

Comparison Counting
For routine bacteriological samples, repeat counts on one or more positive samples are required, at least monthly. If possible, compare counts with an analyst who also performs the analysis. Replicate counts by the same analyst should agree within 5 percent, and those between analysts should agree within 10 percent. Record the results.

Laboratory Duplicates
A laboratory duplicate is an aliquot taken from the same container as an original sample 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 batch.

For most parameters, except bacteria, precision is evaluated using the relative percent difference (RPD) between duplicate LCS results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X1 and X2, the RPD is calculated

from the following equation:

$$RPD = |(X1 - X2)/\{(X1+X2)/2\} * 100|$$

For bacteriological parameters, precision is evaluated using the results from laboratory sample duplicates. Bacteriological duplicate are collected on a 10% frequency (or once per sampling run, whichever is more frequent). These duplicates will be collected in sufficient volume (200 mL or more) for analysis of the sample and its laboratory duplicate from the same container.

The base-10 logarithms of the results from the original sample and its duplicate are calculated. The absolute value of the difference between the two logarithms will be compared to the precision criterion in TableA7.1b. If the difference in logarithms is greater than the precision criterion, the data are not acceptable for use under this project and will not be reported to TCEQ. Results from all samples associated with that failed duplicate (usually a maximum of 10 samples) will be considered to have excessive analytical variability and will be qualified as not meeting project QC requirements.

The precision criterion in Table A7.1b for bacteriological duplicates applies to only samples with concentrations > 10 MPN/100 mL. Field splits are not collected for bacteriological analyses.

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

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

Field Blank
Field blanks are used to assess potential contamination from sample handling, airborne materials, equipment, media, and other sources. Field blanks are not required when using the IDEXX Colilert method but are required when using the Coliscan Easygel method to test for *E. coli* bacteria. A field blank usually consists of a sterile diluent sample that is taken to the site and poured into a properly labeled, sterile sample bottle during the first bacteria sampling of the day. The blank sample is collected in the same type of container, labeled as a field blank, and handled and analyzed along with all the bacteria samples collected on that day. The frequency of the bacteria field blank is one with every 10 samples or once a month if less than 10 samples are collected in a given 30 day period.

The analysis of field blanks should yield values lower than the LOQ. When target analyte concentrations are high, blank values should be lower than 5% of the lowest value of the batch.

Field blanks are associated with batches of field samples. In the event of a field blank failure, all applicable data associated with the field batch may need to be qualified as not meeting project QC

requirements and may be rejected. Regardless, none of the bacteria results acquired from the Coliscan Easygel method will be reported to the TCEQ. These data include all samples collected on that day during that sample run and should not be confused with the laboratory analytical batch.

Deficiencies, Nonconformances and Corrective Action Related to Quality Control

Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP or other applicable documents. Nonconformances are deficiencies that affect data quantity and/or quality and render the data unacceptable or indeterminate. Deficiencies related to QC include but are not limited to field and laboratory QC sample failures.

Deficiencies are documented in logbooks, field data sheets, etc., by field or laboratory staff and reported to the appropriate field or laboratory supervisor who will notify the H-GAC PM. The H-GAC PM will notify the GBEP QAO of the potential nonconformance. The H-GAC will initiate a CAR to document the deficiency.

The H-GAC PM, in consultation with H-GAC QAO (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 the CAR closed. If it is determined a nonconformance does exist, the H-GAC PM in consultation with the H-GAC QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by the H-GAC by completion of a CAR (see Appendix G).

CARs document: root cause(s); 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. CARs will be included with quarterly progress reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to TCEQ verbally and in writing.

B6 Instrument/Equipment Testing, Inspection and Maintenance

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

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within Eastex's laboratory QAM and SOPs and are available upon request. The QAM and SOPs apply to *E.coli* samples submitted to Eastex only.

B7 Instrument/Equipment Calibration and Frequency

Field equipment calibration requirements are contained in the *TCEQ Surface Water Quality Monitoring Procedures, Volume 1*. 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 should be disregarded. Refer to section C1 for description of corrective action reports.

Detailed laboratory calibrations are contained within the Eastex Laboratory QAM and SOPs and are available upon request. The incubator used to analyze Coliscan Easygel bacteria tests will have the unit thermometer checked against a National Institute of Standards Technology or NIST thermometer every ten batches or at least monthly.

B8 Inspection/Acceptance of Supplies and Consumables

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

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within Eastex laboratory QAM and SOPs and available upon request. H-GAC PM or designee will retain all records related to Coliscan Easygel analyses.

B9 Non-Direct Measurements

Data of known and documented quality are integral to the success of this project, as these data could be used to support future decision-making. The establishment of data quality standards, and acknowledgement of conformity to quality standards, is therefore a high priority. Each of these datasets is validated by the responsible agency, usually when the datasets are updated. H-GAC accepts by reference the quality and validation/verification routines of these agencies. Metadata for each of the GIS datasets is stored within the feature class for the layer. Metadata for all other datasets are included in the database as a separate descriptive file that defines the source, download date, and nature of the dataset, and is stored in the same folder as the raw project dataset on the H-GAC server called G-drive. Data employed in this project may include, but are not limited to:

- o water quality data from SWQMIS,
- o flow data from the USGS,
- o daily precipitation data from NOAA Climactic Data Center,
- o monthly average wastewater discharge data from Discharge Monitoring Reports provided by TCEQ,
- o wastewater permit data provided by TCEQ, and
- o all GIS data and layers accumulated by H-GAC.

No data will be specifically collected nor submitted for inclusion in SWQMIS. Data collected by the TCEQ, the USGS, and the Texas CRP partners that meet the data quality objectives of this project may be useful in satisfying the data and informational needs for GBEP. The collection and qualification of the TCEQ and USGS data are addressed in the TCEQ SWQM QAPP (<www.tceq.state.tx.us/waterquality/monitoring/swqm_guides.html>). The collection and qualification of the Texas CRP data are addressed in the Texas CRP QAPPs (<www.tceq.texas.gov/waterquality/clean-rivers/qa/index.html>).

The water quality data to be acquired for this project will include available 'non-qualified,' routine or special study, ambient, fixed station bacteria water quality data and associated field parameters in SWQMIS collected since January 1, 2002, from the BIG project area within the H-GAC region as well as associated field parameters.

The TCEQ's SWQMIS is the largest and most complete repository for water quality data collected under

accepted QAPP procedures in the State of Texas and was selected for that reason for these projects. Data will be downloaded from SWQMIS for each determination of correlation and analyses. The list of parameters includes bacteria results and field parameters only. Only data collected since January 1, 2002 will be used in this project. SWQMIS data are available from the TCEQ "Surface Water Quality Viewer" site (http://www.tceq.state.tx.us/_gis/surface-water-quality-viewer). This source of information will be specified in the Management Report/Final Report for this project.

For the parameter *E. coli*, since July 1, 2008, only analytical data generated by a NELAP accredited laboratory may be submitted to TCEQ for inclusion in SWQMIS. For field and bacteria data, only surface water data collected at a depth of 1 meter or less will be used. Only data without qualifier codes will be downloaded from SWQMIS for use in this project. The acquired data will include routine water quality data collected by TCEQ, CRP partners, and the USGS. Data will include only that which was collected after January 1, 2002.

Comparability of methods is based on TCEQ's CRP FY2016-2017 Guidance, Task 5. This document gives guidance for which method codes can be combined and which are considered comparable. The document also suggests methods on how to substitute or censor data reported below quantitation limits. All censored data methods will be evaluated before data is used in the final analysis and fully documented.

The H-GAC Community & Environmental Planning Department's Data Management Plan, August 2015 (The Plan) outlines how both tabular (non-geographic) and spatial (geographic) datasets are captured, manipulated, analyzed, stored, and displayed within the Geospatial/GIS environment as it relates to sharing of data, development of geospatial applications, cartography, and underlying GIS resources. The Plan can be found in Appendix B. H-GAC utilizes ESRI® ArcGIS 10 platform for all geospatial analysis and mapping needs. The ESRI® ArcGIS 10 platform includes integrated Python programming capabilities, which allows for the creation of programming scripts or batch programs to improve efficiency and documentation of processes. The Python programming language is an Open Source platform, and is freely distributable. H-GAC will first acquire the TCEQ GIS layer that has delineated watersheds for the selected AUs in the BIG project area for evaluations.

Only 'published' GIS data from recognized sources will be used to determine if there are correlations between watershed characteristics (land use/land cover) and the acquired ambient bacteria data. Land cover datasets have been compiled for the years 1996, 2001, 2006, 2011 and 2015.

During this project, GIS datasets may be or have already been acquired by H-GAC (See The Plan, Appendix B). The Plan outlines how both tabular (non-geographic) and spatial (geographic) datasets are captured, manipulated, analyzed, stored, and displayed within the Geospatial/Geographic Information Systems (GIS) environment as it relates to sharing of data, development of geospatial applications, cartography, and underlying GIS resources. The publishing of geospatial data by various organizations implies that the data is of known quality that it has been subject to review and approval by the publishing organization and has required metadata to prove its accuracy and completeness.

Additional geospatial data may be available from various local, regional, state, and federal organizations and may be used for cartographic purposes. Maps developed for reports will be for illustrative purposes. Geospatial data utilized in maps of the study area may include land use, precipitation, soil type, ecoregion, TCEQ monitoring location, TCEQ permitted outfall, gage location, city/county/state boundary, stream hydrology, reservoir, drought, road, watershed, municipal separate storm sewer system, urbanized area, basin, railroad, recreational area, area landmark, aerial photography, and park information. The above data come from the following reliable sources: USGS, TNRIS, TCEQ, US Census Bureau, COGs, and local governments. Geospatial data from these sources are accepted for developing project maps

based on the reputability of these data sources and the lack of known comparable sources for these data. Geospatial data will be cited in reports.

B10 Data Management

The water quality data acquired for this project as well as data produced by this project will be maintained in a permanent SAS data table where it can be electronically and/or visually screened for errors. H-GAC Data Manager will create a metadata file once all data has been verified and validated from the original source to document datasets appropriateness for use. Bacteria data downloaded from TCEQ in pipe-delineated text will be stored, write protected in a project folder on the H-GAC data server. Data will be copied into secondary files of manipulation and analysis.

A description of the software and hardware to be used for GIS data, how data is converted or manipulated for use, how the metadata is documented, and stored is described in the C&E Data Management Plan located in Appendix B. Information about computer workstations and software supporting this project are also described in the C&E Data Management Plan located in Appendix B.

C1 Assessments and Response Actions

The following table presents types of assessments and response action applicable to this QAPP.

Table C1.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	H-GAC Project Manager, , GIS Data Manager or designee	Monitoring of the project status and records to ensure requirements are being fulfilled.	Report to the TCEQ in Progress Report. Ensure project requirements are being fulfilled.
GBEP QA Review and Contractor Review.	Annual	GBEP PM and/or Quality Assurance Officer	Monitoring of H-GAC's project status, Quality Assurance Program, and Project Deliverables.	Report to Management and Contractor for response and any corrective actions.

DEFICIENCIES AND CORRECTIVE ACTION

Deficiencies are any deviation from the QAPP and procedures referenced herein. It is the responsibility of the H-GAC PM, in consultation with the H-GAC QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the GBEP PM in writing in the project progress reports and by completion of a corrective action report (CAR) (Appendix G).

Corrective Action Reports (CARs) should:

• identify the problem, nonconformity, or undesirable situation,
• identify immediate remedial actions if possible,
• identify the underlying cause(s) of the problem,
• identify whether the problem is likely to recur, or occur in other areas,
• evaluate the need for Corrective Action,
• use problem-solving techniques to verify causes, determine solution, and develop a CAR,
• identify personnel responsible for action,
• establish timelines and provide a schedule,
• document the corrective action in CARs.

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

The H-GAC PM or QAO is responsible for implementing and tracking corrective action procedures as a result of audit findings. Records of audit findings and corrective actions are maintained by the H-GAC PM and/or QAO. Corrective action documentation will be submitted to the GBEP PM with the progress report.

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

C2 Reports to Management

Reports to H-GAC Project Management

The table below lists all the reports that are generated by H-GAC for this project. The reports are described in greater detail in the sections following the table. The final report will include a complete discussion regarding the analyses conducted, results of same analyses, the appropriate use and limitations of the data in terms of quality as well as all developed GIS datasets.

Table C2.1 QA Management Reports

Type of Report	Frequency (daily, weekly, monthly, quarterly, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipients
Project Updates	As needed	E-mails and conference calls	H-GAC PM	GBEP PM
Project Updates & Verbal Reports	Bi-weekly	Regularly scheduled staff meetings	H-GAC PM	H-GAC Water Resources Manager
TCEQ Quarterly Progress Report	Updates with Quarterly progress reports	15th day of the month following the end of the quarter. Monthly Progress Reports beginning June 2016.	H-GAC PM	H-GAC Water Resources Manager & GBEP PM
Preliminary Action Report	Updates with Quarterly progress reports	August 4, 2016	H-GAC PM	H-GAC Water Resources Manager & GBEP PM
Source Identification Report	Updates with Quarterly progress reports	March 2, 2017	H-GAC PM	H-GAC Water Resources Manager & GBEP PM
Draft Final Report	Updates with Quarterly progress reports	April 30, 2017	H-GAC PM	H-GAC Water Resources Manager & GBEP PM
Final Report with hard copies and digital copies. GIS shapefiles and Data files will be provided to the TCEQ & to the EPA upon request.	Following TCEQ Comment Period	May 31, 2017	H-GAC PM	H-GAC Water Resources Manager & GBEP PM

Reports to TCEQ Project Management

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

Progress Report –Summarizes the H-GAC's activities for each task; reports monitoring status, problems, delays, and status of corrective actions; and outlines the status of each task's deliverables. Submittal of progress reports will be at the frequency and format as identified in the contract or work order.

Reports by TCEQ Project Management

Contractor Evaluation - The H-GAC is evaluated in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Support Services Division, Procurements and Contracts Section.

D1 Data Review, Verification, and Validation

Water quality data collected by the TCEQ, the USGS, and all CRP partners have been reviewed, verified, and validated according to the requirements of the respective programs prior to being loaded into SWQMIS. Only 'un-qualified' (unflagged), routine, ambient, fixed station water quality data currently stored in SWQMIS will be used in this project. All AU data for bacteria and field parameters will be evaluated for temporal extent, censored data, the availability of instantaneous flow and precipitation data. Sample collection methods and field measurement procedures have been monitored and audited by H-GAC staff since the mid 1990's. Laboratory analyses were performed using validated standard methods, and in many cases, by laboratories that had an acceptable quality system in place prior to the requirement that all laboratories submitted data obtain accreditation under NELAP by 2008. H-GAC believes data that has been collected as part of the routine sampling and produced by regional CRP partners and established laboratories, has met the review, verification, and validation requirements of CRP and meets the requirements of this project and all relevant DQOs. Comparable methods and limits of quantitation will be dealt with as required by CRP and described in the analysis of data for the Final Report referred to in section A6.

Only published geospatial data will be acquired for use in this project. Those organizations include, but are not limited to, the USGS, TNRIS, TCEQ, US Census Bureau, COGs, National Weather Service, and others. Each of the agencies generating Geospatial data have their own procedures for reviewing, verifying, and validating their data prior to being published. All published data will be considered adequately reviewed, verified, and validated. Any inconsistencies or inaccuracies found will be addressed with the publisher by H-GAC staff as they are identified and documented accordingly.

For datasets generated during this project, the data quality will be peer reviewed for logical consistency and coding errors as identified in appropriate standards. The GIS Data Manager, Water Quality Data Manager, PM or his designee will be responsible for overall validations and final approval of the data in accordance with project purpose and use of the data.

D2 Verification and Validation Methods

Data collected by the TCEQ, the USGS, and Texas CRP partners have been verified and validated according to the requirements of the respective programs prior to their use in this project. Data compilations created for this project will be electronically and/or visually screened for errors.

The H-GAC PM or GIS Data Manager will provide review and approval of the datasets before closure of the project. All data layers will be reviewed for FGDC-compliant metadata. GIS datasets lacking appropriate metadata will not be used in an analysis or delivered to outside agencies. Documentation of provisional datasets will be reviewed to verify references to the use and limitations of the data. The H-GAC PM or GIS Data Manager will review QC reports and peer reviews to ensure they are acceptable. The H-GAC PM or GIS Data Manager will also compare final datasets with original source information for consistency.

D3 Reconciliation with User Requirements

Data acquired for this project, and data collected by other organizations (e.g., USGS, TCEQ, etc.), will be analyzed and reconciled with project data quality requirements sufficient to produce the Management

Report/Final Report. Results of analysis may be used by the GBEP for implementation planning, future project planning and other water quality planning as appropriate.

The final data will be reviewed to ensure that it meets the requirements as described in section A6 of this QAPP. CARs will be initiated in cases where invalid or incorrect data have been detected. Any limitations on the use of the analyses presented in the Management Report/Final Report will be documented in the results and conclusion section of the report.

The data analysis, including LDCs, will be used to evaluate bacteria concentrations in AUs within the BIG project area. It will provide information pertaining to historical trends in water quality, trends in LU/LC change, relationship of pollutant loads to flow regimes, potential loading from areas within selected AUs, and the impacts of watershed processes on loads in selected AUs.

Once the final version of the LU/LC map is produced, the GBEP PM will review the product to determine if the results meet the quality objectives of this QAPP. If data quality indicators do not meet the project's requirements as outlined in this QAPP the revised dataset will be returned for revisions.

The LDC framework utilized for this project will be used to evaluate *E. coli* loading in relation to flow regimes in the BIG project area. These analyses will aid in targeting water quality planning recommendations to the most likely areas of *E. coli*.

The Final Report will be a document that describes data collection and analysis procedures, data analysis and results, and summarizes the data. The summaries will include charts, tables and graphical presentations, including LDCs, as well as proper citations, analyses and results. The final document will be provided to the TCEQ in both hard copy and electronic formats or a combination of each, along with data and GIS files as requested. Once the TCEQ gives document approval, the Final Report will be shared with the BIG stakeholders.

Appendix A: Work Plan/Scope of Work

Bacteria Implementation Group's Top Five Most and Top Five Least Impaired Water bodies

The BIG was formed in 2008 following the completed Total Maximum Daily Load (TMDL) study, to develop an implementation plan (I-Plan) to address the elevated levels of bacteria in 72 bacteria-impaired segments in the region. The BIG project area drains to Galveston Bay, where a sizeable area of the Bay's oyster producing waters are restricted to recreational harvest by the Texas Department of State Health Services due to elevated bacteria levels. This project will address the Non-point Source and Point Source action plans of the Galveston Bay Plan, a Comprehensive Conservation Management Plan of the Galveston Bay Estuary Program. Monitoring will be conducted to demonstrate water quality improvement.

The Performing Party as a member of the Bacteria Implementation Group (BIG) has tracked bacteria levels to develop the Top Ten Most/Top Ten Least Lists, "Most Wanted" (i.e. those streams with the highest geometric means relative to the state standards for bacteria) and "Most Likely to Succeed" (i.e. stream locations with the lowest geometric means relative to the state standards for bacteria) The Performing Party is seeking to address ten targeted watersheds (five from the Top Ten Most and five from the Top Ten Least) by prioritizing the watersheds through a desk review, identifying sources of bacteria in the field, and reporting those sources to local jurisdictions. The Performing Party will not correct the sources but will work with BIG partners to remove the sources. This project will demonstrate improved water quality and document the value of a prioritized watershed approach for correcting bacteria sources.

The Performing Party will conduct a desk review and ground truth analysis of ten impaired watersheds in the BIG project area to prioritize for wet and dry weather monitoring. Desk reviews will include previously collected ambient monitoring data gathered by The Performing Party and its partners through the quality assured State's CRP. Ten impaired watersheds will be prioritized based on the I-Plan's recommendation under the Geographic Priority Framework for five criteria: Bacteria Level, Accessibility, Use Level, Implementation Opportunities, and Future Land Use Changes. If other criteria are determined as this project develops, those criteria will be written into the Final Report and made into a recommendation to the BIG for revision of the BIG I-Plan.

Based on the prioritization, a subset of the 10 watersheds (due to the level of funding, a minimum of one to two watersheds from the Top Ten Most list and one to two from the Top Ten Least list) will be monitored during wet weather and dry weather conditions. Water quality monitoring will be used to further refine source identification and to aid in tracking the source(s) of the impairment to the greatest extent practicable. Once verified, the source(s) of the bacteria loading will be relayed to the appropriate jurisdiction for correction. Additionally, any potential sources identified through the desk review and field ground truth analysis will be directed to local jurisdictions. The Performing Party will track implementation of the corrective action and conduct additional monitoring of the original sites to determine if the corrective action results in improved water quality.

Project Tasks

Task 1: Project Administration

Objective: To effectively administer, coordinate, and monitor all work performed under this project including technical and financial supervision and preparation of status reports.

Subtask 1.1: Project Oversight - The Performing Party will provide technical and fiscal oversight of the staff and/or sub-grantee(s)/ subcontractor(s) to ensure Tasks and Deliverables are acceptable and completed as scheduled and within budget. With the TCEQ Project Manager's authorization, the Performing Party may secure the services of sub-grantee(s)/ subcontractor(s). Project oversight status will be provided to TCEQ with the Quarterly Progress Reports (QPRs)/Financial Status Reports (FSRs).

Subtask 1.2: QPRs/FSRs - The Performing Party will prepare electronic QPRs/FSRs for submission to TCEQ. QPRs/FSRs will document all activities performed and costs incurred quarterly and will be submitted by the 15th ofMarch, June, September, and December. For the final quarter of the Contract period, QPRs/FSRs are required to be submitted monthly.

The QPRs/FSRs are to include the following:
- status of deliverables for each task;
- brief narrative description in QPR format;
- expenses documented on FSR forms; and
- supply supporting financial documentation.

Subtask 1.3: Contract Communication - The Performing Party will participate in a post-award orientation meeting with TCEQ within 30 days of Contract execution and at minimum, annually thereafter. Performing Party will document the meetings through written meeting summary. The Performing Party will maintain regular telephone and/or email communication with the TCEQ Project Manager regarding the status and progress of the project. Matters that must be communicated to the TCEQ Project Manager include, but are not limited to:

- Notification within 7 days before the Performing Party has scheduled public meetings or events, initiation of construction, or other major task activities.
- Notification within 48 hours regarding events or circumstances that may require changes to the budget, scope of work, or schedule of deliverables.
- Meeting held within 30 days of Contract execution and annually, summary due 15 days after each meeting.

Task 1 Deliverables:
- QPRs;
- contract communication; and
- meeting summaries

Task 2: Quality Assurance

Objective: To refine, document, and implement data quality objectives (DQOs) and quality assurance/control (QA/QC) activities to ensure data of known and acceptable quality are generated through this project.

Subtask 2.1: QAPP - The Performing Party will create a Quality Assurance Project Plan (QAPP), sufficient for the needs of the data quality objectives of this Scope of Work. The Principle Investigator (PI) will submit a written draft QAPP within 60 days of contract execution for review and consideration of approval by the TCEQ Project Manager and in accordance with the EPA R-5 document guidelines. The draft QAPP will be revised to address comments received from the TCEQ and/or EPA. A final QAPP without highlights or strikeout text will be submitted for approval by the TCEQ. Collection of environmental data and processes associated with the collection of environmental data will not commence prior to approval of the QAPP.

Subtask 2.2: QAPP Annual Updates or Reissuances - The Performing Party will submit annual QAPP updates or reissuances no less than 90 days prior to the end of the effective period of the QAPP. The last approved version of a QAPP will remain in effect only for the specified approval period. Upon expiration of the approval period for a QAPP, all the work covered by the expired QAPP will cease until such time as a revised QAPP has been fully approved by TCEQ and, if necessary, EPA.

Subtask 2.3: QAPP Amendments - The Performing Party will review, approve, and incorporate all changes into a revised QAPP during the annual revision process, or will submit an amendment to the QAPP 90 days prior to the scheduled initiation of changes or additions to activities listed in the current QAPP. The Performing Party will document all changes to the QAPP and the reasons for the changes. The Performing Party will ensure the current QAPP is followed until an amended QAPP is signed/fully approved by TCEQ and, if necessary, EPA.

Subtask 2.4: Data Acquisition – The Performing Party with gather available datasets to conduct a desktop and on-the-ground analysis. Acquired data, including Geographic Information System (GIS) land use/land cover, CRP ambient monitoring, permit outfall, on-site sewage facility, and other available data will be reviewed to determine if the data was collected using common practices and standards for the date and time of the collection. The process for determining the quality of acquired data and acceptability for use must be detailed in the QAPP.

Subtask 2.5: Data Collection –
The Performing Party will conduct an initial desk review, Desk Review 1, of the Top 10 Lists to prioritize this list and pare it down to create a top five list for each top ten list. The Performing Party will then conduct a more thorough desk review, Desk Review 2, to refine these lists one step further. The resulting prioritized list of two from each top five lists will then be subjected to ground truth analysis. The survey design, field measures, and forms must be detailed in the QAPP.

The Performing Party, unless noted in the QAPP, will collect all samples for the project following procedures described in SWQM Procedures, Volume 1: Physical and Chemical Monitoring Methods. List of parameters for wet and dry weather sampling include: all CRP field parameters and *E. coli*. All samples will preferably follow a 72 hour antecedent dry period. Wet

weather sampling events may also occur in the absence of a 72 hour antecedent dry period if trace rains with a total accumulation of less than 0.25 inches has occurred prior to sampling. Bacteria screening samples will be processed in house using the Coliscan Easygel method. Bacteria samples processed using IDEXX Colilert method will be processed at a NELAP accredited lab.

Unless authorized by the TCEQ, monitoring projects that include *E. coli* sampling are required to have samples processed by an accredited laboratory within an 8 hour time-frame for regulatory samples and 24 hour time-frame for non-regulatory samples.

Task 2 Deliverables:
- Draft and Final QAPP;
- QAPP Annual Updates;
- QAPP Amendments as needed; and
- Data Submittals

Task 3: Data Acquisition and Analysis - Desktop and Ground-Truth Analysis

Objective: To collect and analyze data in accordance with the approved QAPP. This task will incorporate the priority strategy identified in the *Bacteria Implementation Plan for Seventy- Two Total Maximum Daily Loads for Bacteria in the Houston-Galveston Region's* Geographic Priority Framework. The processes will include defining mini-watersheds for every outfall within Assessment Units (AUs) of interest and identify land cover throughout each watershed.

Subtask 3.1: Data Acquisition - The Performing Party will conduct desktop and on-the-ground analysis to refine the Top Ten Most and Top Ten Least lists to better direct wet and dry weather monitoring. Desktop analysis will use GIS land use/land cover data, ambient monitoring data, permit outfall data, on-site sewage facility system data and other available data for 10 watersheds from the Top Ten Most/Top Ten Least lists. Ground truth identification will include road – windshield surveys – and shoreline walks of accessible areas. Key stakeholders will be identified and asked to contribute to project planning, review of analysis and development of the prioritization strategy.

Subtask 3.2: Data Analysis - The Performing Party will analyze data and information collected in accordance with the QAPP under Task 2.1. The Performing Party will develop a Geospatial database using ESRI ArcGIS software to perform analysis of multiple data layers. Results will be used to further refine the watersheds and develop the prioritization strategy for wet and dry weather data collection under Task 4.0.

Subtask 3.3: Map Development - Results from Task 3.2 will be used to generate a map that will be used in the wet and dry weather data collection under task 4.0.

Subtask 3.4: Data Submittals - The Performing Party will review, verify, and validate water quality monitoring data before it is submitted to the TCEQ. The Performing Party will submit a semi-annual report of water quality data that is consistent with TCEQ formatting requirements for upload into the SWQMIS.

The Performing Party will submit data reports and presentations for review and approval at least two weeks prior to the scheduled public release.

Subtask 3.5: Data Acquisition and Analysis Report - The Performing Party will develop a report, Desk Review/Ground Truth Preliminary Action Report, detailing activities conducted under this task, including the development of a revised targeted watershed list.

Task 3 Deliverables:
- Desk Review/Ground Truth Preliminary Action Report;
- Geospatial Data Set; and
- Map Layer

Task 4: Data Collection and Analysis - Wet and Dry Weather Sampling and Analysis

Objective: To collect and analyze wet and dry weather samples that can be used to better identify sources of bacteria. Data will be used to generate an action report that will be delivered to local jurisdictions to follow up and remediate any sources. Follow up wet and dry weather sampling will be used to determine if corrective actions improved water quality.

Subtask 4.1: Data Collection - Wet Weather Sampling
The final number of wet weather monitoring sites will be based on results from Task 3. A minimum of 4 samples will be taken from each of the four Assessment Units (AUs), two AUs selected from each of the Top Five Most and Top Five Least watersheds identified in 3.0. List of parameters: all CRP field parameters and *E. coli*. All samples will preferably follow a 72 hour antecedent dry period. Wet weather sampling events may also occur in the absence of a 72 hour antecedent dry period if trace rains with a total accumulation of less than 0.25 inches has occurred prior to sampling. Bacteria screening samples will be processed in house using the Coliscan Easygel method. Bacteria samples processed using IDEXX Colilert method will be processed at a NELAP accredited lab. Additional samples will be collected during the last quarter of the project to monitor water quality benefits derived from corrective actions.

Subtask 4.2: Data Collection - Dry Weather Sampling
The final number of dry weather monitoring sites will be based on results from Task 3.0 and 4.1. A minimum of 20 samples will be taken from four AUs, two AUs selected from each Top Five Most and Top Five Least watersheds identified in 3.0. To assist with tracking illicit discharges to a source prior to collecting, the Performing Party will be prescreening bacteria using the Coliscan Easygel method. Bacteria samples processed using IDEXX Colilert method will be processed at a NELAP accredited lab. Water quality monitoring will focus on all CRP field parameters and *E. coli*.

Subtask 4.3: Data Analysis - The Performing Party will analyze data and information collected in accordance with the QAPP. All analysis will be processed in-house. Data will be processed using basic and advanced statistical analyses to determine trends and correlations.

Subtask 4.4: Data Submittals - The Performing Party will review, verify, and validate water quality monitoring data before it is submitted to the TCEQ. The Performing Party will submit a semi-annual report of water quality data that is consistent with TCEQ formatting requirements for upload into the SWQMIS. The Performing Party will submit data reports and presentations for review and approval at least two weeks prior to the scheduled public release.

Subtask 4.5: Data Collection and Analysis Report - The Performing Party will develop a Source Identification Report, detailing activities conducted under this task. Report will be delivered to local jurisdictions within the project area. Local jurisdictions will be encouraged to investigate any identified sources and to report on any action taken to address the identified source(s).

Task 4 Deliverables:
- Source Identification Report

Task 5: Reporting

Objective: To provide targeted outreach, education and training opportunities to local watershed stakeholders and produce a Final Report that summarizes all activities completed and conclusions reached during the project. The report will describe project activities, and identify and discuss the extent to which project goals and purposes have been achieved, and the amount of funds spent on the project. The report will emphasize successes, failures, lessons learned, and include specific water quality data demonstrating water quality improvements if applicable. The Final Report will summarize all the task reports in either the text or as appendices.

Subtask 5.1: Outreach, Education and Training - Select venues to conduct direct and meaningful outreach to target audiences, including the Performing Party's clean watershed initiative workshops. Selection of venues and presentations will include coordination with TCEQ. Additionally, general outreach and education concerning this project will be provided throughout the project period in conjunction with outreach efforts of the BIG and other community and environmental programs, including but not limited to: the Performing Party website, the Performing Party and partner meetings, and presentations to local governments, organizations and the public.

Subtask 5.2 Draft Final Report/Management Report -The Performing Party will provide a draft report that summarizes all activities completed and conclusions reached during the project. The report will describe project activities, and identify and discuss the extent to which project goals and purposes have been achieved, and the amount of funds actually spent on the project. The report will emphasize successes, failures, lessons learned, and will include specific water quality data demonstrating water quality improvements if applicable. The draft report will summarize all the Task Reports referencing and/or attaching them as web links or appendices. The report should be structured per the following outline:

Title;

Table of Contents;

Executive Summary;

Introduction;

Project Significance and Background;

Methods;

Results and Observations;

Discussion;

Summary;

References; and

Appendices

Subtask 5.3: Final Report/Management Report - The Performing Party will revise the draft report to address comments provided by the TCEQ Project Manager.

Task 5 Deliverables:

- Agency Action Report;
- Outreach and Education Report;
- Draft Final Report/Management Report;
- Address any comments; and
- Final Report/Management Report.

Delivery Schedule

Deliverable and associated sub-task	Due Date(s)
QPRs (1.2)	QPRs will document all activities performed quarterly and will be submitted by the 15th ofMarch, June, September, and December. For the final quarter of the Contract period, reimbursement forms are required to be submitted monthly.
Contract communication and meeting minutes (1.3)	Meeting held within 30 days of Contract execution and annually, minutes due 15 days after each meeting
Draft and Final QAPP (2.1)	Within 60 days of contract execution
Final QAPP (2.1)	Within 30 day following TCEQ review of the draft QAPP
QAPP Updates/Reissuance (2.2)	Annually
QAPP Amendments (2.3)	as needed
Data Submittals (2.5)	as needed
Desk Review/Ground Truth Preliminary Action Report (3.5) • Geospatial Data Set • Map Layer	8/4/2016
Source Identification Report • Wet Weather Data Collection (4.1) • Dry Weather Data Collection (4.2)	3/2/2017
Outreach and Education Report (5.1)	4/30/17
Draft Final Report (5.2)	4/30/17
Final Report (5.3)	5/31/17

Appendix B: Data Management Plan

Data Management Plan
July 2015

HOUSTON-GALVESTON AREA COUNCIL
Community & Environmental Planning Department

Prepared in cooperation with the
Texas Commission on Environmental Quality
under the authorization of the Texas Clean Rivers Act

Table of Contents

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Introduction

The Data Management Plan (The Plan) outlines the standard policies and procedures for data management within the Community and Environmental Planning (C&E) Department. The Plan covers the management of both tabular (non-geographic) and spatial (geographic) datasets. Its primary purpose is to ensure the efficient access and maintenance of these datasets within the C&E Geospatial/Geographic Information Systems (GIS) environment.

GIS technology provides a systematic means to capture, manipulate, analyze, store and display spatially referenced data. GIS supports a wide variety of applications ranging from site assessments, environmental planning, urban planning, and spatial analysis to support organizational strategies. In general, GIS supports the overall departmental goals of guiding regional planning, enhancing the quality of the region's natural environment, and public education through outreach programs. The C&E GIS team supports various programs within the C&E department through data development, spatial analysis, geospatial applications development, cartography in support of departmental goals.

The Plan is considered a dynamic working document which responds to changing technology, funding, staffing, and project requirements. Consequently, the Plan is reviewed on an annual basis and amended as necessary.

Geospatial Services

The following section explains the geospatial services provided by the H-GAC C&E GIS team as it relates to the sharing of data, development of geospatial applications, cartography, and underlying GIS resources. The C&E GIS team is responsible for the development of data and sharing of many publicly viable datasets, developing geospatial applications, cartography, and coordination of maintenance of underlying geospatial hardware and software for C&E.

The C&E GIS team maintains a centralized geospatial warehouse (C&E SDE), an online mapping platform for web-based geospatial applications (Mapping Server), and an FTP download site (Data Clearinghouse). The C&E SDE utilizes ESRI's ArcSDE software running on a Microsoft SQLServer RDBMS. The mapping server uses ESRI's ArcGIS Server platform running on .NET. The Data Clearinghouse is an FTP server that provides C&E with storage space where it can post publicly available datasets for downloading. The C&E SDE, Mapping Server, and Data Clearinghouse platforms are installed by the H-GAC Data Services department (Data Services), with Data Services maintaining only the lower-level technology components such as the physical hardware, software installation, and low-level server and RDBMS functions.

All upgrades and maintenance is coordinated by the C&E GIS Manager. All geospatial content stored in the C&E SDE, the Data Clearinghouse, and Mapping Server, are the responsibility of the C&E GIS staff, which resides within the C&E Socio-Economic Modeling program. A detailed schematic of the geospatial technical architecture and how the various systems are interconnected can be found in the *System Architecture* section below.

Data Sharing

The C&E SDE serves as the primary internal repository for geospatial data, metadata, and other information relevant to the activities and goals of the C&E department. All GIS users within the C&E Socio-Economic Modeling program. and some users from other H-GAC departments are provided *Editor* or *Viewer* access to data in the C&E SDE. The majority of users outside the core C&E GIS team have only viewer access to data in the C&E SDE. Other specific users that maintain data in the C&E SDE have editor access to the datasets. H-GAC C&E staff without *Editor* or *Viewer* access to the C&E SDE server are able to access a copy of the geospatial data through a separate server that houses imported versions of the original GIS layers for project specific editing. This system ensures that the original formatting of geospatial data on the C&E SDE remains unchanged. All user access privileges are assigned by the C&E GIS Manager based upon business needs, GIS skills, and role within the organization. No users outside of the C&E department have editor level access to any GIS data in the C&E SDE, and in some instances there are datasets that are viewable by only C&E GIS users. Instructions for connecting to the C&E SDE are provided to authorized users.

Datasets determined to be viable for publication to the public are exported to the Data Clearinghouse website, thereby allowing the general public widespread access to this information via the internet. Members of the public may view metadata and download any of the datasets that are posted to the Data Clearinghouse. In some instances these datasets are used in web-based mapping applications and can be accessed online via the Mapping Server's services directory, or accessible via the Data Clearinghouse for downloading. All public C&E GIS data, applications, cartographic products, and the C&E map services directory can be accessed via our C&E GIS page athttp://www.h-gac.com/rds/gis-data/gis-datasets.aspx, and a screen shot of the website can be found in Appendix 7.

Geospatial Applications

The C&E department has made a strategic decision to incorporate internet-based mapping applications into its deliverables for many programs and projects. Before, the results of most projects consisted of a large-format map printed on a plotter up to 48"x36" in diameter. This form of cartography although still useful in many settings, did not allow programs to communicate results to the public or external organizations that had an interest in our analysis results. By taking results from C&E projects and coupling this with base map data and imagery, C&E has been able to share the results of projects to a far greater audience, and has created opportunities whereby map layers published on the C&E mapping server can be utilized in other organizations mapping applications.

Currently there are three platforms upon which C&E provides internet-based mapping solutions. The first platform is based on the Adobe Flex programming environment, and all mapping applications developed using this platform run inside standard internet browsers that support the Flash technology, such as Internet Explorer. This platform is intended to provide users with a graphics rich user interface whereby the map can be navigated, layers turned on/off, and information obtained on each feature. In some instances, features have links to additional resources such as photos of monitoring stations, external websites, and detailed reports. This mapping application environment allows the users to make full use of their computers internet browser window, and serves as a simple online GIS.

The second platform utilizes the capabilities of the ArcServer platform to allow users to directly access map layers published on the mapping server. This method of delivery is called 'streaming' and allows end users read-only access to individual map layers ad geoprocessing tools published on the server. Typical users of this method of deliver are other GIS users using desktop GIS, whereby they can connect directly to our ArcServer platform for read-only access and view our map layers. Other instances whereby users may utilize this method is where they are including our map layers in their own mapping applications.

The third and final platform involves developing applications for mobile devices or tablets. The C&E department has developed both native (installed) applications for the Apple iOS platform, as well as server-side scripted applications which utilize the free ESRI ArcGIS for Mobile Devices viewer app, which runs on iOS, Android, or Windows phone devices. In both instances, map layers used in these applications are delivered from the C&E ArcServer platform.
As previously mentioned, access to all the above forms of applications and data sharing methods can be accessed via our C&E GIS page at http://www.h-gac.com/go/cegis.

Mapping and Cartographic Products
The C&E department produces a variety of static cartographic maps for the region as a result of project activities and for general usage. To facilitate the sharing of these maps in an electronic format, C&E has implemented a Map Book as part of their C&E GIS page. Maps can be downloaded in multiple formats. The C&E Map Book can be accessed via our C&E GIS page at http://www.h-gac.com/go/cegis.

System Resources
System Architecture
The C&E department uses an integrated architecture to support the development, analysis, and dissemination of spatial information. The diagram below illustrates this system architecture at a high level. The goal of the overall system is to allow for a streamlined workflow to develop/maintain data, optimize the data for use in online applications, and the consumption of applications via multiple platforms.

Currently the C&E GIS platform supports sharing of geospatial data via the ArcServer mapping server platform. This allows end users internally or externally to consume map layers and geoprocessing tools via GIS desktop, mobile, tablet, or 3rd part applications.
In some instances, applications are configured with public feedback and volunteer GIS workflows that allow the C&E GIS team to obtain information for the public on various geographic features in the region. This public feedback loop allows C&E to investigate feedback and verify its validity prior to incorporating the information into the data warehouse.
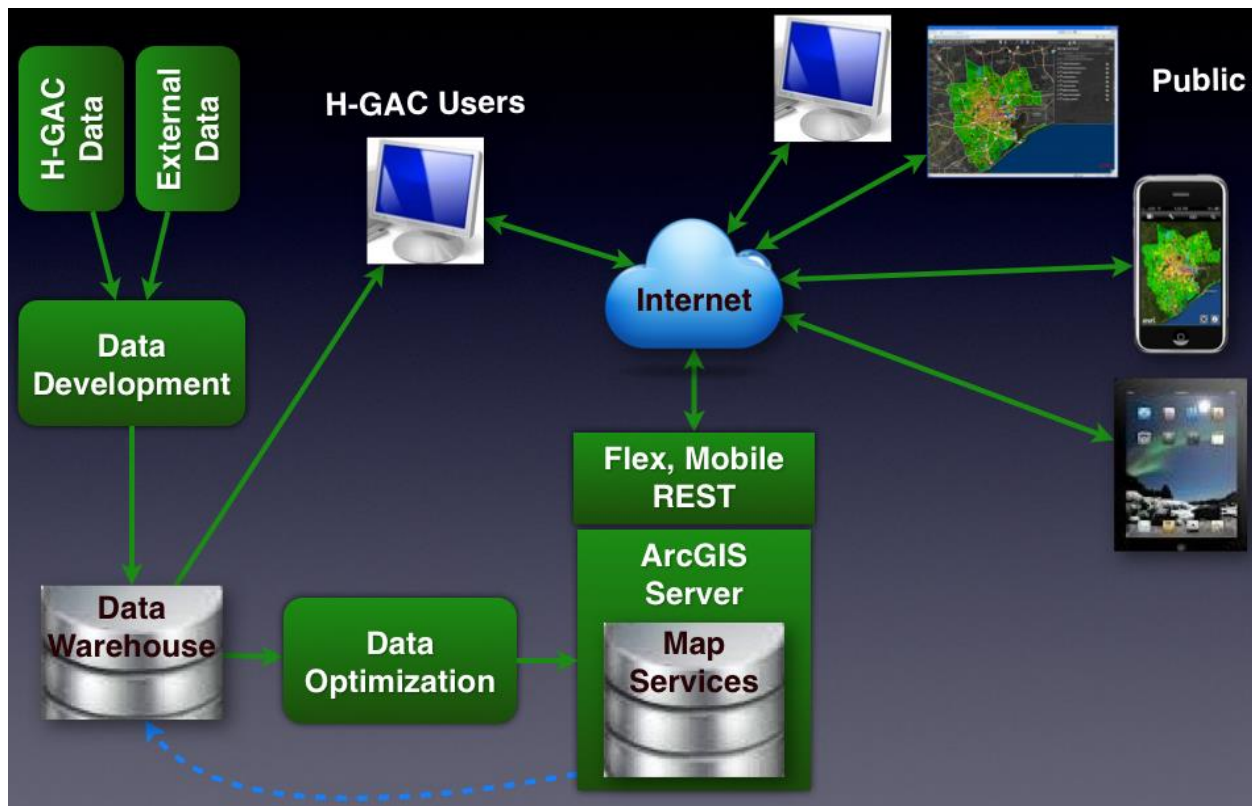
Hardware

The configuration of the hardware used by staff that performs GIS and data Management work is a distributed network" This network consists of several PC's which are connected to central file servers. The department also uses a central web mapping server for online mapping applications. A complete listing of departmental hardware is found in Appendix 3.

Software

The C&E department relies upon the H-GAC Data Services department (Data Services) for all of its end user workstation configuration, installation, and maintenance. Each workstation for users comes with the Microsoft Office software package which includes Outlook (e-mail), Word (word processing), Excel (spreadsheets), PowerPoint (presentations), and in some instances Access (desktop database) should the user require desktop database capabilities. Each workstation is pre-configured and setup to operate within the H-GAC internal network, and has access to central servers for file storage. In some instances, certain personnel have addition non-standard software installed by Data Services as it is required for their responsibilities.

The C&E GIS staff utilizes ESRI's ArcGIS 10.1 platform for all geospatial analysis and mapping needs. In addition, as needed, the staff also utilizes the SAS software platform for further analysis and data development as deemed necessary. The ESRI ArcGIS 10.1 platform includes integrated Python programming capabilities, which allows for the creation of programming scripts or batch programs to improve efficiency and documentation of processes. The Python programming language is an Open Source platform, and is freely distributable.

The centralized SDE is also provided by ESRI, and provided for a centralized geospatial database where GIS staff can store geospatial data for either read-only or editable access by GIS users in the C&E department. The C&E GIS staff maintains access privileges to the SDE datasets, and assigns individual users to various SDE access groups to grant approved accessed to data in the SDE. The SDE is considered the central warehouse whereby GIS users can go to for geospatial data to use in their analysis or mapping projects.

The software products currently used to accomplish the department's data management objectives are listed in Appendix 4.

Programming Languages
Programming services will be provided on an as needed and resource available basis. All programming efforts will follow a standard procedure from needs assessment, program planning, development and testing, to refinement and documentation. The principal programming languages to be used in task automation and project customization will depend on the nature of the need and the current state of the technology. At this time, all web-based GIS applications are developed using the ESRI ArcGIS Server platform, and user interface components to that platform are developed using the Adobe Flex API. Automated data development and analysis workflows utilize the Python programming language and the SAS programming platform as needed.

Data
Department staff members will be consulted annually to determine priority needs for data management. Based on this consultation, specific data sets will be acquired or further developed for the various program areas represented in the department. The current list of department-specific data sets is shown in Appendix 5.

A separate database lists all datasets regularly obtained from external sources, contact information, as well as the frequency of the datasets availability, and its cost. This database is developed using Microsoft Access, and is available to the C&E GIS team for tracking when updates to dataset may be available.

Personnel
The Data Management staff will be responsible for the maintenance and development of the C&E SDE, mapping server, geospatial applications, C&E GIS page, and Data Clearinghouse. These data management responsibilities cover a wide range from original data creation, acquisition and integration, data archiving and distribution. Additional responsibilities include enhancing the geographic extent, feature attributes, and metadata of the datasets.

The C&E GIS team is comprised of 3 full-time GIS professionals, one of which is the GIS Manager, and 2 full-time GIS Analysts. The C&E GIS team supports all programs within the C&E department, which include Clean Rivers/Water Quality, Sustainability, Economic Development, Solid Waste, Ped/Bike, Socio-Economic Modeling, and special project. The C&E GIS team is part of the Socio-Economic Modeling program within C&E.

H-GAC's Data Services Department plays an indirect role in the implementation and maintenance of The Plan. The Data Services Department is responsible for managing the underlying hardware and network upon which C&E stores GIS data and implements GIS-based

applications.

Training

Training for all users of the system is a critical part of The Plan. C&E staff directly responsible for data management will attend conferences, seminars, and software/hardware training courses as needed. H-GAC users of the system will be trained and/or receive technical support by the C&E GIS Manger and other C&E subject matter experts.

Budget

Budgetary requirements to sustain data management efforts will be reviewed annually.

Data Maintenance, Manipulation, and Use

Quality Assurance/Quality Control
QA/QC is designed to standardize screening, documentation, entry, output, analysis, correction, and updating of data in the system. QA/QC will document those responsible for data and system maintenance.

Data Limitations
Prior to the integration of data within the C&E SDE and posting to the Data Clearinghouse, a review of the data set will be completed to determine predefined data limitations such as missing values, different sampling frequencies, multiple measurements, analytical uncertainty, censored or unavailable data, and duplicated data with existing data sets. After review of the data set, a report will be generated which records any errors detected and any corrections that may be necessary.

Data Development Protocol
The C&E GIS staff works to update existing dataset, acquire new data, and perform geospatial analysis in support of various C&E programs. All new data generated from the result of an analysis is a candidate to be stored not only in the SDE as a new dataset, but also as a layer with a mapping application should the need arise. All data development and analysis is done internally to C&E, and at times leverages outside resources such as consultants, other non-profits whom H-GAC is partnering with, as well as with other H-GAC departments to obtain necessary data. Two datasets that the C&E department uses regularly outside the C&E SDE are the Data Services StarMap road centerline dataset, and the Data Services aerial imagery database.

The C&E GIS staff uses a hybrid approach to conducting geospatial analysis. Much of the analysis being performed may need to be re-processed at a later date as new versions of datasets become available, or as inputs to the analysis models are updated themselves. Thus to minimize the time spend re-running analysis models, the C&E GIS staff utilizes the ESRI ArcGIS platform in conjunction with SAS and Python to develop repeatable and documented workflows. This approach saves more time than interactive methods whereby a user must remember the process to follow, and then execute each step in the analysis independently.

Documentation related to data management efforts such as system evolution, structure, and procedures for use will be compiled and made available for the end user. Documentation will be made available online and in hard copy format.

Data Input
Standard conventions for data input will be determined on a per project and or individual data set basis. To ensure Year 2000 Compliance, all data sets with date/time fields will include a four-digit year (YYYY). Either of the following formats will be used: International Standard Date notation where the date field is represented as MM/DD/YYYY (Month/Day/Year), or an ordinal format where the date field is represented as YYYYDDD.

Data Dictionary
A list of all C&E data available in either the C&E SDE or other tabular formats can be found in

Appendix 5. Metadata for each dataset in the C&E SDE is stored with the datasets, and can be viewed by GIS users via their GIS desktop software. Any data provided for public download via the Data Clearinghouse also has a metadata html page that can be viewed via internet browsers.

Metadata

Metadata is data about the original source, quality, content, history, condition, and other characteristics of geospatial data. All GIS datasets generated by H-GAC have been fully documented as per Federal Geographic Data Committee (FGDC) compliant metadata and follow Content Standards for Digital Geospatial Metadata (CSDGM) for all geospatial data. Similarly, outside sources obtained and used by H-GAC will require FGDC-compliant metadata as provided by the source agency. Datasets without a known history and documented quality will be noted as provisional and used only when noted as such. The diagram below illustrates elements of the CSDGM standards. This standard is applied to all Point, Line, Polygon, Raster, and Tabular data that are stored in the C&E SDE. The C&E GIS data manager and/or point of contact has the authorized access to edit/change the metadata when a new dataset is created or updated in the SDE. Metadata for each dataset in the C&E SDE is stored with the datasets, and can be viewed by GIS users via their GIS desktop software. Any data provided for public download via the Data Clearinghouse also has a metadata html page that can be viewed via internet browsers.
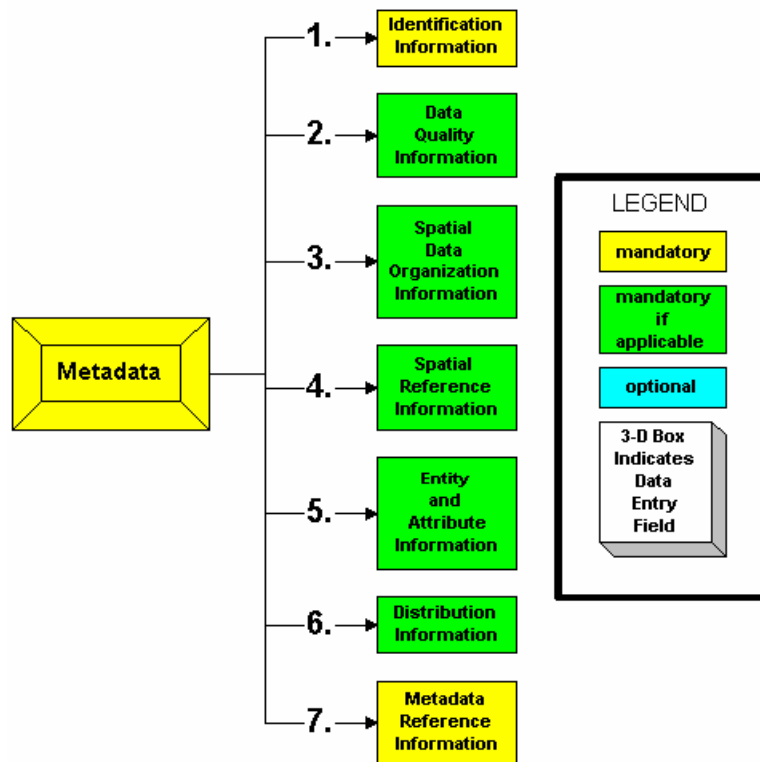
Data Conversion

Data to be imported into the C&E SDE from hard copy, digital or by manual data entry, will follow a uniform conversion protocol to comply with the structure of current data sets. The type

of data being converted will determine the protocol. All data is stored in ESRI geodatabase format within the C&E SDE, and when posted to the Data Clearinghouse the data is stored in the ESRI File Geodatabase file format, unless there is a specific requirement to provide the data in another format such as Shapefile or GIS Coverage.

Coordinate Systems
The Texas Stateplane Coordinate System, North American Datum 1983 (NAD83) will be the standard for geographic data at H-GAC. This coordinate system is based on the Cartesian coordinate system, or rectangular coordinates. When receiving geographic data from other sources the data will be transformed into the Stateplane Coordinate System to ensure compatibility with current data sets.
When publishing mapping services for use in web-based GIS mapping applications, the Web Mercator Auxiliary Sphere projection is used for all Data Frame projections. However, the underlying GIS data within these mapping services still use the Texas Stateplane Coordinate System, North American Datum 1983 (NAD83) projection.

Data Validation
Data Quality Control
When data are received from any source, documentation will be created to include the source name, date received, format of data and a brief description of the contents. Data will be loaded onto the system from the media received and a review of the data will be made along with any corrections being made to the source documentation. An analysis will be made in order to determine the means of data entry into the system whether it is only a stand-alone database, a number of linked tables, or a geographic database. The data will be converted to the appropriate format for integration with the current system whether it is a conversion into MS Access, Excel, SAS, or ESRI ArcGIS. The data will be visually examined to determine its validity and accuracy. If the data is invalid it will be corrected (if possible) otherwise the data will be incorporated into the C&E SDE, and then if applicable, posted to the Data Clearinghouse and used in conjunction with existing data. A QA/QC report of all procedures and a detailed description of how the data was incorporated into the current system (from the date received to the date of integration) will be generated.

Equipment Quality Control
All printers, workstations, and server hardware and operating systems are maintained by the Data Services department, unless otherwise noted in Appendix 3.

Genealogy
Upon receipt of data from outside sources, all data will be screened for integrity and completeness. After the preliminary evaluation of the data, a log of the data source, type and completeness is created and maintained with the associated data. A description of the data and the responsible personnel are documented.
Migration/Transfer
A copy of every C&E generated GIS dataset will be housed in the C&E SDE which C&E GIS staff manage the contents and structure of datasets. The underlying hardware and network connections for the C&E SDE are maintained by the Data Services Department. Datasets that are of public interest will be placed in the Data Clearinghouse for public access. Transfer from the

C&E SDE to the Data Clearinghouse will occur on an as needed basis following department QA/QC measures and is handled by the C&E GIS team.

Data Security & Access
Data placed on the Data Clearinghouse will be available to those with Internet browsing and/or FTP capability. Data requests for non-public data from other agencies and the general public will be evaluated on an individual basis. When the data requests are received, a preliminary evaluation of the deliverable will be determined and a timeline and cost if applicable will be provided to the requesting agency or individual.
GIS and tabular data will be secure through directory permissions. H-GAC will employ Firewall or Proxy Server Technology to filter and severely restrict access to internal networks and database systems. Virus protection will be implemented to ensure system and data integrity.

Archives/Backup
Each week the C&E GIS team runs a schedule backup program to store a copy of all C&E SDE datasets on a portable hard drive with resides in a secure location within the H-GAC office. In addition, Data Services backs up and archives C&E SDE data and server configuration at regular intervals.. A backup will be performed daily and the tapes will be maintained for 8 weeks before they will be recycled. Every six month, a complete system backup will be performed and the tapes will be archived and kept for five years off-site for security.

Disaster Recovery
In the event of a disaster, the C&E department will have access to all C&E SDE data which is stored on the portable hard drive. The C&E GIS team will restore or provide needed data to GIS users from this portable hard drive until such as time that Data Services can restore the C&E SDE onto either a new server or a temporary server.

Appendices

Appendix 1 Data Source Information Sheet
Data Title:

Source Agency:
Contact:
Title:
Address
Phone:

Data Description:
Data source:
Date created:
Accuracy:
Media:
Data items:

Description of data:

Format (specify what software)
Map:
Tabular:
Image:
Text:

Retrieval Procedure:

Command(s):

Appendix 2 Data Log Sheet

Date received: _____

Report Prepared by: _____

Source Name and Phone: _____

Format: _____

Media: _____

Check the following steps to determine the validity of the data:

1. What is the extent of the geographic area? _____
_____

2. Structure (Circle One)   Vector   Raster

3. Scale? _____

4. Projection and Datum? _____

1. Do any of the key fields have missing values?   If so which parameters have missing
values? Yes ___   No ___
_____
_____
_____

2. Any known duplicate records?   Yes ___ No ___

Appendix 3 Hardware
   FTP Server
Windows 2000 Server

Mapping Application Servers

Production Server (NTCEIS01)

Model:	HP Proliant BL460c G6 Blade
CPU:	Quad-Core Intel Xeon X5560 (2.80 GHz, 8M Cache)
Memory:	8GB
Hard Drive:	300GB
OS:	Windows 2008
Internet Address:	204.65.99.189
Domain URL:	http://arcgis02.h-gac.com
Serial #:	USE936RV4S
Purchased:	January 2010

Development/Backup Server (NTIS04)

Model:	HP Proliant DL 380 G3
CPU:	Single Intel Xeon 2800
Memory:	1GB
Hard Drive:	C = 16 GB, D=66 GB
OS:	Windows 2000 SP 4
Internet Address:	204.65.99.240
Domain URL:	http://arcgis.h-gac.com
Serial #:	D313LDN1L122
Purchased:	April 2003

Printers & Plotters
HP1055CM Plotter - Used by C&E staff for large format printing of maps and schematics.
HP2500CM and LaserJet 4M Printers. C&E maintains both printers.

Global Positioning System (GPS) Units
The C&E Department possesses two GPS units.

Scanning Equipment
HP Scanjet 7400c. The CEP Department owns one network-accessible HP scanner.

Fax Equipment
Brother Intellifax 4750e. The C&E Department owns one fax machine.

Portable Storage Devices
Lacie 300GB external hard drive (USB, Firewire)

Appendix 4 Software

Office Productivity Software

Microsoft Office Pro (2007) - Word, Excel, Access, PowerPoint, publisher, InfoPath and
Outlook.
Internet Explorer (ver 7) – Primary Development Tool

Graphics and Desktop Publishing

Macromedia Fireworks 4
Adobe Illustrator (ver 8.01) – Graphics
Adobe Photoshop (ver 5.0) – Graphics
Corel Draw (ver 7.0) - Graphics
Quark Express (ver 5.0) - Desktop Publishing.
Paintshop Pro (ver 4.12)
Camtasia Studio (ver 7.0) – Screen capture and video tutorial production

Programming

Visual Basic (ver 6.0) – Web Mapping Development Tool.
MS Active Server Pages (ver 2.0) – Web Database Development Tool.
Adobe Flex Builder (ver 4.0) – Web-based GIS application development tool
SAS (ver 9.3) – Data development and analytics.

Geographic Information Systems (GIS)

ESRI ArcGIS (ver 10.1, SP1) – Computer mapping and database manipulation capable of using
ArcView, ArcInfo, and ArcEditor licenses as needed.
ESRI ArcGIS Server (ver 10, SP3) – Internet Mapping Application Server.
ESRI ArcSDE (ver 10.1, SP1) – Spatial data warehouse.

Data Management

Access (2007, 2010) - Relational Database.
SQL Server(2000) - Relational Database.

Operating Systems

Windows XP - PC working environment/Operating System
Windows 7 - PC working environment/Operating System
Windows 2003 & 2008 - Server Operating Systems

Appendix 5 Data List

C&E Spatial Data Warehouse (SDE) Datasets

Dataset Name	Type
AustCAD_Parcels_Coverage_2005	Polygon
AustCAD_Parcels_Coverage_2005_pts	Point
AustCAD_Parcels_Coverage_2006	Polygon
AustCAD_Parcels_Coverage_2006_pts	Point
AustCAD_Parcels_Coverage_2007	Polygon
AustCAD_Parcels_Coverage_2007_pts	Point
AustCAD_Parcels_Coverage_2008	Polygon
AustCAD_Parcels_Coverage_2008_Pts	Point
Austin_County	Polygon
AUSTIN_COUNTY_PARCEL_INFO_2005	Table
AUSTIN_COUNTY_PARCEL_INFO_2006	Table
AUSTIN_COUNTY_PARCEL_INFO_2007	Table
Austin_County_Parcel_Info_2008	Table
Austin_County_Parcel_Values_2006	Table
Austin_County_Parcel_Values_2007	Table
Austin_County_Parcel_Values_2008	Table
BrazCAD_Parcels_Coverage_2005	Polygon
BrazCAD_Parcels_Coverage_2005_pts	Point
BrazCAD_Parcels_Coverage_2006	Polygon
BrazCAD_Parcels_Coverage_2006_pts	Point
BrazCAD_Parcels_Coverage_2007	Polygon
BrazCAD_Parcels_Coverage_2007_pts	Point
BrazCAD_Parcels_Coverage_2008	Polygon
BrazCAD_Parcels_Coverage_2008_Pts	Point
Brazoria_County	Polygon
BRAZORIA_COUNTY_PARCEL_INFO_2005	Table
BRAZORIA_COUNTY_PARCEL_INFO_2006	Table
BRAZORIA_COUNTY_PARCEL_INFO_2007	Table
Brazoria_County_Parcel_Info_2008	Table
Brazoria_County_Parcel_Values_2005	Table
Brazoria_County_Parcel_Values_2006	Table
Brazoria_County_Parcel_Values_2007	Table
Brazoria_County_Parcel_Values_2008	Table
Brazoria_County_Political	Polygon
Chambers_County	Polygon
Chambers_County_Political	Polygon
Clean_Rivers_Public_Feedback	Point
Clean_Rivers_Public_Feedback__ATTACH	Table
Colorado_County	Polygon
CRP_Project_Areas	Polygon
FBendCAD_Parcels_Coverage_2005	Polygon

Dataset Name	Type
FBendCAD_Parcels_Coverage_2005_pts	Point
FBendCAD_Parcels_Coverage_2006	Polygon
FBendCAD_Parcels_Coverage_2006_pts	Point
FBendCAD_Parcels_Coverage_2007	Polygon
FBendCAD_Parcels_Coverage_2007_pts	Point
FBendCAD_Parcels_Coverage_2008	Polygon
FBendCAD_Parcels_Coverage_2008_Pts	Point
Fort_Bend_County	Polygon
Fort_Bend_County_Parcel_Info_2006	Table
Fort_Bend_County_Parcel_Info_2007	Table
Fort_Bend_County_Parcel_Info_2008	Table
Fort_Bend_County_Parcel_Values_2006	Table
Fort_Bend_County_Parcel_Values_2007	Table
Fort_Bend_County_Parcel_Values_2008	Table
GalvCAD_Parcels_Coverage_2005	Polygon
GalvCAD_Parcels_Coverage_2005_pts	Point
GalvCAD_Parcels_Coverage_2006	Polygon
GalvCAD_Parcels_Coverage_2006_pts	Point
GalvCAD_Parcels_Coverage_2007	Polygon
GalvCAD_Parcels_Coverage_2007_Pts	Point
GalvCAD_Parcels_Coverage_2008	Polygon
GalvCAD_Parcels_Coverage_2008_Pts	Point
Galveston_Bay_Estuary_Program_Watersheds	Polygon
Galveston_County	Polygon
GALVESTON_COUNTY_PARCEL_INFO_2005	Table
GALVESTON_COUNTY_PARCEL_INFO_2007	Table
Galveston_County_Parcel_Info_2008	Table
Galveston_County_Parcel_Values_2005	Table
Galveston_County_Parcel_Values_2007	Table
Galveston_County_Parcel_Values_2008	Table
Galveston_County_Political	Polygon
Grimes_County	Polygon
Gulf_Of_Mexico	Polygon
Harris_County	Polygon
Harris_County_FCD_Sub_Watersheds	Polygon
Harris_County_FCD_Watersheds	Polygon
HARRIS_COUNTY_PARCEL_INFO_2005	Table
HARRIS_COUNTY_PARCEL_INFO_2006	Table
HARRIS_COUNTY_PARCEL_INFO_2007	Table
Harris_County_Parcel_Info_2008	Table
Harris_County_Parcel_Values_2005	Table
Harris_County_Parcel_Values_2006	Table
Harris_County_Parcel_Values_2007	Table

Harris_County_Parcel_Values_2008	Table
Dataset Name	**Type**
Harris_County_Zones_58	Polygon
HCAD_Parcels_Coverage_2000	Polygon
HCAD_Parcels_Coverage_2000_pts	Point
HCAD_Parcels_Coverage_2003	Polygon
HCAD_Parcels_Coverage_2003_pts	Point
HCAD_Parcels_Coverage_2005	Polygon
HCAD_Parcels_Coverage_2005_pts	Point
HCAD_Parcels_Coverage_2006	Polygon
HCAD_Parcels_Coverage_2006_pts	Point
HCAD_Parcels_Coverage_2007	Polygon
HCAD_Parcels_Coverage_2007_Pts	Point
HCAD_Parcels_Coverage_2008	Polygon
HCAD_Parcels_Coverage_2008_Pts	Point
HGAC_13_County_Airports	Point
HGAC_13_County_Airports_ParcelIDs	Table
HGAC_13_County_BlockGroups_1990	Polygon
HGAC_13_County_BlockGroups_2000	Polygon
HGAC_13_County_BlockGroups_2010	Polygon
HGAC_13_County_Blocks_2000	Polygon
HGAC_13_County_Blocks_2010	Polygon
HGAC_13_County_Brownfield_Sites	Point
HGAC_13_County_Bus_Routes	Polyline
HGAC_13_County_Bus_Stops	Point
HGAC_13_County_Census_PL_Data_2010_Block_Groups	Table
HGAC_13_County_Census_PL_Data_2010_Blocks	Table
HGAC_13_County_Census_PL_Data_2010_Counties	Table
HGAC_13_County_Census_PL_Data_2010_Places	Table
HGAC_13_County_Census_PL_Data_2010_School_Districts	Table
HGAC_13_County_Census_PL_Data_2010_Tracts	Table
HGAC_13_County_Census_Places_2000	Polygon
HGAC_13_County_Census_Places_2000_Clipped	Polygon
HGAC_13_County_Census_Places_2000_Pts	Point
HGAC_13_County_Census_Places_2010	Polygon
HGAC_13_County_Census_Places_2010_Clipped	Polygon
HGAC_13_County_Census_Places_2010_Pts	Point
HGAC_13_County_Census_Urban_Areas_1990	Polygon
HGAC_13_County_Census_Urban_Areas_2000	Polygon
HGAC_13_County_Census_Urban_Areas_2009	Polygon
HGAC_13_County_Census_Urban_Areas_2010	Polygon
HGAC_13_County_Census_Zip_Codes_2010	Polygon
HGAC_13_County_City_Boundaries	Polygon
HGAC_13_County_City_Boundaries_Clipped	Polygon

Dataset Name	Type
HGAC_13_County_City_Ordinance_Areas	Polygon
HGAC_13_County_Closed_Landfill_Inventory	Point
Dataset Name	**Type**
HGAC_13_County_Landfill_Areas	Polygon
HGAC_13_County_Landfill_Areas_Historical	Polygon
HGAC_13_County_Landfills	Point
HGAC_13_County_Landfills_Historical	Point
HGAC_13_COUNTY_COASTAL_VIGNETTE	Raster
HGAC_13_County_Coastline	Polygon
HGAC_13_County_Coastline_Boundary	Polygon
HGAC_13_County_CRP_DO_Stations	Point
HGAC_13_County_CRP_Monitoring_Stations_2008	Point
HGAC_13_County_CRP_Monitoring_Stations_2010	Point
HGAC_13_County_CRP_Monitoring_Stations_2011	Point
HGAC_13_County_CRP_Monitoring_Stations_2012	Point
HGAC_13_County_CRP_Monitoring_Stations_2013	Point
HGAC_13_County_CRP_Monitoring_Stations_2014	Point
HGAC_13_County_CRP_Monitoring_Stations_2015	Point
HGAC_13_County_CRP_Monitoring_Stations_2016	Point
HGAC_13_County_CRP_Monitoring_Stations_Historical	Point
HGAC_13_County_Dams	Point
HGAC_13_County_Districts	Polygon
HGAC_13_County_Election_Precincts_2010	Polygon
HGAC_13_County_Farmland	Polygon
HGAC_13_County_Federal_Aid_Roads	Polyline
HGAC_13_County_G1M	Polygon
HGAC_13_County_G3M	Polygon
HGAC_13_County_G5M	Polygon
HGAC_13_County_Grocery_Stores	Point
HGAC_13_County_Libraries	Point
HGAC_13_County_Libraries_Parcel_Xref	Table
HGAC_13_County_Major_Rivers	Polyline
HGAC_13_County_Major_Roads	Polyline
HGAC_13_County_Metropolitan_Statistical_Area	Polygon
HGAC_13_County_OSSF_Permits	Point
HGAC_13_County_Parks	Point
HGAC_13_County_Parks_Awards	Table
HGAC_13_County_Parks_Features	Table
HGAC_13_County_Parks_Parcels	Table
HGAC_13_County_Pipelines	Polyline
HGAC_13_County_Plats	Polygon
HGAC_13_County_Political	Polygon
HGAC_13_County_Political_Boundary	Polygon
HGAC_13_County_Railroads	Polyline

Dataset Name	Type
HGAC_13_County_Raster_Extent	Polygon
HGAC_13_County_Recycle_Centers	Point
HGAC_13_County_School_Districts_Census_2010	Polygon
Dataset Name	**Type**
HGAC_13_County_School_Districts_TEA_2010	Polygon
HGAC_13_County_Service_Area_Boundaries	Polygon
HGAC_13_County_Soils	Polygon
HGAC_13_County_State_Parks	Polygon
HGAC_13_County_Superfund_NPL_Sites	Polygon
HGAC_13_County_Superfund_NPL_Sites_Pts	Point
HGAC_13_County_TIRZs	Polygon
HGAC_13_County_Tracts_1990	Polygon
HGAC_13_County_Tracts_2000	Polygon
HGAC_13_County_Tracts_2010	Polygon
HGAC_13_County_Transit_Centers_Parks_and_Rides	Point
HGAC_13_County_Water	Polygon
HGAC_13_County_Water_Detailed	Polygon
HGAC_13_County_Watershed_Project_Monitoring_Sites	Point
HGAC_13_County_Zip_Codes_2000	Polygon
HGAC_13_County_Zip_Codes_2002	Polygon
HGAC_13_County_Zip_Codes_2005	Polygon
HGAC_15_County_Aquifer_Recharge_Zones	Polygon
HGAC_15_County_Basins	Polygon
HGAC_15_County_Bio_Monitoring_Sites	Point
HGAC_15_County_Census_Zip_Codes_2010	Polygon
HGAC_15_County_City_Boundaries	Polygon
HGAC_15_County_City_Boundaries_Clipped	Polygon
HGAC_15_County_Coastline	Polygon
HGAC_15_County_Coastline_Boundary	Polygon
HGAC_15_County_Contours_2_Feet	Polyline
HGAC_15_County_Contours_5_Feet	Polyline
HGAC_15_COUNTY_CRP_Impairments	Table
HGAC_15_County_CRP_Lakes	Polygon
HGAC_15_County_CRP_Stream_End_Points	Point
HGAC_15_County_CRP_Streams	Polyline
HGAC_15_County_DEM_10m	Raster
HGAC_15_County_Hillshade	Raster
HGAC_15_County_Major_Rivers	Polyline
HGAC_15_County_Major_Roads	Polyline
HGAC_15_County_Political	Polygon
HGAC_15_County_Political_Boundary	Polygon
HGAC_15_County_School_Districts_TEA_2010	Polygon
HGAC_15_County_Soils	Polygon
HGAC_15_County_Wastewater_Outfalls	Point

Dataset Name	Type
HGAC_15_County_Wastewater_Outfalls_Historical	Point
HGAC_15_County_Wastewater_Outfalls_Info	Table
HGAC_15_County_Water	Polygon
HGAC_15_County_Watershed_Insets	Polygon
Dataset Name	**Type**
HGAC_15_County_Watershed_Signs	Point
HGAC_15_County_Watersheds	Polygon
HGAC_15_County_Zip_Codes_2000	Polygon
HGAC_15_County_Zip_Codes_2002	Polygon
HGAC_8_County_Bikeway_Needs	Polyline
HGAC_8_County_Bikeways	Polyline
HGAC_8_County_BlockGroups_2000	Polygon
HGAC_8_County_BlockGroups_2010	Polygon
HGAC_8_County_Blocks_2000	Polygon
HGAC_8_County_Blocks_2010	Polygon
HGAC_8_County_Census_Places_2000	Polygon
HGAC_8_County_Census_Places_2000_Clipped	Polygon
HGAC_8_County_Census_Places_2000_Pts	Polygon
HGAC_8_County_Census_Places_2010	Polygon
HGAC_8_County_Census_Places_2010_Clipped	Polygon
HGAC_8_County_Census_Places_2010_Pts	Polygon
HGAC_8_County_Census_Urban_Areas_2000	Polygon
HGAC_8_County_Census_Urban_Areas_2009	Polygon
HGAC_8_County_Census_Urban_Areas_2010	Polygon
HGAC_8_County_Census_Zip_Codes_2010	Polygon
HGAC_8_County_City_Boundaries	Polygon
HGAC_8_County_City_Boundaries_Clipped	Polygon
HGAC_8_County_City_Ordinance_Areas	Polygon
HGAC_8_COUNTY_COASTAL_VIGNETTE	Raster
HGAC_8_County_Coastal_Vignette_50_25	Polygon
HGAC_8_County_Coastline	Polygon
HGAC_8_County_Coastline_Boundary	Polygon
HGAC_8_County_Comprehensive_Plan_2010_pts	Point
HGAC_8_County_Eco_Types	Polygon
HGAC_8_County_Forecast_Cities_h	Table
HGAC_8_County_Forecast_Cities_v	Table
HGAC_8_County_Forecast_Counties_h	Table
HGAC_8_County_Forecast_Counties_v	Table
HGAC_8_County_Forecast_G025M_h	Table
HGAC_8_County_Forecast_G1_h	Table
HGAC_8_County_Forecast_G10K_h	Table
HGAC_8_County_Forecast_G10K_v	Table
HGAC_8_County_Forecast_G1M_h	Table
HGAC_8_County_Forecast_G1M_v	Table

Dataset Name	Type
HGAC_8_COUNTY_FORECAST_LU_G1_H	Table
HGAC_8_County_Forecast_RAZ_h	Table
HGAC_8_County_Forecast_RAZ_v	Table
HGAC_8_County_Forecast_Region_v	Table
HGAC_8_County_Forecast_TAZ_h_2003	Table
Dataset Name	**Type**
HGAC_8_County_Forecast_TAZ_v_2003	Table
HGAC_8_County_Forecast_Tracts_h	Table
HGAC_8_County_Forecast_Tracts_v	Table
HGAC_8_County_Forecast_Zip_Codes_h	Table
HGAC_8_County_Forecast_Zip_Codes_v	Table
HGAC_8_County_G025M	Polygon
HGAC_8_County_G1	Polygon
HGAC_8_County_G10	Polygon
HGAC_8_County_G1M	Polygon
HGAC_8_County_Livable_Centers	Point
HGAC_8_County_Livable_Centers_Areas	Polygon
HGAC_8_County_Major_Rivers	Polyline
HGAC_8_County_Major_Roads	Polyline
HGAC_8_County_PedBike_Improvement_Areas	Polyline
HGAC_8_County_PedBike_Improvement_Locations	Polyline
HGAC_8_County_Pedestrian_Pathways	Polyline
HGAC_8_County_Political	Polygon
HGAC_8_County_Political_Boundary	Polygon
HGAC_8_County_Railroads	Polyline
HGAC_8_County_Raster_Extent	Polygon
HGAC_8_County_RAZ	Polygon
HGAC_8_County_School_Districts_TEA_2010	Polygon
HGAC_8_County_Soils	Polygon
HGAC_8_County_TAZ_2003	Polygon
HGAC_8_County_Tracts_1970	Polygon
HGAC_8_County_Tracts_1980	Polygon
HGAC_8_County_Tracts_2000	Polygon
HGAC_8_County_Tracts_2010	Polygon
HGAC_8_County_Water	Polygon
HGAC_8_County_Water_Detailed	Polygon
HGAC_8_County_Zip_Codes_2000	Polygon
HGAC_8_County_Zip_Codes_2002	Polygon
HGAC_8_County_Zip_Codes_2005	Polygon
HGAC_8_County_Zoning_2010_pts	Point
HGAC_Bastrop_Bayou_Sub_Watersheds	Polygon
HGAC_CRP_Watersheds	Polygon
HGAC_LAND_COVER_10_CLASS_2008	Polygon
HGAC_LAND_COVER_10_CLASS_ROADS_2008	Raster

Dataset Name	Type
HGAC_LAND_COVER_3X3_MODE_FILTERED_2008	Raster
HGAC_LAND_COVER_MERGED_6_CLASS_2008	Raster
HGAC_Other_CRP_Monitoring_Stations	Point
HGAC_Sea_Level_Rise_10Ft	Polygon
HGAC_Sea_Level_Rise_15Ft	Polygon
HGAC_Sea_Level_Rise_1Ft	Polygon
Dataset Name	**Type**
HGAC_Sea_Level_Rise_20Ft	Polygon
HGAC_Sea_Level_Rise_25Ft	Polygon
HGAC_Sea_Level_Rise_30Ft	Polygon
HGAC_Sea_Level_Rise_35Ft	Polygon
HGAC_Sea_Level_Rise_3Ft	Polygon
HGAC_Sea_Level_Rise_5Ft	Polygon
HGAC_Sea_Level_Rise_All_Levels	Polygon
HGAC_Sea_Level_Rise_Current_Sea_Level	Polygon
Hurricane_Dolly_Observations	Point
Hurricane_Dolly_Track	Polyline
Hurricane_Ike_High_Water_Measurements	Point
Hurricane_Ike_Observations	Point
HURRICANE_IKE_SALT_BURN_GULF_COAST	Raster
Hurricane_Ike_Storm_Surge_Model_i48_gl2	Polygon
HURRICANE_IKE_STORM_SURGE_MODEL_I48_GL2_RASTER	Raster
Hurricane_Ike_Track	Polyline
Land_Cover_1992_19_Class_NLCD	Raster
Land_Cover_1992_19_Class_NLCD_Corrected	Raster
Land_Cover_1996_22_Class_NOAA	Raster
Land_Cover_2001_15_Class_NLCD	Raster
Land_Cover_2001_15_Class_NLCD_Corrected	Raster
Land_Cover_2001_22_Class_NOAA	Raster
Land_Cover_2005_22_Class_NOAA	Raster
Land_Cover_2006_15_Class_NLCD	Raster
Land_Cover_2011_15_Class_NOAA	Raster
Land_Cover_2011_22_Class_NOAA	Raster
Land_Cover_Change_1992_to_2011_9_Class	Raster
LibCAD_Parcels_Coverage_2007	Polygon
LibCAD_Parcels_Coverage_2007_pts	Point
LibCAD_Parcels_Coverage_2008	Polygon
LibCAD_Parcels_Coverage_2008_Pts	Point
Liberty_County	Polygon
LIBERTY_COUNTY_PARCEL_INFO_2007	Table
Liberty_County_Parcel_Info_2008	Table
Liberty_County_Parcel_Values_2007	Table
Liberty_County_Parcel_Values_2008	Table
Matagorda_County	Polygon

Dataset Name	Type
Matagorda_County_Political	Polygon
METRO_LRT_Lines	Polyline
METRO_LRT_Stations	Point
Model_Buildings	Point
Model_Buildings_Rural	Point
Model_Buildings_Uses	Point
Model_Buildings_Uses_Rural	Table
Dataset Name	**Type**
Model_Parcels	Table
Model_Parcels_Acct_Nums	Polygon
Model_Parcels_Acct_Nums_Rural	Table
Model_Parcels_Addresses	Table
Model_Parcels_Addresses_Rural	Table
Model_Parcels_Features	Table
Model_Parcels_Features_Rural	Table
Model_Parcels_Forecast	Table
Model_Parcels_Removed_Merged	Table
Model_Parcels_Rural	Polygon
MontCAD_Parcels_Coverage_2005	Polygon
MontCAD_Parcels_Coverage_2005_pts	Point
MontCAD_Parcels_Coverage_2006	Polygon
MontCAD_Parcels_Coverage_2006_pts	Point
MontCAD_Parcels_Coverage_2007	Polygon
MontCAD_Parcels_Coverage_2007_pts	Point
MontCAD_Parcels_Coverage_2008	Polygon
MontCAD_Parcels_Coverage_2008_Pts	Point
Montgomery_County	Polygon
MONTGOMERY_COUNTY_PARCEL_INFO_2006	Table
MONTGOMERY_COUNTY_PARCEL_INFO_2007	Table
Montgomery_County_Parcel_Info_2008	Table
Montgomery_County_Parcel_Values_2006	Table
Montgomery_County_Parcel_Values_2007	Table
Montgomery_County_Parcel_Values_2008	Table
Montgomery_County_Zones_4	Polygon
NLCD_IMPERVIOUSNESS_2001	Raster
NLCD_IMPERVIOUSNESS_2006	Raster
NLCD_IMPERVIOUSNESS_CHANGE_2006	Raster
NLCD_TREE_CANOPY_2001	Raster
NOAA_Surge_MOM_Galveston_Bay	Polygon
NOAA_Surge_MOM_Matagorda_Bay	Polygon
San_Jacinto_County	Polygon
SEM_User_Input_Point	Point
SEM_User_Input_Polygon	Polygon
SEM_User_Input_Polyline	Polyline

Dataset Name	Type
Texas_113th_Congressional_Districts	Polygon
Texas_Census_BlockGroups_1990	Polygon
Texas_Census_BlockGroups_2000	Polygon
Texas_Census_BlockGroups_2010	Polygon
Texas_Census_Blocks_2000	Polygon
Texas_Census_Blocks_2010	Polygon
Texas_Census_School_Districts_2010	Polygon
Texas_Census_Tracts_1990	Polygon
Dataset Name	**Type**
Texas_Census_Tracts_2000	Polygon
Texas_Census_Tracts_2010	Polygon
Texas_Census_Urban_Areas_2009	Polygon
Texas_Coastal_Bathymetry	Point
Texas_Coastal_Vignette_50_25	Polygon
Texas_Coastline	Polygon
Texas_COG_Boundaries	Polygon
Texas_Counties_Coastline	Polygon
Texas_Counties_Political	Polygon
Texas_Highways	Polyline
Texas_Impairment_Streams_2008	Polyline
Texas_Impairment_Waterbodies_2008	Polygon
Texas_Major_Rivers	Polyline
Texas_Map_Extent	Polygon
Texas_State_House_Districts_2012	Polygon
Texas_State_Senate_Districts_2012	Polygon
Texas_Stream_Team_Monitoring_Sites	Point
Texas_Zip_Codes_2005	Polygon
The_Woodlands_Pathways	Polyline
TMDL_Project_Areas	Polygon
TMDL_Project_Areas_Mask	Polygon
TMDL_Watersheds	Polygon
US_State_Boundaries	Polygon
USFWS_Wetlands_2009	Polygon
USFWS_Wetlands_2010	Polygon
USFWS_Wetlands_2011	Polygon
USFWS_Wetlands_2012	Polygon
USGS_HUC_10_Watersheds	Polygon
USGS_HUC_12_Sub_Watersheds	Polygon
USGS_HUC_6_Basins	Polygon
USGS_HUC_8_Sub_Basins	Polygon
USGS_River_Basins	Polygon
USGS_Stream_Gauges_2009	Point
USGS_Stream_Gauges_2010	Point
USGS_Stream_Gauges_2012	Point

USGS_Sub_Watershed_Study_Areas	Polygon
WalkCAD_Parcels_Coverage_2005	Polygon
WalkCAD_Parcels_Coverage_2005_pts	Point
WalkCAD_Parcels_Coverage_2006	Polygon
WalkCAD_Parcels_Coverage_2006_pts	Point
WalkCAD_Parcels_Coverage_2007	Polygon
WalkCAD_Parcels_Coverage_2007_pts	Point
WalkCAD_Parcels_Coverage_2008	Polygon
WalkCAD_Parcels_Coverage_2008_Pts	Point
Dataset Name	**Type**
Walker_County	Polygon
WALKER_COUNTY_PARCEL_INFO_2005	Table
WALKER_COUNTY_PARCEL_INFO_2006	Table
WALKER_COUNTY_PARCEL_INFO_2007	Table
Walker_County_Parcel_Info_2008	Table
Walker_County_Parcel_Values_2005	Table
Walker_County_Parcel_Values_2006	Table
Walker_County_Parcel_Values_2007	Table
Walker_County_Parcel_Values_2008	Table
WallCAD_Parcels_Coverage_2007	Polygon
WallCAD_Parcels_Coverage_2007_Pts	Point
WallCAD_Parcels_Coverage_2008	Polygon
WallCAD_Parcels_Coverage_2008_Pts	Point
Waller_County	Polygon
WALLER_COUNTY_PARCEL_INFO_2007	Table
Waller_County_Parcel_Info_2008	Table
Waller_County_Parcel_Values_2007	Table
Waller_County_Parcel_Values_2008	Table
Wharton_County	Polygon
World_Country_Boundaries	Polygon

C&E Non-Spatial Data

Ambient SWQM
Wastewater Self-reporting Data
Parcel-Based Land Use, Attributes, and Valuation (9 counties)
Census Data

Appendix 6 Data Dictionary

Data Dictionary Houston-Galveston Area Council Community and Environmental Planning Department				
Thematic Layer Name				
Feature Class				
Topology				
Table Name				
Data Source				
Report Prepared by				
Phone		Fax		E-Mail
Attribute Table				
Variable	Begin Column	Item Name	Alternate Name	Item Definition
Data History				
Source Agency				
Originating Date				
Originating Scale				
Status Information				
Percentage Complete				
Planned Completion Date				
Geographic Extent				
Planned Enhancements				
Known problems or limitations				
Maintenance Information				
Maintaining Office/Division/Section				
Contact Name				
Contact Telephone Number				
Type of updates performed				
Frequency of Updates				

Data Format Information
Data Format
Software/Version
Number of features/records
Total File Size
Projection
Geographic Projection:
Spheroid:
Zone:
Datum:
Units:
Fips Zone:
Quadrant:
X Shift:
Y Shift:
1st Standard Parallel:
2nd Standard Parallel:
Central Meridian:
Lat. of Projection Origin:
False Easting:
False Northing:
Additional Documentation
Quality Assurance Quality Control
Attribute Reports Available
Additional Documentation Available

Appendix 6 H-GAC C&E GIS Website & Data Clearinghouse

Appendix C: Field Data & Chain of Custody Sheets

H-GAC – Illicit Flow Monitoring Data Sheet

Date: _____/_____/_____   Outfall Location: _____

Time (military):_____   Survey Conducted by:_____

Material of outfall pipe	1 – concrete; 2 – PVC; 3 – metal; 4 - other		Latitude & Longitude	
Describe 'Other' pipe material			# of Days Since Last Significant Rainfall	
Inner Diameter of Pipe	Inches		Rainfall accumulation in last 3 days (inches)	
Depth of Water flowing from outfall pipe	Inches		Primary Contact, # of People Observed (1-10, >10)	
Chlorine Residual	PPM		Evidence of Primary Contact (1- Observed, 0 - Not Observed)	

Secchi Depth (disk or tube)	Observed Turbidity	Water Clarity	Water Color	Water Odor	Algae Cover in/on surface of pipe	Present Weather	Wind Intensity
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 – absent 2 – rare (<25%) 3 – common (26-50%) 4 – abundant (51-75%) 5 – dominant (>75%)	1 – clear 2 – partly cloudy 3 – cloudy 4 – raining 5 – other	1 – calm 2 – slight 3 –moderate 4 – strong

Water Temperature	°C		pH	standard units	
Specific Conductance	µS/cm		Dissolved Oxygen	mg/L	
Comments or Observation					

Surveyor SN:_____   Sonde SN:_____

BACTERIA ANALYSIS

Containers	Preservatives	Analyses Requested
1 x 100 mL Sterile Plastic	Iced	Bacteria: *E. coli*
		Yes / No

Set-Up
Date:_____Time:_____Analyst:_____

Reading
Date:_____Time:_____Analyst:_____

INCUBATION	Period (28-31 hrs)		Temperature (33+/-3°C) Start / End		
SAMPLE 1	Sample Size (mL)		Dilution Factor (100/sample size)	
Colonies Counted		X dilution factor =	Results = Colonies/100 mL	
SAMPLE 2	Sample Size (mL)		Dilution Factor (100/sample size)	
Colonies Counted		X dilution factor =	Results = Colonies/100 mL	
FIELD BLANK	*E.coli* colony growth	(Check One)	Yes	No
DATA QUALITY REVIEW	Checklist completed	(Check One)	Yes	No

Updated: November 4, 2015

DATA QUALITY REVIEW CHECKLIST for BACTERIA TESTING using EASYGEL

	Yes/No	Comments
Monitor is trained & certified		
Is the media expired		
Incubation temperature is 33°C (+/-3°C)		
Incubation time is 28-31 hours		
Data Form is complete		
Optimal colony number is achieved (<200)		
Dilution factor calculation is correct		
Colony Growth on Field Blanks		

Analyst: _____ Date: _____ Time: _____

Updated: November 4, 2015

EASTEX ENVIRONMENTAL LAB, INC.

P.O. Box 1089
Coldspring, TX 77331
(936) 653-3249 * (800) 525-0608

P.O. Box 631375
Nacogdoches, TX 75963-1375
(936) 569-8879 * FAX (936) 569-8951

Company:
Address:
Attn:
Phone#:
Fax#: Email:
P.O. #
Sampler's Name (print)

Bill to:
Address: H-GAC **Attn:** Jean Wright
P.O. Box 22777, Houston, TX 77227-2777
Phone: 713-627-3200 **Email:** jean.wright@h-gac.com
Remarks:

Sampler's Signature

Project Number **Project Name:**

Sample ID	Spec. Cond (µS)	Date	Time	C or G	DO	pH	Cl₂	Flow	Temp	Matrix	Tot #	Size	Type	Pres	Containers	E. coli & Entero. (100mL, Na₂S₂O₃)	Entero. (100mL, Na₂S₂O₃)	TSS (1000mL)	NH₃, T PO₄, NO₂ +NO₃ (1000mL, H₂SO₄)	TKN (500mL, H₂SO₄)	Cl, SO₄ (500mL)

ANALYSIS REQUESTED

Relinquished By: Date Time Received By: Date Time Received Iced: YES / NO
Relinquished By: Date Time Received By: Date Time Received Iced: YES / NO
Relinquished By: Date Time Received By: Date Time Received Iced: YES / NO
Relinquished By: Date Time Received By and/or Checked in By: Date Time Received Iced: YES / NO

LAB USE ONLY Sample Condition Acceptable: YES / NO Temp °C Logged In By: Date Time
Alternate Check In: Date Time

Chain of Custody Sheet

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Appendix D: Texas Stream Team

Bacteria SOP for EASYGEL Method

4.0 E. coli Monitoring and Analysis Procedures

Training Requirements

Texas Stream Team supports certification programs in both the "core" field parameters covered in the first part of the Texas Stream Team Water Quality Monitoring Manual and bacteriological monitoring protocols for *Escherichia coli (E. coli)* bacteria. In addition to the "core" volunteer monitoring certification training, volunteer certification in bacteriological monitoring includes:

- bacteriological information background and sample collection procedures
- media storage and preparation
- proper dilution, plating, and incubation procedures
- colony enumeration
- proper documentation and safety procedures

In order to ensure the highest confidence levels among data users, Texas Stream Team recommends that bacteriological monitors attend an annual bacteriological QC session during which they are updated and evaluated on monitoring techniques and enumeration of bacterial colonies.

Scope and Application

Texas Stream Team monitors will perform bacteria tests on streams, lakes, swimming beaches, and springs. The primary reasons for bacteria testing are determination of ambient conditions. Tests results may also be used to identify potential contamination from broken or leaking septic tanks and sewer lines, wastewater treatment plants, animal-holding operations and other point and nonpoint sources. Bacteriological monitors will develop sampling strategies to suit their objectives and budget, and sampling

frequency will vary accordingly.

Results of the tests are evaluated against State of Texas contact recreation standards. If test results indicate contamination, Texas Stream Team advises the monitor to repeat and verify the initial results. If repeated high counts are found at a site over an extended period of time, the information will also be communicated to the appropriate local and state authorities.

Summary of Method

Coliscan Easygel is a method used to test for *E. coli* and general coliform bacteria. Dr. Jonathan Roth developed the technology for Micrology Laboratories, LLC. Easygel is not an agar, but is a pectin-gel. Easygel comes in a sterilized, two-piece unit, including a bottle of liquid medium and a petri dish treated with a special formulation.

With this method, a .5 to 5 mL of sample of water is collected using a sterile pipette and introduced into a 10 mL bottle of sterile liquid medium. The prepared medium is then plated on a treated petri dish, and incubated at a temperature of 33°C for 28 hours. Commercially available incubators, such as the Hovabator, are recommended. Incubator temperature is maintained and verified with the thermometer included with the incubator. Monitors will conduct field blank quality control analysis for ten percent of sampling events or once a month if less than 10 samplings are done in a month.

Upon incubation, the general coliforms and *E. coli* produce enzymes that react with color reagents in the media to produce pink to red colonies (general coliforms) or dark blue colonies *(E. coli)*. Two samples from each monitoring site are analyzed, and a mean value is reported.

Range and Accuracy

The Coliscan Easygel test can detect as little as one bacterial colony per sample, and can be used to identify up to 200 colonies per sample. Concentrations exceeding 200 colonies per

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sample are recorded as too numerous to count (TNTC). A black and a white grid, which is the same size as the petri dishes, is provided to assist monitors in counting *E. coli* colonies.

Accuracy of Coliscan Easygel is based on the reasonable performance of properly stored, pre-treated sterile plates, media, and pipettes. Extensive evaluation of the Coliscan Easygel method was conducted by Alabama Water Watch, Alabama Department of Fisheries, and Auburn University from February to September 1998 to confirm the accuracy of the Coliscan Easygel method. The results indicated that this method is a reliable and valid tool for the detection of fecal contamination through a variety of concentrations.

In December 1999, Coliscan Easygel was approved by the U.S. Environmnetal Protection Agency (EPA) Region 4 for use in the bacteriological monitoring of surface waters as part of the program developed by the Alabama Water Watch under the direction of Dr. William G. Deutsch of the Department of Fisheries of Auburn University. As a result of this program and other studies, Coliscan Easygel has become the preferred method for bacteriological monitoring in volunteer water quality monitoring programs throughout the United States.

Supplies and Equipment

Necessary Items

The items needed to conduct bacteriological monitoring using the Coliscan Easygel method include:

- sterile bacteriological bottles
- Whirl-Pak™ or Whirl-Pak Thio-Bags™
- sterile Easygel medium
- pre-treated petri dishes
- sterile pipettes
- sterile diluent
- an incubator
- gloves
- bleach or isopropyl alcohol
- sealable plastic bags

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Easygel proprietary items like media and pre-treated petri dishes can be ordered directly from Micrology Laboratories at (888) EASY-GEL or micrologylabs.com. Other equipment and supplies, including sterile diluent, can be purchased from a variety of sources like grocery and laboratory supplies stores. See the monitoring supplies section of the Texas Stream Team website for additional information.

Sample Media Storage and Disposal

When Coliscan Easygel reagents are received, the production date (if known) or arrival date, and the expiration date should be written on the box of media and petri dishes. Media bottles should be kept frozen until ready for use, allowing for a shelf life of up to one year. Thawed media is usable for up to two weeks when stored at room temperature. Medium can be refrozen but repeated freezing and thawing should be avoided. Pre-treated petri dishes

should be stored at room temperature which also allows for a shelf life of one year. To dispose of expired media, pour a teaspoon of bleach into the bottle, cap the bottle, shake well, place the bottle in a sealable plastic bag, and dispose of it in household trash.

Quality Control

Analyzing samples for *E. coli* can introduce challenges in ensuring that contamination does not occur during sample collection and processing. It is important that all Texas Stream Team monitors use the same methods and procedures so that samples within and between streams can be compared to each other, and understanding the importance of quality assurance and quality control practices is crucial to generating credible environmental information. Quality assurance is the system used to make sure that all data collection activities are managed in a way that collected information meets the intended use of the project. Some examples of quality assurance measures include: the consistent Texas Stream Team training program, the use of consistent methods, written procedures, establishing data quality objectives, maintenance of records, and specifying the chain of custody procedures. Quality control procedures reassure that samples are being collected and documented in a consistent and accurate manner at all sites by all monitors. Examples of quality control include: double rinsing of nonsterile equipment prior to use, checking reagents for expiration dates, using data quality objectives to assess data validity, calibrating meters within 24 hours of use, and collecting field blanks on a routine basis. Together, quality assurance and quality control serve volunteer water quality monitors by bringing enhanced data credibility and use.

Cross Contamination

Efforts should be made to avoid contaminating sample containers, hands, tabletops, or any other surface or object. Do not touch bacterial

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colonies. The dishes should be taped shut and kept out of reach of children, pets, and curious wildlife. A disinfectant should be used to clean tabletops or other areas that colonized plates have touched. Monitors should wash hands before and after handling the plates.

Field Blank

Field blanks are used to assess potential contamination from sample handling, airborne materials, equipment, media, and other sources. A field blank usually consists of a sterile diluent sample of 1 mL that is taken to the site and poured into a properly labeled sample container during the first bacteria sampling event of that day. The blank sample is collected in the same type of container, labeled as a field blank, and handled and analyzed along with all the bacteria samples collected on that day. It is used to identify errors or contamination in sample collection and analysis. The frequency of a bacteria field blank is one with every 10 samples. If less than 10 samples are collected in a month, include at least one field blank for any month bacteria samples are collected. Report the results of the field blank on your data form. There should be no *E. coli* colony growth on the field blank samples. If *E. coli* growth occurs on the blank, discard all data collected on that day. Document the results on the data sheet and consult with your trainer.

Sample Collection Procedures

1.0 Sample Site Location

Establishing sampling site locations should follow procedures outlined in *Section 2.00 Choosing a Monitoring Location.* In streams, rivers, and lakes, care should be taken to collect the bacteriological sample at an undisturbed location.

1.1 Sample Containers

Collect bacteriological samples in sterile bacteriological bottles or Whirlpak bags.
Never pre-rinse the sample container. For Whirl-Pak bags, squeeze out the top one inch of water from the bag and whirl the bag to seal. The sealed bag must retain at least 50 mL of sample but leave a small pocket of air. This airspace will help mix the sample when it is shaken just before making dilutions and membrane filtration. During every tenth sampling event (or a minimum of once per month), prepare one additional sample container and petri dish for a quality control field blank. If your sample site is downstream of a wastewater treatment plant outfall, the effluent might contain chlorine disinfectant that could debilitate bacteria. At these sites, Texas Stream Team recommends that monitors use the Whirl-Pak Thio-Bag™. These bags contain 10 mg tablets of sodium thiosulphate to neutralize free chlorine in the sample.

1.2 Sample Labeling

Label each sample container with the station number, site name, date, and time collected.
If it is appropriate to process a field blank sample, this container will have the previously mentioned information plus a "field blank" label.

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1.3 Collecting Samples

When submerging the sample container, take care to avoid contamination by surface scums. The surface film is enriched with particles and bacteria not representative of the water mass. Also be careful not to collect sediment from the bottom of stream or lake. The correct procedure for collecting samples is demonstrated during trainings. When it is appropriate, remember to collect the field blank using the sterile diluent prior to conducting routine sampling at your site. This involves transferring the sterile diluent from its original container to the routine sampling container while at your monitoring location.

In flowing streams, dip the open sample container to a depth of 0.3 m (1 ft), or roughly half the depth, in very shallow streams. Avoid contact with the sediment. With the open end facing upstream, push the mouth of the bag upstream at this depth until full. Always hold the mouth of the sample container upstream of the sampler, sampling apparatus, and any disturbed sediments.

In reservoirs and coastal waters, dip the sample container to a depth of 0.3 m (1 ft). At this depth, push the mouth of the sample container away from the boat, dock, shore, sampler, and any disturbed sediment.

When collecting samples from a bucket of water, collect the bacteria sample before other monitoring activities occur. Pour water into the bacteriological sample container. Never immerse water sample containers in the bucket. This could introduce contamination.

1.4 Sample Preservation and Hold Times

Place sample(s) on ice immediately after collection. Bacteriological samples must transported, processed (diluted and plated), and placed in incubator within 6 hours of sample collection. Do not report samples that are not processed within the time limit. Record the hold time on the Texas Stream Team *E. coli* data sheet.

4.2 Analyzing *E. coli* Using Coliscan Easygel Pour Plate Method

2.0 Preparation

Prepare media for a minimum of two samples for each site. Bottles of media should be removed from the freezer in time to ensure that they have reached room temperature (typically 2-3 hours) before use.

Prepare two petri dishes per sample. During every tenth sampling event (or once per month minimally), prepare one additional petri dish for a quality control field blank. Label the top of each petri dish with:

• site name
• date
• volume of sample
• time the sample is poured into the petri dish

The field blank consists of a sterile diluent sample, and the sample container and petri dish will be labeled like the other samples and will also include "field blank" next to the site name.

2.1 Drawing Proper Sample Size

Shake the sample container vigorously, and then carefully open it without touching the lip of the bag. Leave the pipette in the sterile wrapper until ready to draw the sample. Unwrap the pipette from the bulb end and avoid contacting the tip with anything except the sample water. Submerge the bottom half of the pipette into the sample container and squeeze the bulb to expel the air. Draw the appropriate sample size (1 mL, 3 mL, or 5 mL) into the pipette by releasing the bulb slowly. Squeeze out any sample water in excess of the desired volume. Deposit the sample into the Easygel media bottle, cap, and swirl gently. Record the sample size in the *E. coli* section of the Texas Stream Team data sheet. Draw a 1 mL aliquot for field blanks.
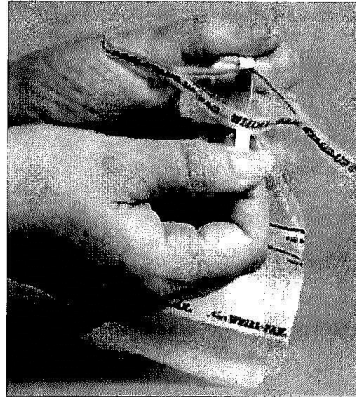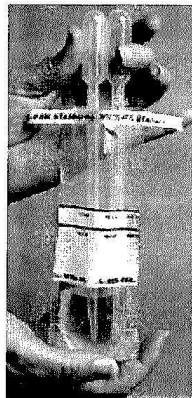
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Figure A

FigureB
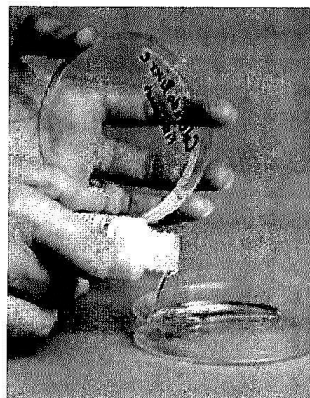

Figure C

Figure D

Figure E

- **Figure A** depicts a monitor holding a Whirlpak bag.
- **Figure B** portrays a monitor labeling a petri dish with the appropriate monitoring information .
- **Figure C** shows a monitor using a 5 mL pipette to remove a sample from the Whirlpak bag.
- **Figure D** shows the monitor placing the stream sample into the Coliscan Easygel bottle media.
- **Figure E** shows a monitor pouring the media, which includes the stream sample, onto the petri dish.

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NOTE: Once mixed with Easygel media, the prepared samples should be either be plated within 10 minutes, or kept on ice or in a refrigerator until plated.

2.2 Determining Sample Size

The ideal number of colonies resulting from a single prepared plate is 20 to 60, and not over 200. Since the number of resulting colonies is dependent on the sample size, it may be necessary to experiment with several sample volumes to determine the best probable sample size to achieve 20-60 colonies. Draw a 1 mL aliquot for field blanks.

To establish a baseline for typical conditions, collect a 1 mL and a 5 mL sample volume during the first sampling event. If the 1 mL *E. coli* colony reading results in zero or only a few colonies, the sample volume should be to increased to 3 mL or 5 mL. Conversely, if the 5 mL sample results in more than 60 colonies, the sample size should be reduced to 1 mL or 3 mL during the next sampling event.

Environmental and precipitation variables will influence levels of bacteria. Urban creeks with low discharge often have abundant *E. coli* and other coliform growth, and the volunteer should begin sampling with 1 mL and 3 mL volumes. Pristine waters may require a 5 mL sample to achieve the preferred range of colonies.

2.3 Plating the Sample

Pour the prepared sample (the Easygel media mixed with the water sample) slowly into the petri dish. Gently swirl until there is a smooth coating of prepared sample across the bottom of the petri dish (but be careful not to splash over the side or on the lid). Set on a level surface and allow five to forty-five minutes for the media to gel. This will help ensure that the sample will be spread uniformly across the petri dish and help prevent shifting or pooling of the media after being placed in the incubator.

2.4 Incubation

Turn on the incubator far enough in advance to ensure the appropriate temperature is reached before loading petri dishes. Place petri dishes right-side up in the incubator and maintain a steady incubation temperature of 33°C. At this temperature, colonies should not be counted for a minimum of 28 hours. For optimum results, count and record colonies at 28 hours of incubation. No counts should be made after 31 hours. Record the incubation time and temperature on the *E. coli* section of the Texas Stream Team data sheet.

2.5 Counting *E. coli* Colonies

Count the number of individual and distinct dark purple and dark blue colonies.

Colonies which have the blue-green color are not considered to be either coliforms or *E. coli* and therefore should be ignored. Similarly, colonies which are white should also be ignored.

Record the number of *E. coli* colonies on the Texas Stream Team data sheet.

NOTE: Refer to the graphic inside the back cover for a color detail of the Easygel Colony Color Guide. Use the grid to assist in your *E. coli* count.

Field Blanks:

The frequency of a bacteria field blank is one with every 10 samples. If less than 10 samples are collected in a month, include at least one field blank for any month bacteria samples are collected. Follow routine handling, plating, and analysis procedures, and report the results on your data form. There should be no *E. coli* colony growth on the field blank samples. If *E. coli* growth occurs on the blank, discard all data collected on that day. Document the results on the data sheet and consult with your trainer. Trainers will work closely with monitors who have issues concerning field blank contamination to resolve the problem.

2.6 Data Reporting

Final results of the analysis for the two samples per site plus the field blank are reported on the Texas Stream Team data sheet as "colonies per 100 mL" of sample water. To arrive at that number you must first determine the dilution factor.

Dilution factor = 100 / sample size

For example, if you collected a sample size of 1 mL in the pipette and added this to the Easygel solution, your dilution factor is 100 / 1 or 100. Common dilution factors are:

.5 mL sample = dilution factor of 200
3 mL sample = dilution factor of 33.3
5 mL sample = dilution factor of 20

To determine the number of colonies per 100 mL, multiply the number of colonies counted times the dilution factor.

For example, if you counted 8 colonies and had a dilution factor of 33.3 (3 mL sample size), your final result is 8 times 33.3 or 266 *E. coli* colonies/100mL. For a count of 11 colonies times a dilution factor of 20 (5 mL sample size) your result is 220 *E. coli* colonies/100mL.

This information should be entered on the *E. coli* section of the Texas Stream Team data sheet to document the final results of each set of samples analyzed. Verify that the dilution factor calculation is correct and marked accordingly on the Quality Data Review Checklist.

INCUBATION: Period (hrs) _____ (28-31 hrs)   Temp. (°C) _____ (33+/-3°C)

SAMPLE 1: Sample size _____ mL   Dilution factor (100/sample size) _____

Colonies counted _____ x dilution factor _____ = _____ colonies/100 mL

SAMPLE 2: Sample size _____ mL   Dilution factor (100/sample size) _____

Colonies counted _____ x dilution factor _____ = _____ colonies/100 mL

FIELD BLANK: *E. coli* colony growth (circle one)   YES / NO

DATA QUALITY REVIEW: Checklist completed (circle one)   YES / NO

2.8 Waste Disposal

To dispose of the used petri dishes, lift the lid and pour 5 ml (about 1 teaspoon) of straight bleach into each dish. Re-tape the lid, make sure the bleach has covered the entire dish, and allow to stand for a minimum of fifteen minutes. Place the dishes in a sealed plastic bag and place in normal household trash.

Periodically clean the inside of incubator with dilute bleach solution and allow it to air dry before the next use.

2.9 Data Review

The following Quality Data Review Checklist is used by the monitor, Texas Stream Team staff, and data user to verify that data are valid.

Data Quality Review Checklist		
	Yes / No	Comments
Monitor is certified		
Is the media expired		
Incubation temperature is 33 ° C (+/- 3 ° C)		
Incubation time is 28 – 31 hours		
Data form is complete		
Optimal colony number is achieved (<200)		
Dilution factor calculation is correct		
Colony Growth on Field Blanks		

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Appendix E: BIG'S Top Ten Prioritized Lists

TOP TEN "MOST WANTED" STREAMS							
Rank	*Assessment Unit*	*Parameter*	*Relative Geomean (MPN/100 mL)*	*Geomean (MPN/100 mL)*	*AU Status*	*Assessment Unit Description*	*Watershed*
1	1013C_01	*E. coli*	39.86	5022	No Change	Unamed tributary located approximately 1.8 miles upstream of the Buffalo Bayou/White Oak Bayou confluence between IH-10 and Memorial Drive west of IH-45 in Harris County	Buffalo Bayou
2	1016D_01	*E. coli*	29.67	3738	No Change	Unamed tributary of Greens Bayou from the confluence with Greens Bayou, west of El Dorado Country Club to Lee Road, west of US Hwy 59 in Harris County	Greens Bayou
3	1017_04	*E. coli*	23.58	2971	Degraded	White Oak Bayou, Brickhouse Gully confluence to a point immediately upstream of the confluence of Little White Oak Bayou in Harris County	White Oak Bayou
4	1007I_01	*E. coli*	22.23	2801	No Change	Plum Creek f rom the Sims Bayou confluence to Telephone Road in Harris County	Sims Bayou
5	1007F_01	*E. coli*	19.59	2469	Degraded	Berry Bayou from a point 2.4 km (1.5 mi) upstream of the Sims Bayou confluence to SH 3	Sims Bayou
6	1101D_01	Enterococcus	19.01	665	Degraded New Listing	Robinson Bayou, from Clear Creek Tidal confluence to 0.05 km (0.03 mi) upstream of Hewitt Street	Clear Creek
7	1007U_01	*E. coli*	16.93	2133	Improved	Mimosa Ditch from the Brays Bayou confluence upstream 2.9 km (1.8 mi) to the Chimney Rock bridge crossing	Brays Bayou
8	1007T_01	*E. coli*	16.89	2128	Improved	Bintliff Ditch from the Brays Bayou confluence to 0.57 km (0.35 mi) upstream of the Fondren Road bridge crossing	Brays Bayou
9	1013A_01	*E. coli*	15.68	1975	Degraded	Little White Oak Bayou, from the White Oak Bayou confluence to Yale Street in Harris County	White Oak Bayou
10	1014N_01	*E. coli*	15.56	1960	Degraded New Listing	Rummel Creek, from the Buffalo Bayou Above Tidal confluence to 1.2 km (0.75 mi) upstream of IH-10	Buffalo Bayou

TOP 10 "MOST LIKELY TO SUCCEED" STREAMS							
Rank	Assessment Unit	Parameter	Relative Geomean (MPN/100 mL)	Geomean (MPN/100 mL)	AU Status	Assessment Unit Description	Watershed
1	1008B_02	*E. Coli*	1.06	133	Improved	Upper Panther Branch, from a point 0.22 miles (0.35 km) upstream of the Bear Branch confluence to the confluence of Lake Woodlands	Cypress Creek
2	1010_02	*E. Coli*	1.18	148	No Change	Caney Creek, from FM 1097 to SH 105	Caney Creek
3	1113A_01	*E. Coli*	1.2	151	New Listing	Armand Bayou, from the upper segment boundary of Armand Bayou Tidal (point 0.8 km (0.5 miles) downstream of Genoa-Red Bluff Road) upstream to Beltway 8	Armand Bayou
4	1113_02	Enterococcus	1.22	43	New Listing	Armand Bayou, from the Horsepen Bayou confluence to the Big Island Slough confluence	Armand Bayou
5	1008C_02	*E. Coli*	1.24	156	No Change	Lower Panther Branch, from Saw Dust Road to the Lake Woodlands Dam	Panther Branch
6	1007A_01	*E. Coli*	1.25	157	Improved New Listing	Canal C-147, from the Sims Bayou confluence upstream to a point 0.71 km (0.44 mi) east of Beltway 8	Sims Bayou
7	1008C_01	*E. Coli*	1.27	160	Improved	Willow Creek, from the Spring Creek confluence to a point 0.48 km (0.3 mi) north of Juergen Rd	Spring Creek
8	1102A_02	*E. Coli*	1.28	161	Improved New Listing	Cowart Creek, confluence with Clear Creek to Sunset Drive	Clear Creek
9	1113C_01	*E. Coli*	1.29	163	Improved New Listing	Horsepen Bayou, from the Horsepen Bayou confluence to Reseda Drive	Armand Bayou
10	1008I_01	*E. Coli*	1.3	163	Improved New Listing	Walnut Creek, from the Spring Creek confluence to a point 41.1 km (25.5 mi) upstream	Spring Creek

Appendix F: Garmin Product Manual

Garmin *eTrex* Vista H GPS Unit

- High-sensitivity
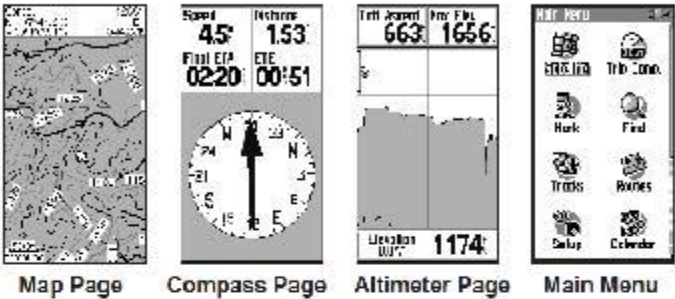- 24 MB internal storage
- USB connection for electronic storage

GPS: Initial Setup

Garmin eTrex Vista H

IN/OUT Zoom
ROCKER
MENU/FIND
QUIT/PAGE
POWER — Also serves as the brightness control

- When you power on, it will acquire satellites
- You MUST be outside

8

GPS: Main Screens

Map Page   Compass Page   Altimeter Page   Main Menu

GPS: Compass Calibration

*Before first use, calibrate the compass

From Main Menu,
Click:
'Setup'
Scroll down and click 'Calibration'

Click:
-'Compass'

Click:
-'Start'

GPS: Coordinate Units

Must change units to **DECIMAL DEGREES**

Click:
'Units'

Defaults to:
Degree Minutes Seconds
Click:
'Position Format'

Scroll:
Up one
Click:
'hddd.ddddd'

GPS: Saving a Waypoint

-From any of the main screens, **HOLD** the 'Rocker' button
to create a Waypoint
-The 'Mark Waypoint' page will appear
-Change the name of the waypoint immediately by clicking
the rocker when the 3-digit name is highlighted
-Type in the desired Waypoint name
-Then click OK twice

It's that easy!

Waypoint symbol

Waypoint name
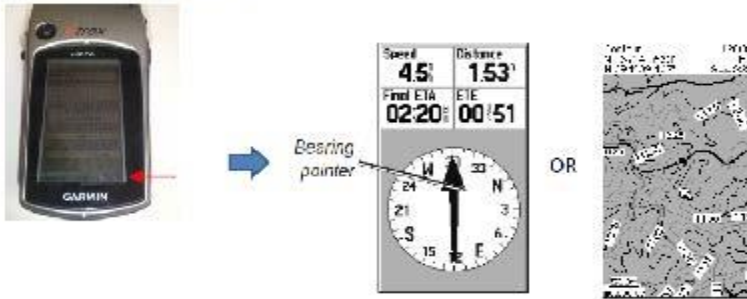
Appendix G: Corrective Action Form

CORRECTIVE ACTION REPORT
QAPP DEVIATION and CORRECTIVE ACTION PLAN

Project Name	
Contract Number	
Lead Organization	
Lead Organization PM	
Lead Organization	
TCEQ GBEP PM	
TCEQ GBEP Manager	
TCEQ Lead QAS	

1. Identification of Deficiencies and Nonconformances
Deficiencies and nonconformances shall be identified and reported to TCEQ as required in the QAPP (see below). The Lead Organization's project manager, in conjunction with the Quality Assurance Officer, will complete the information on this form and send to the GBEP Project Manager with the progress report. The GBEP Project Manager is to **forward copies of corrective action reports to the GBEP PM, the GBEP QAO, and to the TCEQ Quality Assurance Specialist.** When appropriate, the report will be forwarded to the to the lead quality assurance staff to monitor the implementation of corrective action plans and to advise the appropriate project and program manager if the plans are not implemented in a timely manner. In the case of significant conditions, lead quality assurance staff shall also advise the appropriate Program Manager, Section Manager, and the quality assurance manager if corrective action plans are not implemented in a timely manner.

2. Planning and Implementing Corrective Actions
The Lead Organization shall document the following with regard to deficiencies and nonconformances and include the corrective plan of action for each.

A.   List the deviation(s) from the QAPP.

B.   For each deviation described above, describe each of the items in 1-6 for each deficiency.

1.   root cause(s);
2.   programmatic impact;
3.   required corrective action(s), including action(s) needed to prevent recurrence;
4.   means by which corrective action completion will be documented and verified;
5.   timetable(s); and
6.   individuals responsible.

Appendix H: GBEP QAPP Amendment Form

Amendment # _
to the ==Project Name==
Quality Assurance Project Plan

USEPA QTRAK#_____

Funding Source: Check with GBEP PM and Specify ==*State Funds or Grant Title*==
==*Federal Grant #XXXXXXXX-X*==
==State USAS Grant #== ==XXXXXX==

Effective Date: Upon date of final signature

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

==Lead Organization Project Manager Name==
==Title==
==Address== *(Include physical address for package delivery)*
==City, Texas Zip Code==
==(XXX) XXX-XXXX==
==email address==

Note: <mark>Highlighted language</mark> *should be replaced with appropriate text prior to submittal of the QAPP*
Language in italics *should be removed prior to submittal of the QAPP.*

Justification: *Summarize the reason(s) for amending the document and the change(s) that is being proposed. Examples of changes include: parameters, sampling or analytical procedures, and project organization.*

Summary of Changes: *List each section in which a change is proposed and provide a description of the change(s).*

Detail of Changes: *Include a copy of the changed section(s) (e.g., Table A7.1, Section A7, Section B1) in their entirety with changes indicated. New language should be underlined and highlighted. Removed language should be struck out and highlighted.*

Note: Be sure to address all sections that are impacted by the change. For example, if a new parameter has been added, then a new DQO table will need to be referenced and attached as well as a new holding time table, sample container information, etc.

Distribution: The <mark>Lead Organization</mark> QA Officer will provide copies of this amendment to each person on the distribution list and to each sub-tier participant other than TCEQ and EPA staff. The <mark>Lead Organization</mark> QA Officer will provide documentation of this transmittal to the GBEP PM within two weeks of QAPP approval. This documentation will be maintained as part of the Lead Organization's quality assurance records and as part of the GBEP project file.

The GBEP PM is responsible for providing copies of the project plan and any amendments or revisions of this plan to TCEQ and EPA staff other than the TCEQ QA Specialist. Copies must be provided within two weeks of QAPP approval, and documentation of this transmittal will be available for review and maintained as part of the GBEP project file.

Adherence Letters: The <mark>Lead Organization</mark> will secure written documentation from additional project participants (e.g., subcontractors, laboratories) stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan amendment. The <mark>Lead Organization</mark> will maintain this documentation as part of the project's quality assurance records. This documentation will be available for review. Copies of this documentation will also be submitted as deliverables to the GBEP PM within 30 days of final TCEQ approval of the QAPP Amendment.

Approval: The changes are effective upon final approval of the amendment. These changes will be incorporated into the full QAPP document when the QAPP is updated. The TCEQ<mark>, the Lead Organization, and the Subcontractor Name</mark> *(as relevant)* acknowledge and accept these changes by signing this amendment.

_____
<mark>Name, Lead Organization</mark> Project Manager   Date

_____
<mark>Name, Lead Organization</mark>   Date

_____
<mark>Name, Lead Organization /Subcontractor QA Role Date</mark>
(create a signatory line for each person from the Contracted or Subcontracted Entities that signed the original QAPP).

_____
<mark>Name</mark>, TCEQ GBEP Project Manager   Date

_____
Name, TCEQ GBEP QA Coordinator   Date

_____
Name, TCEQ GBEP Program Manager   Date