Water Quality Planning for the Houston-Galveston Region

FY 2018 Water Quality Management Plan Update

Funding for this project was provided by the Environmental Protection Agency through a Clean Water Act 604(b) grant to the Houston-Galveston Area Council, administered by the Texas Commission on Environmental Quality.

Houston-Galveston Area Council

TCEQ

EPA United States Environmental Protection Agency

(This Page Intentionally Blank)

Water Quality Management Plan Update

Fiscal Year 2018

PREPARED IN COOPERATON WITH THE
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY AND
U.S. ENVIRONMENTAL PROTECTION AGENCY

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement 48000054 to Texas Commission on Environmental Quality. The contents of this document do not necessarily reflect views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Prepared by the Houston-Galveston Area Council, in coordination with the Texas Commission on Environmental Quality. This project was funded under a Clean Water Act Section 604(b) grant; TCEQ contract number 582-18-80218.

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

For further information, please contact:

Brian Sims
Senior Planner
Houston-Galveston Area Council
713-993-2438
brian.sims@h-gac.com

(This Page Intentionally Blank)

Table of Contents

Contents

Figures

Tables

Acronyms

30 TAC §285	Title 30 Texas Administrative Code, Chapter 285
ARRA	American Recovery and Reinvestment Act
BIG	Bacteria Implementation Group
BMP	Best Management Practice
CCN	Certificate of Convenience and Necessity
CFU	Colony Forming Unit
CRP	Clean Rivers Program
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DMR	Discharge Monitoring Report
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
FOG	Fats, Oils, and Grease
FWSD	Fresh Water Supply District
FY	Fiscal Year
GBEP	Galveston Bay Estuary Program
GIS	Geographic Information System(s)
GPS	Global Positioning System
H-GAC	Houston-Galveston Area Council
INI	Inflow & Infiltration
IR	*Texas Integrated Report of Surface Water Quality*
MGD	Millions of Gallons per Day
mL	milliliter
MPN	Most Probable Number
MUD	Municipal Utility District
NPS	Nonpoint Source
NRAC	Natural Resources Advisory Committee
OLD	Outfall Location Data Set
OSSF	On-Site Sewage Facility
PCB	Polychlorinated Biphenyl
PCR	Primary Contact Recreation
PER	Preliminary Environment Report
PUC	Public Utility Commission of Texas
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
R12	Region 12
SAB	Service Area Boundary
SABD	Service Area Boundary Data Set
SEP	Supplemental Environmental Project(s)
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflow
SSOI	Sanitary Sewer Overflow Initiative
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load

TPDES	Texas Pollutant Discharge Elimination System
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWDB	Texas Water Development Board
WCID	Water Control and Improvement District
WISE	Water Innovation Strategies of Excellence
WQMP	Water Quality Management Plan
WPP	Watershed Protection Plan
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant

Executive Summary

The *Water Quality Management Plan* (WQMP) *Update* describes a series of data collection, special study, and coordination activities completed by the Houston-Galveston Area Council (H-GAC) in cooperation with the Texas Commission on Environmental Quality (TCEQ). The purpose of these activities is to provide data and analysis regarding wastewater infrastructure, watershed planning, and sources of nonpoint source (NPS) pollution that impact water quality in the Houston-Galveston region. Data acquired and generated under this project are used to inform decisions in numerous watershed projects and programs.

PROJECT FUNDING

This report was prepared by the Houston-Galveston Area Council under a Clean Water Act §604(b) grant from the Texas Commission on Environmental Quality (TCEQ Contract Number 582-18-80218). This project has been funded wholly or in part by the United States Environmental Protection Agency (EPA) under assistance agreement 48000054 to the TCEQ.

PROJECT BACKGROUND

The 13-county Houston-Galveston area region is rapidly growing, with the population expected to increase by an additional 3.5 to 4 million people over the next 30 years. This increase in population will continue to greatly impact the region's water resources and wastewater infrastructure. To better understand the region's complex water quality issues, it is necessary to have up-to-date information available from which wastewater utilities, water quality managers, and locally-led water quality projects can make informed decisions. The *Water Quality Management Plan Update*, in conjunction with other initiatives, aids in the collection of the most current water and wastewater information needed to provide those decision makers with the ability to plan for their current and future needs.

The Clean Water Act requires that WQMPs be updated as needed to fill information gaps and to revise earlier plans. The WQMP Update is prepared annually by H-GAC project staff as a deliverable under the 604(b) contract with TCEQ. The WQMP Update is submitted to TCEQ and H-GAC's Natural Resources Advisory Committee (NRAC) for review and comment. Comments are received and addressed, and the NRAC takes action to recommend to the H-GAC Board of Directors that the report be accepted. Once accepted by the H-GAC Board of Directors, the Final Report is submitted to TCEQ. Upon certification by the TCEQ and approval by EPA, the update will be incorporated into the State's Water Quality Management Plan.

PROJECT OBJECTIVES

In developing the *Water Quality Management Plan Update*, the H-GAC collects and evaluates pertinent water and wastewater information from numerous sources through a series of

related project objectives. As defined in the Project Work Plan, the objectives for this project include:

- **Project Administration** – Coordination and monitoring of all technical and financial activities performed under the contract, including preparation of regular progress reports.

- **Quality Assurance** – Development and updating of Quality Assurance Project Plans for tasks conducted under the contract that are consistent with U.S. Environmental Protection Agency requirements to ensure environmental data acquired is of known and acceptable quality.

- **Wastewater Data Update and Coordination/Geographic Information System (GIS)** – To collect and integrate wastewater infrastructure and permit data to support planning for wastewater treatment plants and water quality projects, and to support TCEQ in their WQMP update process. Specific subtasks for this Objective include:
  - Wastewater Treatment Facility (WWTF) Permitted Outfalls GIS Layer
  - WWTF Service Area Boundaries GIS Layer
  - Discharge Monitoring Report (DMR) Analyses[1]
  - Sanitary Sewer Overflow (SSO) Analyses
  - Clean Water State Revolving Fund (CWSRF) Project Review

- **Supporting Watershed Planning** – To support watershed planning and to support regional information sharing on water quality and related topics.

- **On-Site Sewage Facility (OSSF) Database Update** – To maintain and continue to develop an existing spatial database of permitted OSSFs and projected unpermitted OSSF locations to support regional water quality and wastewater infrastructure projects.

- **WQMP Update/Final Report** – To provide TCEQ with a comprehensive report on water quality management planning activities that summarizes all contract activities and findings that are relevant to the water quality goals of the region.

Data acquired from these project objectives are used to develop the *Water Quality Management Plan Update* final report[2]. Quality-assured data acquired and generated through these efforts are used extensively in other evaluations and water quality projects, such as the Clean Rivers Program, the Bacteria Implementation Group (BIG), and various Total Maximum Daily Load (TMDL) and Watershed Protection Plan (WPP) projects. Data is also made available to project partners and H-GAC member entities for use in their water quality planning activities.

[1] The DMR analysis and SSO analysis are combined to form Appendix B of this WQMP Update report.

[2] Due to size and length considerations, some documents or deliverables, such as GIS layers, are provided in digital format (Appendix A). Task 1 (Project Administration) and Task 6 (Final Report) are administrative in nature and are not discussed in detail in this report.

Through this process, H-GAC is able to achieve vertical integration between base data sources, internal analysis, planning efforts, and external coordination (Figure 1).

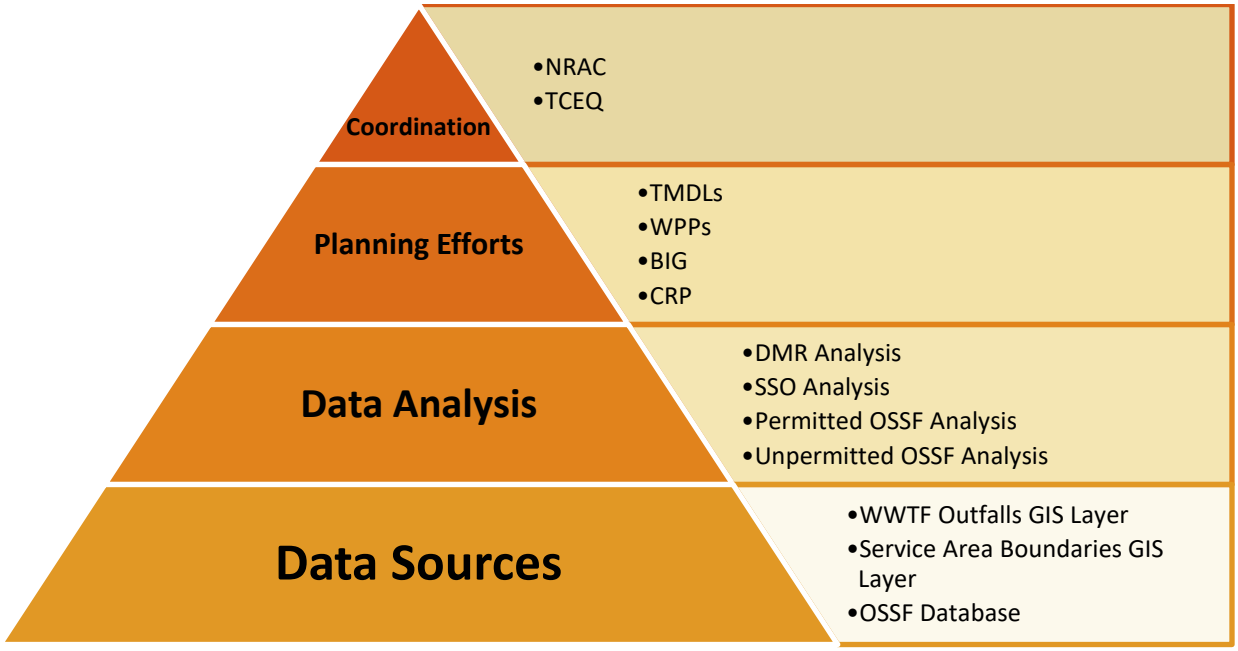

Figure 1 - Vertical integration of data, analysis, planning, and coordination

PROJECT OUTCOMES

Ongoing project efforts for the FY 2018 WQMP Update were to:

- Acquire, evaluate, and update the wastewater infrastructure data sets, including the WWTF outfall data and associated service area boundaries;
- Analyze and summarize self-reported DMR and SSO data for the region;
- Acquire and analyze spatial data sets of OSSFs within the region; and
- Coordination of local watershed planning

Additionally, H-GAC worked to facilitate planning for the San Bernard River watershed as part of a short-term/special project effort.

Key outcomes and findings for each objective are discussed below.

Quality Assurance

For all data collection efforts required for this project, H-GAC worked closely with TCEQ to develop and approve appropriate Quality Assurance Project Plan (QAPP)

documentation. During the FY 2018 WQMP Project, the *Regional Water Quality Data Acquisition and Compilation QAPP* and the *Regional Geospatial Data QAPP* were updated and amended. Both QAPPs were also recertified, as is required annually for the project.

Wastewater Data Update and Coordination

Using processes established by the project's QAPPs, H-GAC staff acquired, compiled, and provided analyses on permitted wastewater outfall locations, service area boundaries, discharge monitoring reports, and sanitary sewer overflows. This data was combined with existing TCEQ data into a series of integrated data sets to allow for meaningful evaluation of infrastructure and water quality decisions.

Wastewater Infrastructure GIS Data

The WWTF outfall locations GIS data set identifies the location of wastewater effluent discharges within the region. The service area boundary data set is the spatial representation of the area served by each permitted wastewater discharger. A major component of the annual WQMP Update is to match outfalls with their corresponding service area boundaries. These integrated data sets are then provided to TCEQ.

The FY 2018 outfall data set contained 1,633 total outfalls, of which 1,544 are current. This is a net increase of 33 outfalls from 2017. During the process of matching service area boundaries, 338 permits were identified that did not have an associated service area boundary. Many of these were matched based upon Certificates of Need and Necessity and other data sources. One of the primary findings from this portion of the project was the identification of approximately 100 small private systems that lack appropriate service area boundaries in the data set. A goal of future projects will be to acquire or develop this information and close this data gap.

DMR Analysis

Self-reported Discharge Monitoring Report data was acquired from TCEQ and EPA. H-GAC evaluated the bacteria data from the DMRs. The primary focus for this objective was to evaluate the occurrences of single grab and geometric mean bacteria violations reported in the region. Key findings of the DMR analysis are as follows:

- Compliance with bacteria permit limits is very high for both daily maximum and geometric mean results.
- Smaller plants, such as those with variable flow or in the <0.1 – 0.5 million gallons per day (MGD) category, typically have higher bacteria

geometric means. However, their total bacteria loading is lower than other categories due to the smaller overall flow volume.

- WWTFs in the >10 MGD category have the largest *E. coli* loading per facility, due to their large discharge volume. However, because of the small number of plants, their total loading contribution is in the midrange of the other categories.

- WWTFs in the 1 – 5 MGD category show the largest overall bacteria contribution to receiving waters, due to the large number of facilities, comprising approximately 22% of the total number of plants submitting self-reported bacteria DMR data.

While upsets and disruptions can occur and cause acute issues, WWTF effluent discharges do not appear to be the primary contributor to chronic bacteria issues in the region. Although WWTFs are contributing bacteria to the receiving waters, because of the high permit compliance, DMR data suggests they are typically discharging effluent with bacteria densities below the primary contact recreation standard. However, it must be noted that DMR results do not take into account such issues as bacterial regrowth in the outfall pipe, and therefore, the contribution may be underestimated.

SSO Analysis

For this Project, H-GAC staff evaluated the occurrence of self-reported sanitary sewer overflows in the region for the period of 2011 – 2017. Key findings are as follows:

- SSOs represent a high potential risk for bacterial contamination due to their elevated bacterial concentrations (as compared to treated wastewater effluent). However, SSOs are generally episodic in nature, with relatively minor volumes.

- Based upon the reported data, around 77% of SSOs were caused by blockages. These includes blockages by roots/rags/debris, fats/oils/grease, or other types.

- Although blockages were the primary cause of SSOs, the largest volume of SSOs in the past year were related to hurricanes, rain, and inflow/infiltration, with an estimated total volume of approximately 13.5 million gallons, compared to 2.8 million gallons for SSOs caused by blockages.

CWSRF Application Review

In support of responsible use of grant funding for infrastructure improvements, H-GAC reviewed and provided recommendations on Clean Water State Revolving Fund (CWSRF) and other state and federal grant project applications as needed. H-GAC reviewed the grant application and associated documentation for concurrence with broad regional planning goals. These reviews help to assure that regional goals such as improving water quality and protecting waterways are represented in project funding decisions at a variety of governmental levels. For the FY 2018 WQMP contract period, H-GAC reviewed and provided comments on six CWSRF project applications.

Supporting Watershed Planning

As part of H-GAC's continued support of watershed planning in the region as a tool for responsible decision-making, project staff continued to facilitate the ongoing planning and implementation efforts associated with the San Bernard River Watershed Protection Plan. Additionally, H-GAC fostered regional coordination through facilitation of the Natural Resources Advisory Committee. In conjunction with these specific efforts, H-GAC also promoted and supported watershed planning efforts with local stakeholders and partners.

OSSF Database Update

Through the WQMP project, H-GAC continued to maintain and update its current database of on-site sewage facility locations and related data. The intent of the existing OSSF database is to provide a comprehensive, spatially-explicit inventory for all permitted OSSF locations throughout the region.

For the FY 2018 WQMP Update, H-GAC added 3,842 new records to the OSSF Permits Database. This update, which incorporated available data through March 2018, brought the total number of permitted OSSFs in the database to 96,268.

CONCLUSIONS AND RECOMMENDATIONS

This year's project successfully built upon progress made in previous years. The completed deliverables and integrated datasets from this project provide a solid base for a number of regional efforts and watershed-based plans.

A primary focus of the FY 2018 WQMP Update was identifying and starting the resolution process for small, private domestic systems whose current boundaries are not complete or are suspected to be incorrect. The data analysis and investigations completed under this project will move forward H-GAC's efforts to address this data gap, with completion of the bulk of the targeted service area boundaries early in the FY 2019 Project year.

Evaluation of self-reported Discharge Monitoring Report data suggests that under normal conditions, WWTFs are likely not a primary source of the chronic bacteria impairments found in

numerous waterways in the region. However, because data related to bacterial regrowth was not analyzed as part of this project, the bacterial contribution from WWTFs may be underestimated. Currently, analysis activities focus exclusively on bacteria impairments. In future iterations of the project, it may be beneficial to analyze nutrient parameters as well, such as ammonia-nitrogen, nitrate-nitrogen, and total phosphorus, where DMR data exists to support such analysis.

In addition to the DMR analysis, sanitary sewer overflows were analyzed to determine their contribution to bacteria levels. Due to their elevated levels of bacteria, SSOs have a high potential risk. However, this risk is somewhat lessened since most SSOs are of short duration and limited flow, which minimizes the volume of discharge. Data indicates that only 25 – 30% of domestic WWTFs in the region are self-reporting SSOs on a regular basis. Whether this is due to a lack of SSOs or a lack of reporting has not been determined. However, it would be beneficial to encourage systems, particularly smaller systems with limited staffing, to develop a process for reporting SSOs or to enter TCEQ's Sanitary Sewer Overflow Initiative (SSOI) program.

H-GAC's database of permitted OSSFs is a valuable resource that provides useful data to numerous watershed-based projects. To gain a better understanding of the role that failing OSSFs may play in water quality issues in the region, it is crucial that better estimates of unpermitted OSSFs be developed. While parcel data has been extremely useful in identifying potential locations of unpermitted OSSFs, H-GAC will attempt to refine the process in future project years by utilizing 911 address data.

Steady interest and participation in H-GAC's visual OSSF inspection course for real estate inspectors and homeowners has indicated that this is a valued program and should be continued as an educational and public outreach tool.

Significant contributions into H-GAC's Supplemental Environmental Project (SEP) for OSSFs during this project term have initiated potential partnerships with regional entities to implement OSSF improvement projects. Contributions into the SEP are expected to continue. With this increased traction, the support of administration and coordination of the SEP would be a valuable addition to the WQMP Update project.

(This Page Intentionally Blank)

Introduction

The *Water Quality Management Plan* (WQMP) *Update* is a report from the Houston-Galveston Area Council (H-GAC) on the fiscal year (FY) 2018 activities conducted under Contract 582-18-80218 (Project), with funding through a Clean Water Act (CWA) § 604(b) grant by the Texas Commission on Environmental Quality (TCEQ). The Project involved acquiring, compiling, and evaluating water and wastewater data, as well as a series of special studies and coordination activities. The purpose of this Project is to support current and future planning decisions related to water quality efforts, development of wastewater infrastructure, watershed management coastal nonpoint source management, and related issues on both a regional and state level.

Within the 13-county Houston-Galveston Area Region (Region), there are a variety of water quality impairments and concerns. Many of our local water bodies fail to meet the water quality standards as defined in the *Texas Surface Water Quality Standards* (TSWQS). As such, many of those water bodies are listed with impairments or concerns in the most recent *Texas Integrated Report of Surface Water Quality* (IR). Elevated levels of bacterial contamination are widespread and of particular interest in the Region.

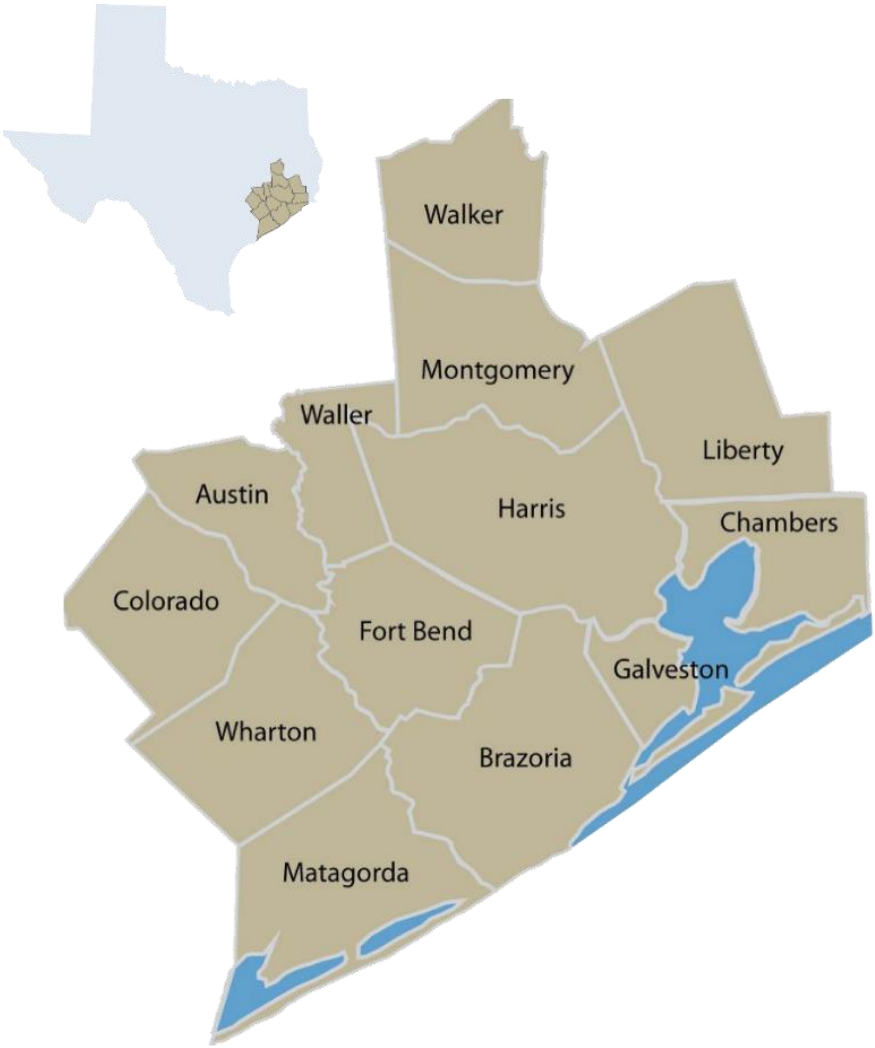

Figure 2 - Houston-Galveston Area Region

Numerous developmental challenges exist as well. As the population in the region has expanded and spread into less urban areas, there has been a proliferation of smaller-sized wastewater treatment facilities (WWTFs) and a diffuse network of infrastructure to provide

utility service to this population. The population is expected to continue to rapidly grow in the coming decades, and the ability to make informed decisions regarding water quality and wastewater infrastructure development will be crucial in planning for the Region's future.

The **Project Background and Significance** section of this document discusses the purposes of the Project and the six Project Objectives (see below). This report serves to advance these purposes through a series of specific studies and the maintenance of regional data sets for local use, as well as in support of the state's WQMP.

The Project is divided into six major Tasks or Objectives[3] (Table 1).

Table 1 – Project Objectives	
Objective 1	Project Administration
Objective 2	Quality Assurance
Objective 3	Wastewater Data Update and Coordination – Geographic Information System (GIS)
Objective 4	Support Watershed Planning
Objective 5	OSSF Database Update
Objective 6	Water Quality Management Plan Update / Final Report

Each of the primary project objectives serves to maintain, expand, or implement H-GAC's store of water quality and wastewater infrastructure data, or provide related services to the Region. Each objective is explained in further detail in the **Project Studies and Coordination Activities** section of the report.

A series of interim deliverables were required for each project objective. The **Methods** section of this report provides a description of the methodologies used to complete these contractual deliverables. Some of the deliverables generated for this project are large electronic data sets, which are unsuitable for full inclusion in a printed version of the final report. However, copies of the full electronic data are available[4], with representative portions of the data included in the actual report. The analyses of self-reported Discharge Monitoring Report data and Sanitary Sewer Overflow data comprise a second report, which is included as an appendix to the WQMP Update.

The **Results and Observations** section of the report provides a discussion of all Project outcomes. The **Discussion** and **Summary** sections discuss the information gathered, the analysis

[3] Objective 1 (Project Administration) and Objective 6 (Water Quality Management Plan Update / Final Report) are not specifically reported on in this document, as they relate only to the maintenance of the contract and the development of this document.
[4] Copies of these electronic data are contained within the media that accompanies this report, and have been provided under separate cover.

performed, and the tasks implemented under this Project. The **Appendices** provide additional information and standalone reports that were completed for some deliverables.

Figure 3 - Freshwater marsh at Mason Park on Brays Bayou

Project Background and Significance

Background

Already one of the largest metropolitan statistical areas in the United States, the Houston region continues to grow at a rapid pace. Development, and its accompanying infrastructure and pollution challenges, continues to expand into counties beyond the urban core. At the same time, existing water and wastewater infrastructure systems have continued to age and face challenges related to drought and flooding events. Hurricane Harvey, in particular, had a major impact on the area's wastewater infrastructure. With the Houston region expected to gain several million more residents by 2040, these challenges will only be exacerbated by future population growth.

The majority of the stream segments in the Houston area are listed as impaired on the State's list of impaired water bodies. Approximately 80% of the Region's streams are unable to meet one or more state water quality standards. The most pervasive issue is elevated bacteria levels exceeding the water quality standard for primary contact recreation. Other development related issues like low dissolved oxygen, polychlorinated biphenyls (PCBs), and dioxins are also present in some water bodies.

Texas Integrated Report

The list of impaired water bodies is part of the State's Integrated Report of Surface Water Quality (for the Clean Water Act Sections 305[b] and 303[d]). The current (2014) report can be accessed online at

https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir

There are a variety of sources that contribute to the elevated bacteria levels in our creeks, streams, and bayous. These sources include human waste, domestic animal waste, pet waste, and wildlife. These wastes may enter the waterways through point sources (i.e., discrete "end of pipe" discharges) or diffusely through nonpoint sources (i.e., carried by precipitation flowing over the land). While some bacteria are naturally occurring, development brings with it additional bacteria sources and a greater potential to impact water quality. Careful planning is necessary to address these additional sources.

Much like the Houston-Galveston Area Region itself, the wastewater infrastructure that serves the Region's increasing population has developed and expanded. In many cases, this has led to a proliferation of smaller wastewater treatment facilities. This is partially due to the Region's flat topography, as larger centralized WWTFs would require a significant number of costly lift stations to consolidate flow. Due to the availability to fund infrastructure through political subdivisions like Municipal Utility Districts (MUDs) and other special districts, many areas of the Region have a wastewater treatment network that is relatively widespread and diffuse rather than limited by the bounds of a traditional, centralized model. Development through this model has created a patchwork of wastewater infrastructure, which offers both future challenges and

opportunities for local decision-makers. The accumulation and analysis of wastewater and effluent quality data can help inform regional solutions to these challenges.

In areas that are not served by a sanitary sewer collection system, which includes a sizable portion of the Region, wastewater is treated on-site rather than being collected and sent to a centralized wastewater treatment facility. These on-site sewage facilities (OSSFs) collect, treat, and disperse wastewater generated by a home or business. If an OSSF fails, it can contribute to groundwater or surface water contamination. An OSSF may fail for numerous reasons, including improper design, faulty construction, system overload, improper operation, mechanical failure, and a lack of system maintenance.

Under previous 604(b) projects, H-GAC has sought to address aspects of the information and data needs related to water quality issues that face the Region. These projects have typically been a mix of both ongoing efforts and short-term special studies. Some of the project efforts have been continuous, such as wastewater data collection and maintenance. Other efforts have been standalone research relating to specific data needs or questions, such as GIS analyses for infrastructure consolidation, Phase II stormwater permit implementation, etc. This balance of continuous and standalone efforts allows for the long-term accumulation of data while retaining flexibility to address specific issues.

Table 2 describes the ongoing and short-term/special project efforts for the FY 2018 Project.

Table 2 - 604(b) Project Efforts for FY 2018

Ongoing Project Efforts	Short-Term/Special Project Efforts
• Acquisition and analysis of regional wastewater infrastructure data • Acquisition and analysis of spatial data sets of OSSF locations • Coordination of local watershed protection planning • Development of annual WQMP Update	• Facilitating watershed planning efforts for the San Bernard River, a regional priority watershed

Significance

Contaminants do not adhere to political boundaries along waterways. From a regional perspective, the water quality and wastewater infrastructure decisions facing our local areas are more effectively considered on a watershed basis. This is particularly important for watersheds that serve as significant sources of drinking water, such as Lake Houston.

The H-GAC maintains a large store of relevant and accessible data in order to provide useful information, analysis, and viable recommendations. The data collection and analysis tasks completed under this Project have significant value for a variety of efforts in the Region. This work greatly benefits local watershed protection planning, wastewater infrastructure planning, and program development efforts.

The significance of the efforts undertaken in this Project is demonstrated by the variety of capacities in which the outcomes are used. Ways in which H-GAC utilizes these data include:

Internal Data Collection and Regional Data Sharing

The wastewater permit data, service area boundaries, and OSSF location data acquired and/or collected under this Project serve to augment existing data sets, inform project decisions on related efforts, and expand internal abilities of both the H-GAC and TCEQ to incorporate and produce future data and analyses. For example, this year's data were used by the Houston-area Bacteria Implementation Group (BIG) and Basins 11 and 13 Total Maximum Daily Load (TMDL) efforts; the Galveston Bay Estuary Program (GBEP), and others.

Regional Project Coordination

Maintaining and expanding data resources allows the H-GAC and TCEQ to better understand and facilitate regional efforts between parties involved in wastewater infrastructure decisions and general water quality/watershed protection efforts (WPP and TMDL efforts, etc.). Participation in regional groups and efforts helps ensure decisions benefit from Project resources and expand the reach of the Project's aims through partner efforts.

Source Water Protection

A large portion of the Region's population is served by treated surface water that originates in our local rivers and lakes. The infrastructure planning and watershed coordination activities of this Project help foster a greater understanding of the relationship between these issues and challenges for surface water drinking sources.

Project Review

Data and analyses allow H-GAC Project staff to assist state and federal granting agencies in review of regional grant applications. These reviews ensure that potential projects concur with regional priorities and regional data projections.

Education and Outreach

Data gathered under this Project have been used as a focal point or basis for several educational efforts, including the OSSF location database and various facilitated meetings, such as the ongoing Natural Resources Advisory Committee (NRAC).

Project Studies and Coordination Activities

This section details the background, process, and outcomes for the Objectives that comprise the components of this year's Project studies and coordination activities. Objectives 1 (Project Administration) and 6 (WQMP Update / Final Report) are administrative tasks and WQMP Update requirements, and therefore are not reported on in this document.

Objective 2 – Quality Assurance

This Objective includes tasks related to the maintenance and updating of two existing Quality Assurance Project Plans (QAPPs). A QAPP is a formal document that outlines the procedures that a project will use to ensure that the data collected and analyzed as part of that project are of known and adequate quality and meet specific project requirements. The two QAPPs for this project are:

1. *H-GAC Regional Water Quality Data Acquisition and Compilation QAPP*

   The purpose of this QAPP is to document how H-GAC acquires, reviews, and compiles data related to wastewater infrastructure and water quality in the Region. This QAPP clearly delineates H-GAC's Quality Assurance/Quality Control (QA/QC) policy, management structure, and procedures to implement the QA/QC requirements necessary to verify, calibrate, and validate the output of the modeling process associated with this Project. This QAPP is reviewed by the TCEQ to help ensure that the outputs and data generated for the Project purposes are scientifically valid and legally defensible.

2. *H-GAC Regional Geospatial Data QAPP*

   The objective of this ongoing QAPP is to document how H-GAC meets QA/QC objectives related to the update and maintenance of a regional OSSF database and a related analysis of potential unpermitted OSSF locations. This QAPP clearly delineates the process, procedure, and methodology used to acquire and map OSSF data as part of maintaining and expanding the existing OSSF database. This QAPP also ensures that data collected under the QAPP and submitted to TCEQ have been collected and managed in a way that guarantees its reliability and therefore can be used as deemed appropriate by the TCEQ.

Adherence to these QAPPs ensures that all data are collected and analyzed in a manner appropriate for the data objectives of the Project.

Task 2.1 – QAPP Planning Meeting

H-GAC and TCEQ staff formally discussed the QAPP needs for the Project as part of a Project kickoff conversation on 9/28/2017 after the initiation of the contract. The outcome of the meeting was a confirmation of the elements covered by each QAPP and a briefing for TCEQ

staff on the project background. Informal discussion regarding the maintenance and update of the QAPPs occurred continuously throughout the project term, including the annual certification of both QAPPs.

Task 2.2 – QAPP Annual Review Certification

QAPPs for this Project are reviewed annually in their entirety and certified by the H-GAC Project Manager and the TCEQ Nonpoint Source Project Manager. A letter certifying this review was submitted to TCEQ as documentation. Amendments to the QAPP since the last review were incorporated at this time. Only nonsubstantive changes not affecting the project design or quality or quantity of work to be performed can be included in the annual certification letter. Examples of nonsubstantive changes include organizational changes or schedule changes based on a contract amendment that do not impact data deliverables. If changes beyond those are necessary, a QAPP amendment must be submitted and approved before the changes are implemented and before the annual review may be certified.

An Annual Review Certification for the Data QAPP was approved by TCEQ on 4/13/2018. This Annual Review Certification (Year 3 of 3) approved the QAPP until 5/31/2019. This is the final year of the QAPP, and a new QAPP will need to be written and approved once it has expired.

An Annual Review Certification for the Geospatial QAPP was approved by TCEQ on 8/8/2017 and incorporated Expedited Amendment #1 into the QAPP. This extended the QAPP approval until 9/28/2018. Due to methodology and project management changes, a QAPP amendment (Expedited Amendment #2) was submitted in June 2018. An Annual Review Certification was also submitted on 7/2/2018, which will extend the QAPP approval until 9/28/2019.

Task 2.3 – QAPP Amendments

On occasion, amendments to the QAPP(s) may be necessary to reflect changes in project management, tasks, schedules, or objectives and methods. QAPP amendments may also be initiated to address deficiencies and non-conformances, improve operational efficiency, or accommodate unique or unanticipated circumstances.

H-GAC amended the Data and Geospatial QAPPs for content and for annual certification. QAPP amendments were minor, and related to personnel changes, updates to the H-GAC Data Management Plan, and Scope of Work changes. The revised versions were submitted and approved by TCEQ.

Objective 3 – Wastewater Data Update and Coordination / Geographic Information System (GIS)

This Objective includes tasks related to wastewater infrastructure data acquisition, data set updates, and State Revolving Fund (SRF) project proposal reviews.

This Project utilizes a series of data sets related to the Texas Pollutant Discharge Elimination System (TPDES) permitted wastewater infrastructure facilities in the Region. These are the **Service Area Boundaries Data Set (SABD)** and the **Outfall Locations Data Set (OLD)**. A primary task under this Project is to update and continue to integrate these data sources. To approach this task, H-GAC set out to address the following questions:

- Is there a corresponding service area boundary (SAB) for every domestic outfall?
- What is the difference between the 2017 and 2018 OLDs for current domestic permits?
- Are there any data errors that need to be reported to TCEQ?

Task 3.1 – Wastewater Infrastructure GIS Data

The SABD, maintained by H-GAC, is the spatial representation of the permitted domestic wastewater dischargers' service area boundaries. Typically, these boundaries includes municipalities, Municipal Utility Districts (MUDs), Water Control and Improvement Districts (WCIDs), Fresh Water Supply Districts (FWSDs), other public districts, and private utilities that serve an area greater than a single facility.

The wastewater outfall layer identifies the location of wastewater treatment facility outfalls for the Region. H-GAC staff requested and received an updated wastewater outfalls GIS data set from TCEQ on 5/2/2018.

H-GAC uses data from multiple sources (MUD records, EPA and TCEQ permit databases, etc.) to update the service area boundary and outfall layer data sets. H-GAC also utilized the Public Utility Commission of Texas' (PUC) Certificates of Convenience and Necessity (CCN) data set to match outfalls to service area boundaries. A CCN grants the holder the exclusive right to provide retail water and/or sewer utility service to a defined geographic area. If a CCN has been issued, it may serve as a proxy for the service area boundary, as the CCN holder is required to provide continuous and adequate service within its CCN boundary.

The data were checked for consistency across all outfalls of a single permit, and for consistency across all permits. It should be noted that while the service area boundaries are integrated for those WWTFs that have boundaries, a 1:1 ratio is not possible as boundaries do not exist for most industrial permits (which may serve a single parcel, and do not have traditional boundaries, but do have outfall locations).

Additionally, staff conducted an integration review after incorporating the most recent version of EPA and TCEQ data during this project period. As part of the review process, project staff compared the existing data set with the most current EPA and TCEQ data sets to identify and resolve any discrepancies.

Maps of the Service Area Boundaries (Figure 4) and Domestic Wastewater Outfalls (Figure 5) are included below. Updated data sets are included in digital format on the media accompanying this report.

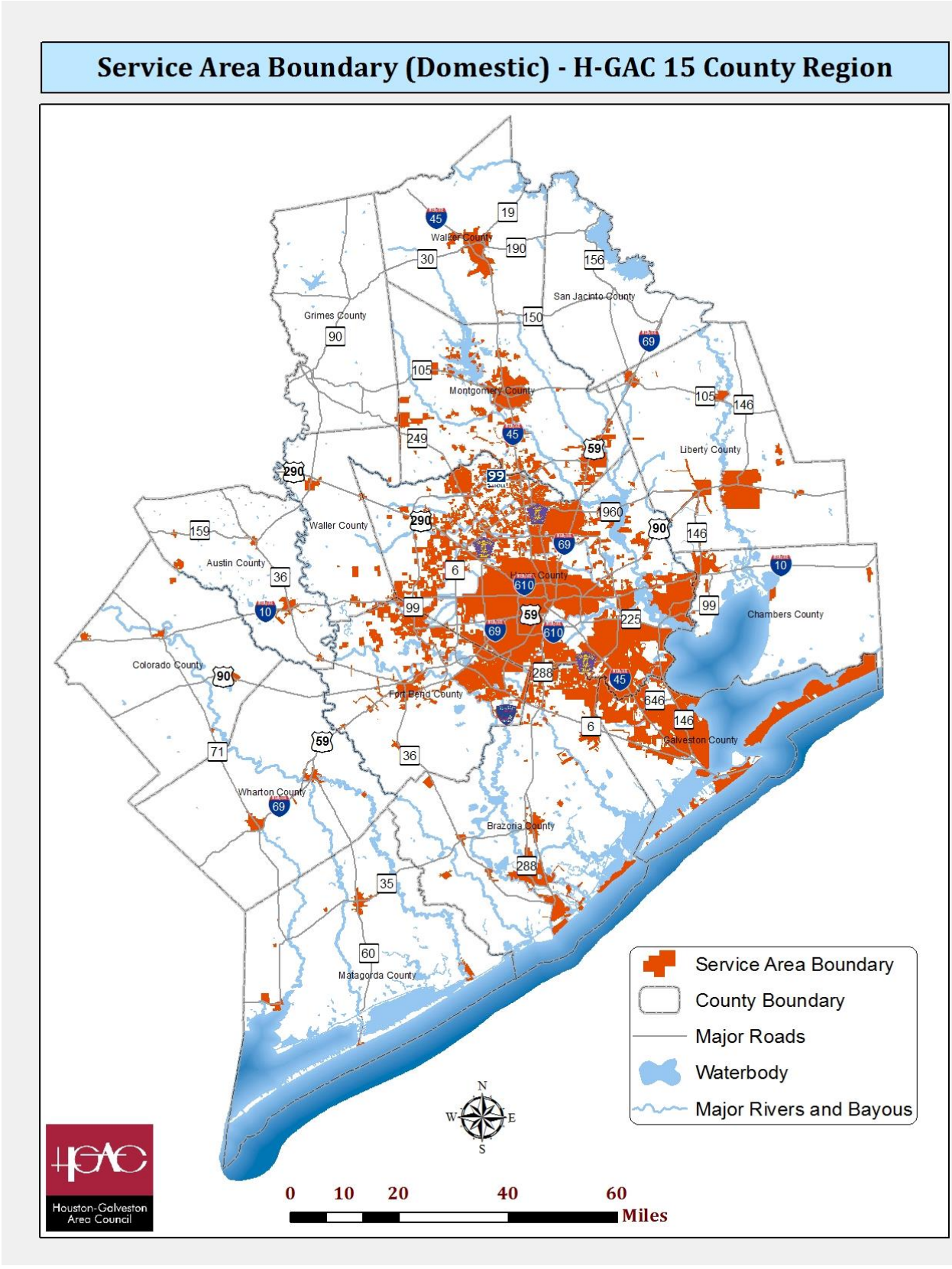

Figure 4 - Map of service area boundaries

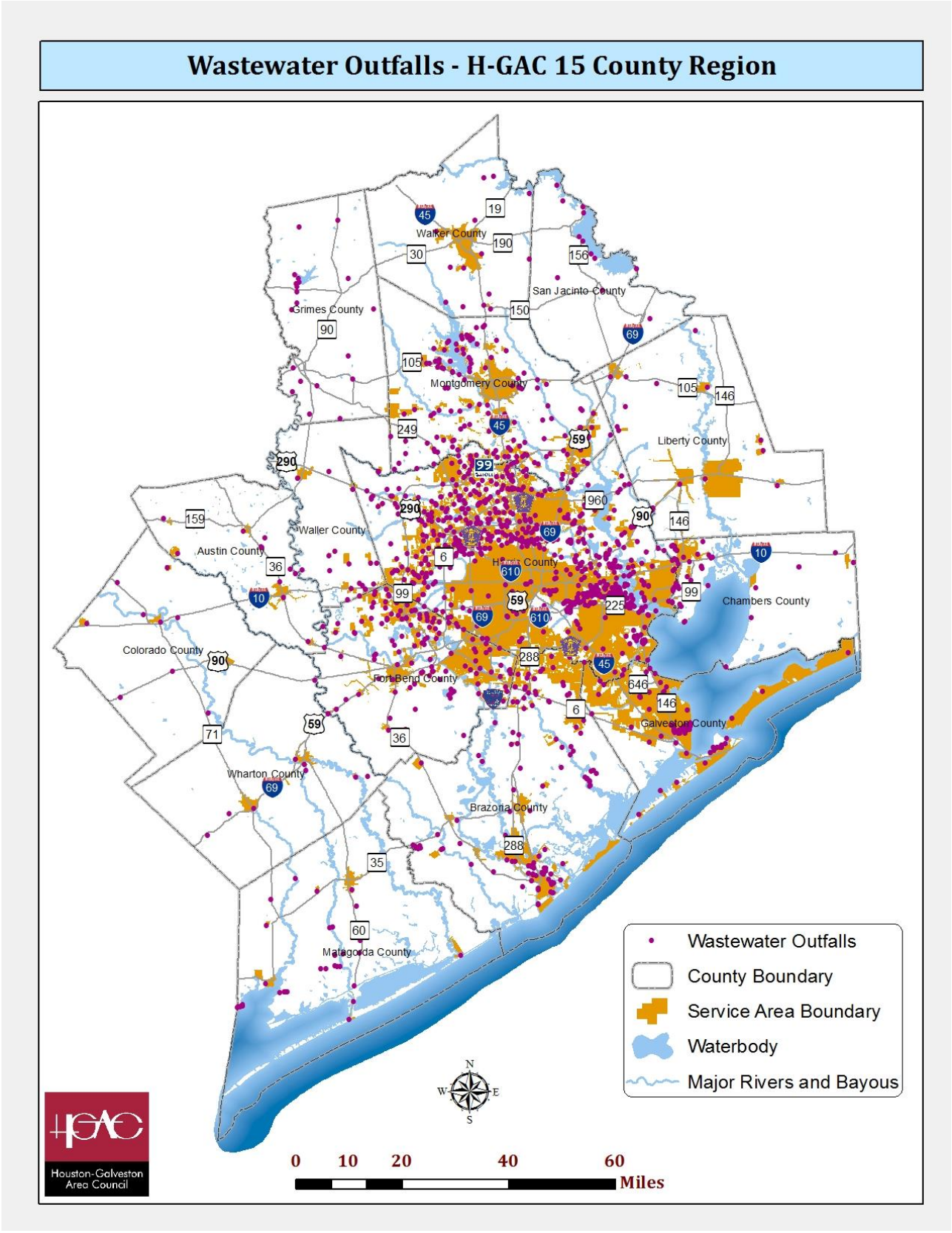

Figure 5 - Map of domestic wastewater outfalls and service area boundaries

Task 3.2 – Wastewater Data Analyses

In addition to the Service Area Boundaries and the Wastewater Outfall GIS layers, H-GAC also acquired self-reported DMR data for permitted facilities to evaluate bacteria permit limit exceedances for the period of 2012 to 2017. Additionally, self-reported SSO data from 2011 to 2017 were acquired and analyzed to locate areas with high or frequent SSO activity. The DMR and SSO data were acquired through TCEQ and EPA. Analyses for this task included:

- An evaluation of SSO events and estimated volume by cause for the region.
- Assessment of the frequency of DMR bacteria violations by WWTF plant size.

The analyses generated for this task are included in digital format on the media accompanying this report. A summary and discussion of analyses results is included as a separate report in Appendix B (*Summary Report – Regional DMR and SSO Data Analyses, FY 2018*).

As mentioned previously, the DMR and SSO data are self-reported by the permittee. Although there are known limitations and inherent uncertainty with self-reported data, these data are still the best available for the broad, regional evaluations conducted under this Water Quality Management Plan Update.

Task 3.3 – Clean Water State Revolving Fund Application Review

In conjunction with H-GAC's role as a regional planning group and the local council of governments for the Houston-Galveston area of the Upper Gulf Coast, staff regularly provides comments on grant proposals of varying types. These reviews help to assure that regional goals are represented in project funding decisions at a variety of governmental levels.

H-GAC reviews the grant application and associated engineering documentation, such as the Preliminary Engineering Report (PER), Environmental Review, population projections, etc., and for concurrence with broad regional planning priorities and goals (such as improving water quality, protecting waterways, reducing bacteria or nutrient loading, etc.).

During this review process, H-GAC staff looked for:

- Population projections that matched TWDB, H-GAC, or other relevant forecasts,
- Alternatives that may impact water quality considerations,
- Concurrence with regional priorities and goals (water quality impacts, etc.).

As part of this Project, H-GAC staff used data gathered under this and previous projects to provide comments on six CWSRF projects. The outcomes of the reviews are shown in Table 3.

Table 3 - FY 2018 CWSRF Projects Reviewed by H-GAC				
Granting Agency	**Project ID#**	**Requesting Entity**	**Project Summary**	**Findings**
TWDB CWSRF	73764	San Jacinto River Authority	Replacement of a wastewater treatment facility sludge dewatering building, aeration basin, and gravity main rehabilitation	Concurs with regional water quality management goals
TWDB CWSRF	73766	Sienna Plantation Municipal Utility District No. 1	Replacement of three interim wastewater treatment plants with a permanent, regionalized plant and transmission infrastructure	Concurs with regional water quality management goals
TWDB CWSRF	73770	Cypress Creek Utility District	Extensive rehabilitation of the District's aging sanitary sewer system and related infrastructure	Concurs with regional water quality management goals
TWDB CWSRF	73787	Sunbelt Fresh Water Supply District	Replacement of existing smaller plant with a new, expandable plant able to serve a greater volume	Concurs with regional water quality management goals
TWDB CWSRF	73797	Brookshire Municipal Water District	Emergency collections system repairs of failing pipes, manholes, and related infrastructure, primarily due to Hurricane Harvey impacts	Concurs with regional water quality management goals
TWDB CWSRF	78731	North Fort Bend Water Authority	Establish a reclaimed water system to distribute Type 1 effluent for irrigation and amenity lake level management	Concurs with regional water quality management goals (with comments)

Objective 4 – Support Watershed Planning

Task 4.1 – San Bernard River Watershed Coordination

H-GAC has established a WPP effort in the San Bernard River Watershed through previous American Recovery and Reinvestment Act (ARRA)/319(h) grants from the TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB). During this project, staff worked to maintain an active and engaged stakeholder base. H-GAC staff gave a project update through presentations at a key partner meeting and through outreach at local events. Additionally, H-GAC coordinated efforts and communication with stakeholders engaged in reopening the mouth of the San Bernard River (a priority concern for the project stakeholders). Speaking engagements, events, and efforts related to this subtask are summarized in Table 4.

The San Bernard River WPP was given final EPA approval in July of 2017. H-GAC is actively looking for funding opportunities to support WPP implementation.

Table 4 – San Bernard River Stakeholder Events		
Date	**Event**	**Participation**
Various	NRAC	H-GAC gave periodic brief updates to the NRAC on the status of the project
Various	GBEP	H-GAC provided San Bernard updates as part of project updates at the GBEP Water and Sediment Quality subcommittee meetings.
Various	OSSF Supplemental Environmental Project (SEP) Program	In conjunction with other projects, H-GAC continued to administer and implement an OSSF SEP program, including devising bilingual materials for dissemination in the San Bernard and other priority watersheds.
2/6/2018	Ranger Program	H-GAC provided outreach materials (Trash Bash brochure, water quality brochures, etc.) for a Friends of the River Ranger Program for school children.
2/10/2018	Annual Stakeholders meeting	H-GAC presented on the WPP and implementation efforts at an annual meeting of stakeholders and local officials hosted by the Friends of the River San Bernard.
3/3/2018	OSSF Workshop	H-GAC discussed and provided outreach support for an OSSF workshop held by the Friends of the River San Bernard.
6/8/2018	World Oceans Day	H-GAC maintained a booth at the nature-oriented festival representing H-GAC water quality projects, including the San Bernard WPP.
6/23/2018	Brazoria County Hurricane Preparedness Expo	H-GAC provided water quality and water safety information for an area including parts of the watershed.

Figure 6 - San Bernard River Annual Stakeholders Meeting, 2/10/2018

Task 4.2 – Coordination

As an extension of H-GAC's role as a coordinator of regional planning efforts in a variety of fields, project staff members develop and maintain relationships with other local and state governments, community groups, and other organizations involved in efforts related to the aims of this Project.

Staff members facilitate the H-GAC's Natural Resources Advisory Committee (NRAC), which provides policy recommendations for the H-GAC's Board of Directors, and serves as a regional roundtable for coordinating environmental efforts. The NRAC provides an efficient communication network and point of contact for H-GAC staff with other local and regional water quality decision makers. Four meetings were held during the Project term. Topics discussed at these meetings are detailed in the Table below.

Table 5 – Natural Resources Advisory Committee (NRAC) Meetings, FY 2018

Date	Topics Discussed

11/2/2017	• Environmental Program Highlights
	  ○ H-GAC Flood Information Mapping Application
	• Water quality monitoring and recovery efforts after Hurricane Harvey
	  ○ City of Houston post-Harvey water quality monitoring efforts and results
	  ○ Galveston Bay Foundation monitoring, debris cleanup, and wildlife assessment projects in the wake of the hurricane
	  ○ Pre- and post-Harvey salinity and phytoplankton community assessment data

2/1/2018	• Environmental Program Highlights ○ Updates on the West Fork WPP, Clean Rivers Program (CRP), and the Houston Area Urban Forests project • Galveston Bay Plan revision update • Recommendations for the FY 2019 604b Water Quality Management Plan scope of work

5/3/2018	• Environmental Program Highlights
	  ○ Updates on the West Fork WPP, CRP Basin Highlights Report and Coordinated Monitoring activities, Trash Bash, and the OSSF SEP program
	• *Water Innovation Strategies of Excellence (WISE) Awards* update
	• Environmental Opportunities beyond water quality
	  ○ Coalition for Environment, Equity and Resilience
	  ○ Regional Transportation Plan and the consideration of environmental factors in the plan

8/2/2018	• Environmental Program Highlights ○ Updates on the West Fork WPP, CRP, and the OSSF SEP program • Water Quality Management Plan Update • Resilience

The NRAC is currently in the process of developing an awards program to recognize projects and programs in the region that help improve water quality conditions through innovative water infrastructure projects and improvements. These awards, the *Water Innovation Strategies of Excellence* (*WISE*) *Awards* (Figure 7), will honor projects related to planning and policy, education and public awareness, and infrastructure. It is anticipated that the application period for the awards program will open on October 1, 2018, with an awards ceremony to be held the following Spring or Summer.

Figure 7 - Draft logo for the WISE Awards

Based upon recent discussions, the NRAC leadership would like to establish work groups as needed to discuss specific projects, efforts, and/or provide comments to other entities. NRAC would like to focus on data collection, development of White Papers, and support of Best Management Practices (BMPs). NRAC leadership have expressed a desire to work more closely and frequently with other H-GAC groups and subcommittees, and are committed to continue to be a source for regional environmental data and discussion. Additionally, NRAC would like to provide an opportunity for involvement for underrepresented user groups, such as fishermen, kayakers, hunters, etc. Finally, the NRAC leadership would like to explore the creation of an Annual Report (beyond the *Water Quality Management Plan Update*).

H-GAC Project staff members also routinely attend meetings of, or otherwise support, a variety of other organizations involved in water quality efforts. During this Project term, staff helped coordinate activities with a wide variety of organizations. Examples of these groups that staff worked with this year includes:

- Coordination with the Clean Rivers Program on the development of the Basin Highlights Report

- Promotion of OSSF data collection efforts related to Objective 5

- Participation in, and presentation at, the Harris County OSSF workshop
- Participation with the Texas Watershed Coordinator's Roundtable
- The Galveston Bay Estuary Program - Subcommittee memberships (Water and Sediment and Monitoring and Research) and leadership (Justin Bower is Vice-Chair of the Water and Sediment Subcommittee)
- Attendance at city council meetings
- A variety of interactions with state and local policy and regulatory efforts (including coordination with ongoing TMDL, WPP, and other efforts). Noteworthy projects include:
  - Bacteria Implementation Group (BIG), East and West Forks of the San Jacinto River, San-Jacinto-Brazos Coastal Basin, Brazos-Colorado Coastal Basin, and Upper Oyster Creek TMDL Implementation Plans
  - West Fork Watersheds, Cedar Bayou, Bastrop Bayou, and San Bernard River Watershed Protection Plans
  - BIG's Top Five Most and Top Five Least Impaired Water Bodies Project

In addition to facilitating regional communication, coordination, and cooperation on water quality efforts through staff presence and participation, H-GAC also uses the data generated under this Project to support various internal and external project needs.

Objective 5 – OSSF Database Update

On-Site Sewage Facilities are a widespread wastewater treatment technology in the Region, especially in the developing counties on the Region's borders. OSSFs are relied upon for the treatment and disposal of wastewater in areas not conducive to centralized sanitary service, but can be appreciable sources of contamination if they are not properly maintained and functioning. Annually, thousands of additional OSSFs are designed, sited, installed, and permitted within the Region, especially in the rapidly developing unincorporated areas of northern Harris and Montgomery Counties, as well as the rural counties that reside along the Region's outer boundary. While new systems are subject to permit requirements as specified in Title 30 Texas Administrative Code Chapter 285 (30 TAC §285), systems installed before 1989 did not require a permit. These older systems may be grandfathered, and specific locations may be unknown. H-GAC estimates that there are over 300,000 OSSFs within the region, with only approximately one-third of them being permitted systems installed after 1989.

TCEQ has authority over regulating and permitting OSSFs in Texas. In many cases, this authority is delegated by TCEQ to Authorized Agents (counties, municipalities, river authorities, and other responsible entities). As there is no centralized repository for OSSF permitting data, the Authorized Agents have traditionally maintained these data in a variety of formats. To ensure a regional, uniform set of data for use by Authorized Agents and water quality planning efforts,

H-GAC developed a comprehensive inventory of permitted system locations and likely unpermitted system locations under previous grant contracts[5]. During the FY 2018 Project, new data provided by the Authorized Agents were added to the OSSF permit database.

Task 5.1 – Permitted OSSF Update

The intent of the existing OSSF database is to provide a comprehensive, spatially-explicit inventory for all permitted OSSF locations throughout the region. No such inventory existed prior to the initiation of H-GAC's initial database development. The initial work had collected existing location data for permitted OSSFs and developed a program under which participating Authorized Agents would submit new system data on a regular basis, including spatial locations using Global Positioning System (GPS) units provided by H-GAC[6]. This information is updated regularly and is available to the public though the OSSF Information System (Figure 8) found on H-GAC's website. This interactive OSSF mapping tool allows the user to view the locations of permitted OSSFs by age, Authorized Agent or permitting authority, number of permits per square mile, and likely locations for old or unpermitted OSSF.

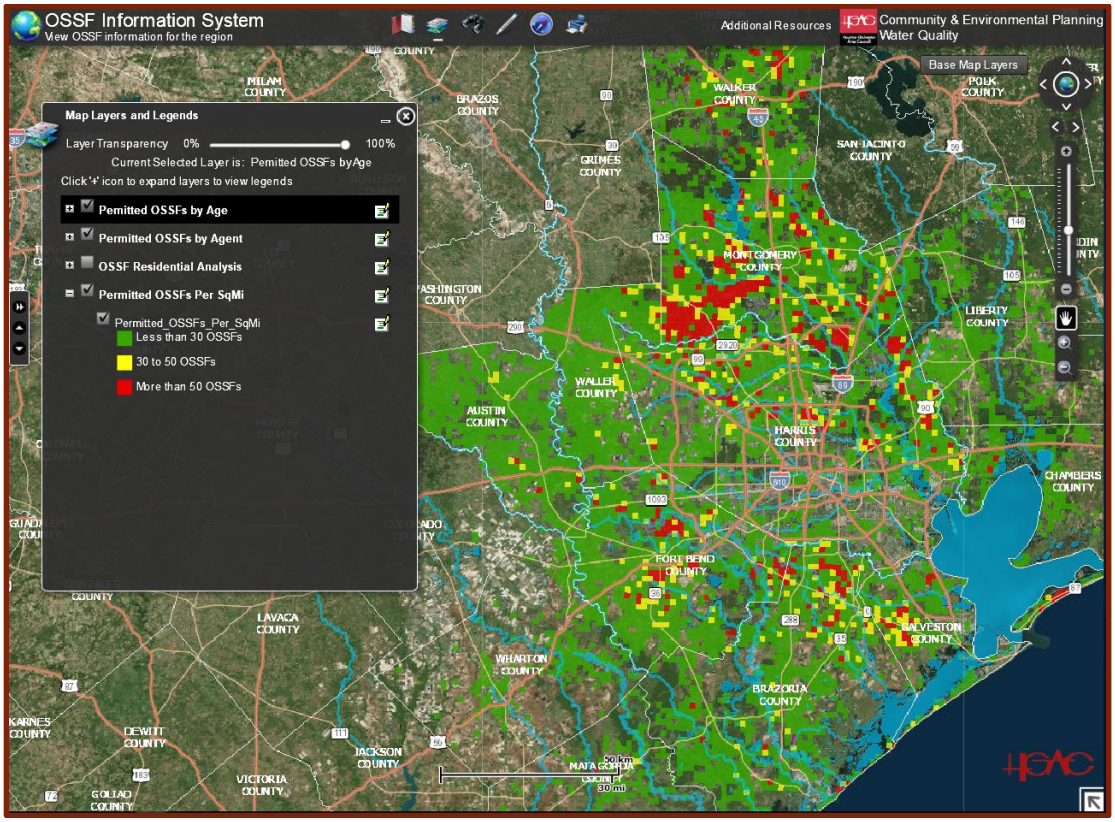

Figure 8 - H-GAC's OSSF Information System

[5] The effort was initiated in an ARRA grant (Federal ID #96690301), and continued in previous years' 604(b) projects.
[6] Further information about the development of the database, the methodologies employed, and previous efforts can be found in the FY 2012-FY 2017 604(b) Final Reports and the Geospatial QAPP.

H-GAC's partners have been very responsive with data submittals. Records submitted by Brazoria County, Chambers County, Fort Bend County, Galveston County, Liberty County, Montgomery County, Waller County, and Wharton County contained latitude and longitude coordinates of the location of the system, allowing very precise siting. Permit Records received by the remaining Authorized Agents were geo-referenced, or identified on a map, by the permit address. Project staff worked directly with several Authorized Agents to improve their data quality and submissions.

In FY 2018, H-GAC added 3,842 new records to the OSSF Permits Database and removed any outdated data. This update, which covers the period through March 2018 (the most recent data submittal by Authorized Agents), brings the total number of OSSFs in the database to 96,268. Table 6 summarizes the permitted OSSF data for the Region based on the FY 2018 update. The updated OSSF database and maps illustrating the location of new permitted systems (Figure 9) and the density of OSSFs by county (Figure 10) are shown below and are included in the digital media attached to this report.

Table 6 - Summary of Permitted OSSFs by County (through March 2018)

County	Number of OSSFs		System Type			
	Total by County[1]	2018 Update[1]	Conventional	Aerobic	Other	Unknown
Austin	3,401	111	203	-	184	3,014
Brazoria	12,645	519	14	2,231	63	10,337
Chambers	1,242	182	1	676	5	560
Colorado	820	108	312	217	171	120
Fort Bend	11,134	327	33	1,623	-	9,478
Galveston	6,196	627	181	2,122	63	3,830
Harris	18,009	507	-	18,009	-	-
Liberty	1,012	27	1	392	11	608
Matagorda	1,360	103	-	331	74	955
Montgomery	29,558	1,008	5,209	19,493	442	4,414
Walker[2]	6,111	55	-	-	-	-
Waller	3,994	205	102	923	20	2,949
Wharton	786	63	-	556	105	125
TOTAL	**96,268**	**3,842**	**6,056**	**46,573**	**1,138**	**36,390**

[1] *This table does not include OSSF data for permits submitted by special districts.*

[2] *Walker County OSSF data submissions do not include information about system type.*

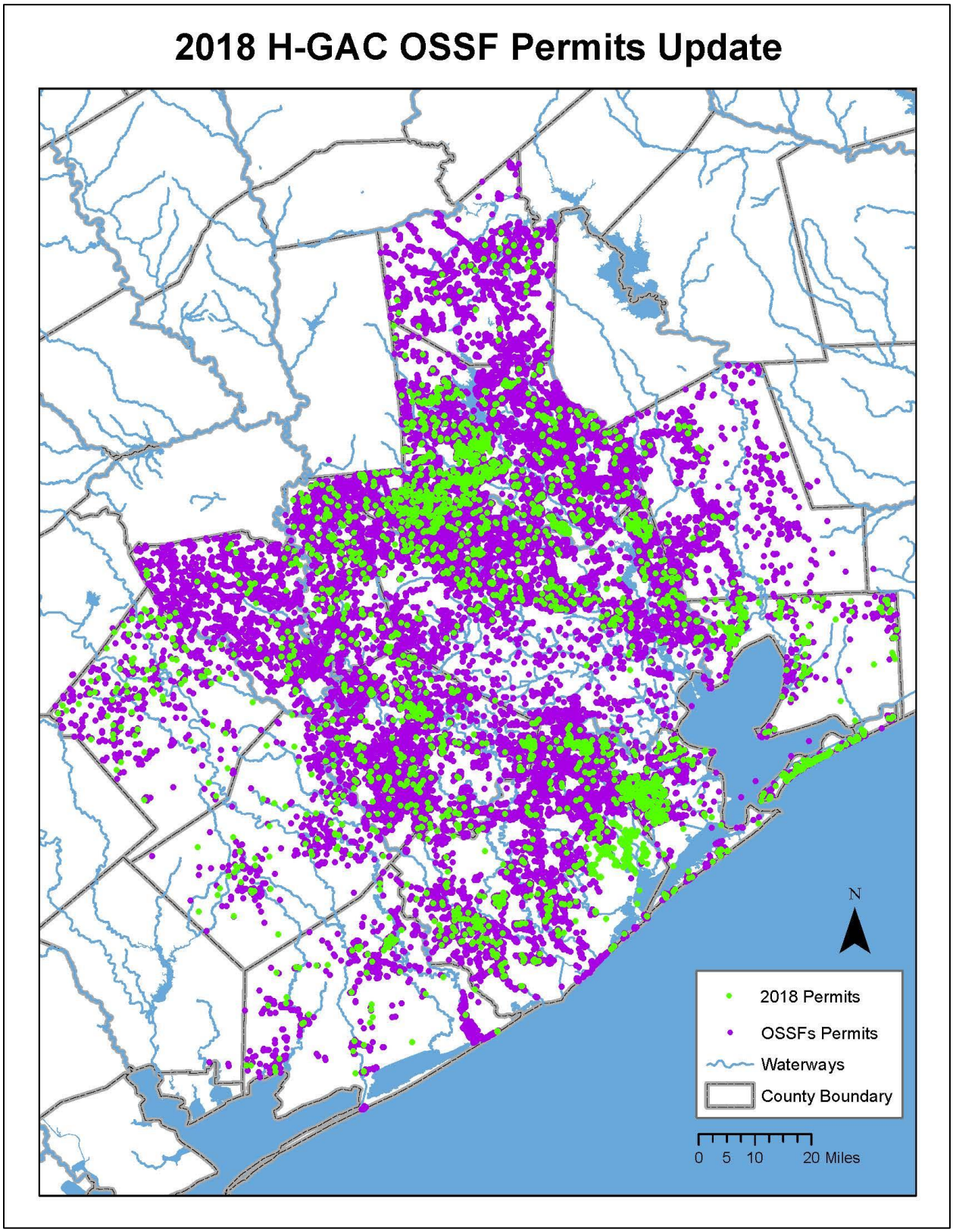

Figure 9 - Map of updated permitted OSSFs, FY2018

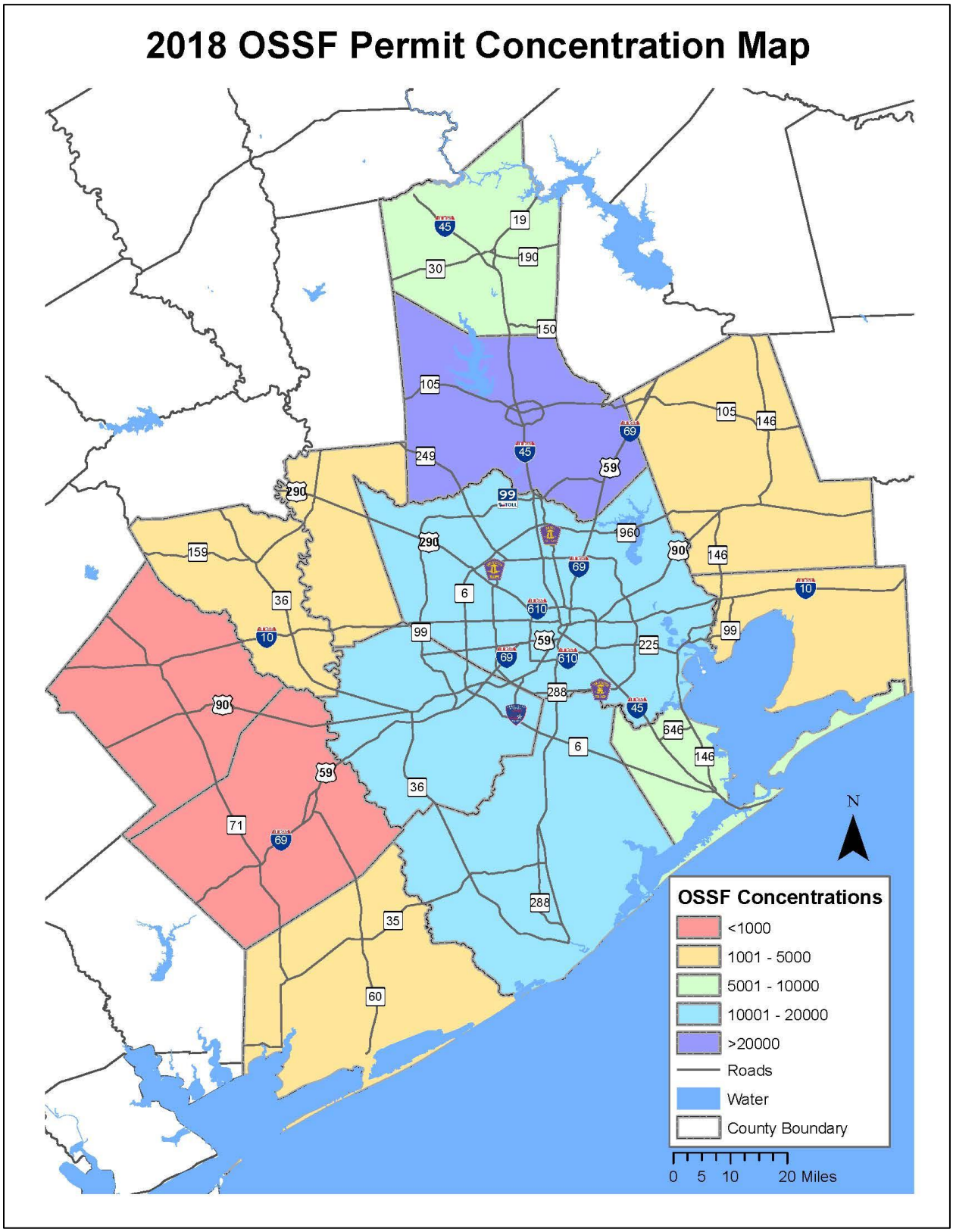

Figure 10 - OSSF permit concentration by county, FY2018

Task 5.2 – Unpermitted OSSF Update

The OSSF inventory data developed by H-GAC under Task 5.1 dealt specifically with permitted OSSFs. For most Authorized Agents, systems began to be permitted after 1989. OSSFs installed prior to this date were not required to have a permit. These systems are considered to be grandfathered and, in most cases, are not actively tracked unless violation data exist for that site. While many of these systems are well-maintained, aging systems in general pose a greater threat of failure (Figure 11) and contamination of surface water sources. Many of these older systems may also be of a type that are not most appropriately suited for the soil type present. These unpermitted systems also potentially represent an appreciable portion of the systems in service, as it is estimated that there are approximately 200,000 unpermitted systems, while only slightly more than 96,000 records are in the database of permitted systems.

Figure 11 - Discharge from failing OSSF

H-GAC devised and tested a methodology to use existing parcel or census block data to identify, by process of deduction, likely locations for unpermitted systems (refer to the corresponding section under **Methods**)**.** During this Project year, the identification methodology was re-run to update the analysis. The updated Unpermitted OSSF map (Figure 12) is included below and in the digital media attached to this report. The map shows all areas where unpermitted OSSFs are located, but differentiates between systems identified by parcel data and those identified by census block data.

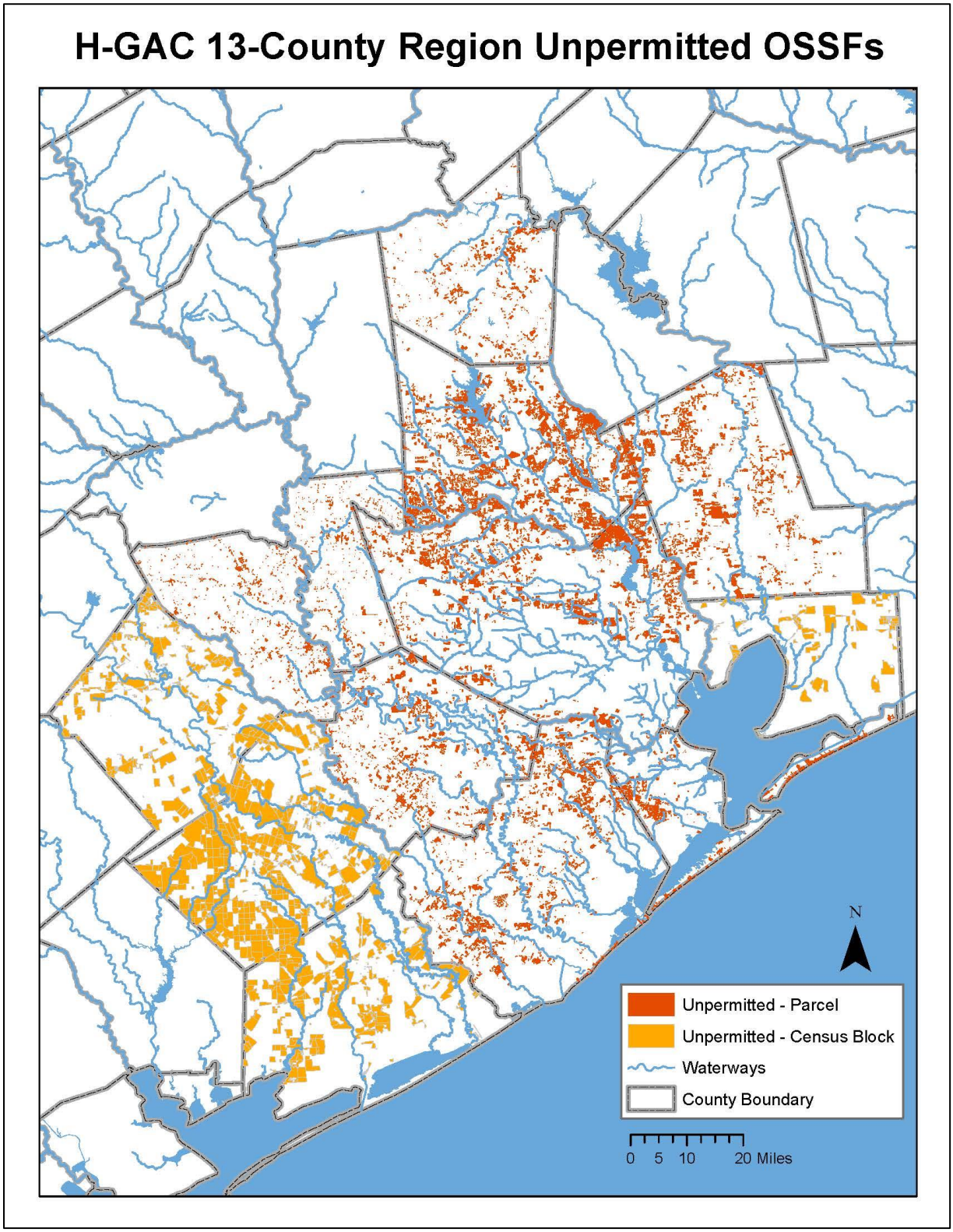

Figure 12 - Map of unpermitted OSSFs

In addition to these contract deliverables, H-GAC promoted our OSSF data resources at a variety of meetings, speaking engagements, and training events (see Task 4). Project staff held OSSF presentations and visual inspection/management trainings in Mont Belvieu and Bacliff and maintained an online OSSF data website[7] and online mapping tool[8]. Training courses provide information to homeowners and real estate inspectors about how to properly inspect and maintain OSSFs on private property. Trainings targeted areas with high numbers of permitted and potentially unpermitted OSSFs identified through H-GAC's OSSF database, as well as watersheds with active WPP or TMDL efforts. OSSF trainings and presentations held by H-GAC during this project period are detailed in Table 7.

Table 7 - FY 2018 OSSF Presentations and Trainings

Date	Event/Communication	Location	Participation
5/5/2018	OSSF Homeowner Visual Inspection Course	Mont Belvieu Public Library	H-GAC staff presented information to homeowners about how to properly inspect and maintain OSSFs.
5/15/2018	Harris County OSSF Symposium	Trini Mendenhall Community Center – Houston	H-GAC staff presented information about OSSF Repair and Replacement Assistance Program.
5/19/2018	OSSF Homeowner Visual Inspection Course	Bacliff Community Center	H-GAC staff presented information to homeowners about how to properly inspect and maintain OSSFs.

H-GAC has created a Supplemental Environmental Project (SEP) through TCEQ to remediate failing OSSF in the priority watersheds of the 13-county region. Throughout FY 2018, H-GAC staff promoted the SEP through one-on-one contacts and events.

[7] Accessible at http://www.h-gac.com/community/water/ossf.aspx
[8] Accessible at http://arcgis02.h-gac.com/ossf/

Methods

The following is a brief summary of the methods employed by Project staff, and their strategy and approach to each of the primary Objectives.

Objective 2 – Quality Assurance

The general strategy employed by H-GAC was to first confirm that the new Project year tasks were covered under the existing QAPPs, and to implement the existing QAPPS. Annual Certification for the Data and Geospatial QAPPs were completed as required. Amendments to the QAPPs were submitted as necessary to update changes in personnel or in methods used to complete the project.

H-GAC utilized its existing QA/QC methods developed with TCEQ and other agencies over the course of many years of related projects, in application to the FY 2018 Project.

Objective 3 – Wastewater Data Update and Coordination

The acquisition and analysis of wastewater infrastructure data adhered to updated QAPPs and QA/QC methods for FY 2018. This included the acquisition and analysis of WWTF outfall locations, service area boundaries, DMRs, and SSO violation reports. For this Project, an updated WWTF outfall GIS layer was acquired from TCEQ, and then filtered to examine just the domestic outfalls. This GIS layer was compared to the previous year's data to determine if data have changed from year-to-year, and if so, to what extent.

A manual review of the GIS outfall layer and service area boundaries was performed to identify outfalls without an associated SAB and address those discrepancies. This process compared the SAB to other sources such as city boundary layers or the CCNs as available through the Public Utility Commission of Texas (PUC).

For the SRF coordination aspects of the Objective, Project staff maintained a manifest in which to log SRF and other project reviews, and in which transition time was monitored internally.

Objective 4 – Support Watershed Planning

H-GAC maintained an active presence in the watershed while working on various projects. Project staff were in contact with key stakeholders through general outreach and participation in meetings and events for numerous TMDL and WPP projects (such as the West Fork WPP, San Bernard WPP, BIG TMDLs, Upper Oyster Creek TMDLs, etc.).

H-GAC staff participated in the Galveston Bay Council's Galveston Bay Estuary Program, including involvement with (and a leadership position on) the Water and Sediment Quality

subcommittee and the Monitoring and Research subcommittee. H-GAC also supported the Galveston Bay Plan revision process with staff participation and review. Project staff coordinated with Clean Rivers Program staff by providing review and data coordination for the CRP Basin Highlights Report process. H-GAC staff also facilitated the H-GAC's Natural Resources Advisory Committee through quarterly meetings held during the project term.

Objective 5 – OSSF Database Update

The methods employed in the update of the OSSF database and unpermitted OSSF analysis are described in further detail in the FY 2018 Geospatial QAPP. Generally, H-GAC maintained regular contact with submitting Authorized Agents to ensure regular data submissions. H-GAC's methods for the unpermitted analysis were the same as previous project years, in which unpermitted locations were deduced through a comparison of known parcels, known OSSFs, and known sanitary sewer systems. Parcels outside service areas, with occupied structures, that did not have a permitted OSSF were assumed to have an unpermitted OSSF.

While parcel data have been extremely useful in identifying potential locations of unpermitted OSSFs, H-GAC will attempt to refine the process in future project years by utilizing the 911 Address data set. This change will begin in the FY 2019 project and was incorporated into the project's Geospatial QAPP with the approval of Expedited Amendment #2. This approach was not used for the FY 2018 analysis because the data for this Project were acquired prior to the approval date of the QAPP amendment (6/29/2018).

Methods Summary

In general, H-GAC staff utilized a methodical approach for all tasks for this Project that was sufficient to meet Project goals within the confines of data quality objectives. The general approach to addressing Project Tasks and deliverables was to assess available data/resources, make a preliminary plan toward the task objective, periodically review the progress and plan, and adjust as necessary.

For those objectives dealing with public interaction, staff utilized existing communication networks and meetings to maximize the number of people reached, and incorporated feedback into revised versions of deliverables.

As much of the data and analysis developed under this Project will likely serve other water quality and watershed efforts, H-GAC coordinated with internal and external project managers to assure that the format and approach to these efforts would provide meaningful products.

To the greatest degree possible, Project staff attempted to streamline and make uniform the methods and processes involved in the various Tasks to increase efficiency in future Project years.

Results and Observations

This year's project was successful in building on progress made in previous years' projects. The completed deliverables from this Project will provide a solid base for a number of regional efforts. In general, H-GAC project staff members are confident in the results of this year's Project. H-GAC feels that the deliverables meet the needs of the current Project and will provide a solid foundation for future work.

The following observations will inform the approach to future iterations of this Project.

Objective 2 – Quality Assurance

The extent of QAPP coverage and the proactive approach to planning for annual certification and other QAPP changes were generally successful. Data and Geospatial QAPPs underwent annual recertification during this Project year. An amendment to the Geospatial QAPP was submitted to address staff and methodology changes. No deviations from the QAPPs were incurred during the acquisition and analysis of the respective data sources.

Objective 3 – Wastewater Data Update and Coordination

The wastewater infrastructure outfall layer data set was acquired from TCEQ in May 2018. The 2018 outfall layer was manually reviewed against the 2017 outfall layer. The 2018 outfall layer contained 1,633 total permitted outfalls. Of these outfalls, 1,544 of them are current/active, with 86 outfalls marked as "pending" in the data set. Two outfalls had duplicate records in TCEQ's data set. For the 2018 TCEQ outfall data set, there is a net increase of 33 outfalls from the previous year.

For the service area boundary analysis, the outfall data were filtered to examine just the domestic outfalls, as industrial outfalls do not typically have a defined service area. The service area boundary layer was reviewed against the domestic permits of the outfall layer data set to ensure that the service area boundary was present for every permit. A primary focus of this effort this year was to identify any data gaps incurred since the last review, and to minimize missing data. Small, private utilities were a key focus of these results. Approximately 100 small, private systems were identified in these analyses as lacking appropriate service area boundaries. H-GAC is working on an ongoing basis to update those boundaries in coordination with the permit holders. This analysis was a significant step in closing a data gap that has been identified in a previous FY project.

During the process of matching up service area boundaries to the wastewater outfalls, 388 outfalls were identified that did not have an associated service area boundary. To determine the cause of this mismatch, all unmatched outfalls were checked against the service area

boundary layer, CCN layer, and the city boundary layer. Names were matched on either the facility, owner, or served area name available in the TCEQ Central Registry and existing layers. This process allowed H-GAC to identify multiple categories of outfalls without service area boundaries (Table 8).

Table 8 - Outfalls without Service Area Boundaries

Category	Number	Description
Outfalls that need SABs created	124	Outfalls that have no boundary associated and need SAB created.
Outfalls that need SABs, but have CCN	116	Outfalls that have no boundary associated, but have a CCN defined.
Outfalls that do not need SABs	102	Outfalls to individual businesses, or single parcel locations (i.e., no service area).
Outfalls with SABs	25	Outfalls that do have SABs, but the SAB record in the SAB layer needs correction to match up (i.e., needs permit number edited or added).
Outfalls with SABs to break out	13	Outfalls have SABs, but need to be broken out of a larger SAB.
Outfalls with city boundaries	6	Outfalls without a SAB or CCN, but do have a city boundary (i.e., municipal plants)
Outfalls with TCEQ data issues	2	Issue with TCEQ data layer
Total Outfalls Without SABs	**388**	Total number of outfalls without SABs

Of these 388 outfalls without service area boundaries, 102 were associated with individual businesses or single parcels and therefore do not have a service area. From the remaining 286 outfalls without boundaries, 116 had a defined CCN and 6 were municipal plants with a city boundary that can serve as a proxy for the service area. An additional 13 were within larger SABs, but need to be broken out into the actual individual service areas. Another 25 outfalls had a boundary, but corrections need to be made to the service area boundary layer (wrong permit number, typographical error, etc.) for these to match, and 2 outfalls had errors in the TCEQ data layer (duplications). After these are addressed, that leaves 124 outfalls that have no boundary associated and need a service area boundary created.

The 124 outfalls that need boundaries created are mostly related to small, privately-owned treatment plants, such as small package plants serving a mobile home park. Electronic records of service area boundaries are typically not found for these smaller systems. As part of the FY 2019 Project, H-GAC will be contacting the permit holders for these systems individually to gain a better understanding and acquire information related to their service area boundaries.

H-GAC staff also analyzed and evaluated self-reported DMR and SSO data for the Region as part of this Project. The data created in this task continues to be widely used by local projects and entities. Water quality protection efforts, including the various WPPs, TMDLs, and the Clean

Rivers Program, use the data to guide and inform planning decisions. A detailed account of the results and findings from DMR and SSO analyses are included in the *DMR and SSO Data Analyses Summary Report* in Appendix B.

Objective 4 – Support Watershed Planning

The NRAC and H-GAC participation in other projects continues to be a valued part of this contract. Due to the density of project work in the Houston area, a good deal of coordination and communication is required. NRAC has continued to be well attended. The development of a Water Quality Award program to recognize local projects was favorably received by the participants.

Additional work has been performed to support the approved WPP for the San Bernard River. H-GAC is actively seeking funding to help begin implementation of that WPP.

Objective 5 – OSSF Database Update

The OSSF data have already been used for a variety of watershed protection efforts and other local planning projects. With the population expansion of the coming decades, and aging infrastructure, additional information about unpermitted system locations will be vital to utility planning. H-GAC is making modifications to the Geospatial QAPP to allow for more accurate and detailed estimations of the numbers and location of unpermitted systems in the H-GAC region in future project years.

Unpermitted OSSF Estimations and Locations

The Unpermitted On-site Sewage Facility Analysis was originally designed to identify the locations of unpermitted OSSFs by tax parcel polygon. H-GAC has a comprehensive parcel database for nine of the thirteen counties in the H-GAC region. Tax appraisal parcels allow for numeric estimations of unpermitted OSSFs; however, there are some limitations. For example, the centroid of the parcel is usually identified as the location of the OSSF. As properties vary in size and shape, the centroid in many cases is not adjacent to the actual system.
For the four counties for which H-GAC does not have digitized tax parcels available (Austin, Chambers, Matagorda, and Wharton), census blocks were used to complete the analysis. However, use of the census blocks are not ideal. Using this methodology, areas containing unpermitted OSSFs could be established, but it is difficult to ascertain a numeric estimation or the exact physical location of systems.

Beginning in FY 2019, H-GAC will begin using 911 address points (which are available for all counties within the H-GAC region) to develop a more accurate and detailed numeric estimation and location of unpermitted systems. The point established in the 911 data set is typically located on the roof of the structure, which is adjacent to the tank and/or drainfield of the on-

site sewage facility. A more accurate model will assist H-GAC with identifying unpermitted OSSFs, especially systems in close proximity to local waterways. The H-GAC Regional Geospatial Data QAPP has been amended to begin incorporating this data during the next Project period.

Identifying Abandoned or Inactive OSSFs

As service area boundaries for districts providing centralized sewer service continue to expand, residences and/or businesses may be removed from their existing on-site system and connected to the sanitary sewer system. At this point, the OSSF is typically abandoned in place by crushing and filling the system. Once the property is disconnected from the OSSF, that OSSF permit is essentially no longer valid.

Records of abandoned or inactive systems are not complete. In many cases, abandonment is not reported to the Authorized Agent or Designated Representative that permitted the system. H-GAC hopes to work more closely with the Authorized Agents/Designated Representatives, OSSF service providers (Installers, Maintenance Providers, Registered Sanitarians, etc.), and Owners/Operators of centralized sewer collection and treatment systems (municipalities, MUDs, WCIDs, etc.) to better capture and analyze these data. Acquiring data related to OSSF abandonment will not only result in a more accurate accounting of the number of permitted OSSFs, it will also assist H-GAC in maintaining and verifying service area boundaries, particularly as these areas expand through growth and expansion.

Future work under this task should consider ways in which to account for OSSF abandonment in expanding sanitary sewer areas, which cannot be easily captured currently.

Figure 13 - Installation of an OSSF

Discussion

Areas of need identified for inclusion in future projects, including any recommended solutions, are identified below.

Data Acquisition QAPP

The current Annual Review Certification approves the QAPP through 5/31/2019. Because this QAPP approval end date falls before the end of the 2019 fiscal year, it will be necessary to complete, submit, and receive approval for a new Data Acquisition QAPP before the end of the FY 2019 contract period.

Service Area Boundaries

As part of an iterative process of refining and improving service area boundary records for the region, H-GAC sets yearly focus area goals. The primary focus goal this year was identifying and starting the resolution process for small, private domestic systems whose current boundaries are not complete or are suspected to be incorrect. The data analysis and investigations completed under this project will move forward H-GAC's efforts to address this data gap, with completion of the bulk of the targeted service area boundaries early in the FY 2019 Project year.

For the FY 2018 Project, H-GAC identified 124 outfalls, which are mostly privately-owned systems (such as mobile home parks), that will need to have service area boundaries created for them. Unlike traditional public utilities, service area boundaries for these systems are not part of traditional data sources and must be handled on a system-by-system basis in conjunction with the permit holder. For the FY 2019 Project, H-GAC plans to contact the permit holders for these systems to determine their boundaries. H-GAC recommends to TCEQ that boundaries for these systems submitted at permit application should be included in existing spatial data sources.

Expand Project Coordination

As H-GAC continues to expand its range of planning projects aimed at supporting water quality (such as urban forestry efforts in the region as they relate to water quality planning), coordination with a wider range of projects through this contract is recommended.

OSSF Database Update

Future Project periods will focus on two primary areas related to the OSSF database:

1) Developing more accurate and detailed numeric estimations and locations of unpermitted OSSFs using 911 address data sets;

2) Identifying permitted OSSFs that have been abandoned or are no longer active due to conversion to centralized sanitary sewer or other factors.

OSSF Trainings

Steady interest and participation in H-GAC's visual OSSF inspection course for real estate inspectors and homeowners has indicated that this is a valued educational program and should be continued.

SEP for OSSFs

H-GAC has funding available to homeowners who meet certain income restrictions for the repair or replacement of failing traditional or aerobic OSSFs in the H-GAC service region. This funding is available through a Supplemental Environmental Project (SEP). These environmentally beneficial projects are approved by TCEQ and are funded by entities as a way to offset assessed penalties in enforcement actions.

Significant contributions into H-GAC's SEP for OSSFs during this project term have initiated potential partnerships with regional entities to implement OSSF improvement projects. Contributions into the SEP are expected to continue. With this increased traction, the support of administration and coordination of the SEP through this project would be a valuable addition to Objective 5 Tasks.

Summary

This year's Project was successful in acquiring and analyzing WWTF infrastructure data for the Region and supported related efforts to address NPS sources. This analysis is beneficial for both state and local purposes. H-GAC, as a regional planning and resource agency, continues to provide its unique perspective to the review of SRF projects.

A primary component of the *Water Quality Management Plan Update* involves the analyses of self-reported Discharge Monitoring Report and Sanitary Sewer Overflow data. These data are important for evaluating potential sources of bacteria in area waterways. Because of the amount of data analyzed for this portion of the WQMP Update, the DMR and SSO data is provided as a standalone report, which is found in Appendix B of this document.

H-GAC continues to develop and foster relationships with interested parties in the Region's watersheds and coordinate regional water quality activities. We have been leaders in previous TMDL and WPP efforts, and the coordination activities of the Project mesh well with our overall approach of outreach, targeted studies, and implementation activities. By having multiple water quality projects concurrently within the same organization, H-GAC is able to achieve vertical integration between base data sources, internal analysis, planning efforts (WPPs, TMDLs, etc.), and external coordination.

The OSSF inventory development continued during this fiscal year and will be an ongoing effort that will be continuously updated. This deliverable remains one of our most well-received efforts among internal and external clients. The data from this portion of the Project are extremely useful in H-GAC's various watershed planning efforts, including numerous TMDL and WPP projects.

This report, the accumulated data sets, the GIS analyses, and other deliverables of this Project are attached in electronic format on accompanying media. Where allowable and appropriate, data from this Project will be used to support other related efforts and/or made available (upon TCEQ approval) on H-GAC's website at http://www.h-gac.com/community/water/quality. This Final Report document, when approved, will be made available at this same location.

Additional Resources

The following resources are provided for additional information on topics discussed in this report.

H-GAC

Water Quality Management Planning
http://www.h-gac.com/community/water/quality/default.aspx

On-Site Sewage Facilities (OSSF)
http://www.h-gac.com/community/water/ossf.aspx

OSSF Information System
http://arcgis02.h-gac.com/ossf/

Clean Rivers Program
http://www.h-gac.com/community/water/rivers/default.aspx

2018 Clean Rivers Program Basin Highlights Report
http://arcgis02.h-gac.com/bhr2018/

Water Resources Information Map (WRIM)
http://h-gac.maps.arcgis.com/apps/MapSeries/index.html?appid=30b802d67f5d4a2aa7915cc30bca9318

Natural Resources Advisory Committee (NRAC)
http://www.h-gac.com/board-of-directors/advisory-committees/natural-resources-advisory-committee/default.aspx

Clean Waters Initiative Workshops
http://www.h-gac.com/community/water/cwi/default.aspx

Bacteria Implementation Group (BIG)
http://www.h-gac.com/community/water/tmdl/big/default.aspx

BIG Reports
http://www.h-gac.com/community/water/tmdl/BIG/reports.aspx

Watershed Protection Plans
http://www.h-gac.com/community/water/watershed_protection/default.aspx

Total Maximum Daily Loads (TMDL) and Implementation Plans
http://www.h-gac.com/community/water/tmdl/default.aspx

Coastal Communities
http://www.h-gac.com/coastal-communities/default.aspx

Water Pollution Complaint Contacts
http://www.h-gac.com/community/water/pollution_complaint.aspx

TCEQ

Texas Surface Water Quality Standards
https://www.tceq.texas.gov/waterquality/standards

Texas Integrated Report of Surface Water Quality
https://www.tceq.texas.gov/waterquality/assessment

State Water Quality Management Plan
https://www.tceq.texas.gov/permitting/wqmp

TCEQ GIS Data
https://www.tceq.texas.gov/gis/download-tceq-gis-data

Surface Water Quality Web Reporting Tool
https://www80.tceq.texas.gov/SwqmisPublic/public/default.htm

Surface Water Quality Segments Viewer
https://www.tceq.texas.gov/gis/segments-viewer

Supplemental Environmental Projects
https://www.tceq.texas.gov/compliance/enforcement/sep

Sanitary Sewer Overflow Initiative
https://www.tceq.texas.gov/compliance/investigation/ssoinitiative

On-Site Sewage Facilities Rules and Regulations
https://www.tceq.texas.gov/permitting/ossf/ossfregulators.html

TWDB

Clean Water State Revolving Fund (CWSRF) Loan Program
http://www.twdb.texas.gov/financial/programs/CWSRF/index.asp

(This Page Intentionally Blank)

Appendices

List of Appendices

A. Summary of Materials Included on Media
B. Summary Report of Regional DMR and SSO Data Analysis, FY 2018

(This Page Intentionally Blank)

Appendix A – Summary of Materials Included on Media

The following materials are included on the media attached with this Report:

Task 3 – Wastewater Data Update and Coordination

- Map of Wastewater Outfalls
- Map of Service Area Boundaries
- Outfalls without Service Area Boundaries spreadsheet
- R12 DMR Analysis
- WWTFs by Plant Size graph
- SSO Rankings graphs
- *E. coli* Total Load Calculations

Task 5 – OSSF Database Update

- Update Permitted OSSF Database
- H-GAC OSSF Permits Map
- H-GAC OSSF Unpermitted Analysis Map
- 2018 H-GAC OSSF Permits Update Map
- 2018 OSSF Permit Concentration Map
- 2018 OSSF Permit Update Concentration Map

Task 6 – Water Quality Management Plan Update / Final Report

- Water Quality Management Plan Update
- Documentation of Public Participation in WQMP Update

(This Page Intentionally Blank)

Appendix B – Summary Report - Regional DMR and SSO Data Analysis, FY 2018

Summary Report

Regional DMR and SSO Data Analyses

FY 2018

Funding for this project was provided by the Environmental Protection Agency through a Clean Water Act 604(b) grant to the Houston-Galveston Area Council, administered by the Texas Commission on Environmental Quality.

Houston-Galveston Area Council

TCEQ

EPA United States Environmental Protection Agency

(This Page Intentionally Blank)

Introduction

Escherichia coli (*E. coli*) is a fecal indicator bacterium commonly found in the gut of warm-blooded animals. Elevated concentrations of *E. coli* in area waterways may indicate the potential presence of untreated or improperly treated fecal waste. *E. coli* bacteria can cause gastrointestinal illness in persons who come into direct contract with contaminated waters. *E. coli* from human waste has a significantly greater pathogenic potential compared to *E. coli* strains from other sources[9].

Currently, nearly half of the stream miles in the 13-county area of the Houston-Galveston Area Council (H-GAC) region (Region 12) have bacterial levels higher than the state standard for contact recreation. One of the ways that the region is addressing the issue is through projects such as the Bacteria Implementation Group (BIG), which addresses point-source pollution.

The BIG is a partnership between the Houston-Galveston Area Council (H-GAC), local governments, business, and community leaders who have come together as stakeholders to develop and implement a single shared plan to reduce bacteria. The BIG project area (Figure 1) is a combination of more than 100 TMDLs in adjacent watersheds.

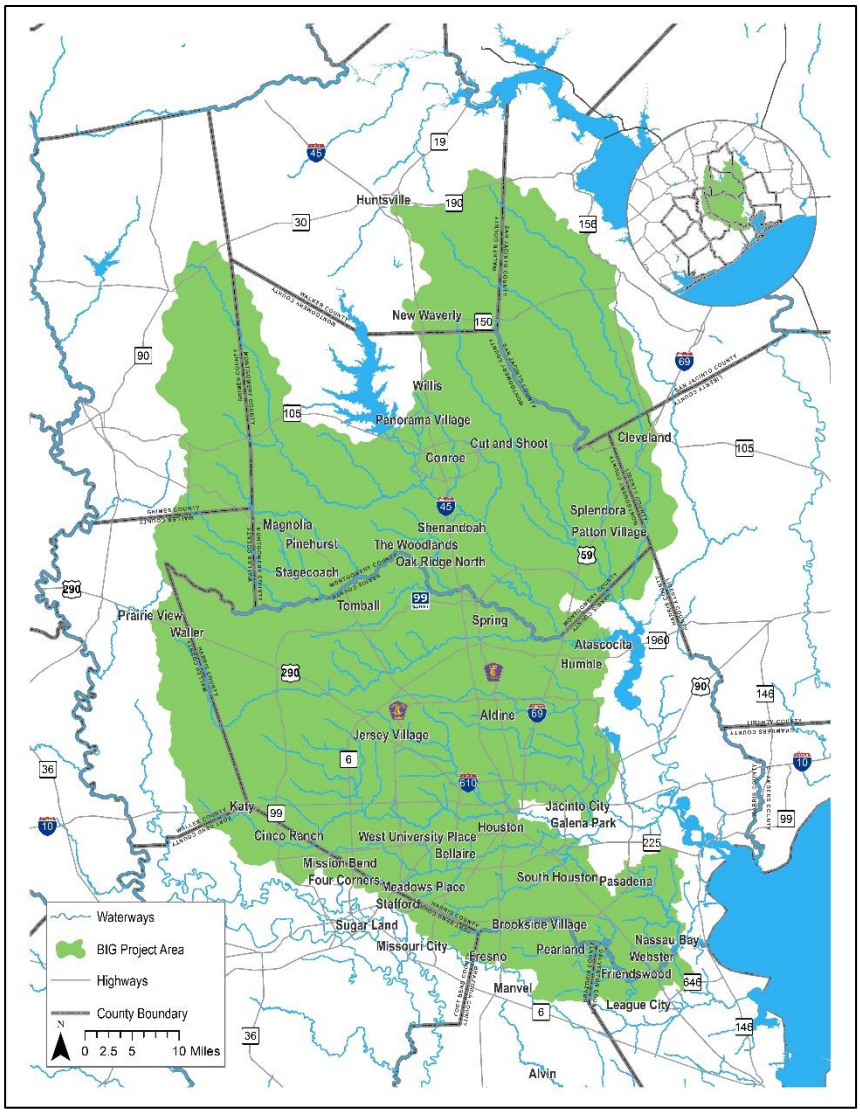

Figure 1 – BIG project area

[9] While the project considers many sources of fecal bacteria, recent research has indicated that human waste has a significantly higher risk of causing sickness in humans as compared to animal sources. Additional information about this research can be reviewed at http://oaktrust.library.tamu.edu/handle/1969.1/158640?show=full. (Gitter, 2017).

One of the water quality protections implemented through the BIG was an initiative to lower the standard bacteria permit limit to 63 MPN/100 mL (most probable number per 100 milliliters) for some wastewater permittees in the BIG project area. This regulatory initiative, along with other non-regulatory activities, has contributed to continued water quality improvement in the BIG area. Although overall bacteria levels for both the BIG area and the entire region (Region 12) have shown a gradual improvement over time since 2006, current bacteria geometric mean values for the region continue to be significantly greater than the state standard for primary contact recreation (Figure 2).

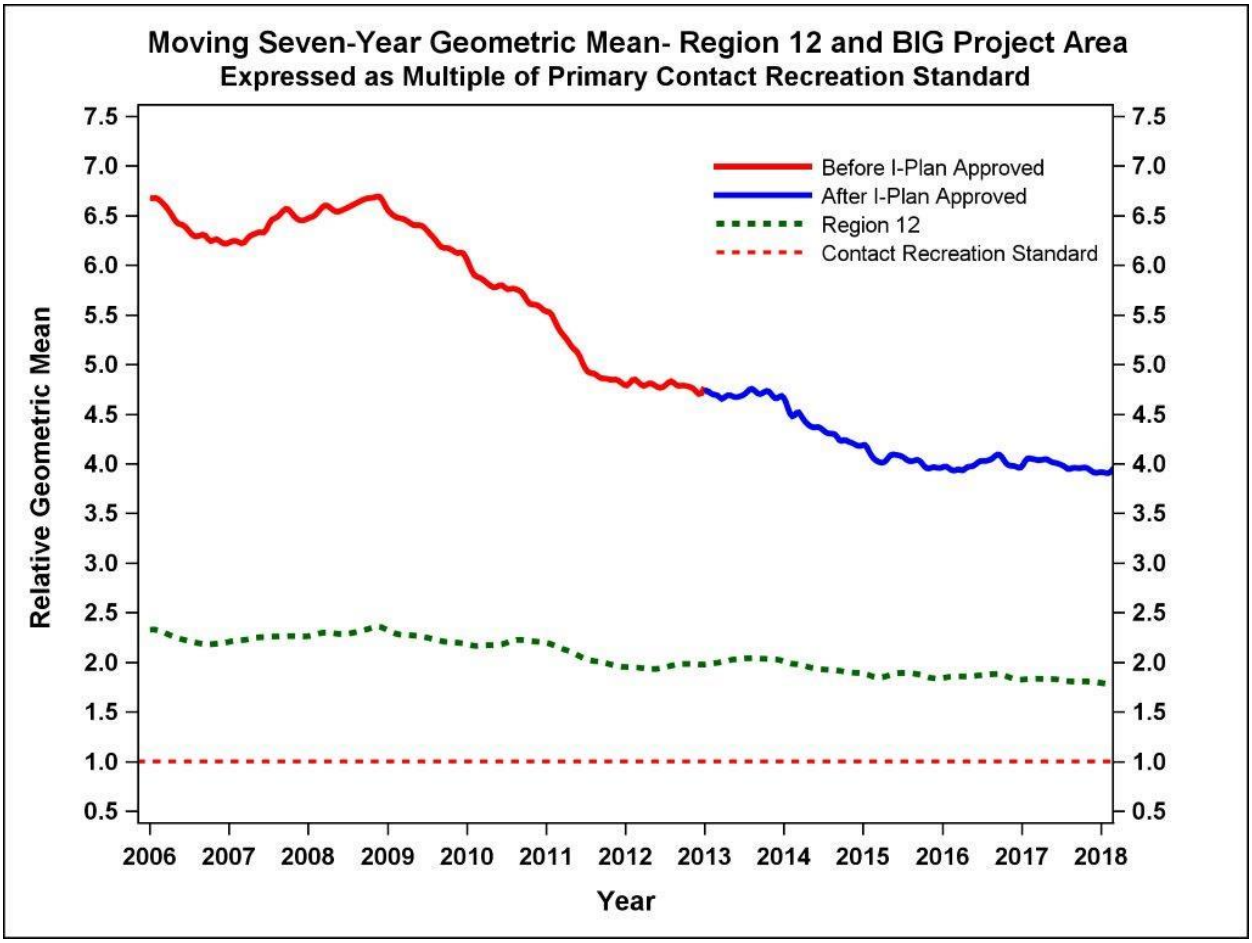

Figure 2- Moving seven-year bacteria geometric mean plot for Region 12

Wastewater infrastructure is a potential contributor of bacteria into area waterways. This may occur through improperly treated wastewater treatment facility (WWTF) effluent discharges or through the occurrence of sanitary sewer overflows (SSOs) (Figure 3) from the plants or throughout the collection systems. Self-reported data from WWTF Discharge Monitoring Reports (DMRs) and SSO violation reports can be analyzed to better evaluate the potential impacts these sources have on bacteria impairments throughout the region.

As the population continues to increase at a rapid pace and the infrastructure continues to age, the integrity of these treatment and collection systems may be adversely impacted. It is important to continuously monitor these systems over time to ensure decision makers and water resource managers implement best management practices, repairs, or system replacements in areas that need it most.

This report summarizes the region's DMR and SSO violation data acquired through the TCEQ. DMR data covers 2012 – 2017, and SSO data covers 2011 – 2017. Spatial analysis of violations was also conducted using current WWTF outfall locations and service area boundaries in the region.

Figure 3 - Sanitary Sewer Overflow (SSO) near Greenway Plaza, Houston, TX

Discharge Monitoring Report (DMR) Data

Discharges from WWTFs are regulated by water quality permits from the TCEQ. Limits for effluent quality are specified in each permit, with discharges being monitored by WWTF personnel on a frequency dependent on plant size, location, wastewater type (domestic or industrial), and other factors. Results from field measurements (pH, dissolved oxygen, instantaneous flow, etc.) and laboratory analyses (biochemical oxygen demand, total suspended solids, ammonia, etc.) from these required monitoring events are submitted to the TCEQ on a monthly basis as a Discharge Monitoring Report (DMR). As with any self-reported data, there is an expectation that some degree of uncertainty or variation from conditions may occur. Additionally, samples are collected at the weir and not at the end of the outfall pipe, so results generated do not take into account potential bacterial regrowth in the outfall pipe. Even with these uncertainties, DMRs are the most comprehensive data available for evaluating WWTFs in the region.

Bacteria Permit Limits

As defined in the 2014 *Texas Surface Water Quality Standards*, the *E. coli* geometric mean criterion for primary contact recreation for ambient surface water is 126 most probable number (MPN) per 100mL of water, and 399 MPN/100mL for single grab samples. For enterococci, which is the designated indicator organism for tidal segments, the criterion for the geometric mean is 33 MPN/100mL, with a single sample criterion of 78 MPN/100mL.

Bacteria Reporting Units

Results for bacteria analyses are typically reported in units of MPN/100mL, or Most Probable Number per 100 milliliters of water. Bacteria results may also be reported as CFU/100mL, or Colony Forming Units per 100 milliliters of water. The units used depends on the method of analysis. MPN is a statistical probability of the number of microorganisms present using multiple-tube fermentation techniques, while CFU is a direct count of bacterial colonies from the surface of a plate using membrane filtration techniques. Although variability in results exists between methods, the results are generally considered equivalent for reporting purposes, and wastewater permits allow for reporting using either methodology.

In most cases, these standards are generally applied as a water quality permit limit for WWTFs as well. In the Houston-Galveston area, the majority of permits have effluent limitations set for *E. coli* bacteria. However, some permits have enterococci permit limits. Select plants may have more stringent bacteria permit limits depending on site-specific conditions or participation in TMDL projects like the BIG.

Evaluating trends in permit exceedances for indicator bacteria is important in understanding the impact WWTFs may have on overall surface water quality. For the data presented in this report, the actual limit for each plant was used in comparison with its plant-specific analytical results. The range of limits for domestic facilities applied to the average and maximum conditions ranges from 63 to 399 MPN/100mL for *E. coli* and 17.5 to 104 MPN/100mL for enterococci.

DMR Bacteria Violation Data Analyses

For this project, H-GAC staff evaluated the occurrence of self-reported bacteria violations through domestic WWTF DMRs in the region for the period of 2012 – 2017. Evaluations were based on the regulatory permit limits specific to each plant and consider the number of exceedances and bacteria loadings by year and by plant size. It should be noted that the data analyzed for this project are self-reported by WWTFs, and that samples are collected before the end of the outfall pipe, so results do not consider the effect of bacteria regrowth.

DMR Analysis Results

The H-GAC acquired the wastewater outfalls GIS layer (version dated 5/2/2018) from TCEQ to perform the analyses in this report. Based upon the TCEQ outfall layer, there are 1,173 permitted facilities within the region. Further analysis examined the domestic facilities that submit DMR data to TCEQ for compliance purposes. DMR data used in this report is from the period of 1/1/2017 to 12/31/2017, and was acquired in March 2018. A total of 1,062 facilities submitted self-reported DMR data to TCEQ during that timeframe. Of those facilities, 898 permittees submitted data for bacteria. 880 of the WWTFs submitting data have established permit limits, with 18 WWTFs reporting results but having no established permit limits. There was one industrial facility with bacteria permit limits that did not report data during the 2017 calendar year. WWTFs that did not submit bacteria DMR data are excluded from analysis in this report.

Table 1 provides a summary of the total number of WWTFs with bacteria (either *E. coli* or enterococci) permit limits that submitted DMR data to TCEQ in 2017. The vast majority of facilities are domestic facilities, with industrial facilities making up a small percentage of the total number of WWTFs.

Table 1 – Summary of WWTFs Submitting DMR Data in 2017

WWTF Type	Number of Permittees with Bacteria Limits Submitting DMR Data	Number of Permittees without Bacteria Limits Submitting DMR Data
Domestic	805	6
Industrial	75	12
Subtotal	**880**	**18**
TOTAL	**898**	

Table 2 and Table 3 summarize the actual *E. coli* and enterococci permit limits for each type of facility. Table 2 shows permit limits for domestic WWTFs, while Table 3 shows permit limits for industrial facilities. These limits were used to evaluate the number of exceedances by year and plant size.

Table 2 – Summary of Current Bacteria Permit Limits for Domestic Plants			
Parameter	**Geometric Mean Limit**	**Daily Maximum / Grab Limit**	**Number of Permits**
E. coli	63	--	2
E. coli	63	197	34
E. coli	63	200	410
E. coli	126	--	1
E. coli	126	200	6
E. coli	126	394	10
E. coli	126	399	274
E. coli	399	--	1
Subtotal (Domestic Permits with *E. coli* Limits)			**738**
Enterococci	17.5	52	1
Enterococci	35	104	64
Enterococci	35	89	2
Subtotal (Domestic Permits with Enterococci Limits)			**67**
		TOTAL	**805**

Table 3 – Summary of Current Bacteria Permit Limits for Industrial Plants			
Parameter	**Geometric Mean Limit**	**Daily Maximum / Grab Limit**	**Number of Permits**
E. coli	--	126	1
E. coli	--	394	1
E. coli	63	--	1
E. coli	63	197	5
E. coli	63	199	1
E. coli	63	200	1
E. coli	126	200	1
E. coli	126	394	6
E. coli	126	399	13
Subtotal (Industrial Permits with *E. coli* Limits)			**30**
Enterococci	--	89	1
Enterococci	35	--	1
Enterococci	35	104	30
Enterococci	35	200	1
Enterococci	35	89	5
Enterococci	126	394	1
Enterococci	168	--	1
Enterococci	168	399	1
Enterococci	168	500	5
Enterococci	350	540	1
Subtotal (Industrial Permits with Enterococci Limits)			**47**
		TOTAL	**77**

As shown in Table 2, there are 738 domestic WWTFs with *E. coli* permit limits and 67 domestic WWTFs having enterococci permit limits, for a total of 805 permitted domestic facilities with bacteria permit limits. For industrial facilities (Table 3), there are 30 permits with *E. coli* limits, and 47 permits with enterococci limits, for a total of 77 permits[10].

Table 4 shows the number of WWTFs submitting bacteria DMR data for the period of 2012 to 2017 based on relative plant size categories as determined by daily flows (in millions of gallons per day, or MGD). The <0.1 MGD plants comprise the largest category of WWTFs, with 33% of the total number of facilities (Table 4 and Figure 4).

Table 4 – Number of WWTFs Submitting Bacteria DMR Data by Plant Size, 2012 - 2017

Relative Plant size	Number of Plants	Percentage of Plants
Variable/Intermittent Discharge	9	1.00
< 0.1 MGD	292	32.41
0.1-0.5 MGD	201	22.31
0.5-1 MGD	138	15.32
1-5 MGD	198	21.98
5-10 MGD	37	4.11
> 10 MGD	26	2.89
TOTAL[11]	**901**	**100[12]**

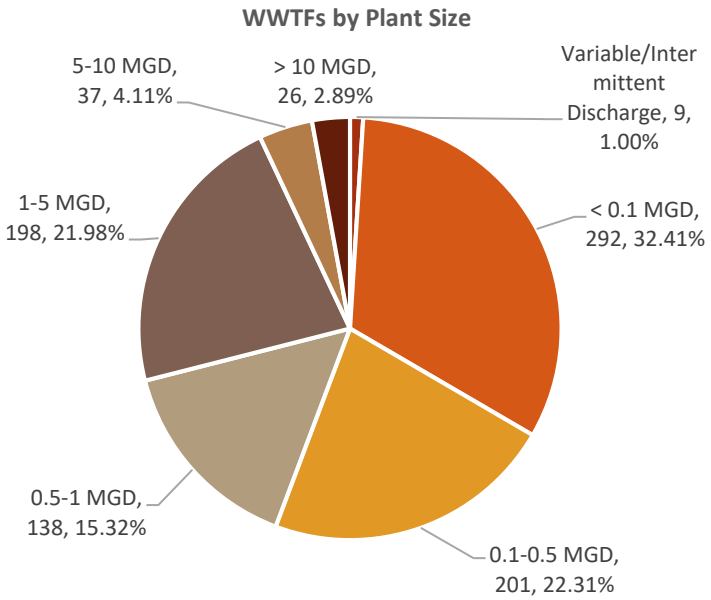

Figure 4 – WWTFs Submitting Bacteria DMR Data by Plant Size, Percentage of Total

[10] As shown in Table 1, there were only 75 industrial permittees with bacteria limits submitting bacteria DMR data to TCEQ, while Table 3 shows 77 industrial permits with bacteria limits. H-GAC has identified a permitted industrial facility with bacteria limits for both *E. coli* and enterococci, which would cause the WWTF to be counted twice. H-GAC also identified one industrial facility that did not submit bacteria DMR data during the 2017 calendar year.

[11] The total number of WWTFs in Table 1 (898) differs from that shown in Table 4 (901) due to the difference in timeframes. Table 1 is based on 2017 data only, while the number of WWTFs by plant size (Table 4) is calculated using six years of data so that permit exceedance rates by year and plant size can be determined.

[12] Due to rounding, the percentage values in the table sum to 100.02% instead of 100.00%.

The percentage of DMRs submitted with bacteria permit limit exceedances are shown in Tables 5 and 6. Table 5 shows exceedances of the geometric mean permit limits, with Table 6 showing daily maximum / single grab sample exceedances. Results are shown by relative plant size and by year for the period of 2012 to 2017.

Table 5 – Percent of DMR Bacteria Geometric Mean Permit Limit Exceedances by Plant Size and Year

Relative Plant Size Based on Discharge, MGD	2012	2013	2014	2015	2016	2017
Variable/Intermittent	0.0%	0.0%	5.4%	6.0%	17.9%	13.5%
< 0.1 MGD	6.1%	4.6%	5.3%	2.6%	1.6%	2.4%
0.1-0.5 MGD	1.7%	0.8%	0.4%	0.9%	1.5%	1.0%
0.5-1 MGD	1.0%	1.0%	0.5%	0.6%	0.9%	0.6%
1-5 MGD	1.9%	1.3%	0.5%	0.3%	0.6%	0.6%
5-10 MGD	0.4%	0.0%	0.0%	1.1%	1.3%	1.0%
> 10 MGD	0.6%	1.0%	0.9%	1.6%	0.0%	0.4%

Table 6 – Percent of DMR Bacteria Single Grab Permit Limit Exceedances by Plant Size and Year

Relative Plant Size Based on Discharge, MGD	2012	2013	2014	2015	2016	2017
Variable/Intermittent	--	--	4.5%	3.8%	16.1%	13.3%
< 0.1 MGD	9.9%	6.6%	7.0%	3.5%	2.0%	4.1%
0.1-0.5 MGD	4.2%	2.8%	1.8%	2.1%	2.1%	2.2%
0.5-1 MGD	5.4%	4.3%	1.9%	2.5%	1.5%	1.8%
1-5 MGD	8.1%	5.6%	3.3%	4.9%	4.7%	4.8%
5-10 MGD	6.4%	9.8%	5.9%	9.7%	8.1%	6.9%
> 10 MGD	9.1%	11.4%	11.4%	15.9%	11.1%	11.9%

In general, results indicate that a very small number of bacteria permit exceedances are reported annually. For 2017, 420 out of 16,416 results (2.6%) were reported as a permit exceedance (Table 7).

Table 7 – Bacteria Permit Exceedance Rates, 2017

Sample Type	Total Results Reported	Total Exceeding Limit	Percent Exceedance
Geometric Mean	8,023	92	1.1%
Single Grab or Daily Maximum	8,393	328	3.9%
TOTAL	**16,416**	**420**	**2.6%**

A greater rate of exceedances is reported with daily maximum or single grab samples as compared to the geometric mean results. This is most likely due to the variability in conditions that can occur in collecting single grab samples. Also, there may be multiple single grab samples for a reporting period, but there will only be one geometric mean calculation for those values. The geometric mean calculation normalizes the range of values being averaged and shows the typical value or central tendency of the data set, so that outliers (such as an atypical elevated single grab value) do not overly influence the results, as would be the case if an arithmetic mean were utilized.

The highest rates of permit limit exceedances are observed with WWTFs with variable or intermittent discharges. There are only 9 WWTFs that have this classification (1% of the total number of treatment plants). Because these plants discharge only as processes and water use dictates, discharges from these plants are typically infrequent and of a smaller volume than most facilities. Based on these factors, the high rates of exceedances (13.5% for geometric mean and 13.3% for grab samples in 2017) would be expected to have minimal impact to the receiving waters.

For plants in the largest size category (>10 MGD), the exceedance rate of the daily maximum or single grab sample limit is higher than all other categories apart from the variable/intermittent dischargers (see Table 6). This is most likely due to the increased frequency at which >10 MGD facilities are required to collect, analyze, and report bacteria samples. However, the exceedance rate for the geometric mean data is lowest for this size category.

Overall bacteria permit limit compliance rates are very high, with percent compliance with single grab / daily max permit limits ranging from approximately 93 – 97% (Table 8) and compliance with geometric mean permit limits at approximately 98 – 99% (Table 9) for the past six years.

Table 8 – Bacteria Single Grab / Daily Max Permit Exceedance and Compliance Rates by Year, 2012 - 2017							
Single Grab / Daily Max Results	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
Total Grab/Max Results Reported	4,119	6,110	7,293	8,028	8,215	8,393	**42,158**
Samples Exceeding Grab/Max Limit	280	318	266	330	286	328	**1,808**
Percent Samples Exceeding Grab/Max Limit	6.8%	5.2%	3.6%	4.1%	3.5%	3.9%	**4.3%**
Grab/Max Percent Compliance	93.2%	94.8%	96.4%	95.9%	96.5%	96.1%	**95.7%**

Table 9 – Bacteria Geometric Mean Permit Exceedance and Compliance Rates by Year, 2012 - 2017							
Geometric Mean Results	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
Total Geomean Results Reported	4,086	5,877	6,955	7,654	7,862	8,023	**40,457**
Samples Exceeding Geomean Limit	85	92	92	80	97	92	**538**
Percent Samples Exceeding Geomean Limit	2.1%	1.6%	1.3%	1.0%	1.2%	1.1%	**1.3%**
Geomean Percent Compliance	97.9%	98.4%	98.7%	99.0%	98.8	98.9%	**98.7%**

Table 10 and Figure 5 compare total loading from different plant sizes. This table shows the mean daily discharge, mean *E. coli* geometric mean, the geometric mean of the geometric means, and estimated loading by plant size for 2017. The total annual loading by plant size category for 2017 is represented in Figure 5.

The data indicate that the highest total *E. coli* loading is from the 1 – 5 MGD plants, followed by the 5 – 10 MGD plants. The > 10 MGD plants, while having the highest volume of discharge, is mid-range for total loading. This is due to the low geometric mean of the *E. coli* values. These data do not take into account the location of the WWTFs. One large point-source discharge in one location is likely more impactful to that location than small discharges spread out over a large area. The spatial distribution of the discharges should be evaluated along with the ambient surface water quality data to help examine and address these impacts.

Table 10 – Mean *E. coli* Geometric Means, Discharge, and Total Loading by Plant Size, 2017				
Relative Plant Size Based on Discharge (MGD)	**Mean Daily Discharge (MGD)**	**Mean Geometric Mean, (MPN/100mL)**	**Geometric Mean of Geometric Mean (MPN/100mL)**	**Estimated Daily Load (Million MPN/Day)***
< 0.1 MGD	<0.010000	1.525	1.327	488.2
0.1-0.5 MGD	0.130000	5.967	2.979	1737.4
0.5-1 MGD	0.230000	1.9117	1.608	4046.3
1-5 MGD	1.010000	11.138	5.303	17084.2
5-10 MGD	4.160000	15.333	9.040	9645.9
> 10 MGD	14.420000	1.333	1.230	7419.1
* Loading calculated using the geometric mean of the geometric mean				

Figure 5 shows the estimated total *E. coli* loading from domestic WWTFs in the region. These data currently only consider *E. coli* DMR results, so enterococci data are not included in the loading calculations. Enterococci loading may be considered in future projects.

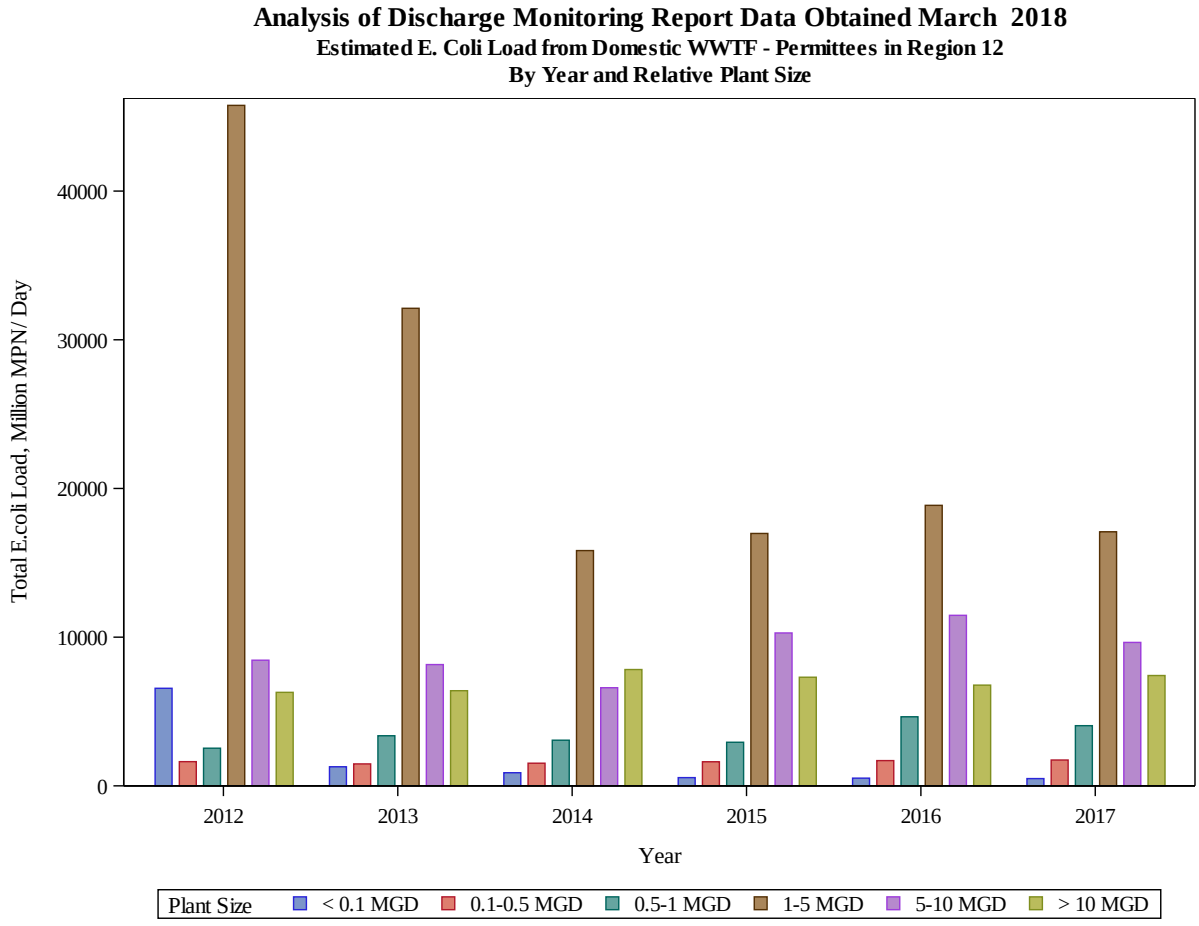

Figure 5 - Estimated Total E. coli loadings per year in regional waterways based on domestic WWTF plant size

While the WWTFs discharging >10 MGD have the highest average *E. coli* loading, reported in million MPN/100mL/Day, this category represents only 2.9% of the domestic facilities within the region. Because of the small number of plants, the total loading from this size category is not as high as other categories. Plants in the two smallest size categories (<0.1 MGD and 0.1 – 0.5 MGD) account for a combined 55% of the total number of WWTFs. While these smaller plants typically have higher average *E. coli* geometric means, the smaller discharge volume keeps the bacteria loading lower in relation to other groups. However, these smaller systems can be within close proximity to each other and can have a cumulative effect.

The plant size category that shows the most significant contribution of bacteria loading into regional watersheds is the 1 – 5 MGD group. Although mid-range for both average *E. coli* concentration and mean daily discharge, with 198 facilities in this class, this group comprises a very sizeable category that represents 22% of the total number of WWTFs. It should be noted that the elevated results for 2012 and 2013 were related to significantly high bacteria results at one plant, which have since been corrected.

Once again, it should be noted that data are self-reported These results also do not take into account bacterial regrowth in the discharge pipe. As such, the reported results may underestimate the actual bacterial density.

Figure 6 is a map illustrating the frequency of DMR bacteria violations between 2012 and 2017 by watershed. This map illustrates areas in the region that have the highest rate of permit exceedances based on the self-reported DMR data acquired from TCEQ. It is evident that the more populated urban and suburban areas present in the region experience the greatest number of bacteria violations compared to more rural watersheds along the region's perimeter. It should be noted that spatial analysis of DMR exceedances are based on the location of WWTF outfalls. Watersheds with no outfalls located within their boundary are shown as having no data.

The map in Figure 7 shows a spatial representation of occurrences of bacteria violations. These data show locations where an increased number of bacteria exceedances are reported.

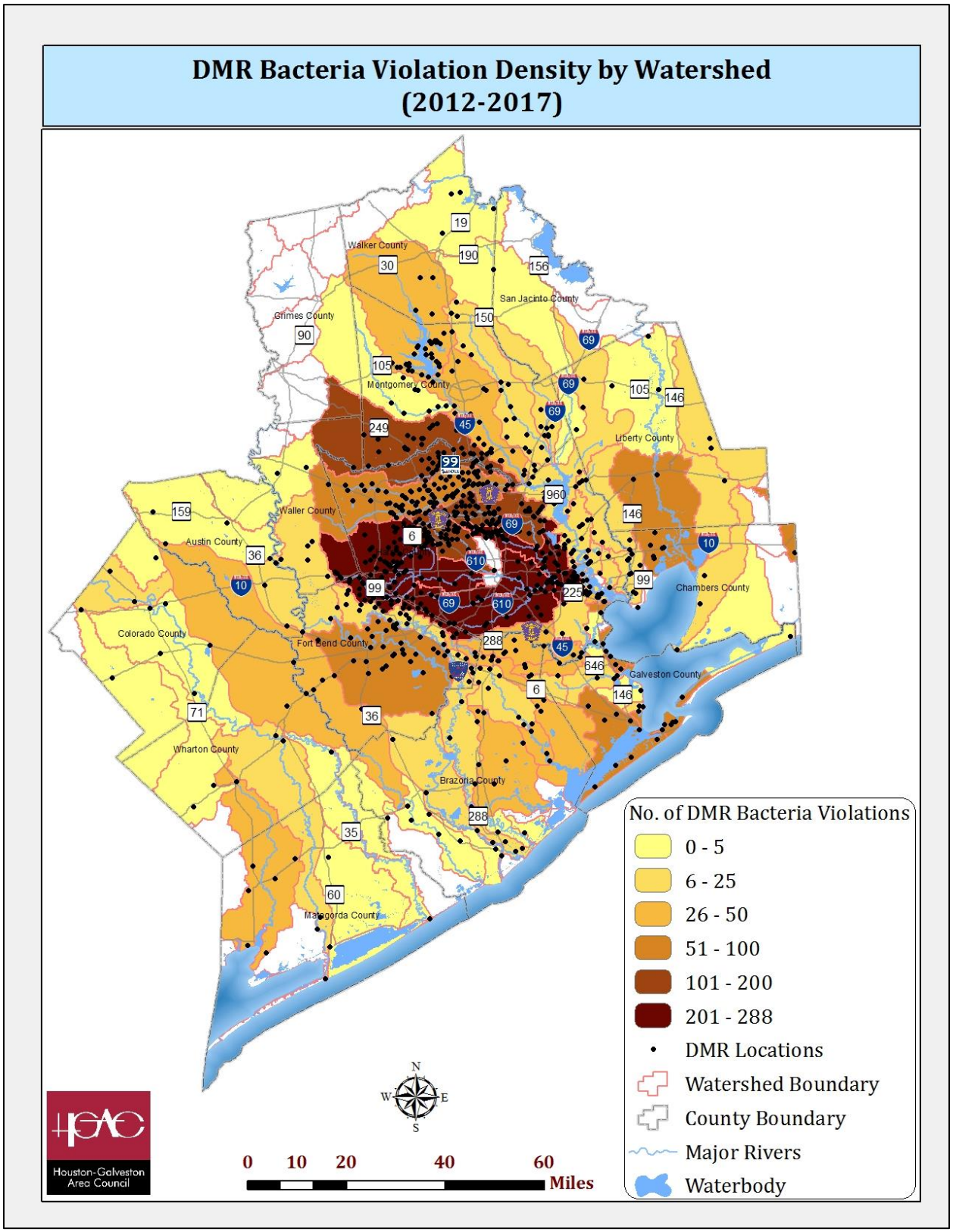

Figure 6 – Frequency of DMR bacteria permit violations by watershed reported between 2012 and 2017

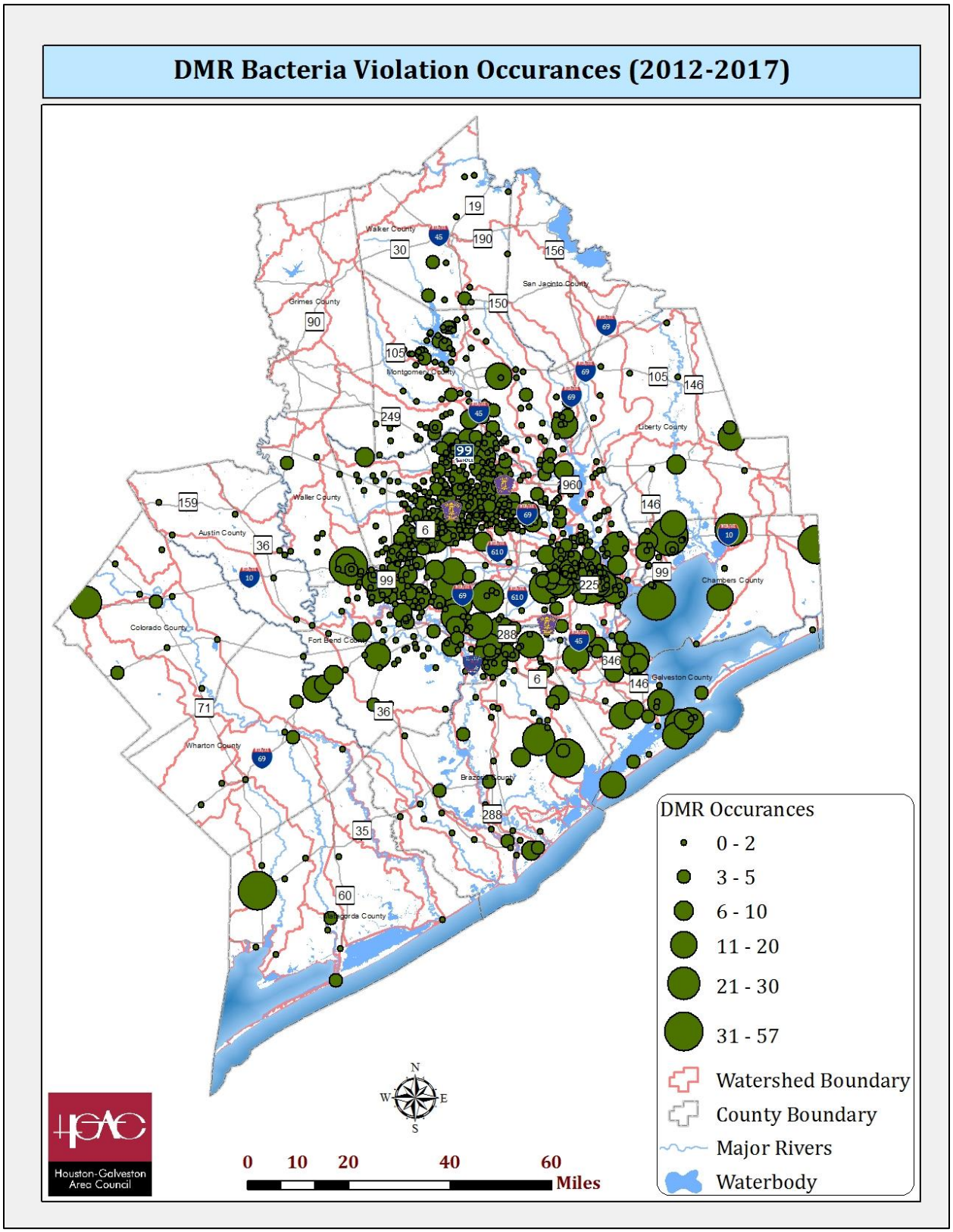

Figure 7 –Occurrences of DMR bacteria permit violations by watershed reported between 2012 and 2017

DMR Analysis Discussion

Based on the analysis of self-reported DMR bacteria violations by plant size, plants with the lowest discharge rates (<0.1 MGD) are reporting violations with the highest bacteria concentrations overall. This would likely include package plants and WWTFs in smaller communities that are generally operated manually by few personnel. In general, plants of this size are older and may lack the funding necessary to upgrade and improve treatment efficiency leading to the potential of increased water quality permit violations. However, due to the low discharge rate, overall bacteria loading to regional waterways originating from smaller plants would likely only cause localized, acute bacteria problems under certain conditions, particularly in areas where outfalls are clustered. Larger WWTFs are contributing a significantly greater daily volume of effluent and therefore have a higher potential of impacting bacteria levels on a regional scale if significant violations occur on a regular basis.

An important caveat to consider when comparing the bacteria loading results for the various plant size categories is that bacteria sampling is a discrete event, with a sample grabbed at a specific point in time. The sample is also collected at the weir or flume and not at the end of the discharge pipe, so the data does not take bacteria regrowth in the pipe into consideration. Bacteria sample collection is an instantaneous measurement, not a continuous one. However, the loading calculations assume that this instantaneous measurement is representative of the average conditions at the plant. This may not truly reflect average conditions, as minor upsets in the process that may not allow for adequate treatment, such as inadequate disinfection concentration or retention time, discharge of particles in the effluent, etc., can occur intermittently. The likelihood of smaller, mostly unmanned plants to have these types of events is greater than at larger plants, which have a greater presence of operational staff to more quickly identify and rectify operational deviations. Effluent discharges with elevated bacteria concentrations may still occur, but the length of time that high levels of bacteria are potentially being discharged may be greatly reduced by adequate staffing and proactive operation and maintenance activities.

Only 420 out of the 16,416 self-reported DMR records (single grab / daily max samples and geometric mean) submitted in 2017 reported bacteria permit limit exceedances. This equates to approximately 97.4 percent of effluents meeting permit requirements. While upsets and disruptions can occur and cause acute issues, WWTF effluent discharges do not appear to be the primary contributor to chronic bacteria issues in the region. Although WWTFs are contributing bacteria to the receiving waters, because of the high permit compliance, DMR data suggests they are typically discharging effluent with bacteria densities below the primary

contact recreation standard. However, it must be noted that DMR results do not take into account such issues as bacterial regrowth in the outfall pipe. This is an area that requires additional study and data collection (including comparative studies of bacteria data collected at the weir or flume and bacteria data collected at the end of the discharge pipe).

Figure 8 – UV disinfection of wastewater effluent

While WWTFs may show appreciable bacteria contributions under certain conditions, the analysis of self-reported DMR data shows that most WWTFs have few reported bacteria exceedances. Nonetheless, due to the potential impact poor effluent quality can have, continued monitoring and compliance inspections of treatment systems remains an essential component of proper water quality management. It should also be noted that the analyses in the WQMP Update use self-reported data and do not consider such issues as bacterial regrowth, which may result in the contribution from WWTFs to be underestimated. The issue of bacterial regrowth in the discharge pipe should be examined further as data becomes available. Additionally, the WQMP Update focuses on bacteria data. At the suggestion of the NRAC, future iterations of this project may look at self-reported nutrient data.

DMR Analysis Summary

For this Project, H-GAC staff evaluated the occurrence of bacteria violations reported through wastewater treatment facility (WWTF) self-reported Discharge Monitoring Reports (DMRs) in the region for the period of 2012 – 2017. Key findings are as follows:

- Only a small number of bacteria permit exceedances are reported annually, with permit compliance for single grab / daily maximum samples ranging from 93 – 97% and geometric mean compliance at 98 – 99%.

- WWTFs in the two smallest size categories (<0.1 MGD and 0.1 – 0.5 MGD) account for a combined 55% of the total number of treatment plants. While these smaller plants typically have higher average *E. coli* geometric means, the smaller discharge volume keeps the bacteria loading lower in relation to other groups.

- The 1 – 5 MGD plant size category shows the most significant contribution of bacteria loading. This is mainly a function of the total number of facilities, as this size category represents 22% of the total number of WWTFs in the region.

- WWTFs discharging >10 MGD have the highest volume of discharge, but with their very low *E. coli* geometric mean and the relatively small number of plants in this category, *E. coli* loading from this size category is in the mid-range of other categories.

- Larger WWTFs contribute a significantly greater daily volume of effluent, increasing the potential of impacting bacteria levels on a regional scale if significant violations occur on a regular or chronic basis.

- DMR analysis indicates that WWTFs, when functioning correctly, are not likely a significant source of chronic bacteria impairments in the region due to the comparatively few exceedances and the relatively small volumes of effluent overall.

- Typical *E. coli* geometric mean concentrations remain considerably lower than the designated permit limits. This may indicate that most discharges are contributing relatively clean effluent to the receiving waters.

- Due to the potential impact poor effluent quality can have, especially in regards to acute loading, continued monitoring and inspection of treatment systems remains an essential component of proper water quality management.

Sanitary Sewer Overflow (SSO) Data

A Sanitary Sewer Overflow (SSO) is defined as any type of unauthorized discharge of untreated or partially treated wastewater from a collection system or its components (e.g., manholes, lift stations, or cleanouts) before reaching a treatment facility. Issues such as blockages, significant inflow/infiltration, poor operation and maintenance, or inadequate capacity to collect, store, or treat the wastewater can result in SSOs.

Unlike treated WWTF effluent, SSOs represent a high, if episodic, risk because they can have bacterial concentrations several orders of magnitude higher than treated effluent. Untreated sewage can contain large volumes of raw fecal matter, making areas with sizeable and/or chronic SSO issues a significant human health risk under certain conditions.

SSO Reporting

Sanitary Sewer Overflows are self-reported to the TCEQ, with each event linked to the water quality permit number for the facility or subscriber reporting the violation. A permitted facility may be a municipality, municipal water district, private individual, or company. Subscribers of permitted facilities include any municipality, business, or organization acting as a waste contributor or customer of a permitted facility.

Since there is no current minimum reportable volume enforced through state or federal regulations, permitted facilities are required to report all SSOs regardless of volume within 24-hours of becoming aware of the event. Public notification via media outlets is required for any events that discharge a volume of 100,000 gallons or more or have the potential of adversely affecting public or private drinking water sources.

It should be noted that SSO volumes are estimates and are based on visual observations or estimated calculations that can be subjective based on the individual reporting the event.

SSO Violation Data Analyses

This study considered TCEQ SSO violation data from 2011 through 2017. Analysis included an overview of the total number of permittees reporting SSOs by year, the cause of SSOs, and the estimated overflow volume by cause. SSO volumes are estimates based on visual observations or estimated calculations. Therefore, the values reported can be subjective based on the individual reporting the event. Additionally, it is possible that SSOs go undetected in certain conditions and are therefore not documented or reported to the TCEQ. However, self-reported SSO violation reports are the most comprehensive source of data that can be used to evaluate SSO events and their potential impact to regional water quality.

SSO Analysis Results

Figure 9 summarizes the total number of permittees submitting SSO violation reports by year compared to the number of permittees in the region submitting DMR data. Based on these data, SSO violations are being reported by approximately 25 – 30% of the domestic WWTFs within the region.

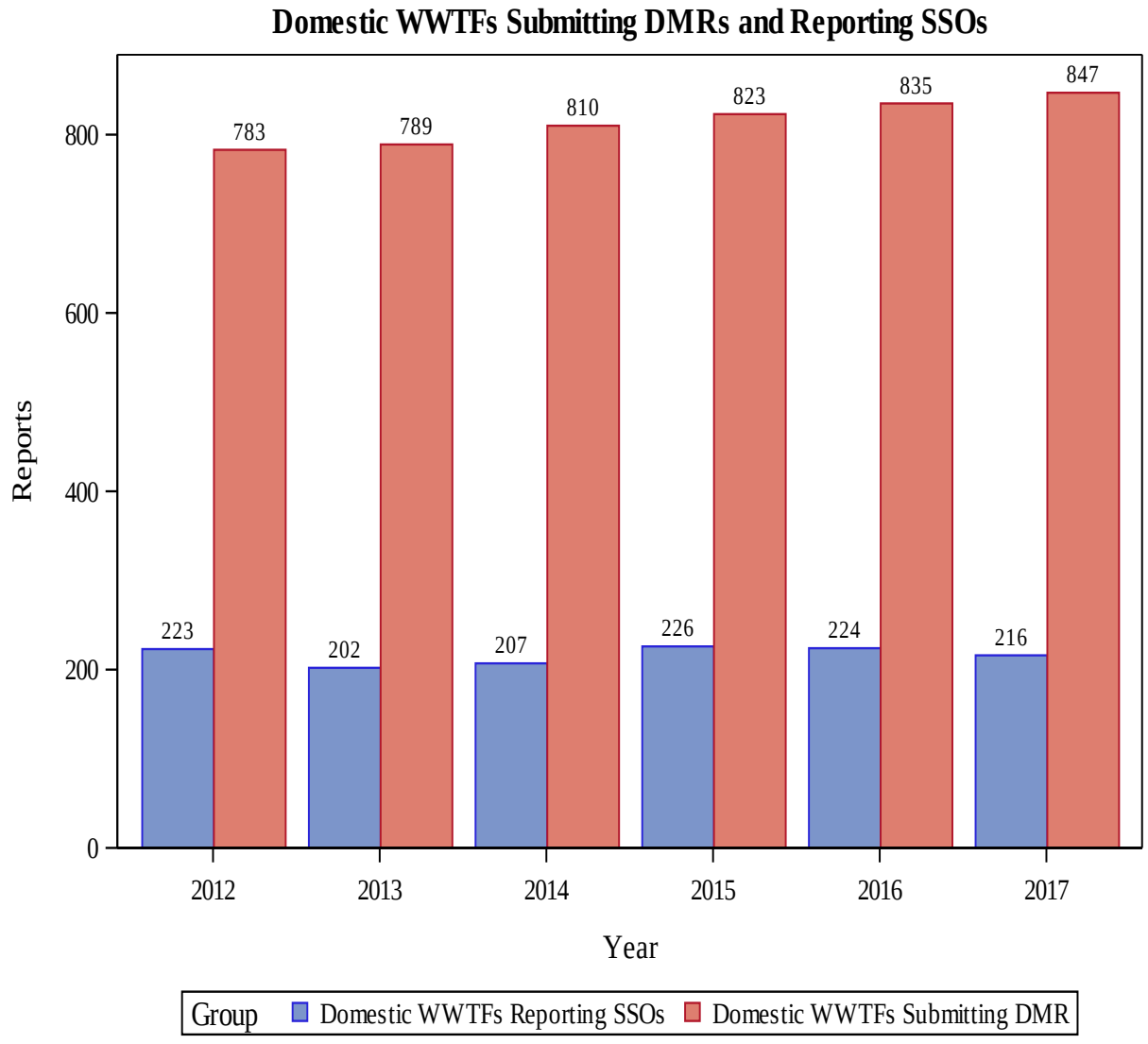

Figure 9 - Total number of permittees reporting SSO violations by year, 2012-2017

The total number of SSO violations and the estimated overflow volumes reported by year from 2011 to 2017 are shown in Table 11.

Table 11 – SSOs and Estimated Discharges by Year

Year	Number of SSOs Reported	Estimated Volume (Thousand Gallons)
2011	2,045	1,894
2012	1,372	7,046
2013	1,434	4,428
2014	1,584	6,622
2015	2,517	28,302
2016	1,568	11,450
2017	3,359	20,720
TOTAL	**13,879**	**80,462**

A significant increase in the occurrence and volume of SSOs is evident in 2017 relative to 2016 (Table 11), although there is not much change seen in the total number of permittees submitting these reports (Figure 9). This could be an indication that some permittees are experiencing chronic SSO issues in localized areas under certain conditions. Table 12 supports this idea by showing that some permittees are reporting SSOs more frequently. For example, over the period between 2011 and 2017, a total of 57 permittees are consistently reporting SSOs on an annual basis, while 345 permittees have never reported an SSO event over the period. This is approximately 40% of WWTFs that have never reported an SSO event over the past 7 years.

Table 12 – Frequency of Reported SSO Events, 2011 - 2017

Number of Years SSO Events Were Reported	Number of Permittees Submitting SSO Reports Over Multiple Years
None Reported	345
1 year	154
2 years	80
3 years	61
4 years	50
5 years	44
6 years	35
7 years	57

SSO causes were separated into four general categories to reflect the breakdown in the SSO database. The causes included in each category are listed in Table 13. It should be noted however that this categorization depends on the accuracy of the data reported by the utilities. Additionally, while a single cause is typically listed on the SSO report, many SSOs are caused by a combination of factors. For example, fats, oils, and grease (FOG) collecting in lift station motors can cause overflows in high rain events when excess water is in a system. The event may be listed as lift station failure, but blockage (due to FOG) and inflow/infiltration of rainwater were also causative elements.

Table 13 – General Categories of SSO Causes

SSO Cause	Inclusions
Blockage (all types)	Blockages due to: • roots/rags/debris, • fats/oils/grease, or • other
Infrastructure/WWTP	• Collection system structural failure, • lift station failure, • WWTP operation malfunction, or • equipment malfunction
Other	• Human error, • power failure, • unknown cause
Rain/INI/Hurricane	• Rainfall, • inflow/infiltration (INI), • hurricane

In recent years, significantly higher precipitation rates and flooding may be the cause for the increased number of SSO events. Figure 10 supports this notion, showing that rain or inflow/infiltration (INI) was reported as the second leading cause for SSOs in 2015 and 2016. In contrast, blockages were more commonly reported during dry conditions, such as in 2011 when the region was experiencing a significant drought.

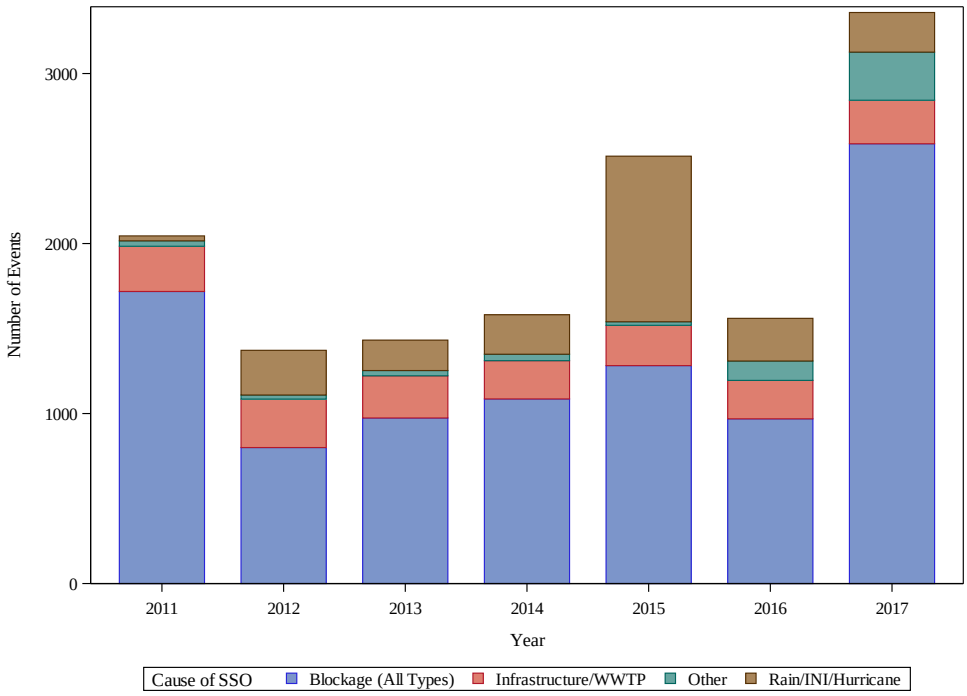

Figure 10 – Cause of reported SSO in the region by year, 2011 - 2017

In 2017, blockages, whether due to roots/rags/debris, fats/oils/grease, or other causes, are the source of the majority of reported SSOs. Blockage was listed as the cause for 2,587 of 3,359 SSOs (77%) reported in 2017 (Figure 11).

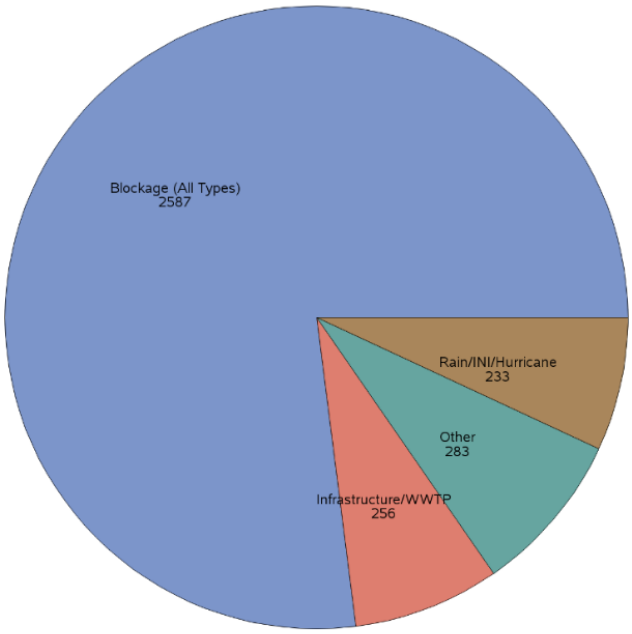

Figure 11 – Cause of reported SSO in the region by year, 2017

Table 14 provides a more detailed breakdown of the reported causes of SSOs, the number of events for each cause, and the estimated volume of discharge due to each cause.

Table 14 – Summary of SSO Reported Causes, 2017		
Reported Cause	**Number of Events**	**Estimated Volume (1000 Gallons)**
Blockage Due to Roots/Rags/Debris	103	786.8
Blockage in Collection System Due to Fats/Grease	989	551.0
Blockage in Collection System-Other Cause	1,495	1,498.6
Collection System Structural Failure	150	543.5
Hurricane	73	11,295.5
Lift Station Failure	80	676.5
Power Failure	14	364.5
Rain / Inflow / Infiltration	160	2,213.2
Unknown Cause	269	1,435.7
WWTP Operation or Equipment Malfunction	26	1,354.5
TOTAL	**3,359**	**20,719.8**

Although the cause of SSOs is important, the volume of discharge reported for each SSO is also a significant factor that should be taken into consideration. Figure 12 ranks SSOs for 2017 by number of events, while Figure 13 ranks them by volume.

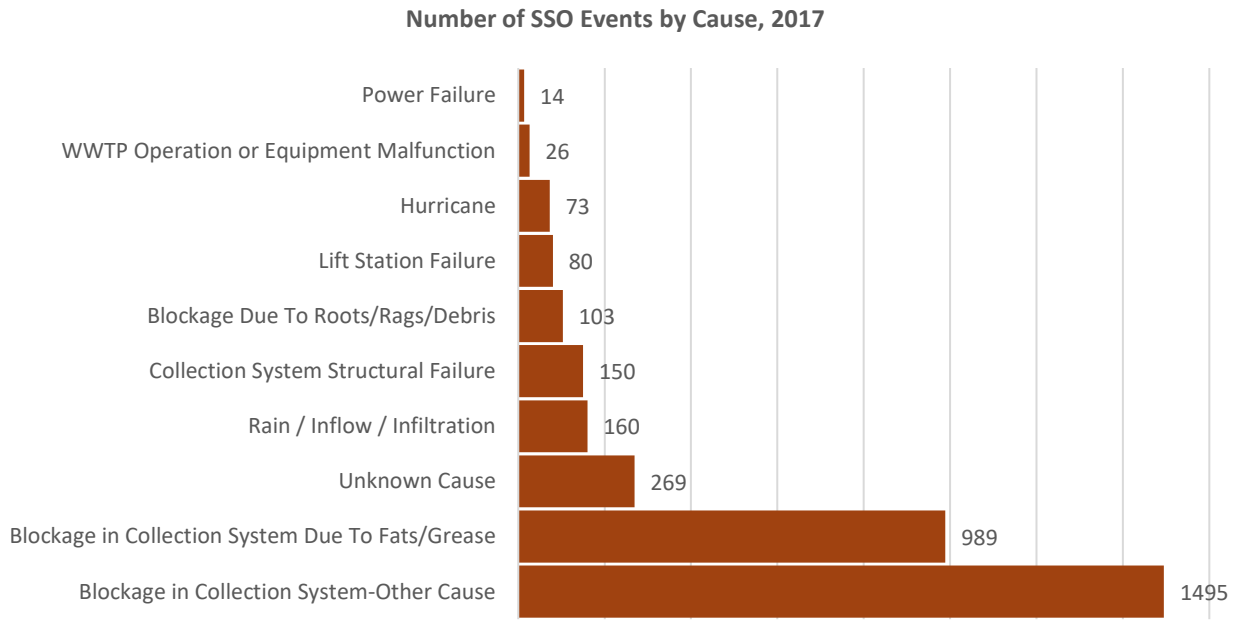

Figure 12– Number of reported SSOs in the region by cause, 2017

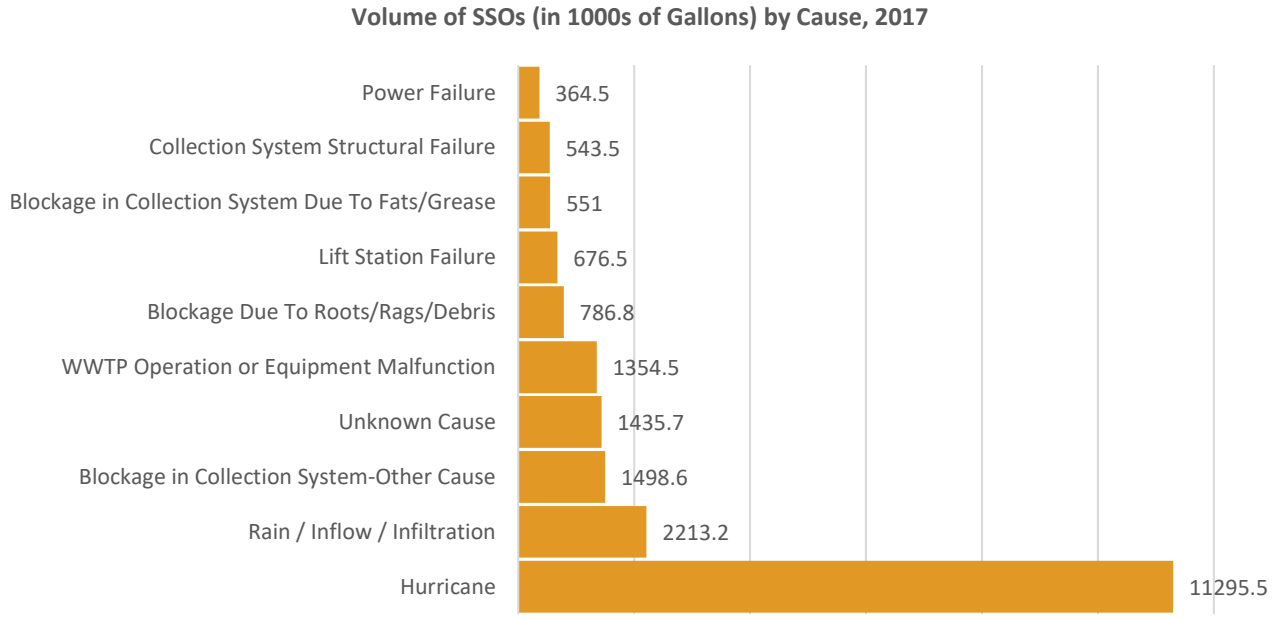

Figure 13 – Volume of SSO discharges (in 1000 gallons) in the region by cause, 2017

Based upon the self-reported data, the majority of SSOs (77%) result from some type of collection system blockage. Although the volume attributable to the three combined blockage categories (14%) is relatively small compared to the overflow volumes from Hurricanes (55%), it does exceed other rainfall or inflow/infiltration causes (11%). It must be pointed out that with self-reported SSO data, the cause of the SSO may be listed as a single cause when in actuality multiple causes were contributing factors.

In 2017, the total number of SSO events caused by blockages equaled 2,587 with a total overflow volume of approximately 2,836,400 gallons. In comparison, the total number of SSO events reported in 2017 caused by inflow/infiltration or significant rainfall (including hurricanes) was only 233, while the total overflow for these events was approximately 13,508,700 gallons.

Figure 14 is a map illustrating the frequency of SSO violations reported in the region between 2012 and 2017 by watershed area. As mentioned previously, SSO events were mapped based on WWTF addresses and service area boundary data. Watersheds with insufficient service area boundary data or no WWTF located within its boundaries are shown as having no data. Figure 15 shows the spatial representation of occurrences of SSO violations.

Based on the locations of reported SSOs, the more populated urban and suburban watersheds throughout the region are experiencing higher rates of SSO violation events compared to the more rural, smaller communities along the outer perimeter of the region. However, it should be noted that some rural communities with small WWTFs and package plants may be underrepresented due to staff and resource limitations resulting in a greater likelihood of SSOs going undetected. Regardless, it is expected that developed areas experience more frequent SSO events due to larger populations putting added strain on the collection systems overall, including contributing fats/oils/greases to the collection system, resulting in a greater frequency of blockages. Also, the amount of impervious cover in urban areas may make SSOs more visibly identifiable, as rural systems may have long runs of pipe between connections or running though undeveloped areas where they may go unseen.

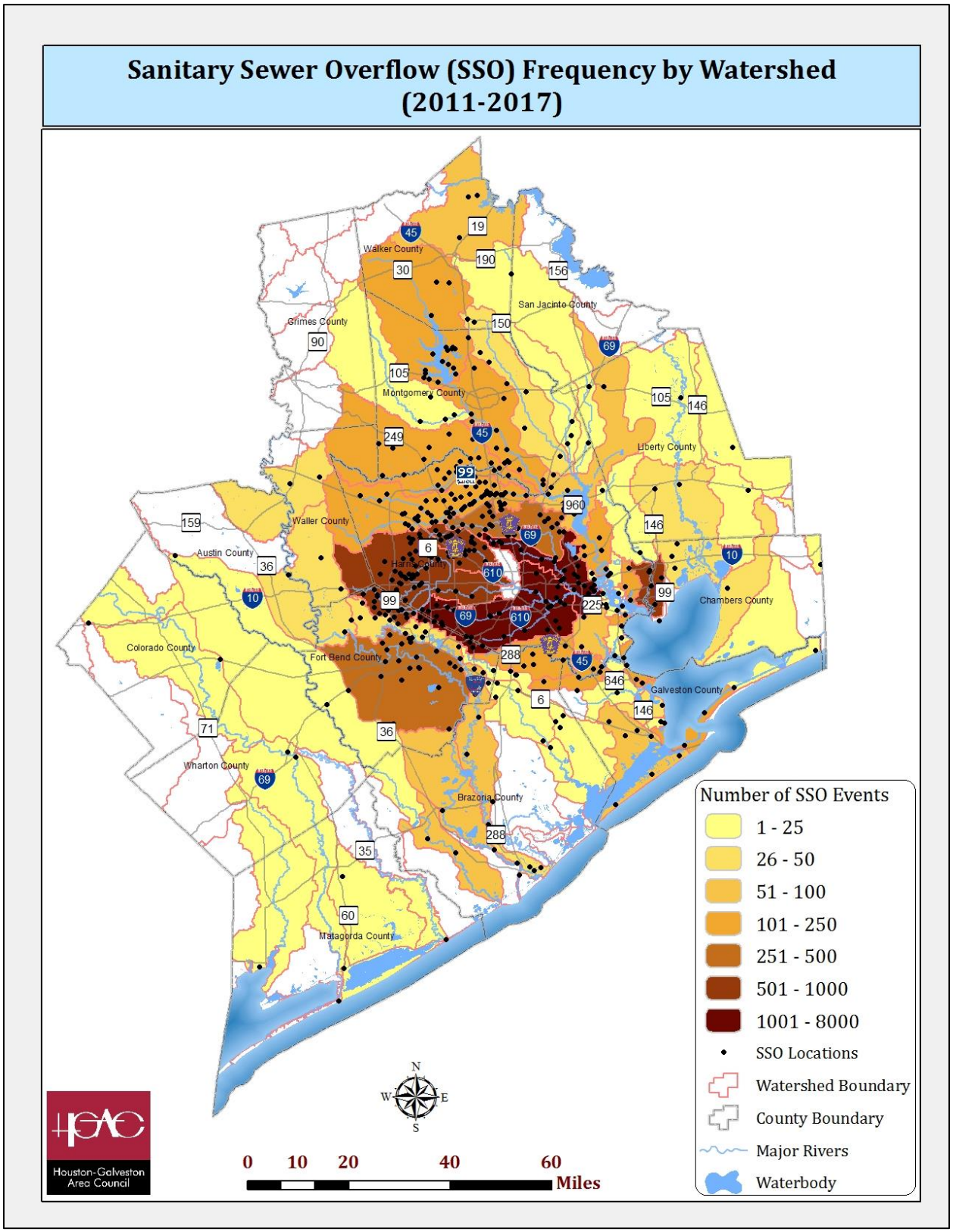

Figure 14 – Frequency of SSOs by watershed reported between 2011 and 2017

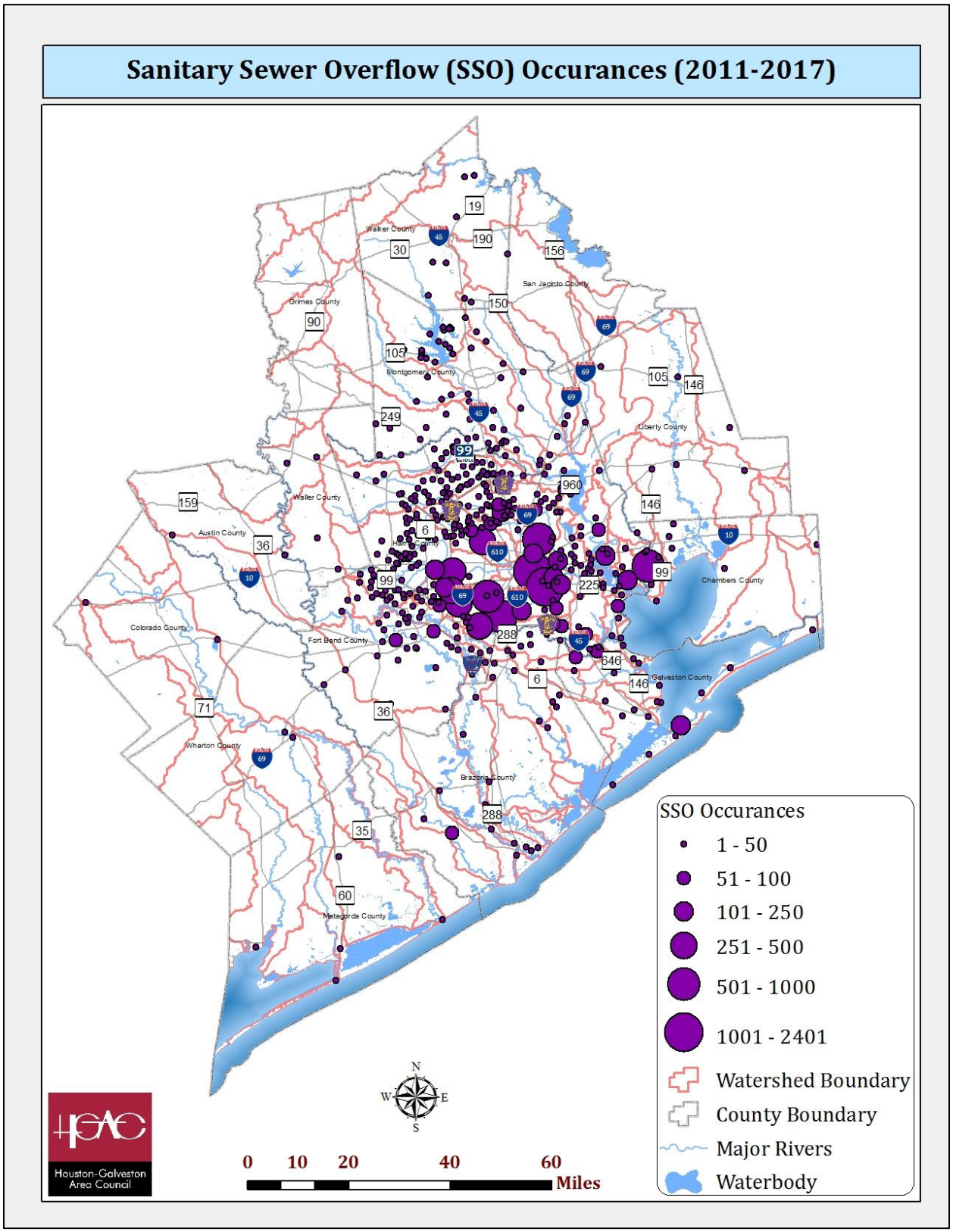

Figure 15 – Occurrences of SSOs by watershed reported between 2011 and 2017

SSO Analysis Discussion

Based on the SSO violation report analyses, the number of SSO events is largely dependent on certain social or climatic conditions. Areas with higher population rates tend to show a significant increase in SSO events likely related to the more frequent occurrence of blockages from fats, oils, and grease. Additionally, highly populated areas generally have more complex sewer systems and require more miles of pipeline to service the populations within their boundaries. With larger, more complex systems, the likelihood of SSOs is also greatly increased. This is especially true during extreme weather conditions such as droughts or heavy rain events, and can clearly be seen by the volume of SSOs directly related to Hurricane Harvey, when several wastewater treatment facilities were completely inundated. As infrastructure continues to age, such factors may exacerbate the rate of SSO events over time. Active maintenance of collection systems is important in managing SSOs, especially during extreme climatic conditions.

Compared to effluent discharges, the volume of discharge from sanitary sewer overflows is much smaller. However, because SSOs involved untreated wastewater, these discharges have a far greater concentration of bacteria. Their concentrations of untreated human waste pose a disproportionately high risk to human health during contact recreation, and their episodic nature can make them an acute risk while they are ongoing. Given their pathogenic potential, inherently close proximity to population centers, and the principle of focusing on those sources within our control, best management practices that reduce the number and volume of SSOs should remain as a priority in the region.

SSO Analysis Summary

For this Project, H-GAC staff evaluated the occurrence of reported sanitary sewer overflows in the region for the period of 2011 – 2017. Key findings are as follows:

- SSOs represent a high potential risk for bacterial contamination due to their elevated bacterial concentrations (as compared to treated wastewater effluent). However, SSOs are generally episodic in nature, with limited duration and flow volumes.

- SSO violations are being self-reported by approximately 25 – 30% of the domestic WWTFs within the region.

- SSO events are reported at higher rates for the more populated urban and suburban watersheds throughout the region, likely due to larger populations putting added strain on the collection systems overall.

- Rural communities with small WWTFs and package plants may be underrepresented due to staff/resource limitations and the long distances between connections, resulting in a greater likelihood of SSOs going undetected.

- Blockages, whether due to roots/rags/debris, fats/oils/grease, or other causes, were listed as the source of 77% of the SSOs reported in 2017.

- The overall SSO volume resulting from blockage events (14%) is relatively small compared to the overflow volumes events caused by hurricanes plus significant rainfall and inflow/infiltration (65%).

- As infrastructure continues to age, this may exacerbate the rate of SSO events over time. Active maintenance of collection systems is important in managing SSOs, especially during extreme climatic conditions.

- Best management practices that reduce the number and volume of SSOs should remain as a priority in the region. This is due to their high pathogenic potential, proximity to urban populations, and the principle of focusing on those sources that are within our control.

Conclusions

Bacteria impairments continue to be the leading water quality issue throughout the region. High bacteria concentrations in area waterways have the potential to cause gastrointestinal illness to those who come into direct contact with contaminated waters. Analysis of self-reported WWTF data provides a means by which decision makers and water resource managers can evaluate the role wastewater infrastructure plays in regional water quality issues.

Based on the analysis of bacteria permit limit exceedances self-reported through WWTF DMRs between 2012 and 2017, WWTF effluent discharges are not likely a significant driver of regional bacteria impairments, provided that the plant is operating correctly. Due to the comparatively few exceedances and the relatively small volumes of effluent discharges overall, WWTFs are not likely to be a source of chronic bacteria issues. However, episodic discharges of elevated bacteria concentrations can result in acute issues at a localized level, and a cumulative effect may occur when outfalls are spatially close to one another. Data analyzed for this project also does not consider the possibility of bacterial regrowth in the discharge pipe, and therefore the actual bacteria contribution may be underestimated. This is an area that warrants future study as data becomes available.

Sanitary sewer overflows of untreated wastewater contain elevated bacteria concentrations. However, the intermittent and irregular nature of SSOs, in conjunction with relatively minor overflow volumes and short durations, somewhat lessens their potential to be leading sources of bacteria in area waterways. However, given their pathogenic potential, inherently close proximity to urban and suburban populations, and the principle of focusing on those sources within our control, best management practices that reduce the number and volume of SSOs should remain as a priority in the region. Additionally, leaking pipelines and illicit discharges are more difficult to track than surface overflows and may be significant contributors of bacteria to area waterways. Additional targeted bacteria monitoring projects are recommended to improve the identification of such bacteria sources.

Due to aging infrastructure and continued population growth in the region, the integrity of treatment and collection systems may be adversely impacted, leading to an increase in WWTF bacteria permit exceedances, SSO events, and leaking pipelines. It is important to continuously monitor these systems over time to ensure best management practices, repairs, or system replacements are implemented in areas that need it most. Active maintenance of collection and treatment systems becomes increasingly important in extreme weather conditions such as during a drought or following a flood event.