TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

May 27, 2022

Rachel Windham
Planner
Houston-Galveston Area Council (H-GAC)
3555 Timmons Lane, Suite 120
Houston, Texas 77027

Re: Approval: East Fork San Jacinto River Watershed Protection Plan Modeling Quality Assurance Project Plan (QAPP), Revision 0

Federal Grant# 99614626

Dear Ms. Windham:

The above-referenced Quality Assurance Project Plan (QAPP) was approved today, May 27, 2022. The Nonpoint Source (NPS) Project Manager will send you the approved QAPP and approval letter.

Please ensure the QAPP and any subsequent amendments are distributed in a timely manner to the appropriate entities listed in Section A3 of the QAPP. Documentation of distribution must be available for review during a quality system audit.

Should you have questions, feel free to contact me at jason.natho@tceq.texas.gov.

Sincerely,

Jason Natho
Lead NPS Quality Assurance Specialist
MC-165

Enclosure

cc: Heather Robinson, TCEQ NPS Project Manager, MC-203
Samantha Litchke, TCEQ NPS QA Coordinator, MC-203

East Fork San Jacinto River Watershed Protection Plan
Modeling Quality Assurance Project Plan (QAPP)
Revision 0

Funding Source:

Nonpoint Source (NPS) Program Clean Water Act (CWA) §319(h)
Prepared in cooperation with the
Texas Commission on Environmental Quality
and the U.S. Environmental Protection Agency
Federal ID # 99614626
QTRAK# 22-265

Effective Period: Three years from date of final approval

Questions concerning this QAPP should be directed to:

Rachel Windham
Planner
Houston-Galveston Area Council (H-GAC)
3555 Timmons Lane, Suite 120
Houston, Texas 77027
(713) 993-2497
rachel.windham@h-gac.com

SECTION A: PROJECT MANAGEMENT

A1 Approval Page

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

Texas Commission on Environmental Quality

Monitoring Division
Laboratory and Quality Assurance (QA) Section

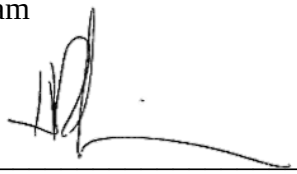
5/27/2022
Sharon R. Coleman, TCEQ Quality QA Manager Date

5/27/2022
Jason Natho, Lead TCEQ NPS QA Specialist Date

Water Quality Planning Division

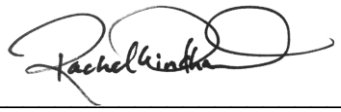
5/27/2022
Faith Hambleton, Team Leader Date
Nonpoint Source (NPS) Program

Samantha Litchke 5/23/2022
Samantha Litchke, NPS QA Coordinator, Date
NPS Program



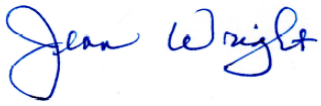
5/23/2022
Heather Robinson, NPS Project Manager Date
NPS Program

H-GAC



5/18/2022

Rachel Windham, Date
H-GAC Project Manager



5/19/2022

Jean Wright, Date
H-GAC QA Officer

Thushara Ranatunga 05/19/2022

Thushara Ranatunga, Date
H-GAC Lead Modeler

Jessica Casillas 05/19/2022

Jessica Casillas, Date
H-GAC Data Manager

H-GAC will secure written documentation from additional project participants stating the organization's awareness of and commitment to requirements contained in this QAPP and any amendments or revisions of this plan. H-GAC will maintain adherence letter 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 TCEQ NPS Project Manager within 30 days of final TCEQ approval of the QAPP. (See sample letter in Appendix D – Adherence Letter.)

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List of Acronyms

ASCII	American Standard Code for Information Exchange
AU	Assessment Unit
AVMA	American Veterinary Medicine Association
C&E	Community and Environmental Planning
CAP	Corrective Action Plan
CAR	Corrective Action Report
CRP	Clean Rivers Program
CSDGM	Content Standards for Digital Geospatial Metadata
CWA	Clean Water Act
DMP	Data Management Plan
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
DOS	Disk Operating System
EPA	United States Environmental Protection Agency
FGDC	Federal Geographic Data Committee
FTP	File Transfer Protocol
GIS	Geographic Information System
GPS	Global Positioning System
H-GAC	Houston-Galveston Area Council
LDC	Load Duration Curve
MS4	Municipal Separate Storm Sewer System
NAD83	North American Datum 1983
NOAA	National Oceanic and Atmospheric Association
NPS	Nonpoint Source
OSSF	Onsite Sewage Facility
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
SAS	Statistical Analysis Software
SDE	Spatial Database Engine
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
SWAT	Soil and Water Assessment Tool
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSSWCB	Texas State Soil and Water Conservation Board
USGS	United States Geological Survey
WPP	Watershed Protection Plan

A3 DISTRIBUTION LIST

The Lead NPS QA Specialist will provide approved versions of this QAPP and any amendments or revisions of this plan to the TCEQ NPS Project Manager. The TCEQ NPS Project Manager will provide approved copies to the H-GAC Project Manager and EPA Project Officer within two weeks of approval. The TCEQ NPS Project Manager will document transmittal of the plan and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review in the event of an audit.

Anthony Suttice, Project Officer
Suttice.Anthony@epa.gov
EPA Region 6
(214) 665-8590

H-GAC will provide copies of this project plan and any amendments or revisions of this plan to each project participant defined in the list below. H-GAC will document receipt of the plan by each participant and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review in the event of an audit.

H-GAC
3555 Timmons Lane, Suite 120, Houston, Texas 77227

Rachel Windham, H-GAC Project Manager
rachel.windham@h-gac.com
(713) 993-2497

Jean Wright, H-GAC Quality Assurance Officer
jean.wright@h-gac.com
(713) 499-6660

Thushara Ranatunga, H-GAC Lead Modeler
thushara.ranatunga@h-gac.com
(832) 681-2551

Jessica Casillas, H-GAC Data Manager
jessica.casillas@h-gac.com
(713) 993-4594

A4 PROJECT/TASK ORGANIZATION

TCEQ

Monitoring Division

Jason Natho, Lead TCEQ NPS QA Specialist
Assists the TCEQ NPS Project Manager in QA related issues. Participates in the planning, development, approval, implementation, and maintenance of the QAPP. Determines conformance with program quality system requirements. Coordinates or performs audits, as necessary, using a wide variety of assessment guidelines and tools. Concurs with proposed corrective actions and verifications. Provides technical expertise and/or consultation on quality services. Recommends to TCEQ management that work be stopped in order to safeguard project and programmatic objectives, worker safety, public health, or environmental protection.

Water Quality Planning Division

Faith Hambleton, Team Leader, NPS Program
Responsible for management and oversight of the TCEQ NPS Program. Oversees the development of QA guidance for the NPS program to be sure it is within pertinent frameworks of the TCEQ. Monitors the effectiveness of the program quality system. Reviews and approves all NPS projects, internal QA audits, program corrective actions, work plans, and contracts. Enforces program corrective action, as required. Ensures NPS personnel are fully trained and adequately staffed.

Heather Robinson, TCEQ NPS Project Manager
Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with projects. Develops lines of communication and working relationships between the contractor, the TCEQ, and the EPA. Tracks deliverables to ensure that tasks are completed as specified in the contract. Responsible for ensuring that the project deliverables are submitted on time and are of acceptable quality and quantity to achieve project objectives. Serves on planning team for NPS projects. Participates in the development, approval, implementation, and maintenance of the QAPP. Conducts independent technical review of the QAPP to ensure compliance with project needs and requirements. Responsible for verifying that the approved QAPP is implemented by the contractor. Notifies the TCEQ Lead NPS QA Specialist of circumstances which adversely affect the quality of data derived from the collection and analysis of samples. Monitors and enforces corrective action.

Samantha Litchke, TCEQ NPS QA Coordinator
Assists Lead QA Specialist with NPS QA management. Serves as liaison between NPS management and TCEQ QA management. Responsible for NPS guidance development related to program QA. Assists with development and maintenance of data management-related standard operating procedures (SOP) for NPS data management. Participates in the development, approval, implementation, and maintenance of the QAPP. Provides input and oversight regarding corrective actions. Maintains record of corrective actions.

H-GAC

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

Jean Wright, H-GAC QAO
Responsible for coordinating development and implementation of the QA program. Responsible for ensuring the most recent version of the NPS QAPP shell document is used for writing and maintaining an official approved copy of the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Responsible for maintaining written records of sub-tier commitment to requirements specified in this QAPP. Responsible for identifying, receiving, and maintaining project QA records. Responsible for coordinating with the TCEQ NPS Project Manager to resolve QA-related issues. Notifies the H-GAC Project Manager and TCEQ NPS Project Manager of and documents particular circumstances which may adversely affect the quality of data. Responsible for validation and verification of all data modeled, collected, and acquired. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Facilitates, conducts, and documents any technical systems audits.

Thushara Ranatunga, H-GAC Lead Modeler
The Lead Modeler is responsible for the operation or oversight of all computer models and associated documentation of model operation. Responsible for accuracy of input data to models. Performs operation of the models to ensure valid results are being predicted. Responsible for formulating model input to reflect the scenarios and situations to be emulated by each model.

Jessica Casillas, H-GAC Data Manager
The Project Data Manager is responsible for acquisition and verification of data, documentation of data sources, and ensuring the accuracy of data. Responsible for maintaining project quality assurance records. Oversees data management for the study. Performs data quality assurances prior to transfer of data to the TCEQ. Responsible for transferring analysis output to the TCEQ in an acceptable format. Ensures analysis output is submitted according to work plan specifications.

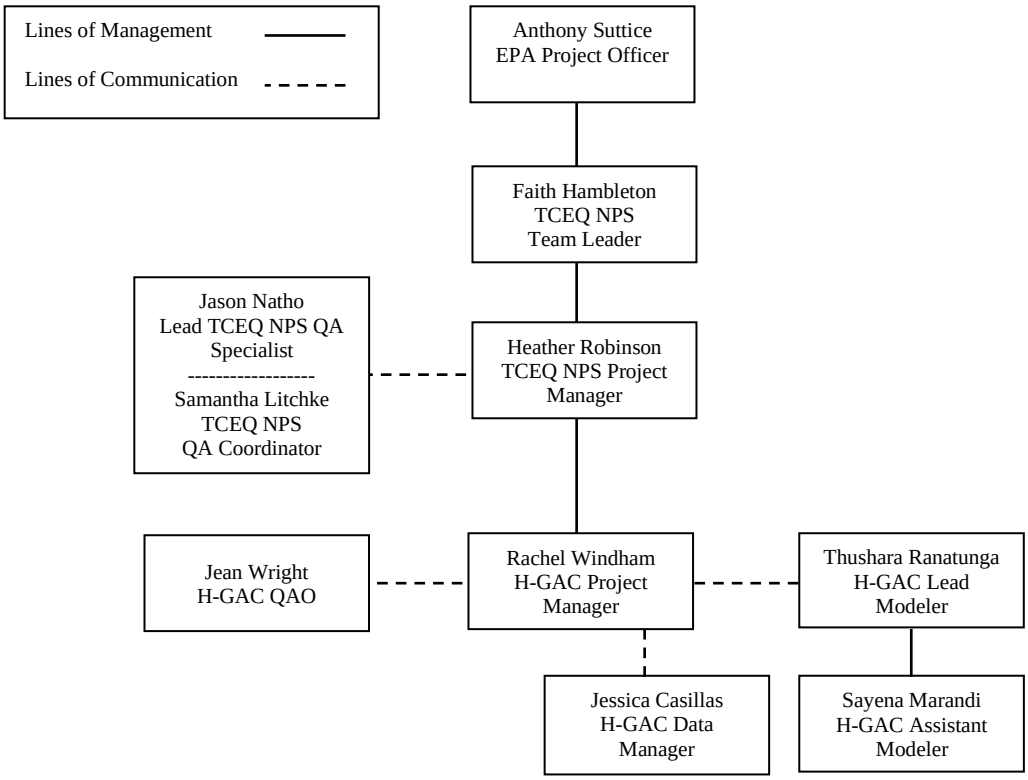
Sayena Marandi, H-GAC Assistant Modeler
The Assistant Modeler supports the Lead Modeler with all tasks related to the development, operation, and review of the models as described for the Lead Modeler.

EPA Region 6

Anthony Suttice, EPA Project Officer
Responsible for managing the CWA Section 319 funded grant on behalf of EPA. Assists the TCEQ in approving projects that are consistent with the management goals designated under the State's NPS management plan and meet federal guidance. Coordinates the review of project workplans,

draft deliverables, and works with the State in making these items approvable. Meets with the State at least annually to evaluate the progress of each project and when conditions permit, participates in a site visit on the project. Fosters communication within EPA by updating management and others, both verbally and in writing, on the progress of the State's program and on other issues as they arise. Assists in grant close-out procedures ensuring all deliverables have been satisfied prior to closing a grant.

Figure A4.1. Organization Chart - Lines of Communication



A5 PROBLEM DEFINITION/BACKGROUND

The East Fork of the San Jacinto River (Segment 1003) flows 84.9 miles south from its headwaters in Walker County to a confluence with Lake Houston (Figure A5.1). The East Fork San Jacinto River Watershed is composed of the drainage area of East Fork San Jacinto River and its unclassified segment tributaries Winters Bayou (1003A), Nebletts Creek (1003B), and Boswell Creek (1003C) as well as a network of natural and manmade drainage channels. This watershed area spans approximately 410 square miles and includes portions of Walker, San Jacinto, Liberty, Montgomery, and Harris counties.

Land cover in the watershed area varies and is characterized by heavily wooded areas, especially in the portions of the watershed spanning Walker and San Jacinto counties. These areas are part of the Sam Houston National Forest. Pasture and woody wetlands are also common in these areas. The southern part of the watershed is more developed, especially in Liberty and Harris counties (Figure A5.1). Development is expected to expand as growing populations push north from the Houston area along the US Highway 59 and State Highway 99 (Grand Parkway) transportation corridors. Small cities such as Cleveland, North Cleveland, Plum Grove, and Roman Forest intersect or are completely contained within the watershed area. Large cities intersecting the watershed area include Huntsville and Houston.

The principal water quality issue in the East Fork San Jacinto River Watershed is a recreational use impairment caused by high levels of *Escherichia coli* (*E. coli*) that have been noted in several assessment units (AUs) in segments of East Fork San Jacinto River and its tributaries (Table A5.1).

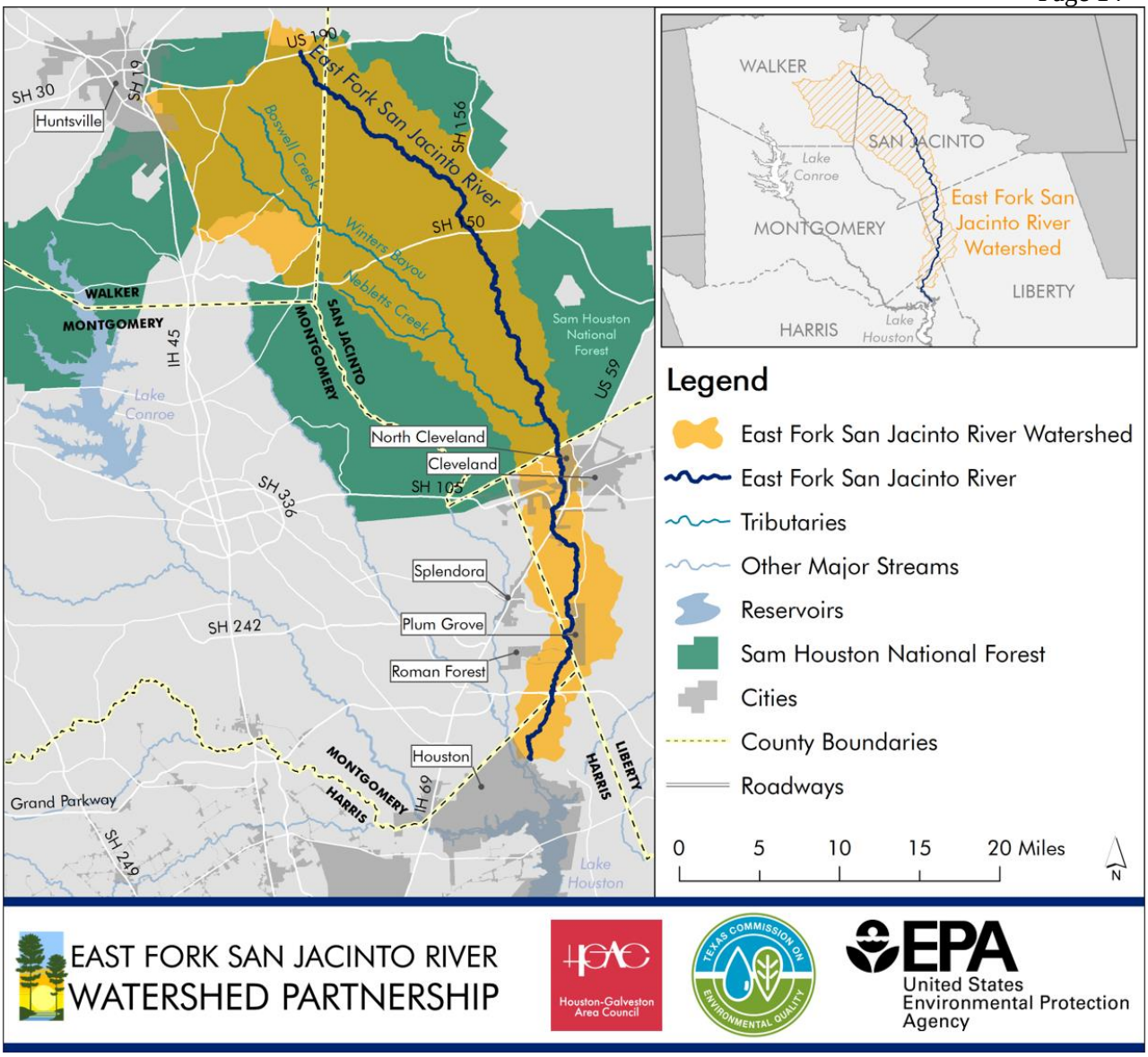


Figure A5.1 – The East Fork San Jacinto River Watershed

Table A5.1 – Water Quality Issues in the East Fork San Jacinto River Watershed[1]

	Impairments			
Segment	**AU(s)**	**Parameter**	**Use**	**Category**
1003	01, 02, 03	*E. coli*	Recreation	4a (all)
1003A	01	*E. coli*	Recreation	5c
	Concerns			
Segment	**AU(s)**	**Parameter**	**Use**	**Level of Concern**
1003C	01	*E. coli*	Recreation	CN

Preliminary modeling and source characterization completed during a previous project[2] indicated that a mix of bacteria sources contributed to issues in the watershed and were projected to increase in the future. The development of a watershed protection plan (WPP) for the East Fork San Jacinto River Watershed will identify and further characterize causes and sources of pollution in the watershed through modeling efforts, as informed by stakeholder input and feedback, and identify management measures to address them.

To facilitate the development of the WPP, H-GAC needs to provide enough information to guide stakeholder discussion, characterize the causes and sources of pollution in the watershed, and identify the reductions needed to meet state standards, and additional information to achieve other water quality goals identified by the stakeholders[3]. The efforts outlined in this QAPP are designed to generate the information needed to guide decisions and allow for feedback and revision from the stakeholders. To ensure that the data generated (and subsequent decisions which rely on it) are defensible and of appropriate quality, H-GAC will conduct its modeling and data evaluation tasks in a manner consistent with this QAPP.

The purpose of the QAPP is to clearly delineate H-GAC's QA policy, management structure, and procedures to implement the QA requirements necessary to verify, calibrate, and validate the output of the modeling process associated with this project.

This QAPP is reviewed and approved by the TCEQ to help ensure that the outputs and data generated for the purposes described within are of known and documented quality and deemed accepted for their intended use. This process will facilitate the use of project outputs and data by the NPS program and other programs deemed appropriate by the TCEQ.

[1] The impairments and concerns represented in this table are based on the Draft 2022 Integrated Report as referenced at https://www.tceq.texas.gov/waterquality/assessment.
[2] Preliminary water quality analyses and LDC analysis for bacteria and dissolved oxygen improvement were conducted between 2014 and 2017 under TCEQ TMDL project 582-12-13254 "Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds."
[3] Water quality goals for this WPP will always include compliance with state water quality standards. Compliance with state standards is always the primary purpose of the WPP, and the development of data therefore. Additional goals may be developed by the stakeholders as part of the public engagement process, for contaminants or issues for which standards and/or numeric criteria do not exist (trash, etc.). Data generated under the efforts covered by this QAPP (water quality analysis, etc.) may assist stakeholders in identifying solutions that achieve multiple benefits or coordinate efforts with existing programs.

A6 PROJECT/TASK DESCRIPTION AND SCHEDULE

The data needs described in A5 relate to characterizing water quality and updating or refining[1] data concerning causes and sources of pollution to guide stakeholder decisions in the development of the WPP. Based on a review of the concerns and impairments, fecal waste pollution is the water quality issue of greatest concern to the waterways.

Specifically, H-GAC will conduct modeling and data evaluation efforts to:

- Evaluate trends and variability in current and historical water quality data, including the use of Statistical Analysis Software (SAS).
- Conduct modeling efforts to define the spatial distribution and amount of fecal bacteria[2] loading using the Spatially Explicit Load Enrichment Calculation Tool (SELECT) model.
- Characterize fecal bacteria and dissolved oxygen concentrations in varying flow conditions and identify the bacteria reductions necessary to meet applicable standards instream using Load Durations Curves (LDCs).

Water Quality Analysis

The acquisition and analysis of water quality data will be conducted for East Fork San Jacinto River based on existing data in the Surface Water Quality Monitoring Information System (SWQMIS), data collected during the project under the Clean Rivers Program's (CRP) existing monitoring QAPP, and sanitary sewer overflow (SSO) and discharge monitoring reports (DMRs) from TCEQ data. SWQMIS/CRP data, indicator bacteria, nutrients, temperature, pH, chlorophyll-a, total suspended solids, flow, and dissolved oxygen (DO) data will be evaluated for trends, seasonal variation, and spatial patterns. Data for current 24-hour DO monitoring will be reviewed for at least one CRP site in each segment if sufficient data are available. H-GAC will evaluate TCEQ's DMR/SSO data for the most recent five years. The output of this effort will be the acquired datasets, the trends and variability analyses derived from SAS, a report on the data to be used for updating modeling efforts, and a report on the trend and variability analyses results. This effort will identify trends, guide decision-making, and provide inputs for the SELECT and LDC modeling efforts.

Load Characterization with SELECT

The SELECT[3] model will be developed based on currently available data and stakeholder feedback. SELECT uses existing spatial data in a geographic information system (GIS) framework and literature values to characterize the extent and spatial distribution of bacteria sources. This methodology was originally selected for this purpose based on use in other similar projects and because it represented a good match between the level of precision needed for the project with the complexity of the model (and the resources available). Spatial data used in SELECT include land

[1] All references to updating or refining water quality analyses or modeling efforts (LDCs, etc.) should be taken to refer to the work completed under project 582-12-13254 "Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds" and its corresponding QAPP.
[2] Throughout this QAPP, "fecal bacteria" will generally refer to *E. coli*, the bacteria indicator for fecal waste.
[3] Additional information on the purpose, methodology, and use of the SELECT model from which this SELECT approach is derived can be found in Teague *et al*. 2009 at https://ssl.tamu.edu/media/11291/select-aarin.pdf.

use/land cover, point sources, roads, hydrology/stream network, subwatershed boundaries, aerial imagery, Texas Pollutant Discharge Elimination System (TPDES) permit outfall locations (including wastewater treatment facilities [WWTFs], concentrated animal feeding operations, and municipal separate storm sewer [MS4s] permits), on-site sewage facility (OSSF) locations, soil data, census tracts, regional demographic projections (spatial), elevations, and other related watershed-specific spatial locations (impoundments, etc.). Non-spatial data, or spatial data not used wholly in a spatial context, will include agricultural census data, DMRs, SSO violation data, wildlife population data, and non-domestic animal population data (feral hogs). Literature values or assumptions[1] derived from data to be used will include population and loading rates for all sources, unpermitted septic system locations, pollutants in WWTF flows, and prevalence of specific sources in different land cover types.

H-GAC will use SELECT to develop analyses for the project area for current and future conditions. The analyses will be broken out by subwatershed. Assumptions and results will be reviewed with stakeholders, TCEQ, and other partners to ensure that they reflect local knowledge and provide an accurate reflection of loading in the watershed. The output of this effort will be visual displays of loading data, potential load estimates, and characterization of relative contribution by sources for current and future conditions. These outputs will guide stakeholder decisions concerning the identification and prioritization of management measures and serve as a basis for updating derived reduction targets in conjunction with the LDC analyses.

For all SELECT analyses, the scenarios will include a weighting factor in which loads generated within 300 feet of waterways will be weighted as 100%. Loads originating outside this "buffer" area will be weighted as 25%. The "buffered" approach utilizes a weighting factor to accentuate the probability of proximate load to waterways having greater impact[2].

Load Duration Curves

This project effort will develop LDCs[3] for bacteria and DO. The LDCs will be used to develop derived load reductions for bacteria and to evaluate any patterns in exceedances of the water quality standard based on flow conditions for all constituents.

LDCs will be completed for at least two stations in the project watershed, utilizing quality assured water quality data from SWQMIS and/or CRP sources and flow data from United States Geological Survey (USGS) gauges. Additional LDCs will be developed as needed from the list of LDCs in Table A6.1 depending on the results of the water quality analyses, evaluation of sources, and the need to characterize individual tributaries, subwatersheds, or sections of a segment. If a representative flow gauge is not available and there is sufficient flow data available, H-GAC will

[1] Additional loading factors may be included based on stakeholder input, including conservative estimates of populations not able to be estimated through existing data (e.g., adding load for wildlife other than deer, or decreasing load from pets based on pet waste station usage).
[2] SELECT does not account for the effects of proximity on bacteria transmission, which may skew source contribution ratios and impact stakeholder decisions. The weighting approach is based on previous WPP approaches (e.g., West Fork San Jacinto River, Cypress Creek, Spring Creek) using some extent of the same approach, as developed and approved by stakeholders.
[3] Additional information on the use and methodology of the load duration curve model being used for this and previous efforts can be found at https://www.epa.gov/sites/production/files/2015-07/documents/2007_08_23_tmdl_duration_curve_guide_aug2007.pdf .

use LOADEST to generate a 10-year period of estimated flow data. Prior to developing the LDCs, H-GAC will evaluate the preliminary information from water quality data analyses to confirm that selected LDC sites are appropriate for characterizing their respective water bodies. The outputs of the LDC analysis will be visual characterizations of the relationship between flow levels and constituent concentrations, and reduction estimates for fecal bacteria loading and DO improvement. The use of this effort will be to help identify variation in loading based on flow and to inform stakeholder decisions regarding scale and type of management measures. The USGS stream gauge and potential monitoring site locations for LDCs are summarized in Table A6.1.

Table A6.1 LDC Monitoring Site Locations

Segment Name	Segment Number	Station Number	USGS Gage
East Fork San Jacinto River at FM 1485	1003	11235	08070200
East Fork San Jacinto River at FM 2090	1003	11236	No Gage
East Fork San Jacinto River at FM 945	1003	11237	No Gage
East Fork San Jacinto River at SH 105	1003	11238	08070000
East Fork San Jacinto River at US 59	1003	14242	No Gage
East Fork San Jacinto River at SH 150	1003	17431	No Gage
East Fork San Jacinto River at North Butch Arthur Road	1003	21939	No Gage
Winters Bayou at Tony Tap Road Near Cleveland	1003A	21417	No Gage
Winters Bayou at FM 2929	1003A	21933	No Gage
Winters Bayou at FM 2693	1003A	21935	No Gage
Winters Bayou at SH 150	1003A	21936	No Gage
Winters Bayou at Dabney Bottom Road	1003A	21937	No Gage
Nebletts Creek at FM 1725	1003B	21938	No Gage
Boswell Creek at Four Notch Road	1003C	21934	No Gage

This modeling approach was chosen based on applicability of the models to the project questions; level of precision needed for development of the watershed protection plan; similarity to other WPP modeling efforts; and through discussions with TCEQ project staff. The fundamental goal of these modeling efforts remains to inform staff understanding of the watershed and stakeholder decisions. The timeline for these efforts is defined in the contractual agreement between H-GAC and TCEQ, as amended from time to time, and summarized in Table A6.2.

Table A6.2 Modeling and Data Analysis Schedule of Deliverables

Contract Task No.	Deliverable	Due Date
3.1	Documentation of data compilation and review	5/31/2022
3.2	Draft Data Analysis Summary Report	5/31/2022
3.2	Final Data Analysis Summary Report	7/31/2022
4.1	Load Duration Curves	8/31/2022
4.2	SELECT Results	8/31/2022
4.3	Draft Modeling Report	8/31/2022
4.3	Final Modeling Report	10/31/2022

The contract that this QAPP is associated with was executed in October 2021 and is estimated to be completed in August 2025. All task and deliverable dates are estimates. Work covered under this QAPP will not begin until the QAPP is executed.

See Appendix A for the contract tasks referenced in this QAPP.

REVISIONS TO THE QAPP

Amendments

Amendments to the QAPP must be approved to reflect changes in project organization, tasks, schedules, objectives, and methods; address deficiencies and nonconformances; improve operational efficiency; and accommodate unique or unanticipated circumstances. Requests for amendments are directed from the H-GAC Project Manager to the TCEQ NPS Project Manager in writing using the NPS QAPP Amendment Shell. The changes are effective immediately upon approval by the TCEQ QA Manager, TCEQ NPS Project Manager, and TCEQ Lead QA Specialist, or their designees.

Amendments to the QAPP and the reasons for the changes will be documented, and full copies of the amendments will be forwarded to all persons on the QAPP distribution list by the H-GAC QAO. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual certification process or within 120 days of the initial approval in cases of significant changes.

Annual QAPP Reviews and Revisions

This QAPP shall be reviewed in its entirety and certified annually by the H-GAC Project Manager and the TCEQ NPS Project Manager. A letter certifying this annual review must be submitted to the TCEQ NPS Project Manager no later than 90 days prior to the QAPP anniversary date. Amendments approved since QAPP approval (or most recent annual review, if applicable) must be included as an attachment along with the letter. Only non-substantive changes not affecting the project design or quality or quantity of work to be performed can be included in the annual certification letter. This includes organizational changes or schedule changes based on a contract amendment that do not impact data deliverables. If changes beyond these are necessary, a QAPP amendment must be submitted and approved before the annual

review may be certified. The TCEQ NPS Project Manager is required to review the QAPP and provide certification of annual reviews to the TCEQ QA Manager and EPA Region 6 Project Officer no later than 30 days before QAPP anniversary dates. If the QAPP expires, work described within this document must be halted.

If the project will extend beyond the third QAPP anniversary date, a full QAPP revision is required.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MODEL INPUTS/OUTPUTS

The general quality objectives for the project are to produce data analyses and updated modeling outcomes that accurately characterize conditions in the watershed and are a sufficient platform on which to base stakeholder decisions concerning the selection and scale of management measures. This is achieved using the best available data (quality-assured[1] as applicable), review of products and inputs with stakeholders and knowledgeable partners and adhering to the preponderance of literature (as amended by reasonable stakeholder review) for modeling assumptions. These goals are fostered by continual and robust engagement with stakeholders, especially partners with specific technical experience.

Data quality objectives for each component effort are described below. For all acquired/existing data sources quality assured data from SWQMIS as collected through CRP or other submitting programs will be used if available.

Water Quality Analysis
The primary data quality objectives for this effort are to ensure data inputs are from quality assured sources (e.g., data collected under existing TCEQ/EPA approved QAPP or another similar source), and that analysis outputs accurately reflect water quality trends in the watershed. The focus of the analyses are long-term trends, although short-term or seasonal trends may be reviewed based on a review of the available dataset, requirements of the stakeholders, and area-specific circumstances. . Data that are not quality assured may be used to help characterize the watershed in a qualitative sense, or as indicators where additional analysis may be needed, but will not be considered equal to data produced under a QAPP. These data sources will not be used for the water quality analyses or mingled with quality-assured data, but only for informal/informative review of potential problem areas not covered by formal monitoring.

Performance criteria for outputs include a proper data management trail (per Appendix E and relevant document retention requirements of this QAPP) of the data evaluation process, and trends/variability analyses that properly utilized SAS methods (See Appendix E), performed by experienced staff. The outputs will be acceptable if the performance criteria are met (this is a qualitative measure, as no calibration or validation of data other than initial validation in submission to SWMQIS is performed on these analyses). The intended use of these outputs will

[1] For the purpose of water quality trends analyses, modeling inputs, and in support of decision-making for the WPP, water quality data used will be limited to quality-assured data processed through a TNI-accredited lab, unless it meets an exception as indicated in 30 TAC, Chapter 25.6. Volunteer data (e.g., Texas Stream Team, or other non-accredited lab data) will only be used for anecdotal purposes or for general watershed information.

be to display water quality trends for stakeholder decision-making processes, including the development of pollutant reduction targets based on the results of the SELECT modeling outputs.

Hardware and software to be used will conform to industry standards (e.g., Microsoft Office products and SAS utilized in a Windows 7 environment). Configuration of SAS analyses will be based on similar water quality analyses conducted by CRP staff using the same data management and data evaluation processes and tools to ensure the data is comparable with those of other regional and regulatory efforts.

Data completeness will be evaluated based on whether all existing data as submitted to SWQMIS has been used. Data representativeness will be based on whether all available data from stations in the watershed is utilized, thus representing the broadest picture of conditions throughout the area.

Trend analysis will include assessment of which ambient monitoring constituents have statistically significant trends. Information about each constituent will include the number of samples evaluated. Evaluation of constituents will be based on their respective water quality standard numeric criteria or equivalent measure (e.g., screening level). Analyses will mirror the approach taken in the development of water quality trends analyses for similar area WPPs. Because the data and methods to be used have previously been reviewed as part of quality-assured processes, no appreciable bias in the data is expected. Systemic bias in water quality sampling is based on skewing of data collection to daylight hours. Systemic uncertainty is found in the lack of continuous data (i.e., periodic grab samples under CRP, etc.). However, these sources of uncertainty are endemic to monitoring programs, and are not expected to produce serious issues for data analysis acceptability.

Load Characterization with SELECT

The primary data quality objectives for this effort are to ensure data inputs are from the best available sources (quality assured or industry standard), that assumptions are scientifically defensible and vetted by stakeholders, and that outputs are driven by appropriate data and stakeholder review. Performance criteria for inputs are that they represent the best available data, and in the case of data sources which may differ from place to place, the most locally appropriate data (e.g., deer population numbers for the specific area as opposed to a statewide average). All spatial data used in SELECT are from sources that are quality-assured, widely used data products appropriate for this task, or based on assumptions used and vetted under previous area WPPs. Performance criteria for outputs include modeling outcomes that are sufficient to guide stakeholder discussion, and which are demonstrably defensible based on the source and vetting of data and assumptions. The outputs will be acceptable if these criteria are met (this is a qualitative measure, as no model calibration or validation of data other than initial validation in submission to SWMQIS is performed for SELECT). The intended uses of these outputs will be to generate potential pollutant load estimates and characterize their spatial relationship, and to guide stakeholder discussions of the scope of management measures. Hardware and software to be used will conform to industry standard (e.g., Microsoft Office products, and the SELECT model utilized in a Windows/ArcGIS environment). Configuration of SELECT assumptions analyses will be based on similar SELECT analyses to ensure the data are comparable with those of other regional and regulatory efforts.

Data completeness will be based on whether enough data are available to generate loads using SELECT. Data representativeness will be evaluated based on whether spatial data and assumptions are indicative of conditions throughout the watersheds. Because the selection of assumptions and the stakeholder review process can introduce some subjectivity in decision-making, some level of bias in the outcomes is expected. Bias will be considered reasonable if modifications to outputs or assumptions are based on reasonable expectations that local knowledge or data are more appropriate than more general values. Systemic uncertainty is inherent to the use of assumptions and literature value. However, these sources of uncertainty are endemic to SELECT modeling and do not compromise the objectives for this modeling effort. SELECT is not intended to be a model of a precision level that would be impacted by these levels of bias and/or uncertainty. Table A7.1 indicates all foreseeable assumptions or literature values that will be applied to the models.

Table A7.1 Modeling Assumptions

Assumption/ Literature Value	Model	Review with Stakeholders?	Source	Value
Feral Hog Density	SELECT	Yes	Texas A&M AgriLife Research (AgriLife) Densities	AgriLife has used a variety of hog densities, with a generic Texas range of 8.9-16.4 hogs per square mile[1], depending on land cover type. This value is expected to be heavily modified by local stakeholders to reflect area or subwatershed populations.
Livestock Populations	SELECT	Yes	United States Department of Agriculture National Agricultural Statistics Service (NASS) Agricultural Census Data (most recent)	County-level data are used to derive a ratio of animals per land cover type. This ratio is then applied to the area of the watershed in each county.
OSSFs Number and Location	SELECT	Yes	H-GAC OSSF Database	Permitted systems are based on actual location data. Unpermitted systems are based on occupied locations outside of service areas, without permitted OSSFs.
OSSF Failure Rates	SELECT	Yes	H-GAC OSSF Data, Stakeholder Input	As these rates are highly variable by location, failure rates will be heavily

[1] http://agrilife.org/feralhogs/files/2010/04/FeralHogPopulationGrwothDensityandHervestinTexasedited.pdf

Assumption/ Literature Value	Model	Review with Stakeholders?	Source	Value
				modified by stakeholder (especially Authorized Agent) input. An estimated 15% failure rate was used in preliminary SELECT outputs.
Animal Excretion/Bacterial Densities	SELECT	No	Literature Value	Based on values indicated in Teague, 2009[1].
WWTF Discharge Concentrations	SELECT	Yes	DMR Data from Each Plant (TCEQ)	Geomean of DMR data, using an assumed 60% of permitted flow as daily average flow to determine total load.
Land Cover Change	SELECT	Yes	H-GAC Regional Demographic Projections	Proprietary data used in most regional WPPs.
Pet Populations	SELECT	Yes	American Veterinary Medicine Association (AVMA)	AVMA estimates of household ownership (0.8 pets/household) used as a starting figure, multiplied by number of households. This will be modified by stakeholders and area-specific reconnaissance. A decrease factor in load may be applied if pet waste station/pet bag use is found to be common in the watershed, based on research and stakeholder input.
Deer Populations	SELECT	Yes	Texas Parks and Wildlife Department (TPWD)	TPWD Resource Management Unit (RMU) data are used to define regional deer population estimates, which are applied to appropriate land cover types, as in Teague, 2009.

[1] "Spatially explicit load enrichment calculation tool to identify potential *E. coli* sources in watersheds." A. Teague, *et al*. 2009. http://ssl.tamu.edu/media/11291/select-aarin.pdf

Assumption/ Literature Value	Model	Review with Stakeholders?	Source	Value
Bird Populations/Fecal Concentrations	SELECT	Yes	TPWD, Stakeholders, EPA, Texas State Soil and Water Conservation Board (TSSWCB)	Bird populations are based primarily on TPWD staff knowledge (if available) and stakeholder knowledge. Of primary concern are the presence of colonial rookeries, swallow nesting sites over water, gulls concentrated at landfills, and other large concentrations of birds. EPA and TSSWCB values[1] for bird fecal rates are used if stakeholder input indicates substantial, or substantially proximate (swallow colonies over bridges, etc.), numbers of birds exist on an annual basis to model. Values dependent on species of concern.
WWTF Outfall Locations	SELECT	No	TCEQ Spatial Data	WWTF outfalls are spatially explicit data.
Other Wildlife	SELECT	Yes	TPWD, Stakeholder input	If data for other wildlife populations exist, they will be considered for inclusion with stakeholders. If data does not exist, a conservative background load expressed as a percent of total may be applied based on stakeholder input and microbial source tracking studies in the state and local area.

[1] Based on studies referenced by EPA and TSSWCB, including http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771205/ and https://www.tsswcb.texas.gov/sites/default/files/files/programs/nonpoint-source-managment/Completed%20Projects/BBBB_Report_23Sep13_Clean.pdf

Load Duration Curves

The primary data quality objectives for this effort are to ensure data inputs are from quality assured sources (e.g., data collected under existing TCEQ/EPA approved QAPP or other similar source); that modeling assumptions are based on the best available literature, established methodologies for specific circumstances, and best professional judgment; and that outputs reflect load durations and related reduction needs (for bacteria, and improvement needs for DO) in a manner that is reflective of the diverse conditions of the project area. Performance criteria for outputs include a proper data management trail of the data evaluation process, and LDC analysis using established methods[1], performed by experienced staff. The outputs will be acceptable if these criteria are met (this is a qualitative measure, as no calibration or validation of data other than initial validation in submission to SWMQIS is performed on these analyses).

The intended use of these outputs will be to develop updated bacteria reductions and define impacts to bacteria and related constituents under various flow conditions. Hardware and software to be used will conform to industry standards (e.g., Microsoft Office products and LOADEST in a current Windows environment). Configuration of LDC assumptions will be based on TCEQ guidance to ensure the data are comparable with those of other regional and regulatory efforts. However, specific configuration of assumptions will be based on best available data, professional judgment, and stakeholder review. Data completeness will be based on whether enough data are available to generate updated LDCs. Data representativeness will be evaluated based on whether selected LDC sites have enough data for an update and are representative of the watersheds in general. Because the selection of assumptions and the stakeholder review process can introduce some subjectivity in decision-making, some level of bias in the outcomes is expected. Bias will be considered reasonable if modifications to outputs or assumptions are based on reasonable expectations that local knowledge or data are more appropriate than more general values or specific choices (e.g., level of reduction to be used in relation to bacteria). Systemic uncertainty is inherent to the simplicity of the model and the complexity of real-world systems. However, these sources of uncertainty are endemic to LDC modeling and do not compromise the objectives for this modeling effort. LDCs are not intended to be a modeling approach of a precision level that would be impacted by these levels of bias and/or uncertainty. If insufficient USGS flow data are available, estimated flow data will be projected using the Soil and Water Assessment Tool (SWAT). The data objectives for the estimated flow conform to the same intended uses as the other LDC inputs and outputs. The intent of estimating flow is to provide stakeholders with information for an area that may otherwise not have enough flow data on which to base an LDC.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

No formal certification is required for the efforts to be conducted under this QAPP. The modeling and project management staff have conducted previous training in all modeling and data evaluation efforts discussed. Any additional staff members that conduct work under this project will have, or receive, training specific to their work. Training taking place within the time frame of this contract will be recorded and maintained by the H-GAC Project Manager.

[1] http://www.epa.gov/tmdl/approach-using-load-duration-curves-development-tmdls

The H-GAC Lead Modeler and Project Manager have conducted SELECT and LDC analyses (including the use of LOADEST in general and for the specific purpose of generating flow data) on a variety of watershed projects and have attended multiple formal training events on SELECT and LDCs. Additionally, they have advanced knowledge of data quality needs and objectives common to modeling approaches in general based on experience and training. LOADEST will use existing data resources, and staff are already trained in its use and application for these purposes, so no additional training is required. The Lead Modeler will oversee the work of the Assistant Modeler, and ensure they have any additional training necessary. Training will be provided directly by the Lead Modeler and Project Manager as needed.

The Data Manager and QAO for this project are the H-GAC lead staff for CRP data analysis, and have extensive training in data management, quality assurance, and SAS operation (data manager). They routinely attend training specific to SWQMIS procedures, and/or SAS operation. Their daily activities have heavy focus on this type of data analysis and quality assurance. Records of educational credentials, training, demonstrations of competency, assessments, and corrective actions are retained by project management and are available for review.

All staff members have worked with QAPPs under prior projects. No additional training is expected to be needed to complete the project efforts.

A9 DOCUMENTATION AND RECORDS

All digital and paper documentation for the project is kept for the period of retention noted in Table A9.1. The H-GAC Project Manager has final responsibility for ensuring project files are compiled in accordance with this QAPP. The QAO and Data Manager will ensure that the H-GAC Project Manager has appropriate documentation for water quality data analyses and records for data from acquired data sources including but not limited to SWQMIS and CRP data. The Lead Modeler will ensure that all modeling records, notes, literature referenced, and other records from modeling efforts compiled by any H-GAC team member are maintained during the project and relinquished to the H-GAC Project Manager for proper retention. Electronic data on the project computers and the network server are backed up daily to the network drive and weekly to external storage. In the event of a catastrophic systems failure, the backups can be used to restore the data in less than one day’s time. Data generated on the day of the failure may be lost but can be reproduced from raw data in most cases. Quarterly progress reports disseminated to the individuals listed in section A3 will note activities conducted in connection with the water quality modeling project, items or areas identified as potential problems, and any variations or supplements to the QAPP.

In addition to general information regarding data and modeling activities, any stakeholder input received, or notes generated regarding input, will be included with modeling files and project documentation.

Modeling Log

Modeling notes created by the Lead Modeler, or the Assistant Modeler will be recorded electronically with model files, on paper, or in a separate electronic file (e.g., Word document).

All electronic files will be stored in the same folder as the modeling files, and all paper files will be retained by the Lead Modeler until the end of the project. At that time, they will be included with project files maintained by the H-GAC Project Manager.

The Lead Modeler will document references and compile any references developed by the Assistant Modeler for model assumptions (and adjustments thereof), stakeholder feedback provided by the H-GAC Project Manager, and model runs. The level of detail will be sufficient to allow another modeler to duplicate the modeling method given the same data and model.

The documents and records that describe, specify, report, or certify activities, requirements, procedures, or results for this project and the items and materials that furnish objective evidence of the quality of items or activities are listed in Table A9.1. All project staff will develop and retain documentation as described in Table A9.1.

Table A9.1 Project Documents and Records

Document/Record	**Location**	**Retention*[a]**	**Form*[b]**
QAPPs, amendments, and appendices	H-GAC	5 years	Paper/Electronic
QAPP distribution documentation	H-GAC	5 years	Paper/Electronic
SOPs	H-GAC	5 years	Paper/Electronic
Model User's Manual or Guide (including application-specific versions)	H-GAC	5 years	Paper/Electronic
Assessment reports for acquired data	H-GAC	5 years	Paper/Electronic
Raw data files	H-GAC	5 years	Paper/Electronic
Data used for FDCs/LDCs	H-GAC	5 years	Electronic
Model input files	H-GAC	5 years	Electronic
Model output files	H-GAC	5 years	Electronic
Statistical Computation Documentation	H-GAC	5 years	Electronic
Code Verification Reports	H-GAC	5 years	Paper
Model Assessment Reports	H-GAC	5 years	Paper
Progress report/CAR/final report/data	H-GAC/TCEQ	3 years	Paper/Electronic

*a – After the close of the project
*b – Electronic files should be American Standard Code for Information Interchange Disk Operating System (ASCII DOS) pipe delimited text files or Microsoft Word/Excel; model input and output files can be archived in the format used by the modeling software, provided the capability of conversion to ASCII DOS pipe delimited text files or Microsoft Word/Excel (TCEQ compatible version) is maintained over the time of retention.

The TCEQ may request records at any time and/or elect to take possession of records at the conclusion of the specified retention period.

SECTION B: MEASUREMENT AND DATA ACQUISITION

The primary source of data for these data analysis and modeling efforts will be SWQMIS data produced under previous QAPPs (e.g., CRP data).

B1 SAMPLING PROCESS DESIGN
Does not apply to this QAPP

B2 SAMPLING METHODS
Does not apply to this QAPP

B3 SAMPLE HANDLING AND CUSTODY
Does not apply to this QAPP

B4 ANALYTICAL METHODS
Analytical methods are described in Section A6.

B5 QUALITY CONTROL
Quality control measures are described in Section A7.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE
Does not apply to this QAPP

B7 MODEL CALIBRATION
No formal calibration (or sensitivity analysis) is used for the data analyses (SAS), SELECT, SWAT, or standard LDCs, including the generation of continuous flow data in absence of representative USGS gauge data by LOADEST. Informal adjustment of the model inputs or outputs may be applied based on stakeholder feedback and more specific local knowledge compared to general assumptions.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES
Does not apply to this QAPP

B9 NON-DIRECT MEASUREMENTS (DATA ACQUISITION REQUIREMENTS)
The modeling and water quality data analysis efforts described in this QAPP will make use of non-direct/acquired data from a variety of sources. The sources and their characteristics are included in Table B9.1.

The primary sources of data for model development are:

- Water quality monitoring data from SWQMIS
- DMRs, SSO violation data, other permit reporting data from TCEQ databases
- Regional demographic forecasting data created by H-GAC
- OSSF location data created by H-GAC for TCEQ
- Spatial datasets and databases created by other state and federal agencies (e.g., H-GAC land cover data, USGS flow data and precipitation data)

- Literature values for model assumptions (see Table A7.1[1])

All non-direct data being used have been previously deemed to be acceptable acquired data sources under other QAPP efforts or was prepared under QAPP coverage or similar quality-assured processes. In all instances, the best available data in terms of quality, quality control, and comparability with other QAPP covered modeling efforts have been selected for use.

Ambient Water Quality Data

No data will be collected specifically for this project nor submitted for inclusion in SWQMIS. The collection and qualification of the TCEQ and USGS data are addressed in the TCEQ Surface Water Quality Monitoring QAPP[2]. Data acquired for this project will include those parameters described in section A6 as well as any other data needed to characterize the watershed; develop, operate, or validate models; or meet other user requirements. These data include conventional parameters, field parameters, bacteriological parameters, and biased sampling conducted under special projects.

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 efforts. The water quality data to be acquired for this project will include routine water quality data collected by TCEQ and sampling partners such as CRP, USGS, and TSSWCB, including available 'non-qualified,' routine or special study, ambient, fixed station water quality data and associated field parameters.

H-GAC's FY2022-2023 CRP QAPP[3] Section B9 explains which TCEQ method codes are used to describe comparable parameters contributing to the CRP dataset. Sections A7, B5 and Appendix A of the FY2022-2023 CRP QAPP also describe limits of quantitation and the process by which analytical results reported to the CRP are required to reflect parameter ranges in excess of those limits. Assessments of CRP data conducted under the Basin Highlights Report(s) and Basin Summary Report falling within this project timeline may be used to supplement analyses conducted under this project. All CRP work is conducted under its own QAPP and is not intended to be covered under this QAPP. However, the data, staff, and processes used are identical to those intended for this project.

TCEQ Permit and Violation Data

This project will make use of data from TPDES and other permittees acquired and maintained by TCEQ. This will include DMRs, SSO violation data, TPDES permit information and compliance history, and other data relevant to TCEQ or EPA-permitted facilities in the watershed. These data are assumed to be of acceptable quality based on inclusion in TCEQ- or EPA-approved datasets, including those prepared by H-GAC for TCEQ under QAPP-covered efforts funded by 604(b)

[1] Table A7.1 includes preliminary model assumptions and literature values. Additional values, assumptions, or modifications thereof may be utilized depending on stakeholder input. The project modeling process relies strongly on working with stakeholders to refine assumptions to best suit local conditions and knowledge.
[2] https://www.tceq.texas.gov/waterquality/monitoring/swqm_guides.html
[3] H-GAC's FY2022-2023 CRP QAPP can be viewed at https://www.h-gac.com/getmedia/aeb4acca-643e-4345-b4cb-5c9c35404f18/FY22-23-QAPP

Water Quality Management Plan projects. H-GAC will work with TCEQ staff to identify, acquire, and update these data sources.

Regional Demographic Forecasting
H-GAC conducts regional demographic forecasting as part of a quality-assured effort. Data to be used for this project include current and future population projections, land cover change projections, and household and job change projections. Additionally, H-GAC develops proprietary land cover data based on LANDSAT satellite imagery that is more current and regionally specific than other land cover data sources. This data source is the standard for the region and is used in comparable QAPP-covered planning efforts as well as broader regional planning efforts.

OSSF Location Data
H-GAC maintains a spatial database of permitted OSSF locations for the region, including the project area. This database was developed and maintained under a TCEQ-approved QAPP as part of an ongoing Clean Water Act 604(b) Water Quality Management Plan partnership between H-GAC and TCEQ.

Existing Modeling
The SELECT and LDC data for the existing preliminary modeling efforts for this watershed will be used as a basis for updating and revising SELECT and LDCs, as described in A6. These LDCs were developed under approved QAPP coverage.

Geospatial Data
The H-GAC Community and Environmental Planning Department's (C&E) Data Management Plan (DMP; Appendix E) 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 (see Appendix E for more detail). Existing geospatial data resources at H-GAC will be combined with additional data from appropriate local, regional, state, and federal organizations as needed. Geospatial data used for modeling exercises will be of acceptable quality based on the data quality objectives of this project and will have been published with appropriate metadata. The publishing of geospatial data by various organizations implies that the data are of known quality, that is, has been subject to review and approval by the publishing organization and has required metadata to prove its accuracy and completeness.

All outside data sources will be reviewed to determine level of quality, compatibility, and completeness. Procedures used to collect these outside sources will also be reviewed to determine compatibility and determine level of sampling bias and uncertainty. Generally, data used from outside sources will be acceptable if they were collected under an existing QAPP, published in peer review literature or if sufficient and documented quality assurance/quality control (QA/QC) procedures were employed during project data collection and analysis.

H-GAC utilizes ESRI's ArcGIS 10 platform for all geospatial analysis and mapping needs. The ESRI ArcGIS 10.X 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.

Derived GIS layer data from other QAPP-covered CRP assessments (e.g., potential sources of contamination in a watershed identified under a Basin Highlights Report or Basin Summary Report) may be utilized if it is of equal or greater adherence with the data quality objectives for this project.

Modeling Assumptions and Literature Values

The SELECT and LDC models rely on a mix of actual measurements and assumptions/literature values. The application of the LOADEST tool to generate a simple hydrological runoff estimation relies on values internal to the tool. Some model values are integral to the models, while others can be modified or are based on local data/accounts. Literature values intended to be used for these modeling efforts include rate, volume, and character of fecal deposition by various sources; event mean bacteria concentrations specific to land cover types; nutrient loading characteristics of land cover types; source population estimates (e.g., number of feral hogs per mile); and impacts of various best management practices. Selection of literature values will show preference to peer-reviewed scientific literature, most locality-specific references, and currency of reference, as modified by agency and stakeholder feedback. User-selected assumptions for SELECT include the use of the buffer approach in discounting loading outside a defined buffer distance from the waterway, and the distribution of some sources for which data are not specific to the watershed (e.g., cattle populations based on county-level data).

Other Data

Data used for qualitative assessment, stakeholder discussion, and watershed characterization not related to modeling efforts covered under this QAPP may include Texas Stream Team volunteer monitoring data, spatial data generated by other entities active in the East Fork San Jacinto Watershed (e.g., habitat data generated by local non-governmental organizations), and other local data as encountered during the course of the WPP development project. These data sources are not intended to be used directly for the modeling efforts covered under this QAPP, but may influence staff and stakeholder decisions regarding assumptions, etc.

Table B9.1 Non-Direct Measurements

Type of Measurement or Analysis	Type of Data (time series, rate, constant, statistic, taxa, etc.)	Units	Source (web link when available)	Quality Assurance Documentation	Use	Date Range
Ambient water quality monitoring data	Periodic water quality	Various	SWQMIS	https://www.tceq.texas.gov/waterquality/monitoring/swqm_guides.html	Used as observed values for modeling efforts	Various, depending on station
DMRs	Periodic water quality reporting	Various	TPDES permittees via TCEQ	N/A	Used to characterize WWTF loading	Various, depending on station
SSO violation data	Episodic violation reporting	Various	TPDES permittees via TCEQ	N/A	Used to characterize collection system loading	Various, depending on station
Regional growth forecast	Modeled projections	Various	H-GAC	https://www.h-gac.com/getmedia/6f706efb-9c6d-4b6a-b3aa-7dc7ad10bd26/read-documentation.pdf	Used to characterize land cover and population change	2020-2045
Regional Land Cover	Spatial database	Various	H-GAC	https://www.h-gac.com/land-use-and-land-cover-data	Used to characterize land cover	Most current available
OSSF locations	Spatial database	Individual OSSF records	H-GAC	Completed under H-GAC Regional Geospatial Data QAPP	Used to characterize OSSF loads	Various-2021
GIS layers	Geospatial datasets	Various	Various	The quality assurance processes are specific to the individual layers. More information on the quality of geospatial source data follows this chart.	Used to develop models and for cartographic purposes	Most current available
Literature values	Various	Various	Various	The quality assurance for the studies and other methods that developed literature values are specific to each value, as noted in project reports.	Used to develop models/tools	Various

Existing geospatial data available from various local, regional, state, and federal organizations may be used for project cartographic and illustrative purposes. These types 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, Texas Natural Resource Information System, TCEQ, TSSWCB, USGS, U.S. Department of Agriculture National Resources Conservation Service, TPWD, EPA, NOAA, General Land Office, and U.S. Census Bureau. Geospatial data from these sources are accepted for use in project maps based on the reputability of these data sources and the fact that there are no known comparable sources for these data. Geospatial data will be cited in reports.

As the project progresses, additional data sources and/or data types may be identified as necessary to complete project tasks. Once identified, H-GAC will notify the TCEQ NPS Project Manager and request approval prior to use. If data will be analyzed or used for any purposes beyond cartographic or illustrative purposes, the QAPP must be amended and approved prior to use. All approved data sources will be clearly documented where such data sources are reported (e.g., technical documents, technical reports, and final reports).

B10 DATA MANAGEMENT AND HARDWARE/SOFTWARE CONFIGURATION

Data evaluated, acquired, produced, or maintained under this QAPP will be handled in accordance with the DMP (attached as Appendix E). H-GAC uses this DMP for all related water quality efforts requiring QAPP coverage (e.g., CRP).

B10 (a) Data Management

H-GAC data management procedures are discussed in Appendix E.

Data Dictionary

H-GAC standard data terminology and definitions are discussed in Appendix E.

Migration/Transfer/Conversion

Migration, transfer, and conversion of data, as well as data history and model outputs, are discussed in Appendix E.

Information Dissemination

Project updates will be provided to the TCEQ NPS Project Manager in progress reports and the information will be made available at stakeholder meetings. Input data and model outputs resulting from the project described in this QAPP will be accessible to the general public and TCEQ. Additional procedures are discussed in Appendix E.

B10 (b) Hardware/Software Configuration

Archives/Data Retention

Complete original data sets are archived on external hard drives and retained on-site by H-GAC for a retention period specified in Table A9.1 Project Documents and Records. Additional discussion of archiving procedure is indicated in Appendix E.

Backup/Disaster Recovery

All work and file storage takes place on a shared network drive(s) which are continuously backed up on the network servers and archived on a regular basis. In the event of a catastrophic systems failure, the archival backups can be used to restore the data in less than one day's time. Data generated on the day of the failure may be lost but can be reproduced from raw data in most cases.

SECTION C: ASSESSMENT AND OVERSIGHT

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table presents types of assessments and response action for activities 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	Monitoring of the project status and records to ensure QAPP requirements are being fulfilled. Monitoring and review of subcontractor's performance and data quality	Report to TCEQ in Quarterly/Monthly Report. Ensure project requirements are being fulfilled.
Technical Systems Audit	Dates to be determined by TCEQ	TCEQ QA Specialist	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP	30 days to respond in writing to TCEQ to provide corrective actions addressing audit findings

Internal Assessment

Since this project is primarily a modeling endeavor, traditional performance and system audits are not appropriate. Instead, the data generated as part of the modeling results will be evaluated during the validation and model output interpretation processes. H-GAC and the TCEQ NPS Program will continually assess model performance per the quality objectives and criteria listed in Section A7, and by evaluation of tasks listed in Section D. H-GAC and the TCEQ NPS Program will also assess any informal adjustments to the model inputs based on stakeholder feedback referenced in Section B7 as needed.

Modeling data and project deliverables will be internally quality-controlled by the TCEQ NPS Project Manager's in-house review. The TCEQ NPS Project Manager will maintain overall responsibility for examining the contracted work to ensure methodologies and processes are consistent with the procedures outlined in this QAPP.

Corrective Action

Deficiencies are any unauthorized deviations from the approved QAPP, and procedures referenced in the QAPP. Deficiencies may invalidate resulting data. All deficiencies from the QAPP require documentation of the nonconformance and corrective action. Deficiencies must be documented in a Corrective Action Plan (see Appendix B for the form and an example) and corrected in a timely manner. Corrective action may include the need for additional model runs. Deficiencies are documented in logbooks or modeling staff. It is the responsibility of the H-GAC

Project Manager, in consultation with the H-GAC QAO and H-GAC Data Manager, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP.

Nonconformances must be communicated to the TCEQ NPS Project Manager immediately via email. A Corrective Action Plan (CAP) Form (see Appendix B for the form and an example) must be submitted to the TCEQ NPS Project Manager within 14 days of the deficiency occurring. Once it is approved, the TCEQ NPS Project Manager will send the CAP to the QA Coordinator who will then email the CAP to the Lead NPS QA Specialist within 30 days of the initial notice of deficiency per TCEQ QMP and after it is reviewed by the TCEQ NPS Project Manager. The deficiency must also be communicated to the TCEQ NPS Project Manager through the Corrective Action Status Table (see Appendix C for the table and an example) to be included with the quarterly progress report.

The H-GAC Project Manager is responsible for implementing and tracking corrective actions. All CAPs will be documented on the Corrective Action Status Table, which will be submitted to the TCEQ NPS Project Manager with the quarterly progress report for review and approval. Records of TCEQ audit findings and corrective actions are maintained by both the TCEQ and the H-GAC QAO. Documentation of corrective action to address audit findings will be submitted to the TCEQ within 30 days of receipt of audit report.

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

Corrective Action Plans

CAPs should:

- Identify the deficiency, 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
- Include a description of the need for Corrective Action
- Include a description of cause(s), determine solution, and propose an action plan
- Identify personnel responsible for action
- Establish timelines and provide a schedule
- Document the corrective action

C2 REPORTS TO MANAGEMENT

Reports to H-GAC Project Management

H-GAC project staff will report to the H-GAC Project Manager on an ongoing basis, but at a frequency no less than once per week. These reports will be informal unless corrective action, relevant modeling notes, or other documentation as discussed in this QAPP apply.

Reports to TCEQ Project Management

Progress Report – Submittal of progress reports will be at least quarterly. Format of the submitted progress report will be as specified in the contract or work orders. Reports should provide enough information so the TCEQ NPS Project Manager can evaluate the modeling effort.

Data Analysis Summary Report – H-GAC will submit a draft Data Analysis Summary Report subsequent to the water quality trends analysis, and a final version with TCEQ comments addressed.

Modeling Report – H-GAC will submit a draft Modeling Report at the culmination of modeling activities and a final version with TCEQ comments addressed.

Watershed Protection Plan – H-GAC will submit to TCEQ a WPP for East Fork San Jacinto River subsequent to stakeholder approval of the draft WPP by the end of the project period.

Final Report – H-GAC will submit a final report, in the form of a Final Quarterly Progress Report with substantive summary of the project, within 15 days of the end of the last fiscal quarter of the project. Any comments from TCEQ will be summarized in a comment response document in the interim.

Corrective Action Report (CAR) – Identifies any deficiencies and nonconformances. The cause(s) and program impacts are discussed. The completed corrective actions are documented, and the report is submitted to the TCEQ NPS Project Manager with the first progress report occurring after the deficiencies and/or nonconformance was identified.

Audit Report and Response – Following any audit performed by the H-GAC a report of findings, recommendations, and responses are sent to the TCEQ NPS Project Manager in the quarterly/monthly progress report. Such reports will include model performance assessments, calibration, and validation performance determination.

Reports by TCEQ Project Management

Contractor Evaluation – 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 Financial Administration Division, Procurements and Contracts Section.

SECTION D: DATA VALIDATION AND USABILITY

Validation - Validation is an extension of the calibration process that reduces uncertainty. No calibration processes are used for the tools and approaches selected for this project and covered under this QAPP other than routine electronic and/or visual screening for errors.

D1 DEPARTURES FROM VALIDATION CRITERIA

The water quality data analyses, SELECT, and LDCs are not calibrated models, and are not predictive of instream water quality conditions[1].

Departure from established criteria may impact the accuracy of model outputs. Sources of discrepancy may be insufficiency of available data and/or locally applicable assumptions. However, given the intended uses of the data (i.e., to facilitate stakeholder decision-making on a broad basis) these potential discrepancies are not expected to have an appreciable impact on model results.

Data collected by TCEQ, USGS, Texas CRP partners, and other listed sources have been reviewed, 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. For more information on data management procedures see Appendix E.

D2 VALIDATION METHODS

Model Validation

The water quality data analyses are not subject to model validation. The SAS outputs are reviewed by H-GAC staff, as part of normal data management procedures.

LDCs are also not validated in a traditional sense, as they are not predictive models. The results of LDC runs are similarly validated by H-GAC staff, and through review with TCEQ project staff and stakeholders. Because LDCs are descriptive rather than predictive, no validation against additional data is possible.

The SELECT runs are predictive of potential load, but without linkage to observed data (i.e., they are not predictive of instream concentrations.) SELECT results are not calibrated to observed data because potential load is not a measurable/measured constituent. Non-technical validation of SELECT inputs and outputs is primarily based on H-GAC, TCEQ, and stakeholder review of model assumptions and outputs. Criteria in these reviews include the applicability and sufficiency of assumptions and subjective comparison of model outputs with local conditions as experienced by stakeholders. This process is not intended as a technical validation.

D3 RECONCILIATION WITH USER REQUIREMENTS

[1] Future scenarios projected under SELECT are based on regional demographic projections but are only predictive of potential loads. They cannot be calibrated against observed values, as they do not predict ambient water quality conditions.

The primary purposes of the data outputs from these analyses and updated modeling efforts are to characterize the conditions in the watershed and guide stakeholder decision-making. The user requirements for WPP development are to provide a high-level understanding of the causes and sources of pollutants in spatial and flow contexts. The modeling framework developed for this project will be used to evaluate contaminant loading in the East Fork San Jacinto River watershed. It will provide information pertaining to historical trends in water quality[1], relationship of pollutant loads to flow regimes and bacteria reductions (LDCs), and potential loading from pollutant within the watershed (SELECT). These analyses will provide critical information for the stakeholders to support the development of the East Fork San Jacinto River WPP.

The user requirements do not assume a detailed and complex hydrologic model with predictive linkage between source loading and instream concentrations. Source load reduction projections sufficient to guide stakeholder decisions will be obtained by applying load reduction percentages generated through updated LDCs to source loads generated in updated SELECT analyses.

The outputs will be evaluated at several levels. First, H-GAC project staff will review outputs for obvious inconsistencies and errors, for compliance with QAPP procedures, and against best professional judgment. Secondly, outputs will be reviewed with TCEQ project staff. Lastly, outputs will be reviewed with stakeholders and technical advisors to ensure local input is acquired and incorporated as appropriate. Additional review will follow revised model runs and scenarios. The final data will be reviewed to ensure that it meets the requirements as described in this QAPP. CARs will be initiated in cases where invalid or incorrect data have been detected. Data that have been reviewed, verified, and validated will be summarized for their ability to meet the data quality objectives of the project and the informational needs of water quality agency decision-makers. The sufficiency of the data to support stakeholder requirements will be based on review of the data with the stakeholders and agency staff.

Some limitations are assumed for the use of the model outputs. The usability of the modeling results will be limited to their intended purposes as part of an EPA 9-element WPP development process. The model results are not intended or designed to provide a level of accuracy or precision beyond what is described or the stated ability of the models. Model results are not intended to be used for legal purposes, to describe property conditions in lieu of environmental assessments, or to be used for other official purposes not stated in this QAPP. The design of the modeling approach is intended to allow the flexibility, as described, to incorporate stakeholder input on assumptions, outputs, and specific locales or events in the watershed.

Model results may be subsequently analyzed and used by the TCEQ for calculating estimated reductions in pollutant loadings resulting from management measures implemented.

[1] The methodology, uses, and data types for the water quality trends analysis are described in detail in Section A7, under the subsection Water Quality Analysis.

APPENDIX A. CONTRACT SCOPE OF WORK AND SCHEDULE OF DELIVERABLES

Scope of Work

The Performing Party, in collaboration with project partners, will use existing water quality data, conduct new water quality modeling, and engage stakeholders to complete a stakeholder driven Watershed Protection Plan (WPP) for the East Fork San Jacinto River Watershed. The WPP will satisfy the expectations of the nine-key elements fundamental to watershed-based plans as described in EPA's *2014 Nonpoint Source Program and Grants Guidelines for State and Territories.*

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 subgrantee(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 subgrantees(s)/subcontractors(s). Project oversight status will be provided to the TCEQ Project Manager with the quarterly Progress Reports.

Subtask 1.2: Progress Reports (PRs) — The Performing Party will submit PRs to the TCEQ Project Manager by the 15th of the month following each state fiscal quarter (Sept – Nov, Dec – Feb, March – May, June – August). PRs will include reporting on the status of Deliverables and proposed revisions to due dates, narrative description of progress by Task, and status of nonconformances/corrective actions. The TCEQ Project Manager will provide a template for the PR to the Performing Party.

Subtask 1.3: Reimbursement Forms (Financial Status Reports) — The Performing Party will submit Reimbursement Forms in accordance with the Special Terms and Conditions.

Subtask 1.4: Contract Communication — The Performing Party will participate in a call/meeting with TCEQ to discuss project scope and contract requirements within 30 days of Contract execution. The Performing Party will maintain regular telephone and/or e-mail communication with the TCEQ Project Manager regarding the status and progress of the project and any matters that require attention between PRs. Communications will include a quarterly conference call to discuss items such as project Tasks, financial status, Quality Assurance Project Plans (QAPPs), corrective actions, and any other matters that require attention. The TCEQ Project Manager may request additional information from the Performing Party prior to the call or meeting. The Performing Party will provide meeting notes and identify action items for the telephone calls within five days of the call.

The first conference call held each fiscal year of the project will cover, as applicable, any staff changes, the previous year's performance, budget estimates, invoicing issues, quality assurance issues, and overall project progress.

Matters that will be communicated to the TCEQ Project Manager include, but are not limited to:

- Notification a minimum of 14 days before the Performing Party has scheduled public meetings or events, initiation of construction, or other major Task activities.
- Notification within 48 hours following events or circumstances that may require changes to the Budget, Scope of Work, or Schedule of Deliverables.
- Requests for prior approval of activities or expenditures for which the Contract requires advance approval or that are not specifically included in the Scope of Work.

Subtask 1.5: Contractor Evaluation — The Performing Party will participate in an annual Contractor Evaluation at the end of each state fiscal year.

Subtask 1.6: Coordination Call with EPA — Upon request by TCEQ and EPA, the Performing Party will participate in a conference call with EPA to share progress on goals, measures of success, challenges, and draft documents.

Subtask 1.7: Project Article — The Performing Party, upon request by TCEQ, will provide a project article. The article will state the project's purpose, describe the activities of the past fiscal year, and include photographs of the project. The Performing Party will address TCEQ comments on the article and provide a final article.

Subtask 1.8: Contract Budget Updates — The Performing Party will discuss annual fiscal year budgets with the TCEQ Project Manager on a quarterly basis at a minimum. Starting in the second year of the project, the Performing Party will provide an Annual Budget Update that details state fiscal year spending projections associated with planned project activities. These updates will be revised when fiscal year spending projections change by 10% or more, or upon request by the TCEQ Project Manager. The update in the final year of the project will include a budget for all remaining project activities. The TCEQ Project Manager will provide a template for the Annual Budget Update.

Deliverables:

1.2 PRs (by the 15th of the month following each state fiscal quarter)
1.3 Reimbursement forms (See Special Terms and Conditions)
1.4 Conference calls with meeting notes and action items (quarterly, notes within five days of meeting)
1.5 Contractor Evaluation (annually, upon request by TCEQ)
1.6 EPA coordination call (upon request by TCEQ)
1.7 Project article and photographs (upon request by TCEQ)
1.8 Contract Budget updates (by the 15th of the month following the end of each state fiscal quarter, in PRs)
1.8 Annual Budget updates (within 2 weeks following TCEQ request)

Task 2: Quality Assurance

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

Subtask 2.1: QAPP Planning Meetings — The Performing Party will schedule a QAPP planning meeting with the TCEQ Project Manager, QA staff, technical staff, and contractors within 30 days of Contract execution, to implement a systematic planning process based on the elements in the applicable QAPP Shell. A QAPP shell/examples may be provided by the TCEQ Project Manager. The information developed during this meeting will be incorporated into a QAPP by the Performing Party. The Performing Party may conduct additional meetings to determine whether changes to an existing QAPP are needed.

Subtask 2.2: Modeling and Data Acquisition QAPP — The Performing Party will develop and submit to TCEQ a QAPP with project-specific DQOs and other components consistent with the following documents:
TCEQ NPS QAPP Shell(s)
EPA Requirements for QAPPs (QA/R5)

EPA Guidance for Modeling QA/G-5M
EPA Guidance for Geospatial Data QAPPs (QA/G-5G)
EPA QAPP Requirements for Secondary Data Research Projects

The Performing Party will develop the QAPP in consultation with the TCEQ Project Manager, QA staff, and contractors. The Performing Party will address comments and submit a final QAPP for review. The QAPP must be signed/fully approved by TCEQ before any environmental data operations begin.

Subtask 2.3: QAPP Annual Reviews, Revisions, and Updates — The Performing Party will submit documentation certifying its annual review of the QAPP no less than 90 days prior to the QAPP anniversary date. Amendments approved since the initial QAPP approval or a subsequent certified annual review (if applicable) must be submitted along with the certification. If extensive changes to a QAPP are necessary, a full revision is required. Once TCEQ certifies the annual review or approves the full revision, the QAPP effective period is extended an additional year. No work described in a QAPP will be conducted outside the effective period of the QAPP.

Subtask 2.4: QAPP Amendments — The Performing Party will submit Draft QAPP Amendments for TCEQ review when changes to QAPPs are necessary. Draft QAPP Amendments should be submitted no less than 90 days prior to the scheduled initiation of changes and must be accompanied by a justification, summary of changes, and detail of changes. The Performing Party will submit Final QAPP Amendments within 30 days of receipt of any comments provided by TCEQ. Final QAPP Amendments will be submitted to TCEQ with the Performing Party's signatures and responses to comments and circulated for appropriate TCEQ signatures. The QAPP Amendments must be signed/fully approved by TCEQ before any changes conveyed within Amendments are implemented.

Subtask 2.5: Corrective Action Reports (CARs) — The Performing Party will provide CARs, as needed, to document deviations from sampling method requirements or sample design, failures associated with chain-of-custody procedures or in field and laboratory measurement systems. The Performing Party will submit CARs with PRs.

Deliverables:

2.1 QAPP Planning Meeting notes (within 30 days of Contract execution)
2.2 Draft QAPP (120 days prior to the scheduled initiation of environmental data operations)
2.2 Final QAPP (30 days prior to the scheduled initiation of environmental data operations)
2.3 QAPP Annual Reviews and Revisions (at least 90 days prior to the QAPP approval anniversary)
2.4 Draft QAPP Amendments (at least 90 days prior to the scheduled initiation of changes or additions to activities listed in the current QAPP)
2.4 Final QAPP Amendments (within 30 days of receipt of TCEQ comments)
2.5 CARs (as needed, submitted with PRs until the issue is resolved)

Task 3: Data Acquisition and Source Identification for WPP

Objective: To acquire, compile, and evaluate existing data, historical information, and other related information for use in watershed characterization, stakeholder education, and development of the East Fork San Jacinto River WPP. The Performing Party will work with stakeholders to refine these evaluations. No new data will be collected as part of this project.

Subtask 3.1: Acquire, Compile, and Evaluate Existing Data — The Performing Party will acquire, compile, and evaluate existing data and information pertaining to water quality impairments and issues in the watershed, including data acquired from the Clean Rivers Program (CRP) and via TCEQ sanitary sewer overflow (SSO), on-site sewage facility (OSSF) permits, and discharge monitoring reports (DMRs). DMR and SSO data will be acquired for the last five years for all permitted wastewater entities in the East Fork San Jacinto River Watershed.

Acquired data and information will, to the extent possible:

- Describe relevant watershed characteristics and conditions (e.g., watershed boundary, hydrology, climate, soils, land use/cover, water quality trends analysis),
- Evaluate trends in wastewater volume by year, volume by cause, number of events by year, and number of events by cause for each reporting permitted entry,
- Support Geographic Information Systems (GIS) analysis, and
- Identify the potential sources of pollution and causes of water quality impairments and issues.

The Performing Party will assess the existing data and information to determine if it allows for determination of sources and quantities of pollution. If data gaps are identified, the Performing Party will work with stakeholders to determine how to address them.

The data and information will be presented to stakeholders in appropriate formats including graphs, tables, and maps.

Subtask 3.2: Acquired Data Analysis Report — The Performing Party will analyze the existing data and information and, to the extent possible, characterize water quality conditions, watershed conditions, and potential sources of pollution contributing to water quality impairments and issues. The Performing Party will assess the existing data and information to determine quality and adequacy in defining the pollutant sources. If data gaps are identified, the Performing Party will work with stakeholders to determine how to address them. The analysis will:

- Describe the outcomes of data acquisition and evaluation, including:
  - Watershed characteristics;
  - Potential sources of pollution and causes of water quality impairments and issues; and
  - Plans for addressing data gaps;
- Identify indicator parameter(s) that can be used to assess conditions and measure progress toward meeting water quality goals;
- Describe trends in the data for the identified indicator parameters; and
- Describe conditions when water quality impairments occur and possible sources of pollution.

Deliverables:

3.1 Documentation of data compilation and review (quarter 3 in Draft Acquired Data Analysis Report; updated in Final Acquired Data Analysis Report)

3.2 Draft Acquired Data Analysis Report (quarter 3)

3.2 Final Acquired Data Analysis Report (within 30 days after receipt of TCEQ comments)

Task 4: Modeling

Objective: To develop and refine modeling efforts for the East Fork San Jacinto River Watershed to identify extent, causes, and spatial distribution of bacterial contamination and reduction goals.

Subtask 4.1: Load Duration Curves — The Performing Party will develop load duration curves as needed for water quality impairments in the East Fork San Jacinto River Watershed to define conditions under which loading is occurring and to calculate the pollutant load reductions (or percent improvement) needed to meet water quality standards in the East Fork Watershed. The load duration curves developed as part of the prior total maximum daily load (TMDL) efforts will inform the development of the WPP effort.

Subtask 4.2: Spatially Explicit Load Enrichment Calculation Tool (SELECT) — The Performing Party will develop a SELECT model for the East Fork San Jacinto Watershed to include the most current version of its data sources, and revise findings based on stakeholder feedback. SELECT will be used in the WPP to identify the relative prominence of bacteria sources, their spatial distribution, and the total potential bacterial load to the watershed. Both current and future condition runs will be updated.

Subtask 4.3: Modeling Report — The Performing Party will develop a report detailing activities conducted under this Task and summarize the results of the modeling for inclusion in the WPP.

Deliverables:

4.1 Load Duration Curves (quarter 4, in Modeling Report)

4.2 SELECT results (quarter 4, in Modeling Report)

4.3 Draft Modeling Report (quarter 4)

4.3 Final Modeling Report (within 30 days after receipt of TCEQ comments)

Task 5: Stakeholder Facilitation

Objective: To engage and maintain a stakeholder group representative of interests in the watershed, for the purpose of developing and implementing the WPP, and coordinating related efforts.

Subtask 5.1: Public Participation Plan (PPP) — The Performing Party will develop a PPP which details the strategy for engaging the public and stakeholders in the watershed planning process for the East Fork San Jacinto River Watershed. The PPP will, at a minimum, include 1) stakeholder group ground rules, 2) stakeholder group structure (i.e., steering committee, work groups) and membership, 3) stakeholder meetings topic/purpose and tentative schedule, and 4) a targeted outreach plan to increase public participation in the process.

Subtask 5.2: East Fork Watershed Partnership Formation — The Performing Party will compile and maintain a database of watershed stakeholders and affected parties for use in engaging the public in the watershed planning process for each primary subwatershed outreach area. A stakeholder group (the East Fork Watershed Partnership) will be established from this list and other interested parties and will represent a diverse cross section of the East Fork Watershed's stakeholders.

The Performing Party will maintain a record of individuals and organizations invited to meetings, as well as a sign-in sheet of attendees. The Performing Party will maintain a record of public comments via meeting notes, and coordinate with Partners to document response to stakeholders.

Subtask 5.3: Communication with Stakeholders — The Performing Party will facilitate communication with stakeholders to engage the public and affected entities in the watershed planning process, assisted by local organizations helping to advertise and host meetings. The Performing Party will utilize all appropriate communication mechanisms including direct mail, e-mail, a project website, and mass media (print, radio, television) to the extent necessary to

meet project communication goals. The Performing Party will submit all promotional material to the TCEQ Project Manager for review and approval at least two weeks prior to distribution or release.

Subtask 5.4: Stakeholder Facilitation — The Performing Party will facilitate public participation and stakeholder involvement in the watershed planning process, specifically through project meetings and related outreach activities. Existing materials will be used or adapted to the greatest degree practicable. The Performing Party will coordinate meetings, secure meeting locations, and prepare and disseminate meeting notices and agendas. Meeting summaries will be prepared and posted to the project website within 30 days after a meeting is held. Public meetings will be held at a minimum frequency of every two months. The Performing Party will submit all meeting presentations, notices, agendas, and meeting summaries to the TCEQ Project Manager for review and approval at least two weeks prior to public dissemination.

Subtask 5.5: Attend Public Meetings — The Performing Party will attend and participate in other public meetings as appropriate, to communicate project goals, activities, and accomplishments to affected parties. Such meetings may include, but are not limited to, city councils, county commissioners' courts, regional water supply planning, environmental flows, Clean Rivers Program (CRP) Basin Steering Committee and Coordinated Monitoring, local soil and water conservation districts (SWCDs), Galveston Bay Council and subcommittee meetings, and other appropriate meetings of critical watershed stakeholder groups. Written approval from the TCEQ Project Manager will be required prior to attendance. The Performing Party will submit all meeting presentations, notices, agendas, and meeting summaries to the TCEQ Project Manager for review and approval at least two weeks prior to public dissemination. The Performing Party will attend a minimum of six (6) of these types of meetings.

Subtask 5.6: Education and Outreach Events — The Performing Party will engage in education and outreach events whose purpose is to engage stakeholders, raise general awareness of watershed issues, or address specific water quality concerns raised in the WPP development process. The Performing Party will submit all meeting presentations, notices, agendas, and meeting summaries to the TCEQ Project Manager for review and approval at least two weeks prior to public dissemination.

The Performing Party will seek to support and coordinate with events and meetings held by partners that are relevant to WPP goals (e.g. Texas Watershed Stewards). The Performing Party will attend at least two partner events in the watershed for the purpose of public outreach and education and will seek to attend and present information on the project at local events, festivals or other appropriate venues as determined by approval from TCEQ. The Performing Party will host a Texas Stream Team training event within (or serving) the watershed as specific outreach and stakeholder engagement activities.

Subtask 5.7: West Fork and Lake Creek WPP Coordination — The Performing Party will provide coordination and stakeholder support for this approved WPP, including but not limited to identifying and pursuing funding resources; maintaining a presence for the project at local meetings and events of relevance; holding an annual stakeholder coordination meeting; and holding or supporting partner education events pertinent to the watershed project. Partner education events will include: at least one (1) residential OSSF training, at least one (1) Texas Stream Team training in coordination with the East Fork as necessary, at least four (4) presentations to local partners or community organizations, and at least three (3) local environmental events.

Subtask 5.8: Stakeholder Outreach Task Report — The Performing Party will submit a report summarizing activities completed under this task.

Deliverables:

5.1 Draft Public Participation Plan (by the end of quarter 1)
5.1 Final Public Participation Plan (30 days following TCEQ comments on the draft PPP)
5.2 Stakeholder outreach list (quarterly, with PRs)
5.3 Documentation of communication with stakeholders (quarterly, with PRs)
5.4 Documentation of project stakeholder meetings, including meeting notices, materials, presentations, agendas, attendance lists, and summaries (held once every two months; documented within 30 days to TCEQ)
5.5 Documentation of other public meetings attended, including dates with brief summaries of topics discussed and action needed (minimum of six, approximately one per quarter; documented within 30 days to TCEQ)
5.6 Documentation of education and outreach events attended (quarters 3-12; documented within 30 days to TCEQ)
5.6 Documentation of partner events attended, including dates with brief summaries (minimum of two; documented within 30 days to TCEQ)
5.6 Documentation of Trash Bash and Stream Team training events hosted (documented within 30 days to TCEQ)
5.7 Documentation of coordination efforts (quarterly, with PRs)
5.8 Draft Stakeholder Outreach Task Report (by the end of quarter 8)
5.8 Final Stakeholder Outreach Task Report (within 30 days after receipt of TCEQ comments)

Task 6: On-site Sewage Facility Remediation (OSSF)

Objective: The Performing Party will perform OSSF demonstration projects to supplement outreach efforts and increase residential engagement.

Subtask 6.1: OSSF Outreach — The Performing Party will provide targeted outreach for OSSFs through existing homeowner and real estate inspector training courses utilized under prior WPP projects. The Performing Party will provide a summary of workshop attendance and sign in sheets to TCEQ.

Subtask 6.2: OSSF Remediation — The Performing Party will replace or repair at least two failing OSSFs, in coordination with H-GAC's Failing OSSF Replacement Program and funded with match dollars.

Deliverables:

6.1 Documentation of OSSF Outreach (quarterly, with PRs)
6.2 Documentation of OSSF Remediation (quarterly, with PRs)

Task 7: Watershed Protection Plan Development

Objective: The Performing Party will facilitate the development of a WPP through a stakeholder driven process. The Performing Party will work with stakeholders to identify information that satisfies the expectations of the nine-key elements fundamental to watershed-based plans as described in EPA's *2014 Nonpoint Source Program and Grants Guidelines for State and Territories*. The WPP will:

1. Identify and quantify existing pollutant loadings that need to be controlled;
2. Determine pollutant load reductions needed to meet water quality standards;
3. Identify management practices to achieve water quality standards;

4. Estimate technical and financial assistance needed to implement plan;
5. Describe the information and education component needed to implement plan;
6. Develop an implementation schedule;
7. Describe interim measurable milestones for management measure implementation;
8. Describe water quality evaluation criteria; and
9. Describe a monitoring program to assess water quality conditions.

Subtask 7.1: WPP Development — The Performing Party, in collaboration with project partners, will develop a WPP for the East Fork San Jacinto River Watershed that satisfies EPA's *Nine Key Elements for WBPs* as described in the latest (FY2014) EPA document, Nonpoint Source Program and Grants Guidelines for States and Territories. The WPP will be based on decisions made by stakeholders through the watershed planning process (Tasks 5 and 6) and incorporate findings from project technical evaluations (Tasks 3 and 4). The WPP will be designed to achieve the load reductions identified by modeling results and approved by the stakeholders. The Performing Party will facilitate public review and stakeholder approval of the WPP.

Prior to drafting the WPP, a detailed timeline and outline will be developed by the Performing Party in consultation with the TCEQ Project Manager.

Subtask 7.2: Review and Approval Process — The Performing Party will develop a stakeholder document review plan at the beginning of the project. The review plan will include submittal of multiple interim partial drafts for review by stakeholders and TCEQ. Stakeholders and TCEQ will approve the WPP before it is submitted to EPA for review. The Performing Party will work with stakeholders and TCEQ to address any EPA comments. The Performing Party will release a draft of the WPP to the public and address any comments that may be received. TCEQ will submit a Final WPP to EPA with all comments addressed.

Subtask 7.3: Executive Summary — Performing Party will develop an "executive summary" style document, based on the WPP, which will serve as a public outreach tool to garner support for the implementation of the WPP and achieve long term sustainability. This document will be reviewed by TCEQ for approval prior to distribution.

Subtask 7.4: Disseminate Documents — After EPA has completed a satisfactory nine key elements consistency review of the WPP, the Performing Party will publish, print, and distribute the WPP and "executive summary" documents to stakeholders.

Deliverables:

7.1 WPP Development Timeline and Outline (by the end of quarter 2)
7.2 WPP document review plan (by the end of quarter 2)
7.2 Multiple interim partial WPP drafts to stakeholders and TCEQ (quarters 3 – 9, as needed)
7.2 Draft WPP to stakeholders (by the end of quarter 9)
7.2 Response to comments from stakeholders (30 days after receipt of comments from stakeholders)
7.2 Documentation of final stakeholder approval of the WPP (by the end of quarter 10)
7.2 Draft WPP to TCEQ (quarter 10, month 1)
7.2 Response to comments from TCEQ (30 days following receipt of comments from TCEQ)
7.2 Final WPP to TCEQ (quarter 10, month 3)
7.2 Draft WPP to EPA submitted by TCEQ (quarter 10, month 3)
7.2 Response to comments from EPA (30 days following receipt of comments from EPA)
7.2 Final WPP to EPA (by the end of quarter 11)

7.3 Draft Executive Summary public outreach document (1 month following WPP approval from EPA)
7.3 Final Executive Summary public outreach document (15 days following receipt of comments from TCEQ)
7.4 Documentation of distribution of WPP and Executive Summary (within 30 days following acceptance by EPA, and approval by TCEQ)

Task 8: Final Report

Objective: To produce a Final Report that summarizes all completed activities completed and the amount of funds spent on the project.

Subtask 8.1: Final Report — The Performing Party will submit the final PR as the Final Report. This final PR will follow the template provided by the NPS Project Manager and will summarize all project activities.

Deliverables:
8.1 Draft PR as Final Report (the 15th of the first month following the last fiscal quarter of the project)
8.1 Address TCEQ comments (within 10 days after receipt of TCEQ comments)
8.1 Final approved PR as Final Report (at least two weeks prior to the end of the Contract)

APPENDIX B. CORRECTIVE ACTION PLAN FORM

APPENDIX B - CORRECTIVE ACTION PLAN FORM

Nonconformance Report and Corrective Action Plan
QAPP Title: **QAPP Contractor:** **Contract No.:** **Issued by:** **Date of Occurrence:** **Date Identified:** **Report No.:** **Date Issued:**
Description of deficiency
Root Cause of deficiency
Programmatic Impact of deficiency
Does the seriousness of the deficiency require immediate reporting to the TCEQ? If so, when was it reported?
Corrective Action to address the deficiency and prevent its recurrence
Proposed Completion Date for Each Action
Individual(s) Responsible for Each Action
Method of Verification
Date Corrective Action Plan Closed? NPS Project Manager Initial When Closed _____ *Please forward CAP to Lead NPS QAS once it is closed.*

Example Corrective Action Plan Form

Nonconformance Report and Corrective Action Plan
QAPP Title: Watershed Protection Plan Implementation – LID BMP Monitoring QAPP **QAPP Contractor:** River Authority **Contract No.:** 582-10-10101 **Issued by:** Jane Doe **Occurrence Date:** 7/15/2014 **Date Identified:** 7/16/2021 **Report No.:** 1 **Date Issued:** 7/25/2014
Description of deficiency The pavement monitoring station at the university is measuring a larger runoff volume than is estimated possible. Runoff measured is higher than the total precipitation volume calculated by multiplying the catchment area by the precipitation measured at the site.
Root Cause of deficiency (1) It is possible that the drainage area was not measured accurately, it may be larger. (2) The outfall of the monitoring station might not adequately allow runoff to flow through causing pooling around the flow-measuring point. The accumulation of non-flowing water could be confounding the flow meter since its physical principal of measurement is hydrostatic pressure caused by water depth.
Programmatic Impact of deficiency The illogical results of the pavement runoff measurement indicate that further calibration of the equipment is necessary. Data collected at this event are not able to be used in analysis or results.
Does the seriousness of the deficiency require immediate reporting to the TCEQ? If so, when was it? Yes, it was reported to the TCEQ NPS PM via email on 7/18/2014.
Corrective Action to address the deficiency and prevent its recurrence A survey will be conducted on the site to determine the ridge of the catchment area. A wider and deeper channel will be dug out at the monitoring point outfall to ensure all the flow drains away from the measuring point. Storm event runoff will not be measured at this site until this work has been completed.
Proposed Completion Date for Each Action 8/15/2014
Individual(s) Responsible for Each Action David Lopez, Contractor PM
Method of Verification Results of the catchment area survey will be emailed to the TCEQ NPS PM. Photos of the modified measurement site will be emailed to the TCEQ NPS PM.
Date Corrective Action Plan Closed? *The TCEQ NPS PM will provide a closed date once the corrective action has been verified.* NPS Project Manager Initial When Closed _____ *Please forward CAP to Lead NPS QAS once it is closed.*

APPENDIX C. CORRECTIVE ACTION PLAN STATUS FORM

Corrective Action Status Table

Corrective Action #	Date Issued	Description of Deficiency	Action Taken	Date Closed

Corrective Action Status Table Example

Corrective Action #	Date Issued	Description of Deficiency	Action Taken	Date Closed
1	7/25/2014	Runoff measured at pavement was greater than total area runoff.	The area is being surveyed to ensure the catchment area size is correct. The monitoring station location is being modified to ensure runoff flows through properly.	
2	8/1/2014	Sample residual insufficient for analysis of TSS.	Data estimated but questionable, not will not be submitted to TCEQ.	8/8/2014

APPENDIX D. ADHERENCE LETTER

Appendix D. Example Letter to Document Adherence to the QAPP

TO: *(name)*
(organization)

FROM: Rachel Windham
Houston-Galveston Area Council (H-GAC))

RE: H-GAC, East Fork San Jacinto River Watershed Protection Plan Modeling QAPP

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

Rachel Windham
3555 Timmons Lane, Suite 120
Houston, TX 77027

I acknowledge receipt of the "East Fork San Jacinto River Watershed Protection Plan Modeling QAPP, Revision Date". I understand the document describes quality assurance, quality control, data management, and reporting, and other technical activities that must be implemented to ensure the results of work performed will satisfy stated performance criteria.

My signature on this document signifies that I have read and will comply with the document contents pertaining to my program. Furthermore, I will ensure that all staff members participating in modeling activities will be required to familiarize themselves with the document contents and adhere to them as well.

_____

Signature Date

Note: Copies of the signed letter should be sent by the Lead Organization to the TCEQ NPS Project Manager within 30 days of the final TCEQ approval the QAPP. This letter should be submitted for all subcontractors that did not sign the QAPP (under section A1 of this QAPP).

APPENDIX E. DATA MANAGEMENT PLAN

Geospatial Data Management Plan

July 2021

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

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 Application), and an FTP download site (Data Clearinghouse). The C&E SDE utilizes ESRI's ArcSDE software running on a Microsoft SQL Server RDBMS. The mapping application uses ESRI's ArcGIS.com & ArcGIS Server platform running on .NET. The Data Clearinghouse is an FTP server (h-gac.sharefile.com) that provides C&E with storage space where it can post publicly available datasets for downloading. The C&E SDE, Mapping Application, 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 are coordinated by the C&E GIS Manager. All geospatial content stored in the C&E SDE, the Data Clearinghouse, and Mapping Application, are the responsibility of the C&E GIS staff, which resides within the C&E Socio-Economic Modeling program. However,

Data Service department maintains some of the other GIS data such as transportation, 911 address, and workforce solutions, and stored in a separate SDE that everybody in H-GAC has access to them. 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 C&E Socio-Economic Modeling program and users from other H-GAC departments are provided *Editor* access to data in the C&E SDE. All other users have only viewer access to data in the C&E SDE. H-GAC C&E staffs without *Editor* access to the C&E SDE server can access a copy of the geospatial data through a separate server that houses imported versions of the original SDE data to develop 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, 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 interactive mapping applications and can be accessed online via the Mapping Server's services directory, or accessible via the Data Clearinghouse for downloading. The data sharing through downloading is facilitated through H-GAC's Sharefile system. All public C&E GIS data, applications, cartographic products, and the C&E map services directory can be accessed via "GIS, Imagery, & Online Mapping Tools" section of the H-GAC website. 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 two platforms upon which C&E provides web-based mapping solutions.

The first platform is based on the JavaScript programming technology, and all mapping applications developed using this platform run on various operational systems including Windows, MacOS, ISO, and Android. 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 technology allows the users to display its information on different screen-size devices including desktop, laptop, tablet, and mobile phone.

The second platform utilizes the capabilities of the ArcServer/Arcgis.com 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 access to individual map layers and geoprocessing tools published on the server. Typical users of this method of delivery are other GIS users using ArcMap GIS, whereby they can connect directly to our ArcServer platform for read-only access and view our map layers. Other instances whereby Arcgis.com's users may utilize this method is where they are including our map layers in their own mapping applications.

Mapping and Cartographic Products

The C&E department produces a variety of static cartographic maps for the region because 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 https://www.h-gac.com/map-book/default.aspx.

System Resources

<u>System Architecture</u>
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 interactive 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.

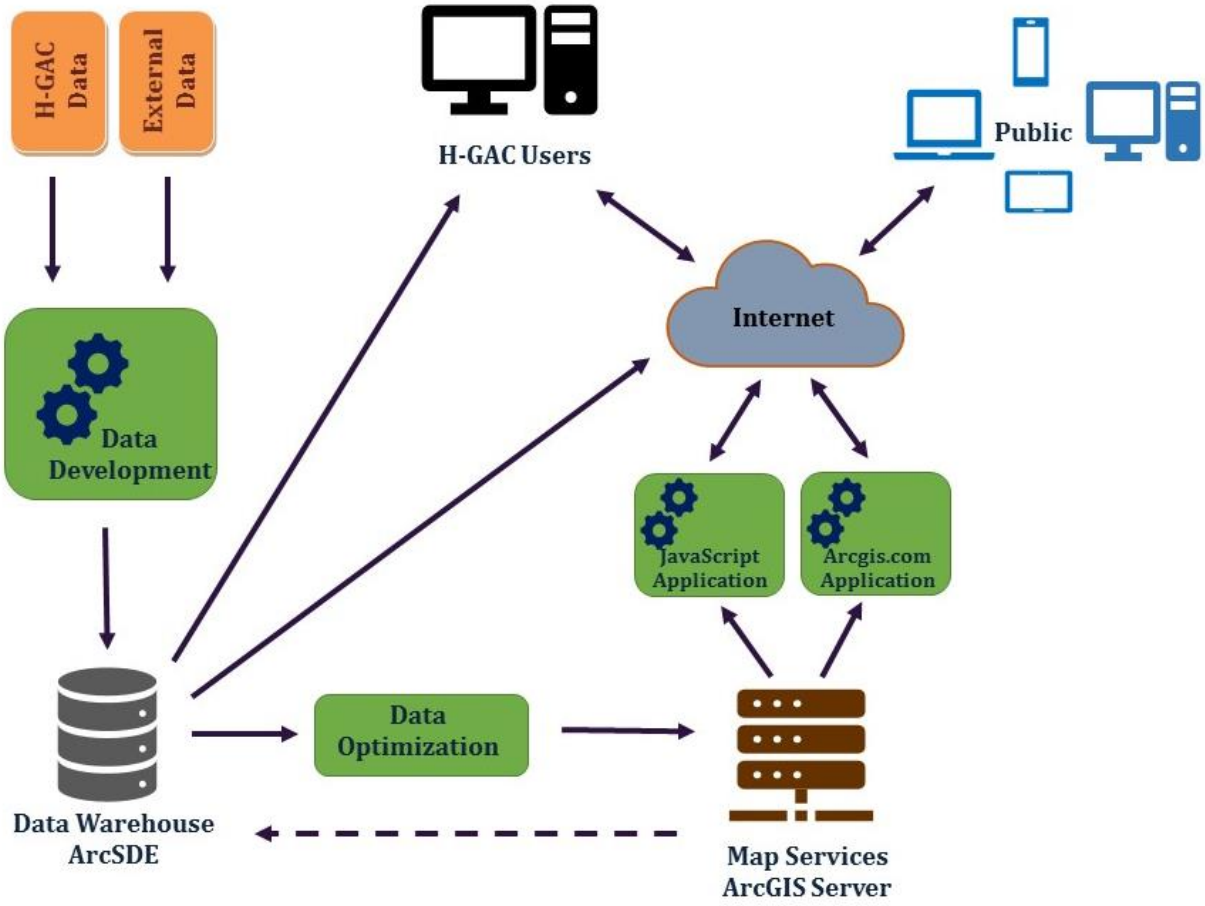


Figure 1: H-GAC Geospatial System Architecture

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 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.

The C&E GIS staff utilizes ESRI's ArcGIS 10.6.1 and ArcGIS Pro 2.4 platforms for all geospatial analysis and mapping needs. In addition, as needed, the staff also utilizes the SAS and ENVI software platforms for further analysis and data development as deemed necessary. SAS is used for statistical analysis and modeling of tabular data. Whereas, ENVI is used for remote sensing data processing and analysis. The ESRI ArcGIS 10.6.1 and ArcGIS Pro 2.4 platforms 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 where 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 ESRI JavaScript 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 Excel 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 9 full-time GIS and data analysis professionals. 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 are 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 later as new versions of datasets become available, or as inputs to the analysis models are updated themselves. Thus, to minimize the time spent 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 department-specific list of all C&E data available in the C&E SDE can be found in Appendix 5.

Metadata

Metadata is data about the original source, quality, content, history, condition, and other characteristics of the 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, data obtained from outside sources and used by H-GAC will include FGDC-compliant metadata from the source agency. Datasets without a known history and documented quality will be identified 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 (designee) 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.

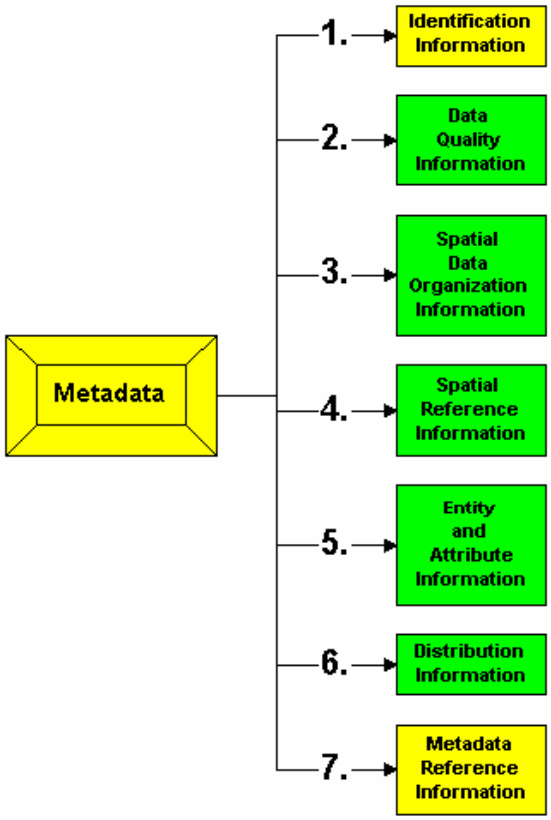


Figure 2: Elements of CSDGM Standards

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 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 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.

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? _____

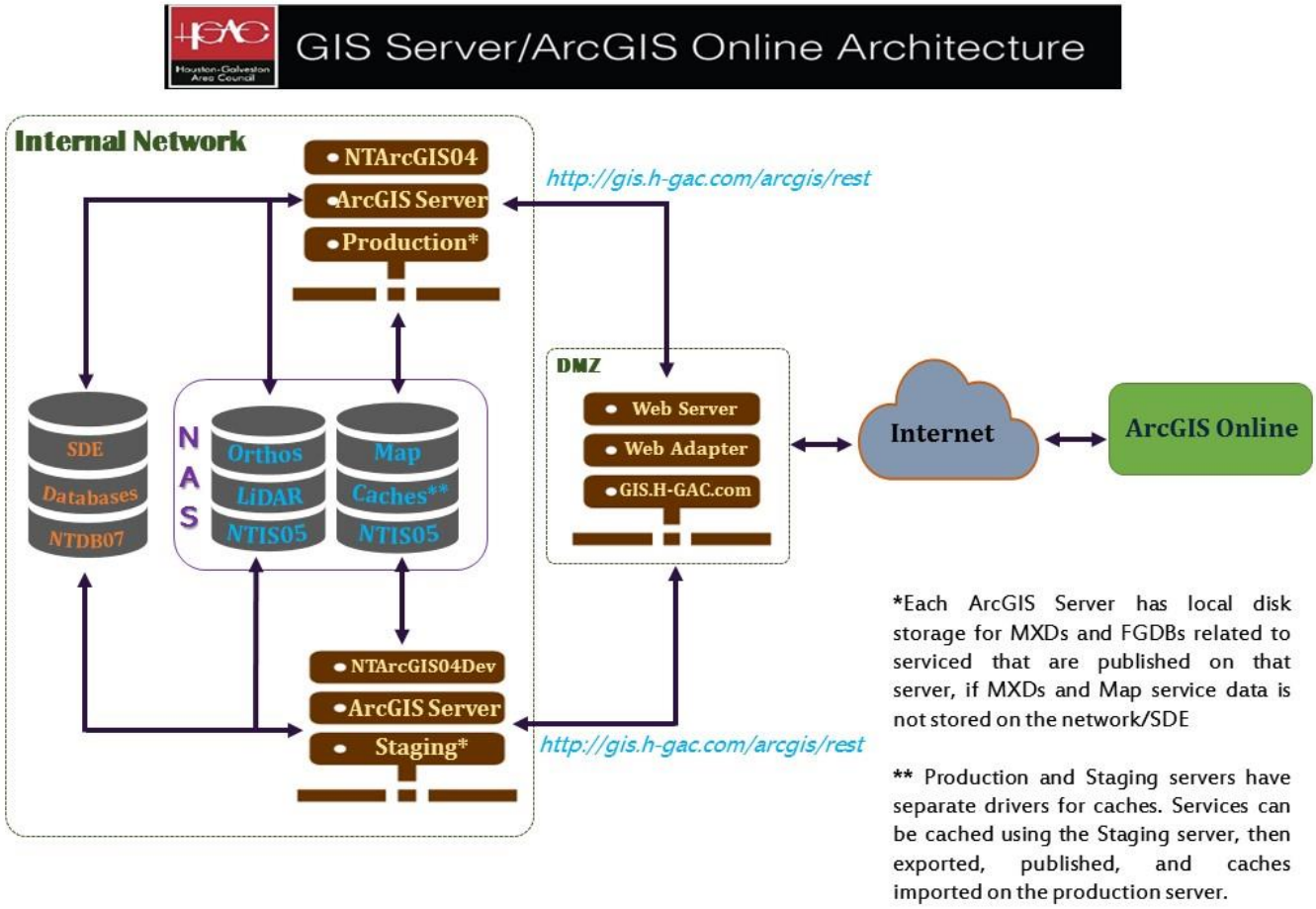
1. Do any of the key fields have missing values? If so which parameters have missing values? Yes ___ No ___
_____
_____
_____

2. Any known duplicate records? Yes ___ No ___

Appendix 3 Hardware

FTP Server
h-gac.sharefile.com

Mapping Application Servers



Desktop PC (Primarily used for GIS analysis)

1. Intel Core i7-9700 CPU @ 3.00 GHz – 32 GB RAM
2. Intel Core i7-9700 CPU @ 3.00 GHz – 32 GB RAM
3. Intel Core i7-9700 CPU @ 3.00 GHz – 32 GB RAM
4. Intel Xeon E-2186G CPU @ 3.80GHz – 16 GB RAM
5. Intel Core i7 9700 CPU @ 3.00 GHz – 16 GB RAM
6. Intel Core i7-9700 CPU @ 3.00GHz – 16 GB RAM
7. Intel Xeon E3-1245 v6 CPU @ 3.70GHz – 16 GB RAM
8. Intel Core i7-9700 CPU @ 3.00GHz – 16 GB RAM
9. Intel Core i7-8700 CPU @ 3.20GHz – 32 GB RAM

Plotters, Printers and Scanners

HP Designjet UPD Generic Plotter

HP Designjet T920 Postscript Plotter

- These two plotters are used by all H-GAC staff for large format printing of maps and schematics.

Xerox Workcenter 7845 and Cannon Advanced 4545 Printers and scanners. C&E maintains both printers.

Global Positioning System (GPS) Units

The C&E Department possesses two GPS units.

Fax Equipment

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

Appendix 4 Software

Geographic Information Systems (GIS)

ESRI ArcGIS (ver 10.6.1) – Computer mapping and database manipulation capable of using ArcView, ArcInfo, and ArcEditor licenses as needed.
ArcGIS Pro 2.4 – Geospatial data analysis and visualization
ESRI ArcGIS Server (ver 10.2, SP3) – Internet Mapping Application Server.
ESRI ArcSDE (ver 10.2, SP1) – Spatial data warehouse.
ENVI Remote Sensing Data Analysis Package – Harris Geospatial

Data Management

Microsoft Access (365) - Relational Database.
SQL Server (2012) - Relational Database.

Programming

Microsoft Visual Studio – Web Mapping Development Tool.
Web AppBuilder for ArcGIS (ver 1.8) – Web-based GIS application development tool
SAS (ver 9.4) – Data development and statistical analytics.

Office Productivity Software

Microsoft Office 365 - Word, Excel, Access, PowerPoint, publisher, InfoPath and Outlook.

Graphics and Desktop Publishing

Adobe Illustrator (ver 8.01) – Graphics
Adobe Photoshop (ver 5.0) – Graphics
Camtasia Studio (ver 7.0) – Screen capture and video tutorial production

Operating Systems

Windows 7 - PC working environment/Operating System
Windows 10 - PC working environment/Operating System
Windows 2012 & 2016 - Server Operating Systems

Appendix 5 Data List

H-GAC Spatial Data Warehouse (SDE) Dataset

Dataset Name	Type
CE_SDE/ACE_HEX_2017	Polygon
CE_SDE/ACS_Housing_Counties_2017	Polygon
CE_SDE/ACS_Housing_Places_2017	Polygon
CE_SDE/ACS_Housing_Tracts_2017	Polygon
CE_SDE/ActivityPopulation_2000	Polygon
CE_SDE/Barker_and_Addicks_Reservoir_Watersheds	Polygon
CE_SDE/BGs_2014	Polygon
CE_SDE/BGs_2015	Polygon
CE_SDE/BGs_2016	Polygon
CE_SDE/BGs_2017	Polygon
CE_SDE/BGs_2018	Polygon
CE_SDE/BGs_Veterans_2016	Polygon
CE_SDE/BGs_Vulnerable_2015	Polygon
CE_SDE/BGs_Vulnerable_2016	Polygon
CE_SDE/BGs_Vulnerable_2017	Polygon
CE_SDE/BGs_Vulnerable_2018	Polygon
CE_SDE/BlueMap_ActivityPopulation	Polygon
CE_SDE/BZ_Model_Predictions_v2018	Polygon
CE_SDE/Cedar_Bayou_Watershed_Project_Monitoring_Sites	Point
CE_SDE/Census_Places_2014	Point
CE_SDE/Census_Places_2015	Polygon
CE_SDE/Census_Places_pt_2015	Point
CE_SDE/Census_Tracts	Polygon
CE_SDE/Census_Tracts_1	Polygon
CE_SDE/Census_Tracts_2014	Polygon
CE_SDE/CEnsus_Tracts_2015	Polygon
CE_SDE/CH_Model_Predictions_v2018	Polygon
CE_SDE/Closed_Landfill_Inventory	Point
CE_SDE/COH_Plats_2018_2020_feb	Polygon
CE_SDE/Congressional_Districts_115th_ACS_2017	Polygon
CE_SDE/Congressional_Districts_2017	Polygon
CE_SDE/Congressional_Districts_2018	Polygon
CE_SDE/Counties_2014	Polygon
CE_SDE/Counties_2015	Polygon
CE_SDE/Counties_2016	Polygon
CE_SDE/Counties_2017	Polygon

CE_SDE/Counties_2018	Polygon
CE_SDE/Counties_TX_Veterans_2016	Polygon
CE_SDE/County_LEHD_09_17	Polygon
CE_SDE/County_LEHD_2018	Polygon
CE_SDE/Critical_Facilities_2017	Point
CE_SDE/CRP_MonitoringStations_Subwatersheds	Polygon
CE_SDE/CRP_Project_Areas	Polygon
CE_SDE/Current_Future_Land_Use	Polygon
CE_SDE/Current_Future_Land_Use_2018	Polygon
CE_SDE/Employment_2000	Polygon
CE_SDE/FB_Model_Predictions_v2018	Polygon
CE_SDE/Forecast_Census_Tracts_2017	Polygon
CE_SDE/Forecast_Census_Tracts_2018	Polygon
CE_SDE/Forecast_H3M_2017	Polygon
CE_SDE/Forecast_H3M_2018	Polygon
CE_SDE/Forecast_TAZ5217_2017	Polygon
CE_SDE/Forecast_TAZ5217_2018	Polygon
CE_SDE/Galveston_Bay_Estuary_Program_Watersheds	Polygon
CE_SDE/GV_Model_Predictions_v2018	Polygon
CE_SDE/Harris_County_FCD_Sub_Watersheds	Polygon
CE_SDE/Harris_County_FCD_Watersheds	Polygon
CE_SDE/Harris_County_Zones_58	Polygon
CE_SDE/HEX_H1M_09_17	Polygon
CE_SDE/HEX_H1M_LEHD_2018	Polygon
CE_SDE/HGAC_13_County_ACS_2015_Blockgroup_summary	Polygon
CE_SDE/HGAC_13_County_Airports	Point
CE_SDE/HGAC_13_County_Airports_ParcelIDs	Table
CE_SDE/HGAC_13_County_Brownfield_Sites	Point
CE_SDE/HGAC_13_County_Closed_Landfill_Inventory	Point
CE_SDE/HGAC_13_County_CRP_DO_Stations	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2008	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2010	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2011	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2012	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2013	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2014	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2015	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2016	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_2017	Point
CE_SDE/HGAC_13_County_CRP_Monitoring_Stations_Historical	Point
CE_SDE/HGAC_13_County_Districts	Polygon

CE_SDE/HGAC_13_County_Ecological_Mapping_System_TPWD_2015	Polygon
CE_SDE/HGAC_13_County_Farmland	Polygon
CE_SDE/HGAC_13_County_Federal_Aid_Roads	Polyline
CE_SDE/HGAC_13_County_G1M	Polygon
CE_SDE/HGAC_13_County_G3M	Polygon
CE_SDE/HGAC_13_County_G5M	Polygon
CE_SDE/HGAC_13_County_Grocery_Stores	Point
CE_SDE/HGAC_13_County_Landfill_Areas	Polygon
CE_SDE/HGAC_13_County_Landfill_Areas_Historical	Polygon
CE_SDE/HGAC_13_County_Landfills	Point
CE_SDE/HGAC_13_County_Landfills_Historical	Point
CE_SDE/HGAC_13_County_Libraries	Point
CE_SDE/HGAC_13_County_Libraries_Parcel_Xref	Table
CE_SDE/HGAC_13_County_Mobile_Home_Parks_FEMA	Point
CE_SDE/HGAC_13_County_MS_Building_Footprints_2015	Polygon
CE_SDE/HGAC_13_County_Opportunity_Zones	Polygon
CE_SDE/HGAC_13_County_OSSF_Permits	Point
CE_SDE/HGAC_13_County_OSSF_Permits_2017	Point
CE_SDE/HGAC_13_County_OSSF_Permits_2018	Point
CE_SDE/HGAC_13_County_OSSF_Permits_2019	Point
CE_SDE/HGAC_13_County_OSSF_Permits_2020	Point
CE_SDE/HGAC_13_County_OSSF_Permits_2021	Point
CE_SDE/HGAC_13_County_Parks	Point
CE_SDE/HGAC_13_County_Parks_Awards	Table
CE_SDE/HGAC_13_County_Parks_Features	Table
CE_SDE/HGAC_13_County_Parks_Parcels	Table
CE_SDE/HGAC_13_County_Plats	Polygon
CE_SDE/HGAC_13_County_Recycle_Centers	Point
CE_SDE/HGAC_13_County_Service_Area_Boundaries	Polygon
CE_SDE/HGAC_13_County_Service_Area_Boundaries_2013	Polygon
CE_SDE/HGAC_13_County_Service_Area_Boundaries_2014	Polygon
CE_SDE/HGAC_13_County_Service_Area_Boundaries_2015	Polygon
CE_SDE/HGAC_13_County_Service_Area_Boundaries_2017	Polygon
CE_SDE/HGAC_13_County_Service_Area_Boundaries_Domestic_2018	Polygon
CE_SDE/HGAC_13_County_Soils	Polygon
CE_SDE/HGAC_13_County_Superfund_NPL_Sites	Polygon
CE_SDE/HGAC_13_County_Superfund_NPL_Sites_Pts	Point
CE_SDE/HGAC_13_County_Transmission_Lines_FEMA	Polyline
CE_SDE/HGAC_13_County_Wastewater_Outfall_Domestic_2018	Point
CE_SDE/HGAC_15_County_Aquifer_Recharge_Zones	Polygon
CE_SDE/HGAC_15_County_Basins	Polygon

CE_SDE/HGAC_15_County_Bio_Monitoring_Sites	Point
CE_SDE/HGAC_15_County_CRP_Impairments	Table
CE_SDE/HGAC_15_County_CRP_Lakes	Polygon
CE_SDE/HGAC_15_County_CRP_Monitoring_Stations_2019	Point
CE_SDE/HGAC_15_County_CRP_Monitoring_Stations_2020	Point
CE_SDE/HGAC_15_County_CRP_Monitoring_Stations_2021	Point
CE_SDE/HGAC_15_County_CRP_Stream_End_Points	Point
CE_SDE/HGAC_15_County_CRP_Streams	Polyline
CE_SDE/HGAC_15_COUNTY_LAND_COVER_2015_10_CLASS	Raster
CE_SDE/HGAC_15_COUNTY_LAND_COVER_2018_10_CLASS	Raster
CE_SDE/HGAC_15_COUNTY_LAND_COVER_2020_15_CLASS	Raster
CE_SDE/HGAC_15_County_NHDPlus_Streams	Polyline
CE_SDE/HGAC_15_County_NHDPlusV2_Catchment_Boundary	Polygon
CE_SDE/HGAC_15_County_Service_Area_Boundaries_2019	Polygon
CE_SDE/HGAC_15_County_Service_Area_Boundaries_2020	Polygon
CE_SDE/HGAC_15_County_Service_Area_Boundaries_2021	Polygon
CE_SDE/HGAC_15_County_Soils_2012	Polygon
CE_SDE/HGAC_15_County_Soils_2012_w_taxonomy	Polygon
CE_SDE/HGAC_15_County_Wastewater_Outfall_Domestic_2019	Point
CE_SDE/HGAC_15_County_Wastewater_Outfall_Domestic_2020	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_2017	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_2019	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_2020	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_2021	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_Domestic_2021	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_Historical	Point
CE_SDE/HGAC_15_County_Wastewater_Outfalls_Pre2017	Point
CE_SDE/HGAC_15_County_Water_Detailed_2018	Polygon
CE_SDE/HGAC_15_County_Watershed_Insets	Polygon
CE_SDE/HGAC_15_County_Watershed_Signs	Point
CE_SDE/HGAC_15_County_Watersheds	Polygon
CE_SDE/HGAC_8_County_Bikeway_Needs	Polyline
CE_SDE/HGAC_8_County_Bikeways	Polyline
CE_SDE/HGAC_8_County_Comprehensive_Plan_2010_pts	Point
CE_SDE/HGAC_8_County_Eco_Types	Polygon
CE_SDE/HGAC_8_County_Forecast_Cities_h	Table
CE_SDE/HGAC_8_County_Forecast_Cities_v	Table
CE_SDE/HGAC_8_County_Forecast_Counties_h	Table
CE_SDE/HGAC_8_County_Forecast_Counties_v	Table
CE_SDE/HGAC_8_County_Forecast_G025M_h	Table
CE_SDE/HGAC_8_County_Forecast_G1_h	Table

CE_SDE/HGAC_8_County_Forecast_G10K_h	Table
CE_SDE/HGAC_8_County_Forecast_G10K_v	Table
CE_SDE/HGAC_8_County_Forecast_G1M_h	Table
CE_SDE/HGAC_8_County_Forecast_G1M_v	Table
CE_SDE/HGAC_8_COUNTY_FORECAST_LU_G1_H	Table
CE_SDE/HGAC_8_County_Forecast_RAZ_h	Table
CE_SDE/HGAC_8_County_Forecast_RAZ_v	Table
CE_SDE/HGAC_8_County_Forecast_Region_v	Table
CE_SDE/HGAC_8_County_Forecast_TAZ_h_2003	Table
CE_SDE/HGAC_8_County_Forecast_TAZ_v_2003	Table
CE_SDE/HGAC_8_County_Forecast_Tracts_h	Table
CE_SDE/HGAC_8_County_Forecast_Tracts_v	Table
CE_SDE/HGAC_8_County_Forecast_Zip_Codes_h	Table
CE_SDE/HGAC_8_County_Forecast_Zip_Codes_v	Table
CE_SDE/HGAC_8_County_G025M	Polygon
CE_SDE/HGAC_8_County_G1	Polygon
CE_SDE/HGAC_8_County_G10	Polygon
CE_SDE/HGAC_8_County_G1M	Polygon
CE_SDE/HGAC_8_County_PedBike_Improvement_Areas	Polygon
CE_SDE/HGAC_8_County_PedBike_Improvement_Locations	Point
CE_SDE/HGAC_8_County_Pedestrian_Pathways	Polyline
CE_SDE/HGAC_8_County_Sector_25	Polygon
CE_SDE/HGAC_8_County_Soils	Polygon
CE_SDE/HGAC_8_County_Water	Polygon
CE_SDE/HGAC_Bastrop_Bayou_Sub_Watersheds	Polygon
CE_SDE/HGAC_CRP_Watersheds	Polygon
CE_SDE/HGAC_Lakes_AUs_2016	Polygon
CE_SDE/HGAC_Lakes_Segments_2016	Polygon
CE_SDE/HGAC_Other_CRP_Monitoring_Stations	Point
CE_SDE/HGAC_Region_WWTF_Outfalls_FY17	Point
CE_SDE/HGAC_Streams_AUs_2016	Polyline
CE_SDE/HGAC_Streams_Segments_2016	Polyline
CE_SDE/HHW_Centers	Point
CE_SDE/HouseholdPopulation_2000	Polygon
CE_SDE/Houston_Bcycle_Stations_2018	Point
CE_SDE/HR_Model_Predictions_v2018	Polygon
CE_SDE/HR_Model_Predictions_v2018_p1	Polygon
CE_SDE/HR_Model_Predictions_v2018_p2	Polygon
CE_SDE/HR_Model_Predictions_v2018_p3	Polygon
CE_SDE/Intersection_2000	Polygon
CE_SDE/ISD_2018	Polygon

CE_SDE/ISDs_2016	Polygon
CE_SDE/ISDs_2017	Polygon
CE_SDE/Job_HH_Ratio_2000	Polygon
CE_SDE/Landfill_Areas	Polygon
CE_SDE/Landfills	Point
CE_SDE/LB_Model_Predictions_v2018	Polygon
CE_SDE/LivableCenters	Polygon
CE_SDE/MG_Model_Predictions_v2018	Polygon
CE_SDE/Model_Buildings	Point
CE_SDE/Model_Buildings_2017	Point
CE_SDE/Model_Buildings_2017_events	Point
CE_SDE/Model_Buildings_2020	Point
CE_SDE/Model_Buildings_Rural	Point
CE_SDE/Model_Buildings_Uses	Table
CE_SDE/Model_Buildings_Uses_Rural	Table
CE_SDE/Model_Parcels	Polygon
CE_SDE/Model_Parcels_2017	Polygon
CE_SDE/Model_Parcels_2020	Polygon
CE_SDE/Model_Parcels_AcctNums	Table
CE_SDE/Model_Parcels_AcctNums_Rural	Table
CE_SDE/Model_Parcels_Addresses	Table
CE_SDE/Model_Parcels_Addresses_Rural	Table
CE_SDE/Model_Parcels_Features	Table
CE_SDE/Model_Parcels_Features_Rural	Table
CE_SDE/Model_Parcels_Rural	Polygon
CE_SDE/Montgomery_County_Zones_4	Polygon
CE_SDE/MS4_Permitted_Areas_2018	Polygon
CE_SDE/Nine_SQM_Grid	Polygon
CE_SDE/Nine_SQM_Grid_1	Polygon
CE_SDE/NLCD_IMPERVIOUSNESS_2016	Raster
CE_SDE/One_SQM_Grid	Polygon
CE_SDE/One_SQM_Grid_1	Polygon
CE_SDE/Ped_Bike_Destinations_2017	Point
CE_SDE/Place_LEHD_09_17	Polygon
CE_SDE/Place_LEHD_2018	Polygon
CE_SDE/Places_poly_2015	Polygon
CE_SDE/Places_poly_2016	Polygon
CE_SDE/Places_poly_2017	Polygon
CE_SDE/Places_poly_2018	Polygon
CE_SDE/Places_pt_2016	Point
CE_SDE/Places_pt_2017	Point

CE_SDE/Places_pt_2018	Point
CE_SDE/Recycling_and_HHW_Centers	Point
CE_SDE/Recycling_Centers	Point
CE_SDE/TCEQ_AU_Line_2020	Polyline
CE_SDE/Texas_Coastal_Zone_Boundary	Polygon
CE_SDE/Texas_Impairment_Streams_2008	Polyline
CE_SDE/Texas_Impairment_Waterbodies_2008	Polygon
CE_SDE/Texas_Stream_Team_Monitoring_Sites_2016	Point
CE_SDE/Texas_Stream_Team_Monitoring_Sites_2018	Point
CE_SDE/Texas_Stream_Team_Monitoring_Sites_2020	Point
CE_SDE/TexasStateHouse_2018	Polygon
CE_SDE/TexasStateSenate_2018	Polygon
CE_SDE/The_Woodlands_Pathways	Polyline
CE_SDE/TMDL_Watersheds	Polygon
CE_SDE/TPWD_13_County_LWRCRP_conservation_and_recreation_lands	Polygon
CE_SDE/Tract_LEHD_09_17	Polygon
CE_SDE/Tract_LEHD_2018	Polygon
CE_SDE/Tracts_2016	Polygon
CE_SDE/Tracts_2017	Polygon
CE_SDE/Tracts_2018	Polygon
CE_SDE/Transportation_Analysis_Zones_2954	Polygon
CE_SDE/Transportation_Analysis_Zones_2954_1	Polygon
CE_SDE/Transportation_Analysis_Zones_5217	Polygon
CE_SDE/Transportation_Analysis_Zones_5217_1	Polygon
CE_SDE/USFWS_15_County_Wetlands_2018	Polygon
CE_SDE/USGS_Stream_Gauges_2009	Point
CE_SDE/USGS_Stream_Gauges_2010	Point
CE_SDE/USGS_Stream_Gauges_2012	Point
CE_SDE/USGS_Stream_Gauges_2017	Point
CE_SDE/WA_Model_Predictions_v2018	Polygon
CE_SDE/Watershed_Based_Plans_2021	Polygon
CE_SDE/Zips_2014	Polygon
CE_SDE/Zips_2015	Polygon
CE_SDE/Zips_2016	Polygon
CE_SDE/Zips_2017	Polygon
CE_SDE/Zips_2018	Polygon
Global_SDE/Austin_County_Commissioner_Precincts	Polygon
Global_SDE/Brazoria_County_Commissioner_Precincts	Polygon
Global_SDE/Brazos_Transit_District_Bus_Routes	Polyline
Global_SDE/Brazos_Transit_District_Park_and_Rides	Point
Global_SDE/Chambers_County_Commissioner_Precincts	Polygon

Global_SDE/CoH_Council_Districts	Polygon
Global_SDE/CoH_Historical_Districts	Polygon
Global_SDE/CoH_Police_Districts	Polygon
Global_SDE/CoH_Public_Libraries	Point
Global_SDE/CoH_Street_Pavement_Edges	Polyline
Global_SDE/CoH_Traffic_Signals	Point
Global_SDE/CoH_Traffic_Signs	Point
Global_SDE/Colorado_County_Commissioner_Precincts	Polygon
Global_SDE/Colorado_Valley_Transit_Bus_Routes	Polyline
Global_SDE/Connect_Transit_Bus_Routes	Polyline
Global_SDE/Conroe_Transit_Bus_Routes	Polyline
Global_SDE/DataAxle_Businesses_2021	Point
Global_SDE/DataAxle_Businesses_Nix_2021	Point
Global_SDE/DataAxle_Businesses_Pre_2021	Point
Global_SDE/DataAxle_Businesses_Suspect_2021	Point
Global_SDE/DataAxle_Consumers_2021	Point
Global_SDE/EPA_Texas_Eco_Regions	Polygon
Global_SDE/FEMA_Floodplains_DFIRM_Q3_2010	Polygon
Global_SDE/FEMA_Floodplains_NFHL_2015	Polygon
Global_SDE/Fort_Bend_County_Commissioner_Precincts	Polygon
Global_SDE/Fort_Bend_County_Constable_Precincts	Polygon
Global_SDE/Fort_Bend_Transit_Bus_Routes	Polyline
Global_SDE/Galveston_County_Commissioner_Precincts	Polygon
Global_SDE/GCR911ECD_Counties_Coastline	Polygon
Global_SDE/GCR911ECD_Counties_Political	Polygon
Global_SDE/Gulf_Of_Mexico	Polygon
Global_SDE/Harris_County_Commissioner_Precincts	Polygon
Global_SDE/Harris_County_Constable_Precincts	Polygon
Global_SDE/Harris_County_Sheriff_Districts	Polygon
Global_SDE/Harris_County_Transit_Bus_Routes	Polyline
Global_SDE/HGAC_AEL_Providers	Point
Global_SDE/HGAC_Airport_Runways	Polygon
Global_SDE/HGAC_Airport_System	Point
Global_SDE/HGAC_Art_of_Transportation	Point
Global_SDE/HGAC_Buy_Active_EndUsers	Point
Global_SDE/HGAC_Buy_PO_EndUsers	Point
Global_SDE/HGAC_Career_Offices	Point
Global_SDE/HGAC_City_Boundaries	Polygon
Global_SDE/HGAC_City_Council_Districts	Polygon
Global_SDE/HGAC_City_ETJ_Boundaries	Polygon
Global_SDE/HGAC_City_Ordinance_Areas	Polygon

GLOBAL_SDE/HGAC_COASTAL_VIGNETTE_RASTER	Raster
Global_SDE/HGAC_CoH_Council_Districts_UI_Claims	Polygon
Global_SDE/HGAC_Commissioner_Precincts	Polygon
Global_SDE/HGAC_Commissioner_Precincts_UI_Claims	Polygon
Global_SDE/HGAC_Contours_2_Feet	Polyline
Global_SDE/HGAC_Contours_5_Feet	Polyline
Global_SDE/HGAC_Counties_Coastline	Polygon
Global_SDE/HGAC_Counties_Coastline_15C	Polygon
Global_SDE/HGAC_Counties_Coastline_Boundary	Polygon
Global_SDE/HGAC_Counties_Coastline_Boundary_15C	Polygon
Global_SDE/HGAC_Counties_COVID_19_Cases	Polygon
Global_SDE/HGAC_Counties_Demo_Jobs	Polygon
Global_SDE/HGAC_Counties_Hospital_Beds	Polygon
Global_SDE/HGAC_Counties_Political	Polygon
Global_SDE/HGAC_Counties_Political_15C	Polygon
Global_SDE/HGAC_Counties_Political_Boundary	Polygon
Global_SDE/HGAC_Counties_Political_Boundary_15C	Polygon
Global_SDE/HGAC_Counties_UI_Claims	Polygon
Global_SDE/HGAC_Counties_UI_Claims_TWC	Polygon
Global_SDE/HGAC_COVID_19_Active_Cases	Table
Global_SDE/HGAC_COVID_19_Confirmed_Cases_and_Tests	Table
Global_SDE/HGAC_COVID_19_Deceased_Cases	Table
Global_SDE/HGAC_COVID_19_Harris_County_Info	Table
Global_SDE/HGAC_COVID_19_Hospital_Beds_and_Ventilators	Table
Global_SDE/HGAC_COVID_19_Recovered_Cases	Table
Global_SDE/HGAC_COVID_19_Test_Sites	Point
Global_SDE/HGAC_COVID_19_TSA_Q_Info	Table
Global_SDE/HGAC_COVID_19_US_MSAs_Confirmed_and_Deceased_Cases	Table
Global_SDE/HGAC_Dams	Point
Global_SDE/HGAC_Election_Precincts	Polygon
Global_SDE/HGAC_Ex_Offender_Resources	Point
Global_SDE/HGAC_Flex_Zones	Polygon
Global_SDE/HGAC_FM_Roads	Polyline
Global_SDE/HGAC_Freshwater_Saltwater_Boundary	Polyline
Global_SDE/HGAC_Gulf_Coast_ETPS	Point
GLOBAL_SDE/HGAC_HILLSHADE	Raster
Global_SDE/HGAC_Hurricane_Dolly_Observations	Point
Global_SDE/HGAC_Hurricane_Dolly_Track	Polyline
Global_SDE/HGAC_Hurricane_Evacuation_Routes	Polyline
Global_SDE/HGAC_Hurricane_Evacuation_Zip_Codes	Polygon
Global_SDE/HGAC_Hurricane_Ike_High_Water_Measurements	Point

Global_SDE/HGAC_Hurricane_Ike_Observations	Point
GLOBAL_SDE/HGAC_HURRICANE_IKE_SALT_BURN_GULF_COAST	Raster
Global_SDE/HGAC_Hurricane_Ike_Storm_Surge_Model	Polygon
GLOBAL_SDE/HGAC_HURRICANE_IKE_STORM_SURGE_MODEL_RASTER	Raster
Global_SDE/HGAC_Hurricane_Ike_Track	Polyline
GLOBAL_SDE/HGAC_LAND_COVER_10_CLASS_2008	Raster
GLOBAL_SDE/HGAC_LAND_COVER_10_CLASS_ROADS_2008	Raster
GLOBAL_SDE/HGAC_LAND_COVER_3X3_MODE_FILTERED_2008	Raster
GLOBAL_SDE/HGAC_LAND_COVER_MERGED_6_CLASS_2008	Raster
Global_SDE/HGAC_Learning_Centers	Point
Global_SDE/HGAC_LiDAR_Breakline	Polyline
Global_SDE/HGAC_LiDAR_Contours_1_Foot	Polyline
Global_SDE/HGAC_LiDAR_Spot_Elevation	Point
Global_SDE/HGAC_Major_Lakes_and_Reservoirs	Polygon
Global_SDE/HGAC_Major_Rivers	Polyline
Global_SDE/HGAC_Major_Rivers_15C	Polyline
Global_SDE/HGAC_Major_Roads	Polyline
Global_SDE/HGAC_Major_Roads_15C	Polyline
Global_SDE/HGAC_MSWF_Managed_Lanes	Polyline
Global_SDE/HGAC_MSWF_Traffic_Management_Strategies	Point
Global_SDE/HGAC_NWR_Areas	Polygon
Global_SDE/HGAC_Parks	Polygon
Global_SDE/HGAC_Parole_Offices	Point
Global_SDE/HGAC_Pipelines	Polyline
Global_SDE/HGAC_RAZ	Polygon
Global_SDE/HGAC_Re_Entry_Resources	Point
Global_SDE/HGAC_Regional_Employers	Point
Global_SDE/HGAC_School_Districts	Polygon
Global_SDE/HGAC_School_Districts_UI_Claims	Polygon
Global_SDE/HGAC_Sea_Level_Rise	Polygon
Global_SDE/HGAC_Seaports	Point
Global_SDE/HGAC_Sidewalks_Final	Polyline
Global_SDE/HGAC_Sidewalks_Preliminary	Polyline
Global_SDE/HGAC_StarMap_Addresses	Point
Global_SDE/HGAC_StarMap_Centerlines	Polyline
Global_SDE/HGAC_StarMap_ZipCodes	Polygon
Global_SDE/HGAC_State_Highways	Polyline
Global_SDE/HGAC_State_House_Districts_UI_Claims	Polygon
Global_SDE/HGAC_State_Senate_Districts_UI_Claims	Polygon
Global_SDE/HGAC_TAZ_2954	Polygon
Global_SDE/HGAC_TAZ_5217	Polygon

Global_SDE/HGAC_Texas_Coastal_Vignette	Polygon
Global_SDE/HGAC_Texas_State_House_Districts	Polygon
Global_SDE/HGAC_Texas_State_Senate_Districts	Polygon
Global_SDE/HGAC_Texas_US_House_Districts	Polygon
Global_SDE/HGAC_TIRZ	Polygon
Global_SDE/HGAC_Transit_Stops	Point
Global_SDE/HGAC_Trauma_Service_Areas	Polygon
Global_SDE/HGAC_UI_Claimants	Point
Global_SDE/HGAC_Urban_Areas_2000	Polygon
Global_SDE/HGAC_Urban_Areas_2010	Polygon
Global_SDE/HGAC_US_House_Districts_UI_Claims	Polygon
Global_SDE/HGAC_Water	Polygon
Global_SDE/HGAC_Water_15C	Polygon
Global_SDE/HGAC_Water_Detailed	Polygon
Global_SDE/HGAC_Workforce_Centers	Point
Global_SDE/HGAC_Workforce_DARS	Point
Global_SDE/HGAC_Workforce_Solutions_Offices	Point
Global_SDE/HGAC_Workforce_Solutions_VR_Offices	Point
Global_SDE/HGAC_Zip_Codes_2000	Polygon
Global_SDE/HGAC_Zip_Codes_2002	Polygon
Global_SDE/HGAC_Zip_Codes_2005	Polygon
Global_SDE/HGAC_ZIP_Codes_Area_NAICS_Hexagon	Polygon
Global_SDE/HGAC_ZIP_Codes_Demo	Polygon
Global_SDE/HGAC_ZIP_Codes_Jobs	Polygon
Global_SDE/HGAC_ZIP_Codes_UI_Claims	Polygon
Global_SDE/HGAC_ZIP_Codes_UI_Claims_TWC	Polygon
Global_SDE/HRWY_Employers	Point
Global_SDE/InfoGroup_Businesses_2014	Point
Global_SDE/InfoGroup_Businesses_2015	Point
Global_SDE/InfoGroup_Businesses_2016	Point
Global_SDE/InfoGroup_Businesses_2017	Point
Global_SDE/InfoGroup_Businesses_2018	Point
Global_SDE/InfoGroup_Businesses_2019	Point
Global_SDE/InfoGroup_Businesses_2020	Point
Global_SDE/InfoGroup_Businesses_Nix_2014	Table
Global_SDE/InfoGroup_Businesses_Nix_2015	Point
Global_SDE/InfoGroup_Businesses_Nix_2016	Point
Global_SDE/InfoGroup_Businesses_Nix_2017	Point
Global_SDE/InfoGroup_Businesses_Nix_2018	Point
Global_SDE/InfoGroup_Businesses_Nix_2019	Point
Global_SDE/InfoGroup_Businesses_Nix_2020	Point

Global_SDE/InfoGroup_Businesses_Pre_2018	Point
Global_SDE/InfoGroup_Businesses_Pre_2019	Point
Global_SDE/InfoGroup_Businesses_Pre_2020	Point
Global_SDE/InfoGroup_Businesses_Suspect_2014	Point
Global_SDE/InfoGroup_Businesses_Suspect_2015	Point
Global_SDE/InfoGroup_Businesses_Suspect_2016	Point
Global_SDE/InfoGroup_Businesses_Suspect_2017	Point
Global_SDE/InfoGroup_Businesses_Suspect_2018	Point
Global_SDE/InfoGroup_Businesses_Suspect_2019	Point
Global_SDE/InfoGroup_Businesses_Suspect_2020	Point
Global_SDE/InfoGroup_Consumers_2014	Point
Global_SDE/InfoGroup_Consumers_2015	Point
Global_SDE/InfoGroup_Consumers_2016	Point
Global_SDE/InfoGroup_Consumers_2017	Point
Global_SDE/InfoGroup_Consumers_2018	Point
Global_SDE/InfoGroup_Consumers_2019	Point
Global_SDE/InfoGroup_Consumers_2020	Point
Global_SDE/Island_Transit_Bus_Routes	Polyline
Global_SDE/Island_Transit_Bus_Stops	Point
Global_SDE/Lambert_Grid	Polygon
Global_SDE/Lambert_Grid_Product	Polygon
Global_SDE/Lambert_Grid_Products_1	Table
Global_SDE/Liberty_County_Commissioner_Precincts	Polygon
Global_SDE/LiDAR_Building_Footprints_2014_Fort_Bend_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Austin_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Brazoria_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Chambers_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Fort_Bend_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Galveston_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Grimes_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Harris_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Jefferson_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Liberty_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Matagorda_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Montgomery_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Walker_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Waller_County	Polygon
Global_SDE/LiDAR_Building_Footprints_2018_Washington_County	Polygon
Global_SDE/LiDAR_Grid_2008	Polygon
Global_SDE/LiDAR_Grid_2014	Polygon

Global_SDE/LiDAR_Grid_2018_Full_Extent	Polygon
Global_SDE/LiDAR_Grid_2018_HCFCD_Extent	Polygon
Global_SDE/Matagorda_County_Commissioner_Precincts	Polygon
Global_SDE/Metro_Bus_Routes	Polyline
Global_SDE/Metro_Bus_Stops	Point
Global_SDE/Metro_LRT_Lines	Polyline
Global_SDE/Metro_LRT_Stations	Point
Global_SDE/Metro_MTA_Tax_Area	Polygon
Global_SDE/Metro_Park_and_Rides	Point
Global_SDE/Metro_Transit_Centers	Point
Global_SDE/Montgomery_County_Commissioner_Precincts	Polygon
Global_SDE/NGS_Control_Stations	Point
GLOBAL_SDE/NLCD_IMPERVIOUSNESS_2001	Raster
GLOBAL_SDE/NLCD_IMPERVIOUSNESS_2006	Raster
GLOBAL_SDE/NLCD_IMPERVIOUSNESS_2011	Raster
GLOBAL_SDE/NLCD_IMPERVIOUSNESS_2016	Raster
GLOBAL_SDE/NLCD_IMPERVIOUSNESS_CHANGE_2001_TO_2006	Raster
GLOBAL_SDE/NLCD_IMPERVIOUSNESS_CHANGE_2006_TO_2011	Raster
GLOBAL_SDE/NLCD_LAND_COVER_1992_19_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_1992_19_CLASS_CORRECTED	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2001_15_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2004_17_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2006_15_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2008_17_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2011_15_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2013_16_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_2016_16_CLASS	Raster
GLOBAL_SDE/NLCD_LAND_COVER_CHANGE_1992_TO_2011_9_CLASS	Raster
GLOBAL_SDE/NLCD_TREE_CANOPY_2001	Raster
GLOBAL_SDE/NLCD_TREE_CANOPY_2011	Raster
GLOBAL_SDE/NLCD_TREE_CANOPY_2016	Raster
GLOBAL_SDE/NOAA_LAND_COVER_1996_22_CLASS	Raster
GLOBAL_SDE/NOAA_LAND_COVER_2001_22_CLASS	Raster
GLOBAL_SDE/NOAA_LAND_COVER_2006_22_CLASS	Raster
GLOBAL_SDE/NOAA_LAND_COVER_2011_15_CLASS	Raster
GLOBAL_SDE/NOAA_LAND_COVER_2011_22_CLASS	Raster
GLOBAL_SDE/NOAA_LAND_COVER_CHANGE_1996_TO_2010	Raster
Global_SDE/NOAA_Surge_MOM_Galveston_Bay	Polygon
Global_SDE/NOAA_Surge_MOM_Matagorda_Bay	Polygon
Global_SDE/NPS_Texas_National_Parks	Polygon
Global_SDE/NTAD_Raillines	Polyline

Global_SDE/NTAD_Raillines_General	Polyline
Global_SDE/POHA_Ship_Channel	Polygon
Global_SDE/PUCT_Texas_Area_Codes	Polygon
Global_SDE/Strava_Bike_Usage_2017	Polyline
Global_SDE/Strava_Bike_Usage_2018	Polyline
Global_SDE/Strava_Bike_Usage_2019	Polyline
Global_SDE/Strava_Bike_Usage_2020	Polyline
Global_SDE/TAMU_Texas_Coastal_Bathymetry	Point
Global_SDE/TAMU_Texas_Coastal_Bathymetry_Contour	Polyline
Global_SDE/TCEQ_Texas_Regions	Polygon
Global_SDE/TCEQ_Texas_Surface_Water_Rights_Diversion	Point
Global_SDE/TEA_School_Districts	Polygon
Global_SDE/TEA_Schools	Point
Global_SDE/TEA_Texas_Education_Service_Regions	Polygon
Global_SDE/TEA_Texas_School_Districts	Polygon
Global_SDE/TEA_Texas_Senate_Board_of_Education_Districts	Polygon
Global_SDE/TFT_Texas_Adoption_Sites	Point
Global_SDE/The_Woodlands_Township_Bus_Routes	Polyline
Global_SDE/THHS_Texas_Community_Nursing_Homes	Point
Global_SDE/TNRIS_Texas_Major_Aquifers	Polygon
Global_SDE/TNRIS_Texas_Minor_Aquifers	Polygon
Global_SDE/TNRIS_Texas_National_Forests	Polygon
Global_SDE/TPWD_Texas_Natural_Regions	Polygon
Global_SDE/TWDB_Texas_Groundwater_Conservation_Districts	Polygon
Global_SDE/TWDB_Texas_Major_Rivers	Polyline
Global_SDE/TxDOT_Highway_Milemarkers	Point
Global_SDE/TxDOT_Texas_COG_Boundaries	Polygon
Global_SDE/TxDOT_Texas_Highways	Polyline
Global_SDE/TxDOT_Texas_Hurricane_Evacuation_Routes	Polyline
Global_SDE/TxDOT_Texas_State_House_Districts	Polygon
Global_SDE/TxDOT_Texas_State_Senate_Districts	Polygon
Global_SDE/TxDOT_Texas_US_House_Districts	Polygon
Global_SDE/USCB_ACS_2018_5Yr_Block_Groups	Polygon
Global_SDE/USCB_ACS_2018_5Yr_Counties	Polygon
Global_SDE/USCB_ACS_2018_5Yr_Places	Polygon
Global_SDE/USCB_ACS_2018_5Yr_Tracts	Polygon
Global_SDE/USCB_ACS_2018_5Yr_Zip_Codes	Polygon
Global_SDE/USCB_BlockGroups_1990	Polygon
Global_SDE/USCB_BlockGroups_2000	Polygon
Global_SDE/USCB_BlockGroups_2010	Polygon
Global_SDE/USCB_Blocks_2000	Polygon

Global_SDE/USCB_Blocks_2010	Polygon
Global_SDE/USCB_Metropolitan_Statistical_Area	Polygon
Global_SDE/USCB_PL_Data_2010_Block_Groups	Table
Global_SDE/USCB_PL_Data_2010_Blocks	Table
Global_SDE/USCB_PL_Data_2010_Counties	Table
Global_SDE/USCB_PL_Data_2010_Places	Table
Global_SDE/USCB_PL_Data_2010_School_Districts	Table
Global_SDE/USCB_PL_Data_2010_Tracts	Table
Global_SDE/USCB_Places_2000	Polygon
Global_SDE/USCB_Places_2000_Pts	Point
Global_SDE/USCB_Places_2010	Polygon
Global_SDE/USCB_Places_2010_Pts	Point
Global_SDE/USCB_PSAP_Prep_BlockGroups_ACS_2017	Polygon
Global_SDE/USCB_PSAP_Prep_CDPs_and_Cities	Polygon
Global_SDE/USCB_PSAP_Prep_Tracts	Polygon
Global_SDE/USCB_PSAP_Prep_Tracts_ACS_2017	Polygon
Global_SDE/USCB_Texas_BlockGroups_1990	Polygon
Global_SDE/USCB_Texas_BlockGroups_2000	Polygon
Global_SDE/USCB_Texas_BlockGroups_2010	Polygon
Global_SDE/USCB_Texas_Blocks_2000	Polygon
Global_SDE/USCB_Texas_Blocks_2010	Polygon
Global_SDE/USCB_Texas_Coastline_Boundary	Polygon
Global_SDE/USCB_Texas_Counties_Coastline	Polygon
Global_SDE/USCB_Texas_Counties_Political	Polygon
Global_SDE/USCB_Texas_Political_Boundary	Polygon
Global_SDE/USCB_Texas_School_Districts_2010	Polygon
Global_SDE/USCB_Texas_Tracts_1990	Polygon
Global_SDE/USCB_Texas_Tracts_2000	Polygon
Global_SDE/USCB_Texas_Tracts_2010	Polygon
Global_SDE/USCB_Texas_Urban_Areas_2000	Polygon
Global_SDE/USCB_Texas_Zip_Codes_2005	Polygon
Global_SDE/USCB_Texas_Zip_Codes_2010	Polygon
Global_SDE/USCB_Tracts_1970	Polygon
Global_SDE/USCB_Tracts_1980	Polygon
Global_SDE/USCB_Tracts_1990	Polygon
Global_SDE/USCB_Tracts_2000	Polygon
Global_SDE/USCB_Tracts_2010	Polygon
Global_SDE/USCB_Urban_Areas_1990	Polygon
Global_SDE/USCB_Urban_Areas_2000	Polygon
Global_SDE/USCB_Urban_Areas_2010	Polygon
Global_SDE/USCB_US_State_Boundaries	Polygon

Global_SDE/USCB_Zip_Codes_2010	Polygon
Global_SDE/USDOT_Navigable_Waterway_Lines	Polyline
Global_SDE/USFWS_Wetlands_2009	Polygon
Global_SDE/USFWS_Wetlands_2010	Polygon
Global_SDE/USFWS_Wetlands_2011	Polygon
Global_SDE/USFWS_Wetlands_2012	Polygon
Global_SDE/USGS_15_Minute_Quad	Polygon
Global_SDE/USGS_24K_Quad	Polygon
GLOBAL_SDE/USGS_DEM_10M	Raster
Global_SDE/USGS_DOQQ_Grid	Polygon
Global_SDE/USGS_HUC_02_Regions	Polygon
Global_SDE/USGS_HUC_04_Subregions	Polygon
Global_SDE/USGS_HUC_06_Basins	Polygon
Global_SDE/USGS_HUC_08_Subbasins	Polygon
Global_SDE/USGS_HUC_10_Watersheds	Polygon
Global_SDE/USGS_HUC_12_Subwatersheds	Polygon
Global_SDE/USGS_Texas_HUC_02_Regions	Polygon
Global_SDE/USGS_Texas_HUC_04_Subregions	Polygon
Global_SDE/USGS_Texas_HUC_06_Basins	Polygon
Global_SDE/USGS_Texas_HUC_08_Subbasins	Polygon
Global_SDE/USGS_Texas_HUC_10_Watersheds	Polygon
Global_SDE/USGS_Texas_HUC_12_Subwatersheds	Polygon
GLOBAL_SDE/USGS_TEXAS_TERRAIN_COLOR_MAP	Raster
Global_SDE/Walker_County_Commissioner_Precincts	Polygon
Global_SDE/Waller_County_Commissioner_Precincts	Polygon
Global_SDE/Wharton_County_Commissioner_Precincts	Polygon
Global_SDE/World_Country_Boundaries	Polygon

C&E Non-Spatial Data

Ambient Surface Water Quality Monitoring
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

General Information		
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 7 H-GAC GIS Data and Mapping Applications