BACTERIA IMPLEMENTATION GROUP

Monitoring and Research Workgroups
Meeting Agenda
Monday, May 7, 2018
1:00 PM to 3:00 PM
H-GAC, Conference Room A

Call to Order/Welcome/Introductions

Review Notes from April 3, 2017 Meeting

Discussion: Preparing BIG 2018 Annual Report – I-Plan Strategy 9.0 Mon. and 10.0 Research

Workgroup will:

- review the 2017 Annual Report,
- review the timeline for preparing the 2018 report,
- report on implementation activities accomplished in the 2017 calendar year,
- review and discuss graphical representations of the moving bacteria geometric mean,
- discuss expectations for the 2018 Annual Report, and
- discuss focus and priorities for 2018 calendar year.

Discussion: Review I-Plan Strategy 9.0 Monitoring and 10.0 Research Language

Workgroup will:

- review approved I-Plan wording
- discuss potential editorial changes
- agree on any updates, and
- develop recommendations, if necessary, that will be presented at the annual BIG meeting for approval.

Adjourn

Upcoming Meeting Schedule

BIG Annual Meeting: 1:00 PM on 6/5/2018

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To call in, dial 713-481-0090 (or 800-240-3895). You will be asked to enter your pass code, followed by the # sign. The pass code is 1084242. If you dial in before H-GAC, you will hear "music on hold". Once H-GAC dials in, the music will cease and the conference call will begin. During the course of the conference, you may hear beeps. A single beep indicates someone has joined the conference call. A double beep indicates someone has left the conference call. Remember--if you do press hold, everyone will hear your hold music.

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BACTERIA IMPLEMENTATION GROUP

Monitoring and Research Workgroups
Meeting Summary
Monday, April 3, 2017
1:00 PM to 3:00 PM
H-GAC, Conference Room A

Call to Order/Welcome/Introductions

Zafar Ahmed (COH), Camila Biaggi (Harris Co.), Linda Broach (TCEQ), Glenda Callaway (East and West Fork San Jacinto River), Danielle Cioce (Harris Co.), Tom Ivy (Public), Linda Pechacek (Public), Robert Snoza (HCFCD)

Review Notes from January 26, 2016 Meeting

Work group reviewed the summary from the previous meeting.

Discussion: Preparing BIG 2017 Annual Report – I-Plan Strategy 9.0 Mon. and 10.0 Research

Work group reviewed the 2016 Annual Report and timeline for preparing the 2017 report. H-GAC provided update CRP and TST information which included stations added due to East and West Fork of the San Jacinto River project area being added. It was also noted that a new CRP partner from Sam Houston State University was added. This was a result of the East and West Fork stakeholder process and interest in additional monitoring in rural East Fork of the San Jacinto River portions of the project area. Work group members were interested in a non-ambient monitoring bmp result summary that evaluates effectiveness of measures.

Discussion: Review I-Plan Strategy 9.0 Mon. and 10.0 Research Language

Workgroup reviewed approved I-Plan wording and did not suggest potential changes. H-GAC noted that the 5th year of implementation would be captured in 2017 and that it would be the right time to begin to consider changes to the I-Plan.

Adjourn

Upcoming Meeting Schedule

BIG Annual Meeting: 1:00 PM on 5/23/2017

Monitoring and I-Plan Revision

9

Summary

To assess I-Plan progress, the BIG is required to monitor ambient water quality data and the progress of all implementation activities. Using these data, the BIG produces this annual report. This keeps BIG stakeholders apprised of progress and helps to determine if the I-Plan or any of its individual elements require revisions to their implementation strategies or schedules. The monitoring data will be an important indicator of whether I-Plan guidance results in the desired reduction of bacteria loading. A more in-depth evaluation will occur every five years, as resources are available and with stakeholder participation.

The review will address answers to the following questions:

- Do ambient water quality monitoring data indicate that bacteria levels are changing?
  - If so, are the bacteria levels increasing or decreasing?
- Are implementation activities and controls being undertaken as described in the I-Plan?
- Which activities have been implemented and which have not?
- Do non-ambient water quality monitoring data indicate implementation activities are reducing bacteria loads?

Ambient vs. Non-Ambient

Ambient monitoring routinely collects data without selecting for special conditions.

Non-ambient monitoring targets data collection for a specific often non-routine purpose and considers special conditions such as time, precipitation events, and location.

The Monitoring and Plan Revision Workgroup met jointly with the Research Workgroup on April 3, 2017, with eight members in attendance. Under modifications to the I-Plan (Activity 9.4), the BIG approved a modification to the I-Plan which lead to the East and West Fork of the San Jacinto watershed to fully joining the BIG project area. BIG stakeholders reported continued collection of non-ambient sampling tied to BMPs. H-GAC continued to develop the BIG Regional Implementation Plan tracking database and several organizations completed BMPs in 2016.

2017 Focus

- H-GAC and BIG stakeholders aim to
  - Continue ambient water quality monitoring and analysis;
  - Strengthen implementation tracking and coordination of non-ambient efforts through completion and analysis of data; and
  - Continue to develop a BIG Regional Implementation Plan Database.

Implementation Strategies

9.1 Continue to Utilize Ambient Water Quality Monitoring and Data Analysis

Interim Measure: Each year, H-GMC and BIG stakeholders will monitor ambient water quality to help determine if waterbodies are meeting state standards for bacteria.

Project Status

Not Started	Behind Schedule	*– This activity is On Schedule to meet the annual target.*
Initiated	**On Schedule**	
In Progress	Ahead of Schedule	
Completed		

Implementation Effort

- **Texas Stream Team (TST).** In 2016, there are nineteen volunteer TST monitors actively monitoring sites in the BIG Project Area. Four additional monitors are scheduled to complete their Phase III training in 2017. They will be monitoring the East and West Fork of the San Jacinto River.
- **H-GAC's CRP.** H-GAC's Clean Rivers Program (CRP) continues to be the primary vehicle for water quality monitoring and data analysis in the project area (see Appendix F). Data is used to develop geometric means for each segment in the BIG Project Area (see Appendix G):
    - The 2017 Basin Highlights Report How's the Water? Is an interactive web-based report on water quality impairments and trends based on data collected by eight organizations at 208 sites ((includes 11 in the Armand Bayou and 24 in the East and West Fork San Jacinto River (E&W Fork) watershed)) within the BIG project area (Table 7). http://arcgis02.h-gac.com/BHR2017/index.html
    - There is a total of 125 watershed segments in the BIG project area. Those segments are broken down into 179 assessment units (AUs). One hundred and fourteen (114) of the AUs are considered impaired and another 3 AUs listed as a concern due to bacteria concentrations above the state's water quality standards. In 2016, it was observed that 38 AUs are improving, 7 AUs appear to be getting worse, 84 exhibit no change, and 50 were not assessed (Figure 9).
    - CRP gathered observations of contact recreation while gathering ambient water quality data. Of the 173 stations monitored by CRP partners in 2016 in the BIG project area, CPR monitors recorded at evidence of contact recreation at 21 stations. CRP monitors noted direct observations of 54 individuals engaged in a contact recreation activity while onsite (Table 8).

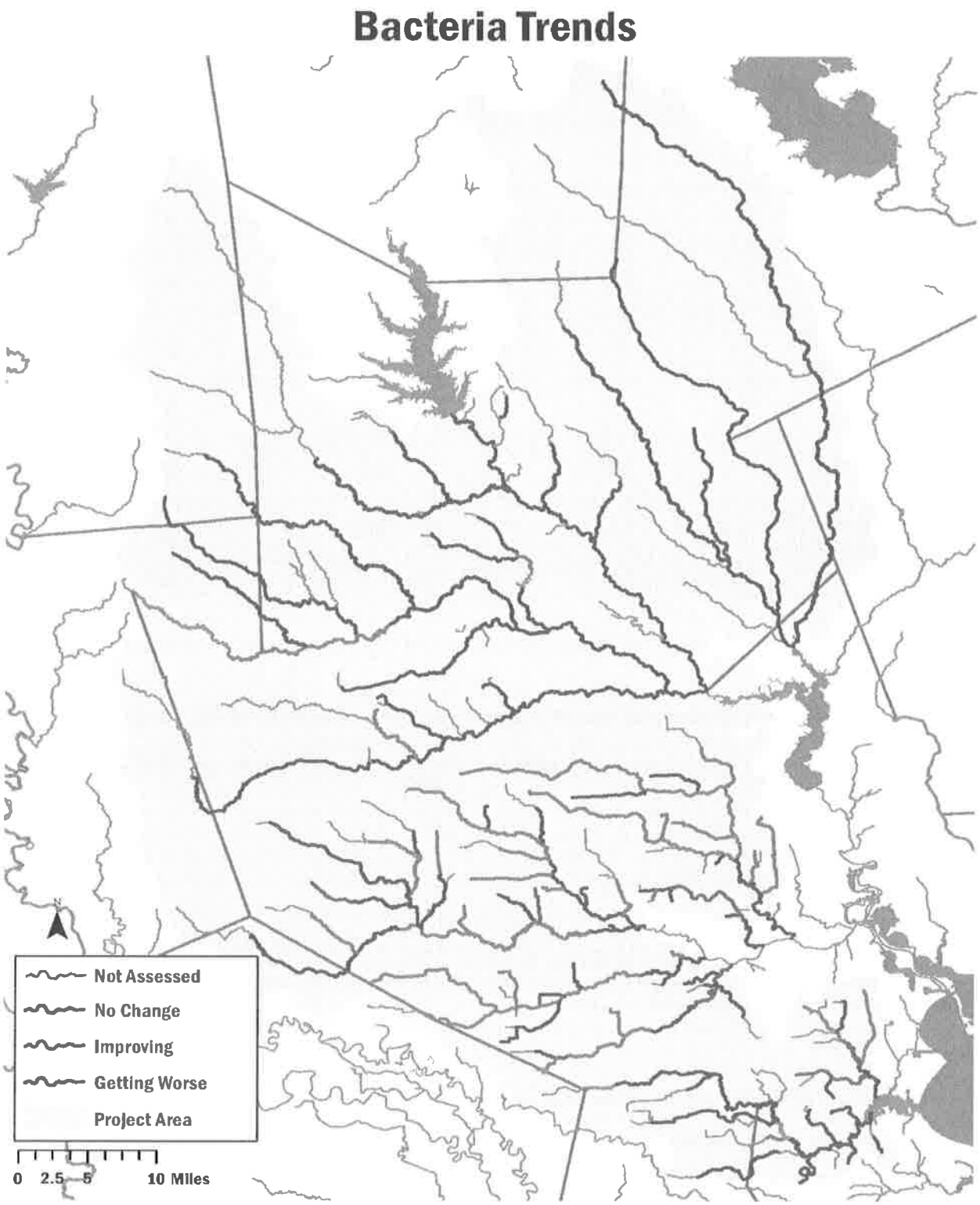


Figure 10 Improving, degrading, no change or not assessed watershed segments (and AUs) in the BIG project area. Much of the improvement is found in the BIG's original project area.

Table 7. CRP Monitoring in the BIG Project Area

Organizations	*Number of Stations in Initial BIG Project Area*	*Number of Stations in Armand Bayou*	*Number of Stations E&W Fork*	*Total Number of Stations*
TCEQ	14	4	2	20
Environmental Institute of Houston	10	0	0	10
Harris County Pollution Control	1	1	0	2
Houston Health and Human Services	119	6	0	125
Houston Water Quality Control	7	0	6	13
San Jacinto River Authority	9	0	0	9
Houston-Galveston Area Council	13	0	6	19
Texas Research Institute for Environmental Studies	0	0	10	10
Total	173	11	24	208

Table 7. CRP monitoring partners and the number of monitoring stations in the initial BIG Project Area and stations in the Armand Bayou area.

Table 8. CRP Stations with Contact Recreation Observed or Inferred 2012-2015

Year	*Evidence of Contact Recreation Observed or Inferred*	*Individuals Observed Involved in Contact Recreation*
2012	16	16
2013	25	79
2014	18	27
2015	22	38
2016	21	54

Table 8. During routine ambient monitoring, CRP partners record observed or inferred evidence of contact recreation. IF evidence of contact recreation, either observed, i.e. a person swimming, or inferred, i.e. a rope swing, then the monitor recorded contact recreation occurring at the site. If people were observed, CRP monitors document the number of individuals recreating at the time.

9.2 Conduct and Coordinate Non-Ambient Water Quality Monitoring

Interim Measures: H-GAC and BIG stakeholders will conduct non-ambient water quality monitoring activities including

- *Developing a regional Quality Assurance Project Plan (QMAA); and*
- *Developing a regional non-ambient monitoring database.*

Project Status

Not Started	Behind Schedule	– This activity is On Schedule.
Initiated	**On Schedule**	
In Progress	Ahead of Schedule	
Completed		

Implementation Effort

- **Non-Ambient Water Quality Monitoring QAPP.** There are currently two non-ambient water quality monitoring QAPPs that have been approved by the TCEQ:
  - BPA project. The City of Houston is working on improvements to Almeda Road in the Medical Center area as part of Urban Street Rebuilds that will include LID. BPA completed the QAPP and began collecting preconstruction water quality sampling for the project. BPA will follow up with a post construction sampling once the LID features are installed.
  - H-GAC Top 5/Least 5 Project. H-GAC completed the non-ambient monitoring QAPP and started to collect bacteria samples in hopes of detecting illicit discharges from BIG waterbodies identified on the Top Ten prioritized lists.

- **Regional BMP Database.** The HCFCD developed a regional BMP database modeled on the International Stormwater BMP Database. Currently, the database includes monitoring information for stormwater BMP projects developed by the HCFCD, as well as other BMP projects in the region. (www.bmpbase.org/LandingPage.aspx)

- **Monitoring Data Implementation.**
  - The City of League City and the Texas Coastal Watershed Program (TCWP) completed the Gharardi Watersmart Park which contains monitored BMPs. The monitoring portion was completed in 2015 and TCWP reported project results in 2016.
  - BPA completed a QAPP and conducted preconstruction water quality sampling in 2016 prior to installation of a LID project on Almeda Rd., part of the Urban Street Rebuilds project.
  - BPA continued to conduct non-ambient monitoring to track down sources of bacteria in the BIG project area. For more details, see section 11. Geographic Priority Framework.
  - Harris County Birnamwood Drive LID monitoring project continues to collect water quality and quantity data. The county intends to prepare a final report in 2017.
  - Harris County collected water quality data as part of the feral hog removal project in Addicks and Barker reservoirs. Data collection and analysis was completed in 2015. The county reported on project results in 2016.
  - Environmental Institute of Houston (EIH) at the University of Houston – Clear Lake retrofitted a detention basin in the Armand Bayou Watershed with a stormwater wetland to improve run-off in 2012. Wetland monitoring for water quality and habitat quality parameters was completed in August 2014. EIH has begun to share the results with resource agencies and interested parties, for more information contact EIH. (www.eih.uhcl.edu)

Figure 11. The City of Houston Urban Street Rebuild on Almeda Road automated sampler for the BPA LID BMP preconstruction monitoring project.

9.3 Create and Maintain a Regional Implementation Activity Database

Interim Measure: Each year, BIG stakeholders will provide a report on the activities they implemented during the year. H-GMC will compile and share this information in a database.

Project Status

Not Started	Behind Schedule	– *This activity is On Schedule and has met the annual target.*
Initiated	**On Schedule**	
In Progress	Ahead of Schedule	
Completed		

Implementation Effort

- **Regional Implementation Activity Database.** H-GAC continued to develop the implementation database that includes a web application in 2015. The implementation database will include provisions for local reporting efforts and provide annual tracking forms to collect information. (http://h-gac.maps.arcgis.com/apps/MapSeries/index.htm l?appid=a75ba4bb46ca40658066c5755a8dba6e)

9.4 Assess Monitoring Results and Modify I-Plan

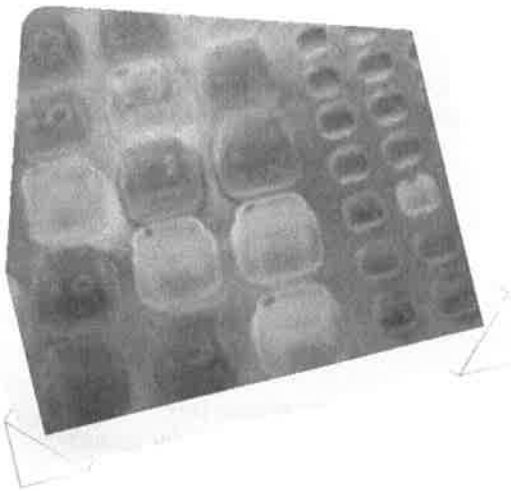
Interim Measure: Each year, H-GAC will assess monitoring in annual reports to identify whether progress is being made and communicate the results to the BIG. The BIG will determine if changes or updates to the I-Plan are needed.

Project Status

Not Started	Behind Schedule	– *This activity is On Schedule and has met the annual target.*
Initiated	**On Schedule**	
In Progress	Ahead of Schedule	
Completed		

Implementation Effort

- **BIG Bacteria Trend Line.** The BIG project area bacteria trend line continues to show improvements (see Appendix B). However, it seems that progress has slowed in the past year. H-GAC will continue to review available data to determine trends in bacteria levels.
- **Non-Ambient Water Quality Monitoring.** Data has not been provided to H-GAC at this time to understand the impact of specific implementation activities that have been undertaken in the BIG project area. However, there are projects underway that will be able to provide data and analysis:
  - The HCFCD BMP database
  - Harris County Birnamwood Drive LID monitoring project
  - The City of League City and TCWP Gharardi Watersmart park
  - The BPA LID project on Almeda Rd.
  - H-GAC Top 5/Least 5
- **Modifications to the I-Plan.** Workgroups reviewed the I-Plan to determine if any modifications might be needed.
  - On October 25, 2016, the BIG approved Addendum #3 to the I-Plan which added seven new assessment units within the BIG project area where TMDLs were completed and approved by TCEQ, for segments in the East and West Fork of the San Jacinto watershed. With this modification, there are 102 impaired assessment units in the BIG project area.



Research

10

Summary

BIG stakeholders support new research initiatives that could result in useful findings and recommendations for reducing bacteria. TMDL studies provide a general overview of the extent and source of the presence of bacteria. However, these studies are not sufficient to determine the most cost- effective courses of action to achieve water quality standards for contact recreation. The BIG has identified three top research priorities: 1) effectiveness of stormwater management activities, 2) bacteria persistence and regrowth, and 3) appropriate indicators to identify health risks presented by contact recreation in impaired waters.

These topics are pertinent to the entire project area. However, research is often driven by the availability of resources. While some research is being conducted within the region, BIG's active participation and advocacy at the state and national levels will help ensure regional priorities are addressed. Local participation will also help to ensure findings and recommendations produced elsewhere are transferable to the project area.

On April 3, 2017, the Research Workgroup met jointly with the Monitoring and Plan Revision Workgroup. Eight stakeholders reviewed data related to ambient and non-ambient water quality. They discussed the status of bacteria studies and potential future research.

2017 Focus

- H-GAC and BIG stakeholders aim to
  - Continue existing research and evaluate available data sources; and
  - Secure funding for additional projects, including.
    - analysis of E. coli species colonizing soil,
    - bacteria seasonal variation study,
    - determining location of a representative sample at a WWTF, and
    - appropriateness of a single grab maximum vs. a geometric mean in evaluating compliance.

Implementation Strategies

10.1 Evaluate the Effectiveness of Stormwater Implementation Activities

Interim Measure: BIG stakeholders will monitor current and future stormwater project effectiveness.

Project Status

Not Started	Behind Schedule	– *This activity is On Schedule.*
Initiated	**On Schedule**	
In Progress	Ahead of Schedule	
Completed		

Implementation Effort

- **BMP Monitoring.**
  - HCFCD actively monitors several stormwater sites within the region and developed a Regional BMP Database where stakeholders can access and evaluate effectiveness data. (www.bmpbase.org)
  - City of League City, in cooperation with TCWP, installed a BMP park. Monitoring of the BMPs was completed in 2015.
  - Harris County Birnamwood Drive LID monitoring project continues to collect water quality and quantity data. Harris County is preparing a report for release in 2017.
  - BPA completed in 2015 a QAPP and is starting preconstruction water quality sampling prior to installation of a LID project on Almeda Road, part of the Urban Street Rebuilds project.
  - H-GAC developed a LID web resource page. (www.h-gac.com/community/low-impact-development/resources. aspx)

10.2 Further Evaluate Bacteria Persistence and Regrowth

Interim Measure: BIG stakeholders will conduct special studies to better understand the extent of human contributions to bacterial loading. Data from these studies should be included in monitoring databases...

Project Status

Not Started	Behind Schedule	– *This activity is On Schedule.*
Initiated	**On Schedule**	
In Progress	Ahead of Schedule	
Completed		

Implementation Effort

- **Special Studies.**
  - The City of Houston, Harris County, and HCFCD continue to implement the Unified Ambient Water Quality Monitoring Program to quantify diurnal bacteria fluctuations in area waterways)
  - Texas Water Resources Institute received an award in 2016 from the GBEP to start a BST project in 2017.

10.3 Determine Appropriate Indicators

Interim Measure: H-GAC and BIG stakeholders should help determine the need for alternative, supplemental, or multiple bacteria indicators to refine the I-Plan.

Project Status

Not Started
Initiated
In Progress
Completed

Behind Schedule
On Schedule
Ahead of Schedule

– Overall t*is activity is On Schedule.*

Implementation Effort

- **Tracking Indicator Research.** BIG tracks ongoing and future research to identify potential indicator bacteria, as funding is made available:
  - EPA completed a review of Coliphages as potential replacement to current fecal indicator bacteria. EPA plans to continue study in 2016.
    - EPA. "Review of Coliphages as Possible Indicators of Fecal Contamination for Ambient Water Quality", April 17, 2015. EPA Office of Water – Office of Science and Technology Health and Ecological Criteria Division. Document 820-R-15-098.

10.4 Additional Research Topics

Interim Measure: H-GAC and BIG stakeholders should conduct additional research on WWTFs, health risks, recreational use, land use modeling, unimpaired waterways, nutrients, and other constituents as funds are available.

Project Status

Not Started
Initiated
In Progress
Completed

Behind Schedule
On Schedule
Ahead of Schedule

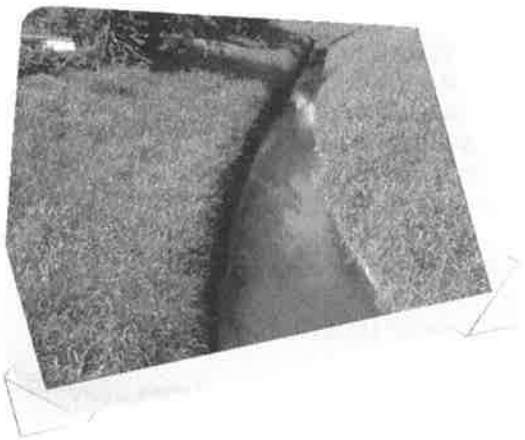
– Activities are *On Schedule.*

Implementation Effort

- **Research Abstracts.**
  - WWTF:
    - Kuo, Jeff and Chi-Chung Tang, "Disinfection of Wastewater Effluent: Comparison of Alternative Technologies." Water Environment Research Foundation. Stock No. 04HHE4. WWW.WERF.Org.
    - Roseman, Jeffrey H., "Innovative Methods in Wastewater Disinfection,"Aqua Ion Plus. Dec. 2004.
    - Erdal, Ufuk G., Innovative/Emerging Wastewater Disinfection Technologies," CH2MHill. Presentation. uerdal@ch2m.com.
    - Ames, Iowa. Wastewater Disinfection Study for the City of Ames, Iowa. Stanley Consultants, Inc. Dec. 2009.
    - Bell, Katherine Y. and Allegra da Silva, "Innovations in Wastewater Disinfection Technology," CDM Smith. 830 Crescent Centre Dr., Suite 400, Franklin, TN 37067.
    - Leng, June, "Wastewater Reuse Treatment Technologies," HDR, Inc.. Presentation. June 2007. jleng@hdrinc.com.
    - State of California. Treatment Technology Report for Recycled Water. January 2007.

- OSSF:
  - Leverenz, Harold, et. al., "Evaluation of Disinfection Units for Onsite Wastewater Treatment Systems," Center for Environmental and Water Resources Engineering, University of California, Davis, CA. Report No. 2006-1. January 2006.
  - Fedler, Clifford B., et. al."Review of Potential Onsite Wastewater Disinfection Technologies," Texas Onsite Wastewater Treatment Research Council. Project No. 582-11-11054. TCEQ. Texas Tech University, Lubbock, TX. December 2012.
- Stormwater:
  - Clary, Jane, et.al. "Can Stormwater BMPs Remove Bacteria?" International Stormwater BMP Database. May 2007.
  - Clary, Jane, et. al. "Pathogens in Urban Stormwater Systems," Urban Water Resources Council. August 2014.
  - Jeong, Jaehak, and Roger Glick, "Application of the SWAT Hydrologic Model for Urban Stormwater Mangement," Presentation. City of Austin and Texas A&M Univiersity/TX AgriLife. UT Arlington, June 5, 2015.
- Agriculture:
  - Wagner, Kevin, "Improving Water Quality of Grazing Lands," Presentation. Texas Water Resources Institute, Texas Agricultural Experiment Station, Texas A&M University System.
  - Collins, Rob, et. al., "Best Management Practices to Mitigate Fecal Contamination by Livestock of New Zealand Waters," New Zealand Journal of Agriculture. 2007.

- **Future Research Topics.** BIG members recommended research, should additional funding become available, including
  - fate and transport of streambed and streambank sediments and associated bacteria and nutrients with the stream water column;
  - wet sieve analysis;
  - sample dilution;
  - use of filters smaller than 0.45 µm.; and
  - testing sludge blankets from wastewater treatment facilities.



11 Geographic Priority Framework

Summary

For the BIG project area to achieve state standards for contact recreation, a wide range of community stakeholders must be responsible for implementing the I-Plan. While some initiatives span the entire project area, others focus on targeted watersheds.

As regional organizations and local jurisdictions work to establish their priorities, they should consider five main categories of concern: 1) bacteria level, 2) accessibility of waterbody, 3) use level, 4) implementation opportunities, and 5) future land use changes. To assist with prioritization, H-GAC continues to publish the Top Ten "Most Wanted"/" Most Likely to Succeed" lists (Top 10 lists) based on either the 10 assessment units with the highest observed concentrations or the 10 assessment units with concentrations just above the contact recreation standard.

2017 Focus

- H-GAC and BIG stakeholders aim to
  - Host meetings in regional watersheds to encourage local stakeholder feedback and participation;
  - Continue to use the Top 10 streams lists to prioritize implementation; and
  - Use the Top 5/Least 5 Project, to begin addressing the Top 10 lists using funding provided by GBEP.

Implementation Strategies

11.1 Consider Recommended Criteria When Selecting Geographic Locations for Projects

Interim Measure: Communities should consider bacteria, accessibility, opportunities, use, and future use when selecting locations for projects.

Project Status

Not Started	Behind Schedule	– *This activity is Ahead of Schedule. Priority criteria have been developed and are in use. Activity requires tracking to ensure stakeholders continue to prioritize implementation.*
Initiated	On Schedule	
In Progress	**Ahead of Schedule**	
Completed		

Implementation Effort

- **BIG's Geographic Prioritization.** H-GAC cross compared the 2015 and 2016 Top 10 "Most Wanted "streams and Top 10 "Most Likely to Succeed" streams (see Appendices H and I):
  - Two assessment units (AUs) improved between 2015 and 2016 but still remain on the list: 1013C_01 and 1016D_01,
  - Two AUs remained unchanged: 1007F_01 and 1007U_01,
  - Four AUs degraded slightly between 2015 and 2016: 1017_04, 1007I_01, 1007T_01 and 1017E_01,
  - Two AUs degraded and are new to the 2016 list: 1004A_01 and 1013A_01, and
  - Two AUs improved and dropped off the list: 1007R_01 and 1014A_01.
- **Top 10 "Most Likely to Succeed" List**. (Appendix I)
  - Three AUs improved between 2015 and 2016 and remained on the list: 1113_02, 1008C_02 and 1113C_001,
  - Three AUs did not change status: 1113A_01, 1102A_02 and 1010_02,
  - One AU degraded slightly between 2015 and 2016: 1008E_01,
  - Three AUs are new to the list: 1008A_01, 1016A_02and 1011_02, and
  - Three AUs dropped from the list: 1008I_02, 1007A_01 and 1016B_01.
- **Top Five/Least Five Project.** Continuing in 2016, H-GAC and BIG partners have been using the Top Ten Lists to investigate five AUs from each list, screening for bacteria, seeking to identify potential sources and reporting those sources to local jurisdictions. All monitoring is being collected under a TCEQ approved QAPP. Any sources that were reported as corrected will receive follow up monitoring to verify improved conditions.
- **Top 10 "Most Wanted" Streams List.** Bayou Preservation Association and the City of Houston are working together to tackle the "Most Wanted" list. BPA conducts reconnaissance and additional wet and dry weather monitoring to track down bacteria source locations. When likely targets are identified, the information is passed on to the City of Houston or other local authorities to address.

Implementation Strategy 9.0: Monitoring and I-Plan Revision

In order to assess progress toward reducing bacterial loading, the BIG will need to evaluate, on a regular basis, the results of ongoing monitoring. This evaluation will be used to determine any changes that are necessary to this I-Plan.

The I-Plan is to address a period of 25 years. However, given the many unknowns pertaining bacteria sources, the cost-effectiveness of management activities, and the availability of resources for implementation, this time frame is provisional. As such, it will be important to continually track both actions taken and instream bacteria levels to gauge the rate of progress and adapt the strategy accordingly.

Monitoring and annual evaluation will determine if the I-Plan or any of its parts are complete, must address a longer time frame, or require revision. Every five years, as resources are available and with stakeholder participation, a more in-depth evaluation will be completed.

Monitoring of both ambient and non-ambient water quality, as well as the implementation activities in this plan, will form the basis for an annual report to be prepared by H-GAC. Conclusions derived from post-implementation water quality monitoring data will be an important indicator of whether implementation activities are resulting in the desired reduction of bacteria loading. The contents of the report will be reviewed by the BIG to determine strategic changes that are necessary to the I-Plan in order to improve progress.

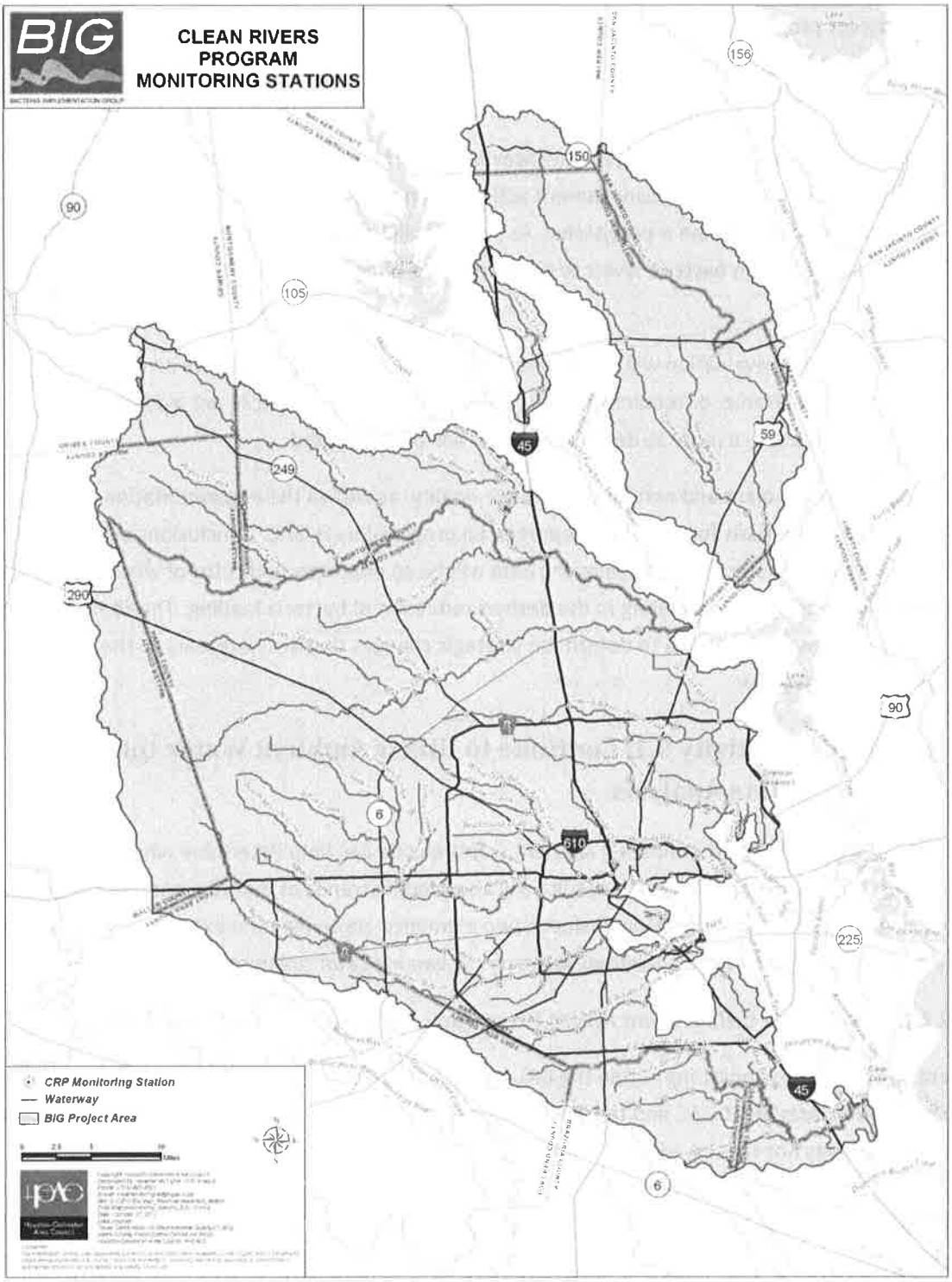
Implementation Activity 9.1: Continue to Utilize Ambient Water Quality Monitoring and Data Analysis

The results of monitoring and evaluating ambient water quality can help determine whether waterways are meeting standards for bacteria. The results will also identify trends of improvement and degradation that need to be addressed. This activity includes two elements: continuing the existing ambient water quality monitoring program and encouraging the use of two indicator organisms in sampling.

9.1.1: Continue to Utilize Clean Rivers Program

Ambient water quality monitoring within the BIG area is primarily the responsibility of the Clean Rivers Program, administered by H-GAC and the TCEQ in conjunction with local partner agencies. This program is ongoing and does not require additional funding for its current efforts. (See Figure 8 for locations of monitoring stations in the BIG project area. More detailed information regarding monitoring data can be found on H-GAC's Water Resources Information Map, or WRIM, which can be found at http://webgis2.h-gac.com/CRPflex/).

Figure 8: Map of Clean Rivers Program Monitoring Stations



The Clean Rivers Program is comprehensive, collecting samples region-wide, and should remain the primary source of data for ambient water quality.[105] This monitoring network includes over 300 sites and provides long-term data accredited by NELAC[106] for the evaluation of ambient conditions in the region's waterways. Monitoring sites are strategically chosen to give the greatest degree of coverage while also attempting to isolate individual waterways or their smaller units to allow for the accumulation of data with direct relevance to local conditions. Monitoring is conducted under a regional Quality Assurance Project Plan (QAPP).[107] Any new ambient monitoring by local partners shall be coordinated with the Clean Rivers Program and shall utilize the regional QAPP.

The Basin Summary Report,[108] produced every five years, evaluates at least seven years of data for each assessment unit and identifies statistically significant change. Along with the general benefit of coordinated regional data, these trend indicators will help guide I-Plan revisions and serve to verify the impact of implementation activities.

The local Clean Rivers Program steering committee meets regularly to discuss ways to improve the ambient water quality monitoring program. Local efforts are coordinated with those statewide to ensure consistency of data and to identify appropriate program improvements, which has already allowed for changes to facilitate this I-Plan. Specifically, monitoring reports now contain standardized information about any recreation that is observed at the sampling site.

9.1.2: Test for Additional Indicators

The presence of *E. coli* or Enterococcus species in water is a commonly employed indicator of the presence of enteric pathogens. Generally, TCEQ guidance and the location of the water sample determine which of the indicators is used. As resources are available, the abundance of both *E. coli* and Enterococcus species should be evaluated at freshwater sampling locations, to ensure a greater ability to correlate impacts of implementation activities on water quality. Additional parameters should be monitored, as deemed necessary and feasible, to target specific activities or sources for which the general correlation between indicators is not precise enough to show impacts. Additional testing may require a new or amended QAPP, and should take into account any existing or ongoing research on correlating current indicator bacteria with pathogens of concern. (See Research Priority 10.3.)

[105] (Houston-Galveston Area Council 2010a)

[106] NELAC, National Environmental Laboratory Accreditation Conference, provides accreditation of environmental labs.

[107] (Houston-Galveston Area Council 2010b)

[108] (Houston-Galveston Area Council 2006)

Implementation Activity 9.2: Conduct and Coordinate Non-Ambient Water Quality Monitoring

While the established ambient monitoring program will form the base of the data, some implementation activities, including monitoring plans for specific implementation activities, may require targeted sampling that may be site or contaminant specific. Because of requirements of the quality assurance plan,[109] this non-ambient program should be separate from the existing ambient program. As such, non-ambient monitoring should be facilitated through four activities.

9.2.1: Create and use a regional non-ambient QAPP

H-GAC will work with the TCEQ to establish a regional QAPP for non-ambient monitoring activities. Applicable sections of existing monitoring efforts, such as Harris County Flood Control District's wet weather monitoring for wet bottom detention basins, should be adopted and incorporated into a regional QAPP, as applicable and practicable.

9.2.2: Create and maintain a regional non-ambient monitoring database

Individual stakeholders will be responsible for implementing activities in their jurisdictions. However, to serve the combined purpose and interests of this I-Plan, the monitoring of non-ambient water quality data will be combined in a regional non-ambient monitoring database. This database could be compatible and coordinated with similar related databases, including the International Stormwater BMP Database[110] and the regional BMP effectiveness database being developed by the Harris County Flood Control District. This database could serve as a clearinghouse for non-ambient or targeted water quality monitoring data from across the region, to ensure availability and coordination of all related efforts. The database will be created in consultation with stakeholders and maintained by H-GAC and will be made available online. The coordinated approach to data acquisition will allow stakeholders, even when working separately, to benefit from their shared experiences. Evaluation of implementation activity effectiveness for one stakeholder can help other stakeholders make more informed decisions concerning the suite of measures they implement to meet the strategies of this I-Plan. Additional data sources that could be incorporated into the database include wet/dry weather monitoring data from MS4 permit holder annual reports, outfall monitoring, and pertinent data (including current and incoming monitoring requirements) from WWTF Discharge Monitoring Reports. This database shall be integrated with the database for tracking implementation activities, described in Implementation Activity 9.3. An ad hoc committee will be invited to participate in the creation of the database. This activity is not intended to create an additional reporting or liability burden for stakeholders.

[109] (Houston-Galveston Area Council 2010b)

[110] (Developed by Wright Water Engineers, Inc. and Geosyntec, Consultants 2010)

9.2.3: Implement targeted monitoring

Targeted monitoring should be implemented in those places where an entity needs to determine the direct impact of an implementation activity or BMP at a site where ambient monitoring will be unable to indicate changes to water quality as a result of the activity. Targeted monitoring may address sampling needs such as:

- Conditions during or differences in loading during dry and wet weather,
- Changes in instream bacteria levels throughout the day,
- Bacteria levels and loading during high-flow and low-flow regimes, and
- Locations specific to implementation activities, such as stormwater BMPs, or potential bacteria sources, such as the evaluation of bacteria levels in water coming from an outfall pipe.

Targeted monitoring of this type is already underway in the BIG area, as conducted by MS4 Phase I entities as part of stormwater permit requirements. These efforts should continue as practicable. Additionally, other entities, regardless of MS4 status, should consider or continue targeted monitoring as needed to evaluate implemented measures. The data collections efforts they undertake should be coordinated as part of the regional QAPP and monitoring database developed for non-ambient water quality in the region.

Implementation Activity 9.3: Create and Maintain a Regional Implementation Activity Database

Implementation tracking provides information that can be used to determine if progress is being made toward meeting the goals of the TMDL. Tracking also allows stakeholders to evaluate actions taken, identify those which may not be working, and make any changes that may be necessary to keep the I-Plan on track. The implementation activity database will contain information on implementation activities conducted by the stakeholders. Each stakeholder will be provided a list of the implementation activities designated under this I-Plan. Each year, the individual stakeholders will provide a report on the activities they implement during the year, and any related information regarding the activities. The BIG, through the H-GAC, will provide a reasonable reminder to each stakeholder prior to the due date, compile the individual reports in the database, and publish a summary as part of an annual I-Plan report. As an incentive to report in a timely manner and in addition to a list of implementation activities undertaken, the report will identify communities that either did not report or did not undertake implementation activities.

While there will be additional paperwork requested of stakeholders, the intent is not to increase reporting requirements unduly. Thus, copies of or access to existing reports or records can be submitted as part of the annual report to the BIG.

Implementation Activity 9.4: Assess Monitoring Results and Modify I-Plan

9.4.1: Assess Data

The information contained in the three databases (ambient, non-ambient, and implementation activity) shall be used to assess progress toward meeting the goals of this I-Plan. Annually, H-GAC shall assess information in the reports to identify whether progress is being made. In particular, H-GAC shall evaluate the following:

1. Does ambient water quality monitoring data indicate that bacteria levels are changing? If so, are the bacteria levels improving or degrading?
2. Do non-ambient water quality monitoring data indicate that implementation activities are reducing bacteria loading?
3. Are implementation activities and controls being undertaken as described in this I-Plan? Which activities have been implemented and which have not?

9.4.2: Communicate results

The information identified through the assessment process will form the basis for an annual report. H-GAC shall compile the annual report and shall present this information to stakeholders through various channels, including e-mail, web publication, presentations, and at an annual meeting.

9.4.3: Continue the BIG

The BIG shall continue to be the decision-making body for this I-Plan, as identified in its ground rules.

9.4.4: Update the I-Plan

The BIG shall review the annual report and, as appropriate, update the I-Plan. As it evaluates the I-Plan, the BIG shall consider reported activities and whether identified milestones are being met, changes in bacteria levels in waterways, changes to surface water quality standards or other regulations, and research. While progress shall be evaluated annually, a more rigorous evaluation should be conducted every five years. At the end of five years, the BIG shall identify costs for the implementation activities.

In its document titled, "Clarification Regarding Phased Total Maximum Daily Loads,"[111] the EPA describes adaptive implementation as "an iterative implementation process that makes progress toward achieving water quality goals while using any new data and information to reduce uncertainly and adjust implementation activities." It is under these auspices that the BIG shall approach updates to the I-Plan. H-GAC shall provide support for these efforts.

[111] (U.S. Environmental Protection Agency, Best-Wong, B. 2006)

9.4.5: Expand the geographic scope of the I-Plan as appropriate

As other watersheds in the vicinity of the BIG project area have TMDLs adopted by the TCEQ, stakeholders from those watersheds may petition the BIG to consider incorporating those watersheds into the I-Plan. These requests shall be considered by the BIG as part of its annual review of the I-Plan. Communities and stakeholders within the region are encouraged to participate in I-Plan activities, either informally and voluntarily, or formally upon incorporation by the BIG into the I-Plan. Voluntary action is particularly encouraged in those watersheds with streams that are impaired for bacteria but which do not yet have adopted TMDLs.

Implementation Strategy 10.0: Research

Bacterial contamination of waterways is a concern for the BIG project area, as reflected in the TMDL studies that this I-Plan addresses. The studies provide a general overview of the extent and character of the presence of bacteria, but they are not sufficient to determine the most cost-effective courses of action to achieve contact recreation standards. A dynamic process is required where affected entities continually expand their knowledge of bacteria sources and effects and where various management approaches are tested and refined. This section identifies potential research topics that will be critical to this undertaking.

Recognizing that many of these topics would be area-specific, the BIG was asked to prioritize those which would have the greatest impact on management actions across the area. Three topics emerged. These topics are pertinent to the entire BIG area, are intended to be implemented as resources are available, and may be superseded as necessary for research needs that are specific to individual stakeholders. Research would be conducted using appropriate methodology and quality assurance that have been developed in consultation with the TCEQ and the EPA. In the following text, although the research priorities are presented in a numerical order, this is not a rank order.

The I-Plan's stakeholders identified three priority research topics which address the following:

- Effectiveness of stormwater activities
- Bacteria persistence and regrowth
- Appropriate indicators

Additional topics were identified and, although important, were not identified as top priorities. Many of these topics are related to the three research priorities. As funding is available, these additional research topics should be considered.

A variety of funding sources should be pursued, with a variety of partners. It is unlikely that any one local entity will find it appropriate to conduct this research. Given the large-scale character of the undertakings, entities should look to coordinate efforts with the various academic institutions of the greater Houston area, federal and state agencies like the EPA, Center for Disease Control and Prevention, and Department of State Health Services, water and environmental research groups like Water Environment Research Foundation and Water Environment Association of Texas, and similar potential partners. A shared project, the result of an inter-local agreement or similar instrument, may allow local entities to feasibly investigate these issues. However, the more practical avenue is likely to be the BIG group as a whole advocating for a national or state-level entity to address research priorities.

Research Priority 10.1: Evaluate the Effectiveness of Stormwater Implementation Activities

Additional monitoring of current and future stormwater projects in the planning area will help provide an area-specific set of data on the relative effectiveness of different management practices. This effort would draw from current and proposed activities undertaken by Phase I MS4 permitted entities. The effectiveness studies would include both structural measures and behavioral measures. Structural measures might be based on both traditional drainage engineering, such as specifications for stormwater outfalls, and sustainable infrastructure design methodologies, such as Green Infrastructure and Low Impact Development. Behavioral measures, such as public outreach, public reporting of illicit discharges, and efforts aimed at changing behaviors. The data collected and the results from the comparative evaluations should be made available to all stakeholders through the monitoring databases described in Implementation Strategy 9.0.

Research Priority 10.2: Further Evaluate Bacteria Persistence and Regrowth

To better understand the extent of human contributions to bacterial loading in waterways, the underlying base layer of background or endemic bacteria should be studied in greater detail. Previous studies of water bodies in the region, including evaluations of Buffalo and Whiteoak bayous in Harris County,[112] indicated that naturally occurring bacteria are prevalent and persistent in our slow-moving waterways. While these naturally occurring bacteria are certainly supplemented with bacteria from human activities and other sources, the relationship and relative percentages of each should be studied in greater detail. Additionally, the character and cycle of bacteria in the waterway pertaining to regrowth potential requires further evaluation. More realistic and comprehensive simulations are required to more fully grasp the nature of bacterial behavior in the waterways. Implementing agencies that choose to conduct these studies for specific projects will make their data available for the rest of the stakeholders through the monitoring databases (or through H-GAC as a facilitator). The results could be used to provide more precise predictions of bacterial loading by following the impact of loading over time within the waterway.

Research Priority 10.3: Determine Appropriate Indicators

An indicator species is an organism whose presence is highly correlated to the presence of another organism (or group of organisms). *E. coli* or *Enterococcus* are used as indicator bacteria based on their pervasiveness and correlation between their presence and the presence of a wide range of potential microbial pathogens. However, that general correlation may not be precise enough to justify their exclusive use in monitoring for this I-Plan. While these indicators are generally accepted nationwide,

[112] (Brinkmeyer, Amon and Schwarz 2008) and (NSF International Engineering & Research Services 2007)

they may not reflect the unique balance of microbial pathogens and water quality characteristics of the region's semi-tropical urban bayous and local water bodies. Many studies, including the data used to formulate the 1986 EPA guidance on bacteria limits for recreational waters,[113] were conducted in areas and water bodies greatly different from the BIG area. The potential need for alternate, supplemental, or multiple indicators should be determined to refine the I-Plan's monitoring approach and further assist stakeholders in identifying sources.

The EPA is currently studying the question of appropriate indicators. The results of their inquiry, due in October of 2012,[114] should be incorporated into future revisions of this I-Plan. Additional consideration of the best indicator(s) for the area could help supplement their findings by providing a more specific understanding of local correlations between indicators and pathogens. Stakeholders are encouraged to participate in EPA's discussion of indicators and to encourage the EPA to consider environments similar to those in the Houston region.

Research Priority 10.4: Additional Research Topics

A variety of additional research topics were identified by stakeholders. The following list gives a brief description of broad groups of research topics and some possible research questions. Research addressing these topics should be conducted as resources are available.

- *WWTFs:* Studies should examine the correlation between bacteria levels in effluent and in-stream bacteria levels. Have in-stream bacteria levels changed as a result of the TCEQ's new rules that limit bacteria levels in effluent? Research may also be conducted to identify how other constituents in wastewater effluent may influence in-stream bacteria levels. How are in-stream bacteria levels influenced by sludge discharges, nutrients, and stormwater discharges from WWTFs?
- *Health risks:* The studies should include cumulative review of epidemiological studies, collection of new epidemiological data, and/or microbial risk assessment efforts aimed at determining human health risks from recreational activities in, on, or near bayous in the BIG region. What is the relationship between the levels of pathogens and indicators in different watersheds?
- *Recreational use:* Generally, eight or more illnesses above the background level are considered problematic. Does the rate of illness from contact recreation in impaired waterways in the project area exceed this threshold? What is the level of recreation on the waterways?
- *Land use:* Research could analyze the correlations between land use, turbidity, and in-stream bacteria levels. Some land use types may lead to increased turbidity, and may be associated with increased bacteria levels. Consideration should be given to evaluating the per-capita

[113] (U.S. Environmental Protection Agency 1986)

[114] (U.S. Environmental Protection Agency 2010c)

contribution of bacteria in relative compact mixed use developments versus lower density developments. Historical land use prior to development may also influence in-stream bacteria levels. Is there a correlation between impervious surfaces and in-stream bacteria levels?

- *Modeling:* The document, "Bacteria Total Maximum Daily Load Task Force Final Report,"[115] contains summary information about the selection and application of various water quality models for use in Texas. However, many questions were raised by the authors regarding how well the models work, how they can be improved to be more accurate, and how well they function as predictive models. Research could be done to provide answers to the questions raised in the report. One particular input for which further information could be done is to improve the flow data available for classified stream sections.
- *Unimpaired waterways:* A minority of sampled waterways in the project area are *not* considered impaired for bacteria. Why do these assessment units have relatively low bacteria levels? How could this information be applied to lower bacteria levels in impaired waterways?
- *Nutrients and other constituents:* Waterways in the project area contain constituents such as nutrients, fine particles, sediment, soil, and other solid materials. Studies and research should examine how such constituents influence instream bacteria levels.

[115] (Jones, et al. 2007)

Implementation Strategy 11.0: Geographic Priority Framework

In order to achieve state standards for contact recreation in the BIG region's waterways, all stakeholders will need to be responsible for some aspects of implementation. Some Implementation Activities, such as those described in Implementation Activity 1.1, will be implemented throughout the BIG Project Area. Others, such as Implementation Activity 3.1, will be implemented in targeted areas. It is this second group of IAs, those that are geographically targeted, that need a framework for prioritization. The framework described here provides guidance to communities in setting local implementation priorities.

Implementation Activity 11.1: Consider recommended criteria when selecting geographic locations for projects

As a community prioritizes actions within its watersheds it should consider five main categories of concern: bacteria level, accessibility, use level, implementation opportunities, and future land use changes. Table 8 lists criteria included in these categories. Communities may want to gather input from residents when setting priorities. This can be accomplished through public meetings or surveys. However, an ordered approach needs to be considered as well, such as targeting specific watersheds or suspected sources.

Table 8: Criteria to be considered when selecting geographic priorities

Category	Criteria to Consider
Bacteria Level	• Is the 7-year bacteria geometric mean for the waterway above the water quality criteria for bacteria? If yes, what is the magnitude of the exceedance? • Based on land use surrounding the waterway, is the source of bacteria more likely human or animal? • Is the flow in the waterway primarily effluent from wastewater treatment facilities? • How many impaired stream segments could be affected by the transport of bacteria downstream from the waterway?
Accessibility	• Is there a large population within 0.25 miles of the waterway? [Note: The meaning of the phrase "large population" can differ from community to community.] • Are there public access points (ramps, bridges, trails, developed parks) to the waterway?

Category	Criteria to Consider
Use Level	• Is contact recreation occurring in the waterway? • If the waterway is not currently used for recreation, would the waterway be used for recreation if the bacteria level were low? • Is the waterway part of a drinking water supply? • Are there signs that the waterway is being used for recreation (rope swings, fishing debris, beer cans, or graffiti)? • Is there an existing group that promotes protection and improvement of the waterway as a community asset? • Are the characteristics of the waterway such that individuals could use it for recreation (appropriate flow, depth, natural or man-made banks)?
Implementation Opportunities	• Are there existing groups to partner with for implementation? • Is there political will to lower a particular waterway's bacteria level? • What funds are available? • Can funding be leveraged with funding from upstream or downstream jurisdictions to expand spatial extent of an IA? • What are initial construction or installation costs? • What are estimated long-term maintenance costs? • Is there a waterway that could easily meet the standard? • Can a specific source of bacteria be singled out to better target IAs? • How much land is available to develop stormwater treatment facilities?
Future Land Use Changes	• What development is expected in the watershed? • Is the waterway threatened, but not yet listed as impaired? [Note: H-GAC Clean Rivers Program staff periodically analyzes water quality data to determine trends and can provide this information to interested communities. Additionally, raw data is available for download from the H-GAC website.]

Appendix A: References and Authorities

References

Abroms, Lorien C, and Edward W Maibach. "The Effectiveness of Mass Communication to Change Public Behavior." *Annual Review of Public Health* 29 (2008): 219-234.

Austin County. "Court Order Adopting Rules of Austin County, Texas, for On-site Sewage Facilities." *TCEQ Web site.* December 19, 2007. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&Auth_Agent_Ar_Num=620008 (accessed October 2, 2010).

Brazoria County. "Rules of Brazoria County, Texas for On-site Sewage Facilities." *TCEQ Web site.* June 30, 2010. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620020 (accessed October 1, 2010).

Brinkmeyer, Robin, Rainer Amon, and John Schwarz. "Population Dynamics of Escherichia coli and Enterococcus spp. in Buffalo Bayou and White Oak Bayou." *H-GAC Web site.* November 11, 2008. http://www.h-gac.com/community/water/resources/documents/tmdl_population_dynamics_of_ec_and_es.pdf (accessed October 12, 2010).

Chambers County. "An Order Entitled On-site Sewage Facilities - Chambers County." *TCEQ Web site.* February 20, 2008. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620048 (accessed October 1, 2010).

City of Houston. *Chapter 47, Article XI, Code of Ordinances, City of Houston, TX.* December 30, 2008. http://library.municode.com/HTML/10123/level2/COOR_CH47WASE.html (accessed 11 2, 2010).

—. "Corral the Grease brochure." *City of Houston.* March 30, 2007. http://www.publicworks.houstontx.gov/utilities/corral_grease.html (accessed September 16, 2010).

City of Houston, Harris County, and Harris County Flood Control District. "Storm water management handbook for construction activities." *Clean Water Clear Choice Web site.* September 1, 2006. http://www.cleanwaterways.org/downloads/professional/construction_handbook_full.pdf (accessed October 13, 2010).

Collection Systems Committee of the Water Environment Federation (WEF). *Home: CMOM.net.* March 2009. http://www.cmom.net (accessed September 30, 2010).

Colorado County. "Order Adopting Rules of Colorado County, Texas for On-site Sewage Facilities." *TCEQ Web site.* June 19, 2001. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620048 (accessed October 1, 2010).

Congress for the New Urbanism, Natural Resources Defense Council, and the U.S. Green Building Council. "LEED 2009 for Neighborhood Development Rating System." Vers. July 2010. *U.S. Green Building Council.* 2009. http://www.usgbc.org/ShowFile.aspx?DocumentID=7583 (accessed October 13, 2010).

Connected Texas. *Connected Texas.* 2010. http://www.connectedtx.org/index.php (accessed November 9, 2010).

Coping with Feral Hogs. 2010. http://feralhogs.tamu.edu/ (accessed October 12, 2010).

Developed by Wright Water Engineers, Inc. and Geosyntec, Consultants. *International Stormwater BMP Database.* Vers. 8 04 2010. Water Environment Research Foundation (WERF), the American Society of Civil Engineers (ASCE) / Environmental and Water Resources Institute (EWRI), the American Public Works Association (APWA), the Federal Highway Administration (FHWA), and U.S. EPA. August 5, 2010. http://www.bmpdatabase.org (accessed October 12, 2010).

Fort Bend County. "Order Adopting Rules of Fort Bend County, Texas for On-site Sewage Facilities." *TCEQ Web site.* November 4, 2005. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620076 (accessed October 1, 2010).

Galveston Bay Estuary Program. *Public Participation and Education Action Plan.* n.d. http://www.gbep.state.tx.us/solutions-partners/public-participation-plan.asp (accessed October 12, 2010).

Galveston County Health District. "A Guidance Manual for Identifying and Eliminating Illicit Connections Municipal Separate Storm Sewer Systems (MS4)." *H-GAC Web site.* August 2002. http://videos.h-gac.com/ce/water_resources/nps_guide_to_identifying_illicit_connections.pdf (accessed October 5, 2010).

—. "Order of the Galveston County Health District Adopting Rules for On-site Sewage Facilities." *TCEQ Web site.* April 4, 2008. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620080 (accessed October 1, 2010).

—. "Voluntary Inspection and Information Assistance Program to Reduce Bacterial Pollution Caused by Malfunctioning Septic Systems in Dickinson Bayou." *Galveston County Health District.* 1998. http://www.gchd.org/ech/DickinsonBayouProject.pdf (accessed September 29, 2010).

Harris County & City of Houston. "Can Your Fats." *CleanWaterways.org.* August 13, 2009. http://www.cleanwaterways.org/downloads/brochures/FOG_brochure_English.pdf (accessed September 16, 2010).

Harris County. "Order Adopting Rules of Harris County, Texas for On-site Sewage Facilities." *TCEQ Web site.* June 15, 2009. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620091 (accessed October 1, 2010).

—. *Regional Watershed Protection Program Harris County.* n.d. http://www.cleanwaterways.org/RWPP/Logon.html (accessed October 12, 2010).

Houston-Galveston Area Council. "Basin Summary Report 2006." *H-GAC Web site.* TCEQ Clean Rivers Program. August 2006. http://videos.h-gac.com/ce/water_quality/bsr.zip (accessed October 12, 2010).

—. "Clean Rivers Program Overview." *H-GAC Web site.* 2010a. http://www.h-gac.com/community/water/rivers/overview.aspx (accessed October 12, 2010).

—. "Regional Quality Assurance Project Plan (QAPP)." *H-GAC Web site.* 2010b. http://www.h-gac.com/rds/water_quality/regional_quality_assurance_project_plan.aspx (accessed October 12, 2010).

—. *Rivers, Lakes, Bays 'N Bayous Trash Bash* . n.d. http://www.trashbash.org/ (accessed October 12, 2010).

International Code Council. *International Green Construction Code.* 2010. http://www.iccsafe.org/cs/igcc/pages/default.aspx (accessed October 13, 2010).

James Miertschin & Associates, Inc. *Technical Support Document for Indicator Bacteria Total Maximum Daily Loads (Lake Houston).* Austin, TX: TCEQ, 2009.

Jones, C. A., et al. "Bacteria Total Maximum Daily Load Task Force Final Report." *Texas Water Resources Institute Web site.* Edited by K. Wyth. Texas Water Resources Institute. June 4, 2007. http://twri.tamu.edu/reports/2009/tr341.pdf (accessed October 12, 2010).

Lally, Katrinka. ""Kids Can't Buy 'Em Here" News Briefs." *Illinois Liquor Control Commission.* December 2000. http://www.state.il.us/lcc/docs/kids-dec_00.pdf (accessed September 29, 2010).

Liscum, Fred. *Effects of Urban Development on Stormwater Runoff Characteristics for the Houston, Texas, Metropolitan Area.* Austin, Texas: United States Geological Survey, 2001.

Lunen, Jacques Von. "Portland company will compost your dog waste." *The Oregonian Web site.* February 2, 2010. http://www.oregonlive.com/pets/index.ssf/2010/02/portland_company_will_compost.html (accessed March 9, 2010).

Map Tech, Inc. and New River-Highlands RC & D. "A Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek." *Virginia Department of Environmental Quality.* July 31, 2008. http://www.deq.virginia.gov/export/sites/default/tmdl/implans/knoxpawip.pdf (accessed September 23, 2010).

Matagorda County. "Order Adopting Rules of Matagorda County, Texas for On-Site Sewage Facilities." *TCEQ Web site.* November 3, 2006. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620137 (accessed October 1, 2010).

Montgomery County. "Order Adopting Rules of Montgomery County, Texas for On-site Sewage Facilities." *TCEQ Web site.* March 8, 2007. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620145 (accessed October 1, 2010).

Muir, T. J., and Gary McEwen. "Methods and Strategies for Managing Feral Hog Damage in Grain Production Areas in Central Texas." Edited by G. W. Witmer, W. C. Pitt and K. A. Fagerstone. *Managing vertebrate invasive species: Proceedings of an international symposium.* Fort Collins, CO: USDA/APHIS/WS, National Wildlife Research Center, 2007. 445-450.

NAHB Research Center, Inc. "The Practice of Low Impact Development." *U.S. Department of Housing and Urban Development.* July 2003. http://www.huduser.org/Publications/PDF/practLowImpctDevel.pdf (accessed September 23, 2010).

National Association of Home Builders and the International Code Council. *National Green Building Standard, National Association of Builders.* n.d. http://www.nahbgreen.org/Guidelines/ansistandard.aspx (accessed October 13, 2010).

New England Interstate Water Pollution Control Commission. *NEIWPCC Capacity, Management, Operation, and Maintenance (CMOM).* 2009. http://www.neiwpcc.org/collectionsystems/CMOM.asp (accessed October 1, 2010).

—. *NEIWPCC Wastewater and Onsite Systems—Collection Systems.* 2010. http://www.neiwpcc.org/collectionsystems/ (accessed September 30, 2010).

—. "Optimizing Operation, Maintenance, and Rehabilitation of Sanitary Sewer Collection Systems." *NEIWPCC Web site.* December 2003. http://www.neiwpcc.org/omrmanual.asp (accessed September 30, 2010).

NSF International Engineering & Research Services. "Regrowth potential of water pathogens in sediment and sewage treatment plan effluent and affinity of water pathogens to attach to soil fractions." *Harris County Watershed Protection Research Web site.* January 17, 2007. http://www.eng.hctx.net/watershed/docs/sediment_and_sewage_treatment_plant_effluent_and_affinity_of_water_pathogens_to_attach_to_soil_fractions.pdf (accessed October 12, 2010).

Private Landowner Network. *Land Conservation Grants & Assistance Programs.* 2006. http://www.privatelandownernetwork.org/grantprograms/ (accessed March 21, 2011).

Reed, Stowe, and Yanke, LLC. *Study to Determine the Magnitude of, and Reasons for, Chronically Malfunctioning On-Site Sewage Facility systems in Texas.* Austin, Texas: Texas On-Site Wasetewater Treatment Research Council, 2001.

Russo, N. "Don't get cited for a dirty site." *Houston Land/Water Sustainability Forum.* April 23, 2008. http://www.houstonlwsforum.org/documents/HLWF_04.23.08_Russo.ppt (accessed October 13, 2010).

San Jacinto River Authority. "Order Adopting Rules for On-site Sewage Facilities within 2075 Feet of Lake Conroe, Texas." *TCEQ Web site.* June 8, 2004. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620146 (accessed October 1, 2010).

State of Texas. "House Bill 1979 Model Standards For a Grease Ordinance." *TCEQ Website.* August 25, 2004. http://www.tceq.state.tx.us/assets/public/assistance/P2Recycle/fog/HB_1979final.pdf (accessed September 16, 2010).

—. "Texas Water Code Section 309.3." *Texas Secretary of State.* November 26, 2009. http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=309&rl=3 (accessed November 2, 2010).

—. "Title 30, Chapter 307 of the Texas Administrative Code." *Texas Administrative Code.* July 22, 2010. http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=307&rl=4 (accessed September 30, 2010).

Stormwater Management Joint Task Force. *Clean Waterways Web site.* n.d. http://www.cleanwaterways.org/ (accessed October 12, 2010).

Taylor, Rick. "The Feral Hog in Texas." *Texas Parks and Wildlife Department.* http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0195.pdf (accessed February 16, 2010).

TCEQ. "2008 Texas 303(d) List (March 19, 2008)." *TCEQ Website.* March 18, 2008a. http://www.tceq.state.tx.us/assets/public/compliance/monops/water/08twqi/2008_303d.pdf.

—. *Chapter 319 - General Regulations Incorporated into Permits, Rule Project No. 2009-005-309-PR.* http://www.tceq.state.tx.us/assets/public/legal/rules/rule_lib/adoptions/09005319_ado_clean.pdf (accessed December 2, 2009).

TCEQ. *Clean water for Texas: Working together for Water Quality.* Austin, TX: TCEQ, 2002.

TCEQ. *Eight Total Maximum Daily Loads for Indicator Bacteria in Greens Bayou Above Tidal and Tributaries.* Austin: TCEQ, 2010a.

TCEQ. *Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries.* TMDL Report, Water Quality Planning Division, Chief Engineer's Office, TCEQ, Austin, Texas: Total Maximum Daily Load Program, TCEQ, 2009a.

TCEQ. *Five Total Maximum Daily Loads for Indicator Bacteria in Brays Bayou Above Tidal and Tributaries.* Austin: TCEQ, 2010b.

—. "Four Total Maximum Daily Loads for Indicator Bacteria in Halls Bayou and Tributaries." *TCEQ Wesbite.* September 15, 2010c. http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/72houmetbact/72-hallsbayou_adopted.pdf (accessed October 1, 2010).

—. "Four Total Maximum Daily Loads for Indicator Bacteria in Sims Bayou Above Tidal and Tributary." *TCEQ Website.* September 15, 2010d. http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/72houmetbact/72-simsbayou_adopted.pdf (accessed October 1, 2010).

—. "General Permit to Discharge Wastes." Vers. 2008. *TCEQ Web site.* February 15, 2008d. http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/stormwater/txr150000.pdf (accessed October 12, 2010).

—. "General Permit TXR040000 for Phase II (Small) MS4s." *TCEQ Web site.* August 13, 2007. http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/stormwater/txr040000.pdf (accessed November 4, 2010).

—. "Improving Water Quality in the Lake Houston Area." *TCEQ Web site.* June 2010f. http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/82lakehouston/82-lakehoustonpo.pdf (accessed October 5, 2010).

—. "Let's Tackle the Grease in This Kitchen! brochure." *TCEQ Web site.* December 10, 2007. http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/gi/gi-290.html/at_download/file (accessed September 16, 2010).

TCEQ. *Nine Total Maximum Daily Loads for Bacteria in Clear Creek and Tributaries.* Austin, Texas: Total Maximum Daily Load Section, TCEQ, 2008b.

TCEQ. *On-Site Sewage Facility (OSSF) Rules Compilation.* Compliance Support Division, Austin: TCEQ, 2009b.

—. "Preamble: Final/Adopted Application of Effluent Sets." *Texas Register Web Site.* November 6, 2009c. http://info.sos.state.tx.us/pls/pub/regviewer$ext.RegPage?sl=T&app=2&p_dir=N&p_rloc=209360&p_tloc=-1&p_ploc=&pg=1&p_reg=200905089&z_chk=48933&z_contains=^^^§210.33 (accessed October 5, 2010).

—. "Procedures to Implement the Texas Surface Water Quality Standards." *TCEQ Web site.* June 2010g. http://www.tceq.state.tx.us/assets/public/legal/rules/rule_lib/adoptions/RG-194.pdf (accessed August 2, 2010).

—. "Sanitary Sewer Overflow (SSO) Initiative: Information for Prospective Participants." *TCEQ Web site.* June 2008c. http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/gi/gi-389.html/at_download/file (accessed September 30, 2010).

—. *TCEQ Central Registry Web site.* July 26, 2010h. http://www12.tceq.state.tx.us/crpub/index.cfm?fuseaction=home.welcome (accessed August 2010).

—. *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d).* July 14, 2010i. http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/305_303.html (accessed October 1, 2010).

—. "Thirteen Total Maximum Daily Loads for Indicator Bacteria in Eastern Houston Watersheds." *TCEQ Web site.* September 15, 2010j. http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/72houmetbact/72-easthouston_adopted.pdf.

—. "Water Quality Noncompliance Notification." *TCEQ We site.* September 10, 2010k. http://www.tceq.state.tx.us/assets/public/compliance/enforcement/forms/00501.pdf (accessed October 1, 2010).

Texas Department of State Health Services. "DSHS Tobacco Prevention and Control - Strategic Plan 2009-2013: Statewide Strategic Plan for Tobacco Prevention." *Texas Department of State Health Services.* July 23, 2007. http://www.dshs.state.tx.us/tobacco/strategic.shtm (accessed December 7, 2009).

U.S. Environmental Protection Agency. "Ambient Water Quality Criteria for Bacteria - 1986." *EPA Web site.* January 1986. http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/health/recreation/upload/2009_04_13_beaches_1986crit.pdf (accessed October 12, 2010).

—. "CMOM Program Self Assessment Checklist." *EPA Website.* October 23, 2003. http://cfpub.epa.gov/npdes/docs.cfm?document_type_id=3&view=Factsheets%20and%20Outreach%20Materials&program_id=4&sort=name (accessed September 30, 2010).

—. "Environmental Impact and Benefits Assessment for Final Effluent Guidelines and Standards for the Construction and Development Category." *United States Environmental Protection Agency.* November 2009a. http://www.epa.gov/guide/construction/files/environment.pdf (accessed April 14, 2010).

—. *EPA Region 4: Management, Operations, and Maintenance (MOM) Program.* January 14, 2009b. http://www.epa.gov/region4/water/wpeb/momproject/index.html (accessed September 30, 2010).

—. "Fact Sheet - Final Rule: Effluent Guidelines for Discharges from the Construction and Development Industry." *United States Environmental Protection Agency.* November 2009c. http://www.epa.gov/guide/construction/files/c_and_d_final_rule_factsheet.pdf (accessed December 22, 2009).

—. "Fact Sheet 2.0: Small MS4 Stormwater Program Overview." *EPA Web site.* December 2005. http://www.epa.gov/npdes/pubs/fact2-0.pdf (accessed November 4, 2010).

—. *Featured Case Studies, Fact Sheets, and Other Information.* October 16, 2007. http://cfpub1.epa.gov/npdes/sso/featuredinfo.cfm?program_id=4 (accessed October 1, 2010).

—. "Impaired Waters and Total Maximum Daily Loads." *EPA Web site.* July 9, 2010a. http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm (accessed October 15, 2010).

—. "Model NPDES Permit Language for Sanitary Sewer Overflows (draft)." *EPA Web site.* August 20, 2007. http://www.epa.gov/npdes/pubs/sso_model_permit_conditions.pdf (accessed September 16, 2010).

—. "National Management Measures to Control Nonpoint Source Pollution from Urban Areas." *United States Environmental Protection Agency.* November 2005. http://www.epa.gov/nps/urbanmm/pdf/urban_guidance.pdf (accessed December 21, 2009d).

—. *Nonpoint Source Outreach Toolbox.* n.d. http://www.epa.gov/owow_keep/NPS/toolbox/ (accessed October 12, 2010).

—. *Onsite Wastewater Treatment Systems Manual.* Washington D.C.: U.S. Environmental Protection Agency, 2002.

—. *Overview of Impaired Waters and Total Maximum Daily Loads Program.* February 25, 2010b. http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/intro.cfm (accessed October 1, 2010).

—. "Recreational Water Quality Criteria: Update to 1986 Criteria." *EPA Web site.* August 24, 2010c. http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/health/recreation/update.cfm (accessed October 12, 2010).

—. "Report to Congress: Impacts and Control of CSOs and SSOs." *U.S. Environmental Protection Agency Web site.* August 25, 2004. http://cfpub1.epa.gov/npdes/cso/cpolicy_report2004.cfm (accessed September 30, 2010).

—. *Sanitary Sewer Overflows and Peak Flows.* May 28, 2010d. http://cfpub1.epa.gov/npdes/home.cfm?program_id=4 (accessed September 30, 2010).

—. "Stormwater Phase II Final Rule: Construction Site Runoff Control Minimum Control Measure." *United States Environmental Protection Agency.* December 2005. http://www.epa.gov/npdes/pubs/fact2-6.pdf (accessed March 23, 2010).

—. "Stormwater Phase II Final Rule: Small MS4Stormwater Program Overview." Vers. December 2005. *EPA Web site.* January 2000. http://www.epa.gov/npdes/pubs/fact2-0.pdf (accessed October 12, 2010).

—. "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003." *EPA Website.* Edited by III, Director, Office of Wetlands, Oceans, and Watersheds Robert H. Wayland. August 26, 2002. http://water.epa.gov/polwaste/nps/success319/319guide03.cfm (accessed September 27, 2010).

U.S. Environmental Protection Agency. *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems.* Office of Water, Washington D.C.: U.S. Environmental Protection Agency, 2003, 60.

—. *What is a TMDL?* October 15, 2008. http://www.epa.gov/owow/tmdl/overviewoftmdl.html (accessed November 1, 2010).

U.S. Environmental Protection Agency, Best-Wong, B. "Memorandum: Clarification regarding "phased" Total Maximum Daily Loads." *EPA Web site.* August 2, 2006. http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/2006_08_08_tmdl_tmdl_clarification_letter.pdf (accessed October 12, 2010).

U.S. Evironmental Protection Agency. "Guide for Evaluating Capacity, Management, Operation, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems." *EPA Website.* Office of Enforcement and Compliance Assurance. January 2005. http://www.cmom.net/cmom_guide_for_collection_systems.pdf (accessed September 16, 2010).

University of Houston & Parsons. "Technical Support Document: Bacteria Total Maximum Daily Loads for the Clear Creek Watershed, Houston, Texas (1101, 1101B, 1101D, 1102, 1102A, 1102B, 1102C, 1102D, 1102E)." *TCEQ Web site.* May 2008. http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/68ccbact/68-technicalsupport_050708.pdf (accessed February 10, 2010).

University of Houston & Parsons. *Technical Support Document: Indicator Bacteria Total Maximum Daily Loads for Eastern Houston Watersheds, Houston, Texas (1006F_01, 1006H_01, 1007F_01, 1007G_01, 1007H_01, 1007I_01, 1007K_01, 1007M_01, 1007O_01, 1007R_01, 1007R_02, 1007R_03, 10074_04).* Austin, TX: Texas Commission on Environmental Quality, 2009d.

University of Houston & Parsons. *Technical Support Document: Indicator Bacteria Total Maximum Daily Loads for the Brays Bayou Watershed, Houston, Texas (1007B_01, 1007C_01, 1007E_01, 1007L_01, 1007B_02).* Austin, TX: Texas Commission on Environmental Quality, 2009C.

University of Houston & Parsons. *Technical Support Document: Indicator Bacteria Total Maximum Daily Loads for the Greens Bayou Watershed, Houston, Texas (1016-01, 1016_02, 1016_03, 1016B_01, 1016C_01, 1016D_01).* Austin: TCEQ, 2009.

University of Houston & Parsons. *Technical Support Document: Indicator Bacteria Total Maximum Daily Loads for the Sims Bayou Watershed, Houston, Texas (1007D_01, 1007D_02, 1007D_03, 1007N_01).* Austin, TX: Texas Commission on Environmental Quality, 2009d.

University of Houston & Parsons. *Technical Support Document: Indicator Bacterial Total Maximum Daily Loads for the Halls Bayou Watershed, Houston, Texas (1006d-01, 1006d_02, 1006i_01, 1006j_01).* Technical Report, Austin, TX: Texas Commission of Environmental Quality, 2009b.

University of Houston and CDM. "Technical Support Document for Buffalo and Whiteoak Bayous TMDL." *TCEQ Web site.* May 2008. http://www.tceq.state.tx.us/assets/public/implementation/water/tmdl/22buffalobayou/22-techsupportdoc.pdf (accessed March 9, 2010).

Upper Chattahoochee Riverkeeper. "Get the Dirt Out Manual." *Get the Dirt Out: Georgia Construction Stormwater Project.* Febrary 2005. http://www.getthedirtout.org/pdf/GTDO_manual.pdf (accessed April 14, 2010).

Wagner, Kevin, Larry Redmon M.D., Terry Gentry M.D., Daren Harmel M.D., and Allan M.D. Jones. "Environmental Management of Grazing Lands." *Texas Water Resources Institute.* October 2008. http://twri.tamu.edu/reports/2008/tr334.pdf (accessed September 23, 2010).

Walker County. "Order Adopting Rules of Walker County, Texas for On-site Sewage Facilities." *TCEQ Web site.* April 16, 2008.

http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620195 (accessed October 1, 2010).

Waller County. "Order Adopting Rules of Waller County, Texas for On-site Sewage Facilities." *TCEQ Web site.* October 5, 2009. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620196 (accessed October 1, 2010).

Wharton County. "Order Adopting Rules of Wharton County, Texas for On-site Sewage Facilities." *TCEQ Web site.* August 9, 2006. http://www5.tceq.state.tx.us/oars/index.cfm?fuseaction=Search.download&AUTH_AGENT_AR_NUM=620199 (accessed October 1, 2010).

Appendix B: Table of Segments and Assessment Units in the Project Area

Table 9: Segments and Assessment Units in the BIG Project Area

Segment ID	Assessment Unit ID	Segment Name	Tidal	TMDL in progress or completed	Included in the original TMDL project area	Year first listed for bacteria impairment
1004E	1004E_01	Stewarts Creek	No	No	Yes	
1004E	1004E_02	Stewarts Creek	No	Yes	Yes	2006
1006D	1006D_01	Halls Bayou	No	Yes	Yes	2002
1006D	1006D_02	Halls Bayou	No	Yes	Yes	2002
1006F	1006F_01	Big Gulch Above Tidal	No	Yes	Yes	2002
1006H	1006H_01	Spring Gully Above Tidal	No	Yes	Yes	2002
1006I	1006I_01	Unnamed Tributary of Halls Bayou	No	Yes	Yes	2002
1006J	1006J_01	Unnamed Tributary of Halls Bayou	No	Yes	Yes	2002
1007A	1007A_01	Canal C-147 Tributary of Sims Bayou Above Tidal	No	No	Yes	2006
1007B	1007B_01	Brays Bayou Above Tidal	No	Yes	Yes	2002
1007B	1007B_02	Brays Bayou Above Tidal	No	Yes	Yes	2002
1007C	1007C_01	Keegans Bayou Above Tidal	No	Yes	Yes	2002
1007D	1007D_01	Sims Bayou Above Tidal	No	Yes	Yes	2002
1007D	1007D_02	Sims Bayou Above Tidal	No	Yes	Yes	2002
1007D	1007D_03	Sims Bayou Above Tidal	No	Yes	Yes	2002
1007E	1007E_01	Willow Waterhole Bayou Above Tidal	No	Yes	Yes	2002
1007F	1007F_01	Berry Bayou Above Tidal	No	Yes	Yes	2002
1007G	1007G_01	Kuhlman Gully Above Tidal	No	Yes	Yes	2002
1007H	1007H_01	Pine Gully Above Tidal	No	Yes	Yes	2002
1007I	1007I_01	Plum Creek Above Tidal	No	Yes	Yes	2002
1007K	1007K_01	Country Club Bayou Above Tidal	No	Yes	Yes	2002

Segment ID	Assessment Unit ID	Segment Name	Tidal	TMDL in progress or completed	Included in the original TMDL project area	Year first listed for bacteria impairment
1007L	1007L_01	Unnamed Non-Tidal Tributary of Brays Bayou	No	Yes	Yes	2002
1007M	1007M_01	Unnamed Non-Tidal Tributary of Hunting Bayou	No	Yes	Yes	2002
1007N	1007N_01	Unnamed Non-Tidal Tributary of Sims Bayou	No	Yes	Yes	2002
1007O	1007O_01	Unnamed Non-Tidal Tributary of Buffalo Bayou	No	Yes	Yes	2002
1007R	1007R_01	Hunting Bayou Above Tidal	No	Yes	Yes	2002
1007R	1007R_02	Hunting Bayou Above Tidal	No	Yes	Yes	2002
1007R	1007R_03	Hunting Bayou Above Tidal	No	Yes	Yes	2002
1007R	1007R_04	Hunting Bayou Above Tidal	No	Yes	Yes	2002
1007S	1007S_01	Poor Farm Ditch	No	No	Yes	
1007T	1007T_01	Bintliff Ditch	No	No	Yes	
1007U	1007U_01	Mimosa Ditch	No	No	Yes	
1007V	1007V_01	Unnamed tributary of Hunting Bayou	No	No	Yes	
1008	1008_01	Spring Creek	No	No	Yes	
1008	1008_02	Spring Creek	No	Yes	Yes	1996
1008	1008_03	Spring Creek	No	Yes	Yes	1996
1008	1008_04	Spring Creek	No	Yes	Yes	1996
1008A	1008A_01	Mill Creek	No	No	Yes	
1008B	1008B_01	Upper Panther Branch	No	Yes	Yes	2006
1008B	1008B_02	Upper Panther Branch	No	No	Yes	
1008C	1008C_01	Lower Panther Branch	No	No	No	
1008E	1008E_01	Bear Branch	No	No	No	

Segment ID	Assessment Unit ID	Segment Name	Tidal	TMDL in progress or completed	Included in the original TMDL project area	Year first listed for bacteria impairment
1008F	1008F_01	Lake Woodlands	No	No	No	
1008H	1008H_01	Willow Creek	No	Yes	Yes	2006
1008I	1008I_01	Walnut Creek	No	No	Yes	
1008J	1008J_01	Brushy Creek	No	No	Yes	
1009	1009_01	Cypress Creek	No	Yes	Yes	1996
1009	1009_02	Cypress Creek	No	Yes	Yes	1996
1009	1009_03	Cypress Creek	No	Yes	Yes	1996
1009	1009_04	Cypress Creek	No	Yes	Yes	1996
1009C	1009C_01	Faulkey Gully	No	No	Yes	2006
1009D	1009D_01	Spring Gully	No	No	Yes	2006
1009E	1009E_01	Little Cypress Creek	No	Yes	Yes	2006
1010	1010_01	Caney Creek	No	No	Yes	
1010	1010_02	Caney Creek	No	Yes	Yes	2006
1010	1010_03	Caney Creek	No	No	Yes	
1010	1010_04	Caney Creek	No	Yes	Yes	2006
1010C	1010C_01	Spring Branch	No	No	Yes	
1011	1011_01	Peach Creek	No	No	Yes	
1011	1011_02	Peach Creek	No	Yes	Yes	2006
1013	1013_01	Buffalo Bayou Tidal	Yes	Yes	Yes	1996
1013A	1013A_01	Little Whiteoak Bayou	No	Yes	Yes	2002
1013A	1013A_02	Little Whiteoak Bayou	No	No	Yes	
1013C	1013C_01	Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal	No	Yes	Yes	2002
1014	1014_01	Buffalo Bayou Above Tidal	No	Yes	Yes	1996
1014A	1014A_01	Bear Creek	No	Yes	Yes	2006
1014B	1014B_01	Buffalo Bayou	No	Yes	Yes	2006
1014C	1014C_01	Horsepen Creek	No	No	Yes	
1014E	1014E_01	Langham Creek	No	Yes	Yes	2006
1014H	1014H_01	South Mayde Creek	No	Yes	Yes	2002
1014H	1014H_02	South Mayde Creek	No	Yes	Yes	2002