HOW'S THE WATER?

07

basin HIGHLIGHTS *report*

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How's The Water?

That is a question we commonly hear while swimming or fishing in our favorite lake or stream. How do you answer? What do you really know about the quality of the water flowing through any of our region's streams? How often do you think about the quality of the water in the creek that flows near your home or in the bayou you cross on your way to work? Do you ever think about the quality of the water that comes out of your tap? If you are like most people, you may never think about it except during certain worrisome circumstances such as: 1). When there is a risk of flooding – Will my property be all right? Will I be able to get home? Will my kids be able to get to school? 2). When they're in a drought – Will the crops survive? Will the cattle have enough water? Will my yard stay nice and green? People think about water during these times because it becomes important to their pocketbooks, to their physical safety or to the appearance of their property.

Water quality is a reflection of the physical, chemical, and biological characteristics of water. All living things need water. With a 16,000-mile network of rivers, streams, and bayous feeding into numerous bays, the Houston-Galveston region is rich in water assets. It also boasts one of the nation's most important estuarine systems – Galveston Bay. These water bodies provide a home for a wide variety of freshwater and saltwater fishes and also support a diverse vegetative habitat along their corridors for an incredible array of other wildlife. To develop a scientific answer to our question of water quality, we must consider various factors:

H-GAC Clean Rivers Program Assessment Area

- **4 basins**
- **39 watersheds**
- **Draining over 9.130 square miles**
- **51 stream segments**
- **Over 16,000 stream miles**

- Nutrients are essential for plants and animals but excessive concentrations can cause harmful effects.
- Sediments can cloud the water, hampering the growth of aquatic plants.
- Water temperature affects when animals and plants feed, reproduce, and migrate.
- Salinity greatly determines where plants and animals live.
- Dissolved oxygen is essential for all aquatic life.
- Chemical contaminants can affect the growth, survival and reproducibility of aquatic life and, at certain levels, can be dangerous for humans to consume.
- Bacteria are found almost everywhere in our environment, but some types of bacteria commonly present in our waterways can cause illness and disease in humans.

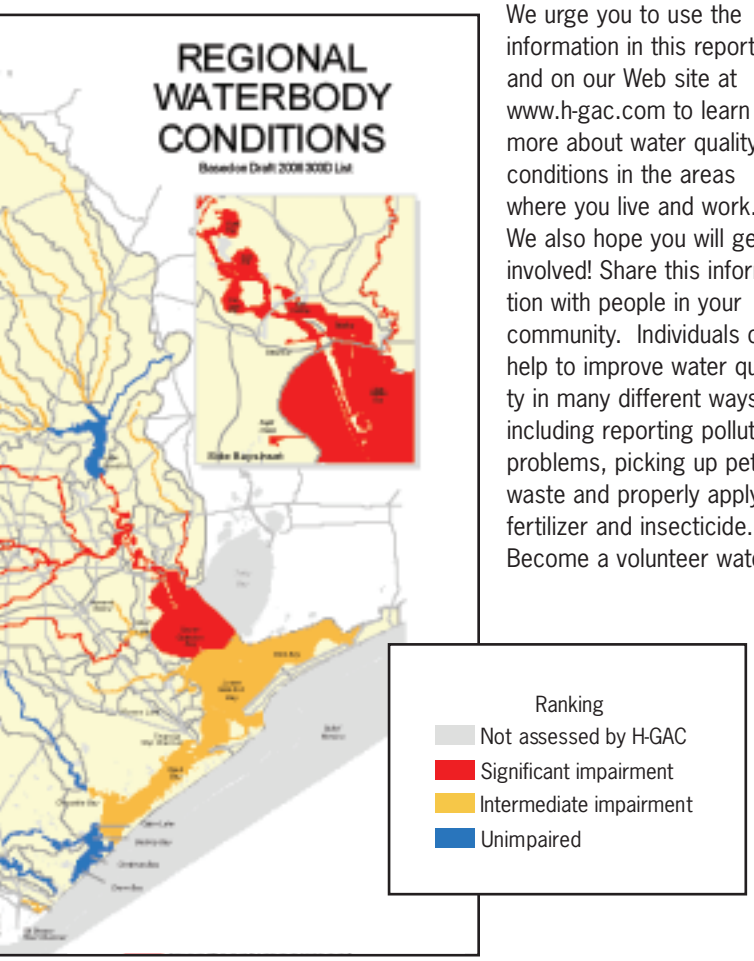
The H-GAC region is experiencing incredible population growth. The current demographic forecast predicts that by 2035 we will add another 3.5 million people to our region. That is roughly equivalent to the population of Los Angeles! That kind of population growth is certain to impact our waterways. Careful planning and management will be necessary to cope with this change, and we will all have to do our part to protect water quality.

So, how is the water? Overall, it's not bad. However, as our population continues to rise and development increases, we also see bacteria numbers rising. The *Draft 2006 Texas Index of Water Quality Impairments* includes 58 new listings for elevated levels of bacteria in H-GAC's CRP assessment areas. Streams in watersheds that have been largely undeveloped in the past are now exceeding the state's bacteria standards. In this region, every reference stream that state environmental agencies have used for the last 20 years now has bacteria impairment on at least part of its length.

Not all the news is bad though. Four segments were removed from the Draft 2006 303(d) list for having depressed levels of dissolved oxygen (DO). Cedar Bayou Above Tidal is now meeting the standard for DO. Pine Gully and Plum Creek, tributaries of the Houston Ship Channel, were removed due to faulty data found through H-GAC's rigorous Quality Assurance (QA) process. An unnamed tribu-

tary of Greens Bayou was removed because of a faulty aquatic life use designation. That doesn't mean that DO levels are rising all over. However, it does mean that DO levels are rising in some streams and that we are coming to understand the uses that some of the other streams in our region can support. Clear Creek Above Tidal was removed from the Draft 2006 303(d) list for chloride. It seems that the capping of abandoned wellheads throughout the watershed has resulted in much lower chloride levels.

We have some definite challenges ahead in regard to rising bacteria levels. Questions regarding appropriate standards for Houston area streams remain unanswered. Implementation plans for Buffalo and White Oak Bayous will begin soon. A Houston Metro Bacteria Total Maximum Daily Load (TMDL) is getting underway. H-GAC is conducting a contact recreation Use Attainability Analysis (UAA) for Houston area bayous. You can read more about those projects later in this report. Community issues related to bacteria will receive quite a bit of attention during the next several years. Local municipalities and counties as well as state and federal agencies will need to agree both on acceptable bacteria reduction methods and acceptable bacteria levels.



We urge you to use the information in this report and on our Web site at www.h-gac.com to learn more about water quality conditions in the areas where you live and work. We also hope you will get involved! Share this information with people in your community. Individuals can help to improve water quality in many different ways, including reporting pollution problems, picking up pet waste and properly applying fertilizer and insecticide. Become a volunteer water quality monitor. Dozens of individuals and groups across the region are collecting water quality data under our Texas Watch program. We hope you will join with the many professionals and volunteers throughout the H-GAC region to make our water resources the best they can be!

Water Quality in 2006, Year in Review

H-GAC and its Clean Rivers Program (CRP) partners continued to make great strides in 2006, enhancing water quality data collection, strengthening quality assurance and streamlining the data management process. Local agencies conducting water quality monitoring under H-GAC's Regional Quality Assurance Project Plan (QAPP) include:

- City of Houston Department of Water Quality Control
- City of Houston Department of Health and Human Services
- City of Pearland
- Environmental Institute of Houston
- Harris County Environmental Public Health Division
- San Jacinto River Authority - Lake Conroe Division
- San Jacinto River Authority – Woodlands Division

H-GAC Ambient Water Quality Monitoring Program

- **6 local agencies collecting samples**
- **283 monitoring sites**
- **5 laboratories analyzing samples**
- **Over 43,000 water quality measurements per year**

Together, these agencies collected ambient water quality samples at more than 280 sites during 2006. This sampling resulted in the collection of data in well over 3,000 separate sampling events and produced more than 68,000 individual results.

Every March, H-GAC convenes a major Coordinated Monitoring Meeting, which includes all CRP partners, other local agencies doing water quality monitoring, staff from the Texas Commission on Environmental Quality (TCEQ) and other state environmental agencies. The focus of this meeting is to maximize available dollars by reducing duplication of monitoring sites and/or parameters moni-

tored. In 2006, this coordination resulted in more accurate placement of monitoring sites. You can find a listing of the sites and parameters monitored in the H-GAC region on the H-GAC Data Clearinghouse Web page www.h-gac.com/dataclearinghouse.

H-GAC staff also continued to work with its CRP partners to minimize the number of times they handled data. The H-GAC's Regional Monitoring Workgroup worked diligently to refine the data review checklist to speed up and strengthen the process for ensuring that all quality assurance objectives are met for all data submittals. Questions on the data review checklist help local agency personnel review their data to check for and correct errors. This allows H-GAC staff to complete QA/QC checks more rapidly because fewer data points are flagged as problems.

As a result of the water quality data assessment that was conducted for the 2006 Basin Summary Report, H-GAC Clean Rivers Staff are changing the way that future assessments will be completed. In the past, Excel software was used to analyze the data. In 2006, the amount of data for many segments exceeded the processing capability of Excel. All future assessments for H-GAC will be conducted using SAS statistical software. By mid-2007, H-GAC hopes to conduct assessments for individual partners on frequent intervals.

In addition to coordination and quality assurance, H-GAC's Clean Rivers Program continued several initiatives in 2006 that added significant value to local water quality monitoring. H-GAC and its partner agencies continue to include field filtered Orthophosphate and Chlorophyll-*a* in their sampling. Measuring these parameters, along with new protocols for laboratory analysis, will provide a much better picture of nutrient levels in the region's water bodies.

H-GAC is also continuing to collect detailed information on priority water bodies by conducting a number of special studies throughout the region, which include:

A water quality and biological characterization study in the Cotton Bayou and West Fork Double Bayou Watersheds. Both watersheds drain to Trinity Bay, which is in the northernmost section of the Galveston Bay system. The limited data that are available for these streams indicate some possible water quality concerns for low dissolved oxygen. The study was designed to collect data in streams that have historically had very little data collection. The final report for this study will be completed in December, 2007.

A water quality and biological characterization study in the Highland Bayou and Marchand Bayou Watersheds. Both watersheds drain to West Bay, which is in the westernmost section of the Galveston Bay system. The limited data that are available for these streams indicate some possible water quality concerns for low Dissolved Oxygen and elevated levels of bacteria. The study was designed to collect data in streams that have historically had very little data collection. The final report for this study will be completed in December, 2007.

Installation of Continuous Monitoring stations in Armand Bayou and Buffalo Bayou. H-GAC and the TCEQ have partnered with local stakeholders to install continuous monitoring stations. Data will be made available in "real time" to the Web as well as to local water quality kiosks that area residents and visitors will be able to view. Stations will collect data on conductivity, dissolved oxygen, pH, and temperature. Water quality samples collected by agency staff show only a snapshot in time. Having a monitoring station that is operating 24 hours a day gives water quality managers better insight into the hourly fluctuations in water quality. These monitoring sites also provide a great public outreach opportunity. The general public will be able to access this data in real time on the Web as well as at kiosks at the University of Houston – Clear Lake and the Downtown Aquarium.

Completion of the 2006 Basin Summary Report

H-GAC was proud to present its 2006 Basin Summary Report. The report was in a completely different format from previous summary reports. After discussing what would be the most useable format for a report of this magnitude, with H-GAC's Technical Advisory Group and Clean Rivers Program Steering Committee, H-GAC's Clean Rivers Staff met with a graphics consultant to discuss formatting options. After considering usability, development and distribution costs, H-GAC decided to go with an all-electronic report format (interactive CD) with a companion booklet that included the Executive Summary and a two-page user's guide for the CD. The CD is 100-percent searchable,

which means it is very easy for any user to search by parameter of concern, by segment name/number or by station.

In regard to cost, the electronic report is much more cost effective. H-GAC was able to produce 1,000 CDs and booklets for $30,000 less than the cost of producing 500 printed copies of the report.

Response to the report has been overwhelming. Users are saying it is the most user-friendly water quality report they have used. They like the fact that they can print any maps they want from the report. The data tables are easy to read and easily printed.

H-GAC plans on producing all future reports in this same type of format. A copy of the report is available online at www.h-gac.com/crp.

Special Studies

Short-term projects are implemented by the H-GAC Clean Rivers Program for three reasons.

1. To collect baseline water quality, biological, and habitat data in areas of the region lacking historical information.

2. To address specific issues or problems already identified within a watershed.

3. To address water quality standards and permit issues.
The following sections are brief summaries of the projects that were completed, conducted or being planned during 2006.

Highland Bayou & Marchand Bayou Special Study 2007

The Highland Bayou watershed is located in southeast Galveston County and has a drainage area of approximately 35 square miles. With headwaters located near the town of Santa Fe, TX, Highland Bayou extends approximately 12.6 miles to the southeast and drains into Jones Bay, which empties into West Bay (Segment 2424). The watershed contains non-urbanized areas as well as highly-developed subdivisions and municipalities. Currently, the cities of La Marque and Hitchcock are the major urbanized communities in the watershed however, urban density is increasing. Marchand Bayou is a smaller water body that drains into Highland Bayou near the middle of its course and shares similar land use characteristics with Highland Bayou. The TCEQ determined that both Highland and Marchand Bayous are not meeting designated water quality standards for dissolved oxygen and bacteria. Consequently, they have been placed on the 303 (d) List of Impaired Waters in the State of Texas. Assessment of environmental quality will provide information to determine the current status of these watersheds and provide a baseline to recognize emerging problems and water quality trends.

In 2006 the Houston-Galveston Area Council (H-GAC) contracted with the U.S. Geological Survey (USGS) to conduct systematic data collection for the assessment of Highland and Marchand Bayous. Data describing physical, chemical, and biological characteristics is being collected to determine if a dissolved oxygen problem exists in Highland and Marchand Bayous, how often it occurs, and to determine the aquatic life use in the freshwater and tidal portions of the streams. An additional project goal is to identify the distribution and frequency of the bacterial contamination in these bayous. The goal of this study is to generate a set of chemical and biological water-quality data not to change the water quality standards. Data collection began in the summer of 2006 and will continue through August 2007.

Cotton Bayou & West Fork Double Bayou Special Study 2007

The Cotton Bayou watershed is located east of Houston, with a drainage area of 16.5 square miles. With headwaters located north of Mont Belvieu, Cotton Bayou extends 6.6 miles to the southeast and drains into Cotton Lake, which empties into Trinity Bay (Segment 2422). The watershed is largely rural. Inputs to Cotton Bayou include runoff from undeveloped land, agricultural fields, small municipalities, and municipal wastewater treatment plants. The principal tributary to Cotton Bayou is Hackberry Gully which has similar land-cover. The TCEQ determined that dissolved oxygen within Cotton Bayou is impaired; however, this assessment was based upon only two sets of samples and those measurements were collected in the tidal portion of the bayou. The City of Mont Belvieu has questioned the extent and validity of the impaired status of Cotton Bayou since the freshwater portion of the water body was not monitored. Assessment of the entire bayou will provide information to determine the current environmental status

of the water body and provide a baseline to aid in recognition of emerging problems and water-quality trends.

The West Fork Double Bayou watershed is located east of Houston near the City of Anahuac and has a drainage area of 35.1 square miles. With headwaters that extend to the Anahuac oil field east of the City of Anahuac, West Fork Double Bayou flows southwest approximately 14 miles to Trinity Bay. The watershed is largely rural, and like the Cotton Bayou watershed, contains unused land, agricultural fields, small municipalities, and municipal wastewater treatment plants. The TCEQ has determined that dissolved oxygen within West Fork Double Bayou is also impaired.

In 2006, the Houston-Galveston Area Council (H-GAC) partnered with the U.S. Geological Survey (USGS), the Trinity River Authority (TRA) and the Texas Commission on Environmental Quality (TCEQ) to conduct a systematic study to assess Cotton Bayou and West Fork Double Bayou. Data describing physical, chemical, and biological characteristics will be collected to determine if a dissolved oxygen problem exists and how often it occurs, and to determine the aquatic life use in the freshwater portion of both water bodies. It is not the purpose of the study to change the water quality standards for these water bodies; rather, the goal is to generate an accurate set of chemical and biological water-quality data only. Data collection began in the summer of 2006 and will continue through August 2007.

Mustang Bayou - 2007

In the past, two separate Receiving Water Assessments (RWAs) were performed on different reaches of the bayou but this fragmented data set made classification of the appropriate aquatic life use difficult. This project was implemented to provide an integrated evaluation of physical, chemical, and biological characteristics in relation to human health concerns, ecological conditions, and designated uses. Assessment of the environmental quality of the bayou will provide information to determine the current status of the watershed and provide a baseline to aid in recognition of emerging problems and water quality trends. An additional goal of this project is to delineate the tidal and non-tidal segments of Mustang Bayou.

The Mustang Bayou watershed, with a drainage area slightly greater than 100 square miles, is located south of Houston in Brazoria County. The headwaters are located northeast of Fresno and extend southeast for approximately 30 miles where it flows into Chocolate Bay. The northern end of the watershed is comprised of mostly rural homesteads ranging in size from less than an acre to small ranches - all relying upon on-site wastewater disposal systems. The City of Alvin is situated in the middle of the watershed and is serviced by a municipal collection system and waste water treatment facility. Downstream of Alvin are agricultural fields and pasture lands with occasional homesteads also relying on-site wastewater disposal systems.

Following approval of the QAPP in July 2004, USGS initiated water quality, stream habitat, and biological monitoring in August 2004. All monitoring was completed in August 2005. Analysis of the data reveals Mustang Bayou's dissolved oxygen concentrations occasionally drops below the minimum criteria to maintain the assumed high aquatic-life use classification. Dissolved oxygen is a primary component used to evaluate the suitability of a stream to sustain fish and other aquatic organisms. Likewise, bacteria results frequently exceeded the state contact recreation standards in 42 percent of the samples collected. Twenty of the 48 bacteria samples exceeded the single grab standard of 394 colonies per 100 ml. However, nutrients such as ammonia, nitrate plus nitrite, and phosphorus did not exceed state screening levels. Chlorophyll-*a* concentrations were also acceptable throughout the bayou. Fifteen pesticide compounds (six herbicides and nine insecticides) were detected in 24 water samples; the highest concentration of the most commonly found pesticide, Atrazine, was 1.42 µg/L which is acceptable. No organochlorine pesticides or PCBs were detected in the bayou sediments and concentrations of metals were below screening levels.

The stream habitat assessment found habitat characteristics to range from "intermediate to limited" at every sampling location on the bayou. The macroinvertebrate specimen (or benthic communities) was widely distributed throughout the bayou. Some areas were limited while other areas had exceptional diversity. Fish communities also indicated a wide variety of aquatic life use. The bayou supported limited diversity and abundance in some areas while supporting exceptional numbers elsewhere.

The full report can be found on the H-GAC Web site, at www.h-gac.com/crp.

Flow Studies 2007

Knowledge of the chemical constituents in surface water is very important; however, the entire picture cannot be interpreted until flow information is included in the evaluation. Currently, flow data is not included in the list of parameters collected by all of H-GAC's local partners. Numerous loca-

tions are sampled during each day's sampling run and time becomes critical in getting samples to the lab. To maintain their current schedules without major modifications, a flow monitoring method has to be devised which would allow one person to quickly and efficiently collect the required information. Later, it would be used to extrapolate flow information about the site. Previously, the USGS developed a "ratings curve" method that could be applied to several sites in the H-GAC region. In 2004, the USGS evaluated 12 potential sites and identified five sites for which to complete "ratings curves." Data collection for the ratings curves began in 2005 and continues through today. The USGS is striving to collect flow data from all stages of flow to make the most accurate ratings curves possible.

Bastrop Bayou Risk Assessment

Located along the Texas Coast, and 50 miles south of Houston, Bastrop Bayou is a popular recreational destination for water skiers, boaters, anglers and birders. Water that falls within the Bastrop Bayou watershed eventually makes its way to Christmas Bay, a pristine coastal estuary that is home to some of the last remaining seagrass beds along the upper coast of Texas. Much of the watershed is currently used for agriculture (primarily rice farming, cattle-grazing, and aquaculture), and residents typically live in small cities and towns (i.e., Angleton, Danbury, Richwood), rural subdivisions, or homes along Bastrop Bayou.

Although much of the watershed is currently rural, forecasted population growth for the Houston-Galveston region indicates that urban areas within and immediately adjacent to the watershed will undergo substantial growth over the next 30 years. In addition to local growth, H-GAC forecasts that the Houston metropolis will add more than 3.5 million people by 2035. This regional growth will exert increased pressure on our natural resources, especially outdoor recreational opportunities along coastal bays and bayous.

During the spring of 2004, residents in the Bastrop Bayou watershed began voicing concerns about threats to water quality that could be posed by the land spreading of sludge, failing septic systems, illegal dumping, and storm water discharge. Specific concerns included potential bacteria, turbidity, pesticide, and nutrient loading of Bastrop Bayou and Christmas Bay – and how these loadings may adversely affect public health, natural resources, and local economies.

In response to these complaints and in an effort to determine the presence or absence of water quality impacts within the Bastrop Bayou watershed, the Galveston Bay Estuary Program, H-GAC and the Texas Clean Rivers Program launched a watershed risk assessment project during the fall of 2004. The risk assessment project included convening a committee of community leaders and local citizens, hosting a series of public meetings, establishing a water quality monitoring network, analyzing the relationships between baseline water quality and land use, and developing a watershed protection strategy.

Water quality monitoring results indicate that Bastrop Bayou and its main tributaries contain elevated concentrations of bacteria that exceed the State of Texas screening levels for contact recreation. While several potential sources of bacteria are present within the watershed (cattle grazing, migratory bird flyways, wildlife, and failing septic systems), the location of bacteria "hot spots" seems to indicate that cattle grazing and failing on-site septic systems are the largest contributors to bacterial non-point source loading.

This project resulted in the formation of an engaged local stakeholder group comprised of local homeowners, cattle ranchers, rice farmers, elected municipal officials, County Health District and Environmental Enforcement representatives, and watershed residents. The stakeholder group provided valuable input regarding local drainage features, potential sources of pollution, recreational uses, public access locations, and effective approaches to educating local residents and watershed visitors.

H-GAC worked closely with the stakeholder group to develop a watershed protection strategy that employs targeted monitoring and best management practices to address

bacteria loading "hot spots," encourage policy change at the local and county levels, secure sustainable funding for watershed protection planning, and increase public awareness and environmental stewardship. The watershed protection strategy includes a strong public outreach and community education component, continued water quality monitoring, and a practical site-specific approach to implementing best management practices. Examples of best management practices identified during this project are excluding cattle from the bayou, building constructed wetlands and package plants that address failing on-site septic systems, and improving the county requirements for sewage treatment associated with future residential development.

To maintain momentum, implement best management practices and sustain the local stakeholder group, H-GAC and the TCEQ are working together to fund a watershed protection plan via the EPA 319 grant program. H-GAC anticipates initiating work on the watershed protection plan during the spring 2007. Targeted monitoring, to be conducted during the development of the watershed protection plan, will shed light on the specific sources and locations of bacteria loading and assist H-GAC and local partners in rapidly developing and implementing solutions to reduce continued degradation and improve existing water quality.

This project could not have happened without the sustaining support of the Galveston Bay Estuary Program (GBEP) and the Texas Clean Rivers Program. The expertise, monitoring partnerships and funding provided by GBEP and the Clean Rivers Program allowed H-GAC to quickly establish a monitoring network, rapidly gather data, and spend time in the watershed earning the public's trust. Continuing the monitoring program beyond the life cycle of the risk assessment will play a critical role in cementing the partnerships needed to develop and implement the watershed protection strategy. The continued contributions of GBEP and the Clean Rivers Program will play a critical role in meeting EPA 319 grant program match requirements, and will ensure that data collected during this project will be of sufficient quality and quantity to equip local and regional decision makers with the information needed to affect policies that protect and preserve the natural resources of the Bastrop Bayou watershed.

Contact Recreation Use Attainability Analysis

H-GAC has contracted with the TCEQ to conduct a Contact Recreation Use Attainability Analysis (UAA) for Houston area bayous. Bacteria levels are high in most of the region's streams. This is not a problem only in southeast Texas; it is a problem in much of the state and in much of the country for that matter. The Draft 2006 Texas Index of Water Quality Impairments has 58 new listings for exceeding the state standard for bacteria in H-GAC's CRP assessment areas.

The UAA will attempt to answer the following questions:

1. Are the current contact recreation standards appropriate for all Houston area bayous? If not, would secondary standards be appropriate?
2. Are current sampling protocols appropriate?
3. Can streams in relatively un-impacted watersheds in the Houston area meet contact recreation standards?

Data collected during this study will lead to:

1. Appropriate bacteria related standards for Houston area bayous.
2. Appropriate methods and protocols for collecting bacteria samples.
3. Confidence that the implementation of future management plans will result in expected reductions of bacteria that will make a positive impact on human health.

A workgroup has been assembled to assist H-GAC with this project. H-GAC staff along with the workgroup is researching protocols and methodologies used by other states to conduct contact recreation UAAs. The group will determine the most appropriate contact recreation UAA protocols for Texas.

Another focus of the project is an epidemiological feasibility study. H-GAC staff and local epidemiologists will determine how best to evaluate what bacteria levels in local

streams are safe for different levels (types) of contact. H-GAC staff are reviewing and summarizing epidemiological studies from around the country to determine which methods will work best in the H-GAC area. H-GAC will also put together a cost estimate for an epidemiological study to determine what level of local cooperation may be needed in FY 2008.

H-GAC has issued a Request for Proposal for bacteria monitoring in Mill Creek in Austin County. The project will focus on the methods used to collect bacteria information. The contractor will collect bacteria samples using traditional sampling methods but will also collect samples over different averaging periods, cross sections, and/or different lengths of stream. Results will help to determine what methods give the best picture of bacteria levels in a stream.

Failing Septic System Initiative

Individual on-site sewage treatment facilities are prone to failure, releasing inadequately treated sewage and wastewater into surface and ground waters. Resulting concerns include bacterial non-point source pollution above state criteria for contact recreation and potential human health affects associated with septic systems and other sources of bacterial contamination. H-GAC, in partnership with the Galveston Bay Estuary Program, conducted a study entitled Failing Septic System Initiative to address these issues.

The study had three overriding objectives: quantification of bacterial contamination, source identification of the contamination, and development of strategies to address the problem of failing septic systems and other bacterial sources. Water samples were taken from standing water in ditches in front of homes in Harris County Precinct 2 (Westfield Estates), in Halls Bayou, and at the Sunbelt Fresh Water Supply District wastewater treatment plant outfall to determine the presence of bacteria. *Escherichia coli (E. coli)*, a predictive indicator for water borne pathogens in freshwater, total fecal coliform, total fecal streptococcus and/or enterococcus were present at most of the locations. Bacterial levels for *E. coli* exceeded State of Texas criteria for contact recreation at half of the ditch locations and some of the Halls Bayou locations. The Sunbelt Freshwater Supply District wastewater treatment plant, which is directly upstream from the community on Halls Bayou, showed negligible *E. coli* at its outfall.

Bacterial Source Tracking using Carbon Utilization Profiles was performed on water samples that contained sufficient bacterial levels for analysis. Reference libraries were created for human, canine, and domestic poultry. Bacteria from human sources (19 percent) were identified in study water from several locations in the community, along with canine (35 percent), chicken (11 percent), and undetermined sources (35 percent).

A local community stakeholders' meeting was held for public input and involvement and to develop a correction strategy for failing septic systems. Formation of a stakeholder partnership was recommended to bring municipal sewer service to the community through creative funding and to increase public awareness of the need for environmental stewardship. H-GAC will be partnering with the Galveston Bay Estuary Program to identify which existing septic systems can be repaired or replaced, and which homes can be supplied with a holding tank until the community can be serviced by sanitary sewer.

Dioxin Total Maximum Daily Load (TMDL) Studies

Due to elevated levels of dioxins in the lower portion of the Houston Ship Channel (HSC) and upper Galveston Bay in 1990, the Texas Department of Health issued a seafood advisory for HSC and upper Galveston Bay stating that no one should consume more than one seafood meal per month (8 ounces/month) and women of child-bearing age should not consume any sea catfish or blue crab from the area.

Phase I of this study included assessments of existing data, major sources as well as fate and transport of dioxin in the environment. The assessment revealed limited sediment data, no water quality data and very little source data.

Phase II of the study included additional data collection, refining a conceptual model, developing a steady-state water quality model and performing sensitivity analyses. This phase showed that concentrations of dioxin in the water exceeded Texas Surface Water Quality Standards more than 80 percent of the time. Although there are no standards for sediment, a Total Organic Carbon target was exceeded by 83 percent of sediment samples. Of tissue samples collected, 96 percent exceeded the health-based standard. Interestingly, dioxin concentrations measured during Phase II were as high or higher than historical levels. The estimated load from storm water runoff was about twice the load estimate from wastewater treatment facilities and loading from domes-

tic wastewater treatment facilities was estimated to be about twice that from industrial facilities.

Phase III is considered the final phase of the project. The vast majority of data collection and monitoring was completed by the end of August 2005. Some air monitoring was conducted in 2006. In 2005 high levels of dioxin were found in the Lower San Jacinto River at IH 10.

Investigations uncovered an old McGinnis waste disposal site. This site had subsided and is currently under investigation by the TCEQ Superfund staff to determine if this will be declared a Federal or State Superfund Site. Current efforts in this TMDL are focused on refining dioxin loads and modeling. The preparation of the TMDL report is expected to begin during September 2007.

More information on stakeholder activities and technical reports can be found at: www.h-gac.com/dioxintmdl.

Bacteria TMDL Studies

There are a number of Bacteria TMDLs underway in the following watersheds: Buffalo and White Oak Bayous; Clear Creek; Dickinson Bayou; Houston Metropolitan Area (Brays, Sims, Greens, Halls and others); and Cypress Creek. The most advanced TMDL study is the Buffalo/White Oak Bayous project. Once the loads and percentage reductions needed to achieve water quality standards are determined, the Implementation Phase will begin.

TMDL allocation calculations are currently being refined for the Buffalo/White Oak Bayou watersheds. This refinement should be complete during September 2007 and the preparation of the TMDL report will begin and should be completed by the end of December 2007. The Clear Creek TMDL should be the first TMDL completed after Buffalo and White Oak Bayou. Work on the other bacteria TMDLs, including implementation plans will are anticipated to continue through the end of State Fiscal Year 2011.

The implementation process for all TMDLs involves consultations with stakeholders, as well as state and federal agencies. Examples of implementation plan elements include possible changes in wastewater and storm water permit requirements, storm water management plans, and best management practices programs. No regulatory actions will take place until the TMDL is determined and an Implementation Plan is in place. Potential bacteria sources that will be dealt with in the Implementation Plan include:

- Inadequate/incomplete disinfection of Waste Water Treatment Plant (WWTP) discharges
- Wastewater collection system leaks and overflows
- WWTP bypasses
- Unpermitted discharges to storm sewers
- Bacteria from upstream sources (Buffalo Bayou)
- Failed septic systems
- Nonpoint sources (NPS) from wildlife, urban areas and stream sediment

There will be a need for continued evaluation to ensure that the plan is effective in helping to reduce bacteria levels throughout each watershed. This will include continued monitoring and adaptive management to make changes to the plan based on monitoring results.

Copies of the work completed, stakeholder meeting information, etc. can be found at: www.h-gac.com/water resource/tmdl/bacteria tmdl/

NELAC

The National Environmental Laboratory Accreditation Conference (NELAC) has developed a set of standards for the accreditation of environmental laboratories performing testing and analysis of environmental samples of any matrix. Prior to NELAC, the existing State programs varied widely in scope and requirements. The NELAC Standard provides uniform requirements for accreditation of environmental laboratories and facilitates mutual recognition among laboratory accreditation programs. The Texas Commission on Environmental Quality offers accreditation to the NELAC Standard as a voluntary option for environmental laboratories. However, if a laboratory wishes to submit data to the State of Texas for regulatory purposes, the laboratory must have accreditation for the parameters they submit.

Changes from the current system

As each laboratory becomes accredited by a National Environmental Laboratory Accreditation Program (NELAP) recognized accrediting authority (TCEQ for the State of Texas), the laboratory and the accredited scope of testing will be entered into a national database. Once a laboratory is accredited by one State for testing under a specific EPA program, it is accredited in another State for the same EPA program without having to meet additional accreditation requirements. The national database will simplify the search for a laboratory capable of performing testing under the requirements for a given EPA program. Services provided by NELAP accredited laboratories provide higher value to stakeholders, though overall costs are expected to increase slightly.

H-GAC's role

H-GAC is taking a leadership role in the accreditation process. The past three years have been very busy for our partners and the hard work has finally borne fruit this year. Two of our partners, Harris County and the City of Houston have submitted their application for accreditation ahead of schedule. Both are currently waiting for TCEQ review. The remaining partners are currently on-schedule to complete the accreditation by the end of the fiscal year. H-GAC will continue to track laboratory performance by using Proficiency Testing (PT) samples. The cost of which is wholly funded by the H-GAC Clean Rivers Program. H-GAC will pay for all PT samples for local partner agencies because the CRP will only be able to accept data from NELAC accredited lab because the agency will only consider these data in regulatory decision making.)

More about NELAC?

You can find a variety of resources, including copies of the NELAC standards and a list of the approved accrediting authorities at http://www.epa.gov/ttn/nelac. For more information about NELAC accreditation in Texas, go to http://www.tceq.state.tx.us/compliance/compliance_support/qa/env_lab_accreditation.html.

If you would like more information about H-GAC's involvement in NELAC please contact Om Chawla at om.chawla@h-gac.com.

Texas Watch Volunteer Water Quality Monitoring Program

Texas Watch is designed to facilitate environmental stewardship by empowering a statewide network of concerned volunteers, partners and institutions in a collaborative effort to promote a healthy and safe environment.

As a Texas Watch partner since 1992, H-GAC shares the goals of the Texas Watch program; to improve water quality through public education and participation. H-GAC supports the Texas Watch program as a full partner and has dedicated staff who coordinates the certified Volunteer Water Quality Monitors in our 13 county area.

H-GAC's Texas Watch program provides training and support for individual monitors, coordinates group monitoring projects, and disseminates information on water quality and non-point source pollution through public education forums.

Volunteer monitoring sites are selected with the volunteer's safety and access in mind and, in conjunction with Clean River Program staff, supports current professional monitoring sites with additional data. Volunteer monitoring data is not only used for educational purposes, we strive to ensure that site selection allows data to be an important part of the watershed analysis utilized by the State for water quality management decisions.

The H-GAC Texas Watch program has continued a steady growth in the last five years. Our focus is to maintain a manageable level of volunteers in order to support their needs for training, quality assurance, supply distribution and recognition. To support environmental stewardship and

provide the best volunteer management, H-GAC Texas Watch has developed alliances with local groups and institutions who share our concern for water quality. Examples of these alliances are Humble ISD Science teachers who incorporate Texas Watch in a service learning project of the Westbury Christian School and the Heartwood Chapter of the Galveston Bay Area Texas Master Naturalists who have adopted Texas Watch as a chapter project.

Maintaining a consistent group of certified water quality monitors can be a challenge. Based on the premise that volunteers who are more involved with an effort will remain active over a longer time period, we provide opportunities beyond monitoring for our Texas Watch volunteers. Volunteers are involved as trainers, quality assurance officers, data managers and assist in public outreach and education through community presentations. Implementing this strategy also ensures the necessary continuity of our Texas Watch program in the event of employee turnover.

H-GAC continues to be committed as a full partner with the Texas Watch program. The dedication and enthusiasm of our region's Certified Water Quality Monitor Volunteers is commendable and will allow us to sustain a high level of promoting environmental stewardship into the next decade.

2006 River, Lakes, Bays 'N Bayous Trash Bash®

Once a year thousands of Trash Bash® volunteers gather along the waterways of our region to do their part in cleaning up the environment. On Saturday, March 25, 2006, 4,417 volunteers picked up 55 tons of trash and 788 tires from the Galveston Bay watershed. The dedicated teams of volunteers from schools, citizen's groups, local businesses, industry, local governments and state agencies have made the River, Lakes, Bays 'N Bayous Trash Bash® a success since 1994. Trash Bash® is regionally coordinated through the H-GAC Solid Waste program and has been the recipient of several state and national awards since its inception. To learn more about Trash Bash® and to become a volunteer – visit www.trashbash.org.

Clean Marinas

The Texas Commission on Environmental Quality (TCEQ) Clean Texas Marinas Program is designed to enhance water quality and environmental compliance by implementing a voluntary certification program for recreational boaters and marina operators. Over 60 of the 357 marinas currently inventoried in the Clean Texas Marina Program are located in the H-GAC region. These marinas support some of the largest concentrations of recreational and commercial boating in the nation, and present some challenges and opportunities regarding storm water management, boat sewage disposal and boater education. Marinas in the H-GAC region include exclusive yacht clubs, vibrant waterfront marinas, power boat enthusiasts and salt water anglers. Local marinas offer a broad range of boating and fishing experiences, from the fresh water reservoir of Lake Conroe to the brackish waters of Clear Lake, Galveston Bay, and Matagorda Bay to the salty waters of the Intra Coastal Waterway and Gulf of Mexico.

The primary objective of the Clean Texas Marinas Program is to educate boaters about safe and clean boating practices. One of the biggest challenges is raising the awareness of properly handling boater sewage. H-GAC developed *"Looking For A Place To Pump Your Head?"* a handy brochure that lists locations and fees for sanitary pump out stations in the H-GAC region. H-GAC worked with local marinas to distribute the brochure to all boaters using marina facilities in our region.

H-GAC has continued to actively promote the Clean Texas Marina program and build relationships with marina operators in our region. H-GAC certified seven new marinas and

conducted certification visits at 25 of the 26 boater sewage pump out facilities in our region in 2006. In addition, H-GAC distributed over 250 Texas General Land Office oil spill prevention and response kits to marina tenants. Through an agreement with Maritime Sanitation, H-GAC is working to identify additional pump out locations on Lake Conroe, Clear Lake and Galveston Bay.

Evaluating Water Quality in Texas

The Texas Commission on Environmental Quality evaluates the condition of the state's water bodies on a periodic basis under the Clean Water Act (CWA) Section 305(b). The results are contained within the Texas Water Quality Inventory and 303(d) List and are comprised of a complete listing of all water quality issues in the State. As required by the Act, the inventory is updated every two years and consists of a review of the past five years' worth of data collected by many organizations statewide including local agencies working with H-GAC. The 2006 Water Quality Inventory and 303(d) List, on which the following information is based, provides an assessment of water quality results using the most recent 5 years worth of data. This inventory is available on the TCEQ Web site at *www.tceq.state.tx.us/compliance/monitoring/water/quality/data/06twqi/twqi06.html*

The term *impairment* is assigned to a portion of a water body when certain water quality constituents reach threshold concentrations as specified in the Texas Surface Water Quality Standards and the Texas Drinking Water Standards based either on the number of exceedances or the mean concentration over the threshold. This designation indicates that the water quality "uses" of the water body (e.g. water supply, contact recreation, aquatic life, and fish consumption) may be degraded. In other words, the water may not be fit to be used as a public water supply, the fish may not be able to get enough oxygen to survive, swimming in the water may cause the swimmer to be exposed to disease producing organisms or fish tissue data indicate that consumption of fish may cause deleterious effects. Water bodies that are shown to have an impairment for one or more constituents are included in the TCEQ's CWA Section 303(d) list.

Once a portion of a stream is placed on the list, a series of actions may be taken by the TCEQ to restore water quality, including, but not limited to: denial of increases in wastewater permit effluent limits; conducting a Total Maximum Daily Load (TMDL) study to allocate pollutant loads to certain sources; and instituting a strategy for reducing loads from all sources.

The term *partial impairment* or *concern* was assigned to a portion of a water body under less rigorous requirements for number of measurements exceeding the threshold, sample frequency, etc. (the term *partial impairment* will not be used in the 2006 assessment). If there is only a small amount of data available, or there are only a few samples not meeting the stream standards then the stream cannot be assessed as impaired with sufficient confidence. Therefore, the water body may be identified as having a *concern* for a certain constituent.

Concerns are also identified for nutrients and chlorophyll-*a*, toxic substances in fish tissue and sediment for which no stream standards have been developed but are otherwise useful in identifying water quality problems. Water bodies that are identified as partially impaired or as having concerns need more information to verify their condition. Additional data collection under the Clean Rivers Program during 2006 has been targeted towards those areas.

The next section of this report contains water quality assessment information about each of the major watersheds within H-GAC's Clean Rivers Program assessment area. It is presented as a result of TCEQ and H-GAC screening. It is important to remember that the information presented represents a snapshot in time and that water quality conditions are dynamic and can change over time. It is also important to note that although a segment may be identified as having "no known problems" it does not necessarily mean there are no problems, rather, there may have been limited, or no data available, and all uses may not have been assessed.

Local Water Quality Review

The following section contains information on each of H-GAC's Clean Rivers Program Watersheds. Each has been ranked according to the degree of water quality issues or concerns.

Ranking Key

1 Frog = Significant water quality impairment and/or concerns have been identified.

2 Frogs = Some water quality impairments and/or concerns have been identified.

3 Frogs = No known water quality impairments or concerns have been identified.

Trinity-San Jacinto Coastal Basin

(Watersheds are listed alphabetically.)

Cedar Bayou Above Tidal (0902) 
Major tributaries: Adlong Ditch, Buck Gully

This segment was identified on the TCEQ list of impaired water bodies as partially supporting its aquatic life use due to depressed dissolved oxygen. However, the current assessment removed DO from the list of impairments. The current assessment lists a possible concern for bacteria for the entire segment.

The segment is currently not monitored by any H-GAC partner. However, a Texas Watch volunteer has begun monitoring in the upper reaches of the Bayou.

Cedar Bayou Tidal (0901) 
Major tributaries: Cary Bayou, McGee Gully

The tidal portion of Cedar Bayou is currently listed as not meeting its fish consumption use due to dioxin in catfish and blue crab tissue. In response to a seafood advisory issued for the area by the Texas Department of Health in 1990, a TMDL study was initiated for Dioxin. Researchers are investigating the extent and level of dioxin contamination in sediment and tissue in the Houston Ship Channel and Upper Galveston Bay. Bacteria was removed from the 303(d) List in 2000, however it is still remains a concern and will be closely monitored.

The ongoing dioxin TMDL study was divided into three separate phases. First, the study focused on assessing current conditions, second, it focused on gathering data for all media types in order to quantify dioxin levels and the third phase is currently focusing on model development and load allocation.

San Jacinto River Basin

(Watersheds are listed alphabetically, upstream to downstream.)

Buffalo Bayou Above Tidal (1014) 
Major tributaries: Bear Creek, Langham Creek, Mason Creek, Neimans Bayou, Rummel Creek, South Mayde Creek, Spring Branch Creek, Turkey Creek

Buffalo Bayou is divided into several segments due to the constructed nature of the Houston Ship Channel into which it flows. The eastern portion of the watershed is densely developed. The western portion along the Interstate 10 corridor between Houston and the City of Katy is one of the most rapidly growing areas in the region. Addicks and Barker Reservoirs, which are floodwater retention basins, sit at the headwaters of the Bayou. Two major parks, Bear Creek Park and George Bush Park are located on either side of the reservoirs.

The entire segment and all sub-segments of Buffalo Bayou Above Tidal are on the TCEQ List of impaired water bodies due to elevated levels of bacteria. Bacteria impairments and nutrient concerns are found throughout the main stem and occur with high frequency. Elevated bacteria levels stem from the usual sources such as, overflows of municipal wastewater systems, failing septic systems, wildlife and avian populations, and pet waste.

In order to address the bacteria issue, TCEQ conducted a TMDL project to understand the reasons for high bacteria levels and attempt to determine possible sources of bacteria. The final task of the now-completed TMDL project consists of refining and developing load allocation methodologies.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers.

Previous investigations on listed sub-segments show either an impairment or concern due to depressed dissolved oxygen. However, recent DO grab sample results indicate compliance and DO was removed from the 303(d) List.

Buffalo Bayou Tidal (1013)
Major Tributary: Tidal portion of Little White Oak Bayou

Buffalo Bayou Tidal is completely urbanized; encompassing downtown Houston, the theater and entertainment districts, residential development, high-volume mixed-commercial development, and light industry. Several parks and natural areas are located along the banks of the bayou.

A major portion of the Houston metropolitan area is drained by Buffalo Bayou. In addition to a large number of municipal and industrial wastewater discharges, the bayou receives significant amounts of urban stormwater runoff.

In order to address the bacteria issue, TCEQ conducted a TMDL project to understand the reasons for high bacteria levels and attempt to determine possible sources of bacteria. The final task of the now-completed TMDL project consists of refining and developing load allocation methodologies.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for exceedances or trends.

Concerns from previous years include chronic copper levels in water in this segment. Copper was removed from the 303(d) list following results from a marine trace metals and copper water effects ratio (WER) study.

Previous investigations listed this sub-segment as having either an impairment or concern due to depressed dissolved oxygen. However, recent DO grab sample results indicate compliance and DO was removed from the list for this segment.

Caney Creek (1010)
Major tributaries: Camp Creek, Dry Creek, Little Caney Creek, McRae Creek, Spring Branch, West Fork Spring Branch, White Oak Creek

The watershed is largely undeveloped except for several small towns along the perimeter of the watershed. A small portion of the Sam Houston National Forest is in the uppermost reach. Caney Creek feeds into the northern fork of Lake Houston, a major water supply for the City of Houston and surrounding communities.

Caney Creek is a now listed on the Draft 2006 Texas Index of Water Quality Impairments for elevated levels of bacteria.

In 2004, a systematic watershed monitoring study was completed on Caney Creek. Samples were collected and the creek was monitored for basic water quality parameters (water temperature, specific conductance, dissolved oxygen, and pH) and for selected chemical constituents. In addition, the watershed was assessed for various biological attributes and indicators. Fish and benthic community data collected during the study was used to determine an ecoregion-specific index of biotic integrity (ECO-IBI) score. Higher IBI scores equate to higher aquatic life use. The (B-IBI) scores for the two sites on Caney Creek, in down-stream order, are high and interme-diate, indicating a healthy Creek for aquatics and benthics.

Cypress Creek (1009)
Major tributaries: Dry Creek, Dry Gully, Faulkey Gully, Lemm Gully, Little Cypress Creek, Live Oak Creek, Mound Creek, Pillot Creek, Seals Creek, Spring Gully

The eastern portion of the watershed is dominated by residential development within forested lands while the western portion, dominated by grasslands used for cattle grazing is experiencing rapid residential growth.

Cypress Creek appears on the 2006 303(d) List as not supporting contact recreation use due to bacteria levels which exceed the state standard. Bacteria may come from several different sources including; failing septic systems, illicit stormwater connections, and stormwater runoff from yards, parking lots, parks, farms and ranches. In order to address the bacteria problem a source identification study was conducted along the entire length of Cypress Creek. The reconnaissance study revealed that drainage from community developments occurs through storm sewer systems and other smaller conveyances. The study also revealed the highest overall bacteria levels are in the rural upper portion of the watershed.

Cypress Creek has new listings on the 2006 303(d) List for impaired habitat and an impaired macrobenthos community in the area between Highway 290 and Highway 249. An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

East Fork San Jacinto River (1003)
Major tributaries: Orange Branch, Miller Creek, Whiskey Branch, Winters Bayou

This watershed is primarily undeveloped forested land except for the lower portion, which is populated by the small cities of Plum Grove and Cleveland. Part of the City of Huntsville is located in the far northern portion along with a large part of the Sam Houston National Forest.

Indicator bacteria are used to assess the suitability of a water body for contact recreation use. Elevated bacteria concentrations are a major concern throughout the watershed. Exceedances above the state standard for E. coli are observed in stations on the segment and the segment will be closely monitored for any trends in bacteria data.

Greens Bayou Above Tidal (1016)
Major tributaries: Garners Bayou, Williams Gully

Above tidal portions of Greens Bayou experience similar issues associated with urban watersheds. Beltway 8 runs through the middle of the watershed with large, high intensity developments and businesses found adjacent to and at intersections with major highways; I-45, US 59 and SH 249. Bush Intercontinental Airport is located in the north central section of the watershed.

This entire segment, its major tributaries, and its sub-segments do not support contact recreation use according to TCEQ criteria due to elevated levels of bacteria. In response to the elevated bacteria levels in the bayous, TCEQ initiated a Bacteria TMDL to determine measures necessary to change water quality to support recreational uses in these water bodies.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. This segment will be closely monitored for any exceedances or trends in bacteria and nutrient levels.

Houston Ship Channel/Buffalo Bayou (1007)
Major tributaries: Berry Bayou, Berry Creek, Brays Bayou, Country Club Bayou, Hunting Bayou, Keegans Bayou, Little Vice Bayou, Pine Gully, Plum Creek, Vince Bayou

This very urbanized watershed includes the Houston Ship Channel (HSC) and more than seventy miles of tidal and non-tidal tributary streams, which ultimately flow into Galveston Bay. The HSC watershed includes the cities of Pasadena, Galena Park, and Houston as well as large petrochemical complexes. Numerous permitted wastewater and stormwater discharges are located throughout the watershed.

Buffalo Bayou and the main stem of HSC do not meet state standards for fish and crab consumption use due the presence of dioxin in their tissues. A seafood advisory was issued for the area by the Texas Department of Health (TDH) in 1990. In addition, the main stem is also listed on the 303(d) List as not meeting standards for Poly Chlorinated Biphenyls (PCBs), Chlordane, Dieldrin and Heptachlor Epoxide in fish tissue.

A three-part TMDL study was initiated because of dioxin levels in fish tissues. The first part of the study focused on assessing current conditions and determining sources. The second gathered data for

all media types in order to quantify dioxin levels. The current third phase focuses on model development and load allocation.

Overall, bacteria impairments and nutrient concerns are found throughout Houston Ship Channel/Buffalo Bayou prohibiting safe contact recreation use in non-tidal portions of tributaries within the watershed. Sources for both bacteria and nutrients are usually associated with municipal rather than industrial activities. Elevated bacteria levels most likely stem from the usual sources such as intermittent municipal collection system overflows, failing septic systems, wildlife and avian populations, and pet waste. In response to the elevated bacteria levels in the bayous, the TCEQ initiated a Bacteria TMDL to determine measures necessary to support recreational uses in these water bodies.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. Bacteria and nutrient levels will be closely monitored for any exceedances or trends.

In the past, several sub-segments of the Houston Ship Channel appeared on the TCEQ list as impaired or a concern due to depressed dissolved oxygen however, the listing was removed in 2006.

Houston Ship Channel (1006)
Major tributaries: Boggy Bayou, Carpenters Bayou, Goodyear Creek, Halls Creek, Patrick Bayou, Tidal portion of Greens Bayou

The whole watershed is heavily developed and receives discharges from several permitted wastewater and stormwater outfalls. The lower portion of the watershed includes the heavy industrial complexes that line both sides of the Channel. This area includes the Cities of Deer Park, Channelview, Houston, Pasadena and parts of unincorporated Harris County.

The main stem of Houston Ship Channel does not meet state standards for fish and crab consumption due to the detection of dioxin in their tissues. A seafood advisory was issued for the area by the Texas Department of Health (TDH) in 1990. In addition, the main stem is also listed on the 303(d) List as not meeting standards for PCBs, Chlordane, Dieldrin and Heptachlor Epoxide in fish tissue.

Overall, bacteria impairments and nutrient concerns are found throughout the Houston Ship Channel prohibiting safe contact recreation use in non-tidal portions of tributaries within the watershed. Sources for both bacteria and nutrients are usually associated with municipal rather than industrial activities. Elevated bacteria levels most likely stem from the usual sources such as intermittent municipal collection system overflows, failing septic systems, pet waste, naturally occurring wildlife and avian populations. In response to the elevated bacteria levels in the bayous, the TCEQ initiated a Bacteria TMDL to determine measures necessary to support recreational uses in these water bodies.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

Houston Ship Channel/San Jacinto River (1005)
Major tributaries and bays: Barbours Cut, Black Duck Bay, Burnet Bay, Goose Creek, Old River, San Jacinto Bay, Scott Bay, Tabbs Bay

This watershed includes the Cities of Baytown and Highlands located on the eastern shore of the channel and river, with the heavily industrialized cities of Channelview, Deer Park and La Porte situated along the western shoreline.

The main stem of the Houston Ship Channel is listed as not meeting its fish consumption use due to dioxin

and PCBs in fish and crab tissue. In 2001, the Texas Department of State Health Services (DSHS) issued a fish consumption advisory for the portion of HSC above the Lynchburg Ferry crossing. The DSHS determined that there was an unacceptable risk to human health due to elevated concentrations of organo-chlorine pesticides, PCBs and dioxin. After studying the fish tissue data in more detail, DSHS rescinded the advisory for the 14 pesticides identified in the original advisory. These contaminants are considered legacy pollutants and persist in the environment however concentrations found in fish tissue do not pose a significant risk to consumers.

Lake Conroe (1012) 

Major tributaries: Caney Creek, East Sandy Creek, Lewis Creek, Little Lake Creek, McDonald Creek, McGary Creek, West Fork San Jacinto River, West Sandy Creek

The watershed is mostly undeveloped with tracts of large forested land and grasslands. Lake Conroe itself encompasses the majority the watershed, with significant development along its shores. The central portion of the watershed is located in the Sam Houston National Forest. The City of Huntsville is the major development located in the northeastern section of the watershed.

Lake Conroe is a public drinking water source for the region and provides abundant recreational activities. There are no known water quality issues that exist for the lake. Hurricane Rita caused significant damage to the levee, which required dropping lake levels for almost a year in order to make repairs. Repairs have been completed and lake levels are normal again. Previous concerns for low dissolved oxygen and high pH values no longer exist since recent monitoring data show no problems associated with these two parameters. H-GAC will continue to closely monitor the watershed for any changes.

Lake Creek (1015) 

Major tributaries: Caney Creek, Fish Creek, Garretts Creek, Landrum Creek, Little Caney Creek, Mound Creek

The watershed is rural in nature and is dominated by forested land and grassland with the major land cover used as pastureland or for hay. However, residential development is occurring rapidly in the watershed increasing the possibility of negative impacts on water quality.

In 2004, a systematic watershed monitoring study was completed on Lake Creek. Samples were collected and the creek was monitored for basic water quality parameters (water temperature, specific conductance, dissolved oxygen, and pH) and for selected chemical constituents. The watershed has also been assessed for various biological attributes and indicators. Fish and benthic community data collected during the study were used to determine an ecoregion-specific index of biotic integrity (ECO-IBI) score. Higher IBI scores equate to higher aquatic life use. Upstream sites for Lake Creek indicate an Intermediate aquatic life use and the most downstream location has a High aquatic life use.

Texas Watch volunteers currently monitor four stations in the Lake Creek watershed for conventional parameters (temperature, DO, pH, and conductivity). Two stations are monitored for bacteria. Exceedances above the state criteria occur in less than 20 percent of reported results.

Lake Houston (1002) 

Major tributaries: East Fork San Jacinto River, Luce Bayou, March Branch, Tarkington Bayou, West Fork San Jacinto River

Lake Houston is the major drinking water supply for the City of Houston and surrounding communities. Residential development is increasing at a rapid rate with most of the heavily developed areas around the lake itself.

Eight watersheds drain into Lake Houston. These include: Cypress Creek, Spring Creek, Lake Creek, the West Fork of San Jacinto River, Lake Conroe, Caney Creek, Peach Creek, and the East Fork of San Jacinto River. Water Quality of these watersheds has a tremendous impact on public water supply.

Lake Houston is a new listing on the Draft 2006 303(d) list for elevated levels of bacteria. A concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

Peach Creek (1011)
Major tributaries: Bee Branch, Boggy Creek, Duck Creek, Gully Branch, Gum Branch, Jayhawker Creek, Lawrence Creek, Mare Creek, Waterhole Branch

This watershed is dominated by forested land with the Sam Houston National Forest in the upper reach. Several small communities including Splendora and Woodbranch are located in the lower reach of the watershed.

Peach Creek has been listed on the Draft 2006 303(d) list for elevated levels of bacteria. This is the first time that the stream has been listed for any parameter. Bacteria numbers have been slowly increasing over the last several years. This may be the result of increased development in the watershed.

In 2004 a systematic watershed monitoring study was completed on Peach Creek. Samples were collected and the creek was monitored for basic water quality parameters (water temperature, specific conductance, dissolved oxygen, and pH) and for selected chemical constituents (ammonia, nitrates, and phosphates). The watershed has also been assessed for various biological attributes and indicators. Fish and benthic community data collected during the study was used to determine a ecoregion-specific index of biotic integrity (ECO-IBI) score. Higher IBI scores equate to higher aquatic life use. The score for Peach Creek sites indicate High aquatic life use.

San Jacinto River Tidal (1001)
Major tributary: Gum Gully Creek

The lower portion of the watershed is heavily developed, with industrial activity along the Houston Ship Channel as its major land use.

Overall, bacteria and nutrient concerns and/or impairments are found throughout the San Jacinto River Basin. Bacteria sources are associated with municipal rather than industrial activities. Elevated bacteria levels likely stem from intermittent municipal collection system overflows, failing septic systems, wildlife and avian populations, and pet waste scattered throughout the watershed.

Dioxin in catfish and crab tissue prevents fish consumption. Exact sources of dioxin are not known at this time. PCBs were detected in catfish, spotted sea trout, and blue crab.

A three-part TMDL study was initiated because of high dioxin levels in fish tissues. The first part of the TMDL study focused on assessing current conditions and determination of sources. The second gathered data for all media types in order to quantify dioxin levels. The current third phase focused on model development and load allocation.

Spring Creek (1008)
Major tributaries: Bear Branch, Birch Creek, Brushy Creek, Dry Creek, Lake woodlands, Mill Creek, Mill Branch, Mink Branch, Panther Branch, Sulfur Branch, Three Mile Creek, Walnut Creek, Willow Creek

The Spring Creek watershed is currently experiencing rapid growth. The City of Tomball and extreme northern portions of Houston border the southern edge of the watershed. The smaller communities of Magnolia and Pinehurst located in the central portion of the watershed are also experiencing rapid growth. The western portion of the watershed remains undeveloped for the most part.

The entire segment of Spring Creek is listed as not meeting contact recreational use due to elevated bacteria levels. The creek also is listed for depressed DO from Field Store Road to SH 249. There is also a nutrient enrichment concern for both orthophosphorus and total phosphorus and nitrate for the sub-segment between SH 249 and I-45.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

West Fork San Jacinto River (1004)
Major tributaries: Camp Creek, Crystal Creek, East Fork Crystal Creek, Caney Creek, Egypt Creek, Harpers Horsepen Branch, Lake Creek, Little Caney Creek, Rice Branch, Sand Branch, Stewarts Creek, West Fork Crystal Creek, White Oak Creek, Woodsons Gully Creek

The watershed is primarily undeveloped forested land except for the City of Conroe. The Sam Houston National Forest occupies the northern section. There are several small communities located in the watershed that have the potential to affect water quality.

Overall, bacteria impairments and nutrient concerns are found throughout the San Jacinto River Basin prohibiting safe contact recreation use in non-tidal portions of tributaries within the watershed. Elevated bacteria levels most likely stem from sources such as intermittent municipal collection system overflows, failing septic systems, pet waste, wildlife and avian populations.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

White Oak Bayou (1017)
Major tributaries: Brickhouse Gully, Cole Creek, Little White Oak Bayou, Vogel Creek

This watershed contains widespread development, with the densest population found in its lower reaches inside Loop 610. Heavy commercial development occurs along the Highway 290 corridor with residential and less dense mixed developments adjacent to the corridor.

White Oak Bayou and its tributaries are listed for not meeting contact recreation use due to elevated bacteria levels. TCEQ conducted a TMDL project to understand the reasons for high bacteria levels and attempt to determine the possible sources of the bacteria. Indicator bacteria Escherichia coli and fecal coliform are used to assess the suitability of a water body for contact recreation use. Documentation shows that natural streams tend to exhibit low bacterial levels during dry weather conditions with essentially all dry weather flow is from treated human sewage (wastewater treatment plants). High concentrations of bacteria are observed when bacteria are transported from their source by rain water and are transported in runoff and washed into local streams.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

San Jacinto-Brazos Coastal Basin

(Watersheds are listed alphabetically.)

Armand Bayou (1113)
Major tributaries: Big Island Slough, Horsepen Bayou, Middle Bayou, Mud Lake, Spring Gully, Willow Spring Bayou

A majority of the watershed is densely developed with the City of Houston (Clear Lake City) in the south, the City of La Porte in the east, and parts of the Cities of Deer Park and Pasadena in the north. High and low intensity residential and mixed commercial developments are the dominant land uses but large industrial facilities are scattered throughout the northern portion of the watershed.

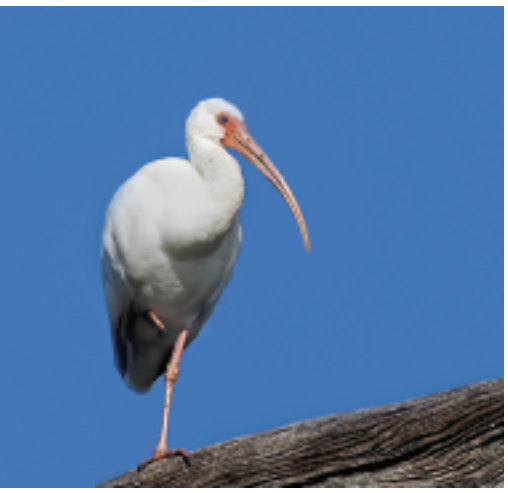
Armand Bayou is listed as not meeting its contact recreation use due to elevated bacteria levels. It is also not meeting the standards for dissolved oxygen.

In response to the elevated bacteria levels in the bayous, TCEQ initiated a Bacteria TMDL to determine measures necessary to support recreational uses in these water bodies. There are several Bacteria TMDLs currently underway on various water bodies throughout the Houston region. Lessons learned from these projects will be applicable to Armand Bayou for facilitating restoration of water quality.

An Armand Bayou Watershed plan has been produced which addresses concerns for the water body and suggests possible solutions. It can be found at www.armandbayou.org/ArmandBayouWatershedPlan.htm

Bastrop Bayou (1105)
Major tributaries: Austin Bayou, Brushy Bayou, Flores Bayou

The main stem of Bastrop Bayou originates near SH 288 south of Angleton and contains a mix of agricultural, wooded areas and coastal wetlands. The watershed is mostly rural, with urban development primarily limited to the cities of Angleton and Danbury. Abundant wetlands are located along the lower reaches of the watershed. In the past, the primary industry was dominated by agriculture with rice fields and cattle grazing. White rice farming remains active in the watershed, but much of the land that was once devoted to rice production is being used for aquaculture and the production of shrimp and crawfish. In addition, farmers are raising koi to support the local water garden and goldfish pond industry.



Bastrop Bayou has an extensive freshwater wetland habitat and is home to endangered and threatened shorebirds, waterfowl, grassland species and birds of prey. Bastrop Bayou is part of the Texas Coastal Preserve, which is home to one of the last assemblages of submerged aquatic vegetation on the Upper Texas Coast. Brazoria National Wildlife Refuge (NWR) is rich in ecology, freshwater sloughs, salt marshes and native bluestem prairies. This habitat is important to the many species of birds that can be found each season. The Great Texas Coastal Birding Trail was completed through the cooperation of private citizens, land managers, conservation groups, businesses, government agencies and communities.

A risk assessment to address water quality issues expressed by local residents was conducted in 2005. The risk assessment concluded that there are several bacteria related problems in the Bastrop Bayou watershed, including several channelized canals, closed-in channel communities with none or very little flow, and livestock observed grazing in and around the bayou. H-GAC will be developing a Watershed Protection Plan over the next 2 years through a 319 grant from the TCEQ.

Chocolate Bayou Above Tidal (1108)
Major tributaries: Hayes Creek, West Fork Chocolate Bayou

This watershed is largely undeveloped with the exception of small urban centers dispersed across its northern and eastern reaches. Towns within the watershed include Manvel, Arcola, Iowa Colony, and the western portion of Alvin. Agriculture is a major land use in this watershed. A system of canals distributes surface water for irrigation purposes. There are stretches of riparian forests that cut through farms and prairie grassland.

There is a possible concern for elevated bacteria with recent sampling results showing exceedances of the standard. H-GAC started a sampling program in the watershed in 2004. More sampling will be needed to confirm this concern.

Chocolate Bayou Tidal (1107)
Major tributaries: Corner Bayou, Cottonwood Bayou, Pleasant Bayou

The majority of the watershed is rural, with the community of Liverpool as the only urban area in the watershed. Agriculture is the major land use which contains large systems of irrigation canals. Riparian forests cut through tracts of prairie grasslands along the length of the watershed. A large industrial complex comprised of several major petrochemical plants is located in the southeast. Duck Lake and Monsanto Reservoir are used as water impoundments by these industries.

There are no major water quality issues or concerns associated with Chocolate Bayou Tidal.

Clear Creek Above Tidal (1102)
Major tributaries: Cowart Creek, Hickory Slough, Mary's Creek Mud Gully, Turkey Creek

The watershed is experiencing rapid growth with a mixture of residential and commercial development. Most of the high intensity development is located along FM 518 which runs from League City in the eastern end, through Pearland west of Hwy 288.

The main stem is included in the TCEQ list of impaired water bodies due to elevated bacteria, chloride, and total dissolved solids (TDS). In addition, tributaries Cowart Creek, Mary's Creek, Hickory Slough, Turkey Creek, and Mud Gully are also listed as impaired due to elevated bacteria levels. New impairments have been identified on the Draft 2006 303(d) List for impaired habitat and fish community for the section of Clear Creek between SH288 to the Hickory Slough confluence. There is also a nutrient enrichment concern for the main stem and its tributaries. A TMDL project is currently underway to determine sources of bacteria contamination in Clear Creek.

Clear Creek Tidal (1101)
Major tributaries: Chigger Creek, Magnolia Creek

The watershed is experiencing rapid growth with mixed residential and commercial development; however, large tracts of grassland and forested land

still exist in the watershed. Most of the high intensity development is located near I-45. The Johnson Space Center and Bay Brook Mall complexes are located in the northeastern section.

Clear Creek and tributaries Chigger Creek and Robinson Bayou are included in the TCEQ List of impaired water bodies due to elevated bacteria levels. In response to the elevated levels TCEQ initiated a TMDL study to determine measures necessary to support recreational uses.

There is a possible nutrient enrichment concern for nitrate which shows results exceeding the state screening criteria. H-GAC will closely monitor nitrate results for any trends or exceedances.

Following a fish-consumption advisory issued in 1993, portions of Clear Creek exhibited elevated concentrations of the pesticide chlordane. In response to the advisory TCEQ initiated a TMDL. Chlordane is considered a legacy pollutant, a chemical that has been banned or severely restricted, but still remains in the environment. Since there are no new significant sources, gradual declines are expected to occur through natural attenuation processes. The 303(d) listing for chlordane has been removed.

Dickinson Bayou Above Tidal (1104)

The watershed includes portions of the Cities of Alvin, Friendswood, League City and Santa Fe. Rapid growth is occurring throughout the watershed. Residential, mixed commercial development and agriculture are the predominant land uses with high intensity developments and business districts at the intersections and along SH 6, SH 35 and FM 528.

Dickinson Bayou appears on the Draft 2006 303(d) List due to depressed dissolved oxygen levels. The Bayou has not met its contact recreation use, due to elevated bacteria levels since 1996. In response to the bacteria problem the TCEQ initiated a TMDL study to determine measures necessary to support contact recreation uses in the stream. Low DO levels are a result of a combination of natural processes and anthropogenic influences. With increasing residential and commercial development in the watershed, greater pressure will be placed on the Bayou to process additional loading from point and non-point sources.

Dickinson Bayou Tidal (1103)

Major tributaries: Bordens Gully, Cedar Creek, Geisler Bayou, Gum Bayou

The watershed is heavily developed and contains the cities of Dickinson, Santa Fe, and League City. Low intensity residential and mixed commercial developments are the predominant land uses.

The entire segment and sub-segments are on the Draft 2006 Texas 303(d) list for elevated bacteria levels. In response to the elevated bacteria levels in the bayous, the TCEQ initiated a Bacteria TMDL study to determine measures necessary to support recreational uses in these water bodies.

A TMDL for dissolved oxygen was initiated in 2000 after the impairment was verified. Depressed dissolved oxygen was removed from all sub-segments during the most recent assessment. H-GAC conducted a special study to determine the extent and severity of the impairment in the bayou. TCEQ removed the DO Concern for all sub-segments of Dickinson Bayou however, the listing remains for the main stem. Currently, the TCEQ is facilitating a stakeholders group which will help determine the best strategies for addressing the problems and, eventually assist in developing a watershed management plan.

Old Brazos River Channel (1111)

This small watershed comprises what was once the mouth of the Brazos River, in southern Brazoria County. Beach-front residential development along with water recreational activities are observed in the lower reaches of the watershed with large expanses of wetlands surrounding the watershed.

While no impairments are listed for this segment, there is a concern for heavy metals in sediment; barium, copper, and nickel. Results from samples collected between 1994 and 2002 show no issues with respect to bacteria and there are no issues with nutrients.

Oyster Creek Above Tidal (1110)

Although there is scattered development in the towns of Missouri City, Fresno, Arcola, Bailey's Prairie, Bonney Village, Angleton, Holiday Lakes and Lake Jackson most of the watershed is either undeveloped or rural. The greater portion of the watershed is bottomland forest, grassland or wetland habitat. Oyster

Creek is very sinuous with numerous oxbow lakes, typical of the Texas Gulf coast region.

Historically, Oyster Creek was listed on the 303(d) list for not meeting its aquatic life use due to occurrences of depressed dissolved oxygen; however the current assessment added elevated bacteria levels to the list.

Oyster Creek Tidal (1109)
The watershed lies in a region of fertile alluvial soil which has supported cotton and sugarcane plantations since the days of the Texas Republic. Development is largely limited to the northwest section of the watershed including the cities of Lake Jackson, Richwood, Clute and Oyster Creek Village while most is covered by natural forest and grassland. Oyster Creek is very sinuous with numerous oxbow lakes, typical of the Texas Gulf Coast region. There are large expanses of coastal wetlands at the southern and eastern edges of the watershed.

In 1998, the topography of Oyster Creek watershed was altered to prevent flooding in Sienna Plantation. As a result this changed the stream flow classification from perennial to intermittent. The impairment should be scrutinized because of the alteration to the stream and the resulting change in flow.

San Bernard River

San Bernard River Above Tidal (1302)
Major tributaries: Coushatta Creek, East Bernard Creek, Little San Bernard Creek, Middle Bernard River, Peach Creek, West Bernard Creek

The watershed is predominately undeveloped with the small communities of East Bernard and Kendleton located in the middle of the watershed. Rice and cotton farming dominate the landscape. The segment is listed as not supporting contact recreation use due to elevated bacteria levels in the lower 50 miles.

San Bernard River Tidal (1301)
Major tributaries: Halls Bayou, Mound Creek

The watershed is predominantly undeveloped with the exception of small towns including West Columbia, Wild Peach Village, Sweeny, Brazoria and Jones Creek Village. West Columbia was the first capital of the Republic of Texas. The watershed consists mainly of forest or grasslands with large areas of wetlands located in the southern end at the mouth of the San Bernard River. Agriculture is the main economic activity in the watershed.

Bays and Estuaries

Barbours Cut (2436)
This segment is in a heavily industrialized area. Dioxin in catfish and crab tissue samples and PCB's in catfish, spotted seatrout and blue crab prevents consumption. Exact sources of the dioxin and PCB's are not known at this time.

The ongoing dioxin TMDL study was divided into three separate phases. The first phase focused on assessing current conditions. The second gathered data for all media types in order to quantify dioxin levels. The third phase is currently focusing on model development and load allocation.

Bastrop Bay/Oyster Lake (2433)
The bay and lake are in an undeveloped estuarine environment and are part of the Christmas Bay system. Bacteria data collected between 1992 and 2003 show several exceedances above the standard. Bastrop Bay is a new listing on the Draft 2006 303(d) list for elevated levels of bacteria in oyster waters.

Bayport Channel (2438)
This segment is in a heavily industrialized area.

Dioxin in catfish and crab tissue prevents consumption. Exact sources of dioxin are not known at this time. There are also PCBs in catfish, spotted seatrout, and blue crab.

The ongoing dioxin TMDL study was divided into three separate phases. The first phase focused on assessing current conditions. The second gathered data for all media types in order to quantify dioxin levels. The third phase is currently focusing on model development and load allocation.

Black Duck Bay (2428), Burnett Bay (2430)
These segments are in a heavily industrialized area.

Dioxin in catfish and crab tissue prevents consumption. Exact sources of dioxin are not known at this time. There are also PCBs in catfish, spotted seatrout, and blue crab.

The ongoing dioxin TMDL study was divided into three separate phases. The first phase focused on assessing current conditions. The second gathered data for all media types in order to quantify dioxin levels. The third phase is currently focusing on model development and load allocation.

Chocolate Bay (2432)
Major tributaries: Chocolate Bayou, Cloud Bayou, Halls Bayou, Mustang Bayou, Persimmon Bayou, Willow Bayou

Elevated bacteria levels from unknown sources prevent oyster harvesting. The bay receives water from Chocolate Bayou, Halls Bayou, Mustang Bayou, and Persimmon Bayou.

Christmas Bay (2434)
Christmas Bay is a coastal preserve and part of the Texas General Land Office/Texas Parks and Wildlife Department Coastal Preserves Program. Christmas Bay is one of the most pristine areas in the Galveston Bay system and is home to numerous species of birds, fish, crustaceans, mollusks, and several species of seagrass. The area is surrounded by undeveloped wetland habitat and is part of a larger system of smaller bays and lakes.

Christmas Bay is a new listing on the Draft 2006 303(d) list for elevated levels of bacteria in oyster waters.

Clear Lake (2425)
Clear Lake is home to one of the most concentrated fleets of recreational boats in Texas and the United States. Numerous marinas are located around the lake providing easy access to Upper Galveston Bay. From jet skis to multi-million dollar yachts, the entire lake is a recreational playground. On the south shore of Clear Lake, the watershed encompasses the Cities of League City, Clear Lake Shores and Kemah.

Both Jarbo Bayou and Robinson Bayou feed into Clear Lake and are listed as impaired for contact recreation due to elevated levels of bacteria. Clear Lake is also listed as having a nutrient enrichment concern and there is an additional concern for excess algal growth.

Drum Bay (2435)
There are no known water quality issues that appear on the TCEQ list of impaired water bodies. However, Drum Bay is included in the Texas Department of State Health Services (DSHS) "restricted areas" or "closed to the taking of shellfish." Data collected between 1996 and 2003 shows a potential impairment for oyster waters and concern for contact recreation due to elevated levels above the fecal coliform standard.

East Bay (2423)
The East Bay watershed encompasses East Bay, the Upper Bolivar Peninsula, and portions of Chambers County which are predominantly undeveloped. Development is limited to vacation homes, fish and bait camps and small commercial businesses. Abundant wetlands, marshes, and coastal prairie habitats cover most of the peninsula.

East Bay is listed as impaired for not fully supporting oyster waters use due to elevated fecal coliform levels.

Lower Galveston Bay (2439)
This segment primarily receives flow from other bodies of water such as Upper Galveston Bay, East Bay, West Bay and the Gulf of Mexico. The land portion of the watershed includes parts of the Cities of Galveston and Texas City. The entire bay is a major recreational area for boating, fishing, and birding.

An unknown source of bacteria lists East Bay as not fully supporting oyster harvesting due to elevated fecal coliform levels.

Moses Lake (2431)
The watershed, which includes much of Texas City and part of the City of La Marque, presents a wide range of environmental conditions. The northeastern and northwestern portions of the watershed consist mostly of grasslands and forested lands, while the southern section is highly urbanized and includes a part of the Texas City petrochemical complex. Large tracts of undisturbed wetlands and marsh habitats surround Moses Lake and Dollar Bay an adjacent lagoon.

Recent results from routine monitoring shows a possible concern for nutrients with respect to orthophosphorus. H-GAC will continue to monitor for trends.

San Jacinto Bay (2427), Scott Bay (2429), Tabbs Bay (2426)
These segments are in the middle of, near, or downstream from heavily industrialized areas.

Dioxin in catfish and crab tissue prevents consumption. Exact sources of dioxin are not known at this time. There are also PCBs in catfish, spotted seatrout, and blue crab.

The ongoing dioxin TMDL study was divided into three separate phases. The first phase focused on assessing current conditions. The second gathered data for all media types in order to quantify dioxin levels. The third phase is currently focusing on model development and load allocation.

Texas City Ship Channel (2437)
The majority of the Texas City Ship Channel watershed is occupied by the Texas City petrochemical complex. The Texas City Ship Channel supports heavy barge and ship traffic on a regular basis. Docks used to load and unload raw materials and finished products occupy the entire north shoreline and the turning basin. The ship channel receives stormwater and wastewater discharges from the industrial complex.

A special study was conducted to verify the depressed dissolved oxygen impairment and nutrient enrichment concern. The study involved 24-hour DO measurements and sample collection for nutrients and conventional water quality samples over an 18-month period. Results from the study de-listed the segment for both DO and nutrient concerns.

Upper Galveston Bay (2421)
The upper portion of the watershed contains a large amount of industrial activity, with barge transportation as the major activity. The lower portion of the watershed is a mix of residential and commercial communities. Dioxin in catfish and crab tissue prevents consumption from Red Bluff to Five Mile Cut to Houston Point to Morgan's Point. Exact sources of dioxin are not known at this time.

An additional concern for nutrient enrichment exists because of elevated levels of ammonia and phosphates, which could lead to algal blooms. Elevated nutrient levels often occur because of excessive use of fertilizers. In the future, bacteria and nutrient levels will be closely monitored for any exceedances or trends.

The ongoing dioxin TMDL study was divided into three separate phases. The first phase focused on assessing current conditions. The second gathered data for all media types in order to quantify dioxin levels. The third phase is currently focusing on model development and load allocation.

West Bay (2424)
Major tributaries: Basford Bayou, English Bayou, Highland Bayou, Marchand Bayou, Offats Bayou.

The West Galveston Bay watershed encompasses the bay side of Galveston Island, a barrier island with many coastal wetlands on the landward side. The West Bay system is located at the eastern end of Galveston Island and includes several small bays, lakes, and bayous that drain into the bay. Oyster harvesting is prohibited in the main part of the bay due to elevated bacteria levels. Both Highland and Marchand Bayous are listed as impaired due to elevated bacteria levels and low dissolved oxygen. There is a nutrient enrichment concern with respect to ammonia for English Bayou and the Crash Basin.

A special project to provide additional water quality data and baseline biological data for Highland and Marchand Bayous began in 2006. During the first year of this study, activities will consist of project planning and development of a comprehensive Quality Assurance Project Plan (QAPP) with data collection to follow.

Gulf of Mexico (2501)
Only one documented issue in the Gulf of Mexico is elevated mercury levels in King Mackerel at 43 inches below the surface and deeper at Bolivar Roads/Bolivar Point to Port Aransas.

Summary

The biggest water quality concern throughout the region continues to be elevated bacteria levels, which inhibit safe contact recreation and oyster harvests. Toxicity, particularly dioxin, continues to be an issue of great concern. Several TMDLs are currently underway to address these issues. Routine monitoring is being used to address some of the less severe issues, including low dissolved oxygen levels in small tributaries. Other special studies have been initiated to identify sources of contamination and to help in the development of reasonable remediation and control strategies.

Expanded ambient monitoring has given water quality managers data to conduct better, and more efficient assessments. Monitoring in watersheds that previously had limited data has improved the knowledge of water quality conditions in more rural areas. The combination of data collection, analysis, education, stakeholder involvement, and reasonable implementation strategies are key factors in watershed management and the understanding of aquatic ecological systems.

Resources

In addition to previous Basin Highlights and Summary Reports, the following publications are available through the Clean Rivers Program and H-GAC's Water Quality Planning Program. Reports and studies are also available for other programs such as habitat preservation and environmental enforcement. If you are interested in any of these publications, please contact H-GAC's Community and Environmental Planning Department at 713-993-2461. Many documents can be found online at www.h-gac.com

Water Quality Reports and Guidance Manuals

Mustang Bayou Systematic Watershed Study, 2006

Bacteria Die-off Study, 2005

Cypress Creek Source ID Study, 2005

Receiving Water Assessment of Unnamed Tributary of Whiteoak Bayou, 2005

Receiving Water Assessments for Urban Water bodies Houston Ship Channel Tributary, 2003

Houston Ship Channel Water Quality Conditions Report, 2003

Hydrologic, Water Quality and Biological Data for Three Water Bodies Texas Gulf Coastal Plain, 2000-2002

A Guidance Manual for Identifying and Eliminating Illicit Connections to Municipal Separate Storm Sewer Systems (MS4), 2002

Dickinson Bayou Pre-TMDL Data Collection, 2002

Urban Bayou Bacteria Source Identification Study, 2001

Regional Habitat Index, USGS Phase 3 document
Dioxin Sediment and Tissue Sampling in Houston Ship Channel and Upper Galveston Bay, 2001

Gulf Coast Region Water Quality Management Planning Document, 2000

Domestic Wastewater Regionalization White Paper, 2000

Copper Water Effects Ratio Study and Trace Metals Study for the Houston Ship Channel, 2000

Greens Bayou Intensive Survey and Wasteload Evaluation, 1999

Water Quality Data Analysis, 1999

Characterization of Water and Sediment Quality, Christmas Bay System, Brazoria County, Texas, 2000

Characterization of Water-Quality and Aquatic-Biological Conditions in the Panther Branch Watershed, near Houston, Texas, 1999

Identifying and Eliminating Illicit Connections Within the Clear Creek, 1998-1999

Gulf Coast Region Water Quality Management Planning Document, 1998

Fish, Benthic Macroinvertebrate, and Stream Habitat Data From the Houston-Galveston Area Council Service Area, Texas 1997-98, 1998

Nutrient Loading and Selected Water Quality and Biological Characteristics of Dickinson Bayou Near Houston, Texas 1995-97, 1997

Action Guide: Erosion and Sediment Control (Construction Activities), 1997

Local Government Water Quality Protection Study, 1994
Houston Ship Channel Success Story, 1992

Brochures

Cypress Creek Watershed Profile, 2006

Bastrop Bayou Watershed Profile, 2006

San Bernard Watershed Profile, 2003

Bacteria Brochure, 2003

Sims Bayou Watershed Profile, 2002

Bacteria in our Bayous, 2002

Greens Bayou Watershed Profile, 2001

Water Quality Data Clearinghouse, 2000

What Watershed Do You Live In?, 2000

Armand Bayou Watershed Profile, 1999

Videos

Can I Swim Here?, 2000

Legend of Water Quality Impairments and Concerns

2006 Draft 303(d) Listing I
2006 Draft 305(b) Listing C

Definition	Storet	Abbreviation	Definition	Storet	Abbreviation
FIELD PARAMETERS			**SALTS / SOLIDS Cont.**		
Temperature (Centigrade)	00010	T	Sulfate (mg/L as SO_4)	00945	SO
Dissolved Oxygen (mg/L)	00300	DO	Total Alkalinity (mg/L as $CaCO_3$)	00410	Alk
pH (standard units)	00400	pH	Total Dissolved Solids (mg/L)	70300	TDS
Conductivity (µmhos/cm)	00094	Con	Total Hardness (mg/L as $CaCO_3$)	00900	TH
Salinity (ppt)	00480	Sal	Total Suspended Solids (mg/L)	00530	TSS
Transparency (meters)	00078	Trnp	Volatile Suspended Solids (mg/L)	00535	VSS
BACTERIA			**METALS**		
Fecal Coliform (#/100 mL)	31616	FC	Aluminum, Dissolved (µg/L)	01106	Al
Fecal Coliform MF Agar (#/100 mL)	31613		Arsenic, Dissolved (µg/L)	01000	As
Enterococcus (mpn/100mL)	31701	Ent	Barium, Dissolved (µg/L)	01005	Ba
E. coli (mpn/100mL)	31699	EC	Cadmium, Dissolved (µg/L)	01025	Cd
			Calcium, Dissolved (mg/L)	00915	Ca
NUTRIENTS			Chromium, Dissolved (µg/L)	01030	Cr
Ammonia (mg/L)	00610	NH	Copper, Dissolved (µg/L)	01040	Cu
Nitrate (mg/L)	00620	Nt	Lead, Dissolved (µg/L)	01049	Pb
Nitrite + Nitrate (mg/L)	00630	NN	Mercury, Total (µg/L)	71900	Hg
Nitrite + Nitrate, Whatman (mg/L)	00593		Nickel, Dissolved (µg/L)	01065	Ni
Total Kjeldahl Nitrogen (mg/L)	00625	TKN	Selenium, Dissolved (µg/L)	01145	Se
Orthophosphate Phosphorus (mg/L)	70507	OP	Selenium, Total (µg/L)	01147	Se
Total Phosphorus (mg/L)	00665	TP	Silver, Dissolved (µg/L)	01075	Ag
Chlorophyll-*a* (µg/L)	32211	CHLa	Zinc, Dissolved (µg/L)	01090	Zn
Total Organic Carbon (mg/L)	00680	TOC			
BOD_5 (mg/L)	00310	BOD	**OTHER**		
$CBOD_5$ (mg/L)	00307	CBOD	Dioxins		Dioxin
			PCBs		PCB
SALTS / SOLIDS			Volatile Organic Compounds		VOC
Chloride (mg/L as Cl)	00940	Cl	Sediment Toxicity		STox
Fluoride (mg/L as F)	00951	Fl	Pesticides		Pest

Summary of Water Quality Impairments and Concerns

Basin & Segment Name	Number	Field Parameters	Bacteria	Nutrients	Salts / Solids	Metals	Other	Notes
TRINITY - SAN JACINTO COASTAL BASIN								
Cedar Bayou Tidal	901		I				I	FC, Dioxin
Cedar Bayou Above Tidal	902	C	I				I	DO, FC, MacroB
SAN JACINTO RIVER BASIN								
San Jacinto River Tidal	1001						I	Dioxin TMDL, PCB, Pest
Lake Houston	1002		I	C				DO, FC, EC, NH, NN, OP, TP
	1002B	C						DO
East Fork San Jacinto River	1003		I					EC
West Fork San Jacinto River	1004		I	C				DO, FC, EC, NN
	1004D		I					EC, FC
	1004E	C	I					DO
Houston Ship Channel / San Jacinto River and Select Bay Segments	1005						I	Dioxin TMDL, PCB, Pest
Houston Ship Channel	1006	I	I	C		I	I	DO, Bacteria, NN, OP, TP, Hg, Dioxin TMDL, PCB, Pest, Stox
	1006D		I	C				FC, EC, NH, OP, TP
	1006F		I					FC, Ent
	1006H		I					FC
	1006I		I					FC, Ent
	1006J		I					FC, Ent
Houston Ship Channel Buffalo Bayou Tidal	1007		I	C			I	Bacteria TMDL, NH, NN, OP, TP, Dioxin, PCB, Pest, Stox
	1007A		I					Bacteria
	1007B		I	C				FC, NH, NN, OP, TP
	1007C		I	C				FC, EC, NH, TP
	1007D	C	I	C				DO, FC, EC, NH, OP, TP
	1007E		I					FC
	1007F		I	C				FC, NH, TP
	1007G	C	I					DO, FC
	1007H		I					FC
	1007I		I					FC
	1007K	I	I					DO, FC
	1007L		I					FC
	1007M		I					FC
	1007N		I					FC
	1007O	I	I					DO, FC
	1007R	I	I	C				DO, FC, NH
Spring Creek	1008		I	C				FC, NN, OP, TP
	1008B		I	C				EC, NH, OP, TP

Basin & Segment Name	Number	Field Parameters	Bacteria	Nutrients	Salts / Solids	Metals	Other	Notes
TRINITY - SAN JACINTO COASTAL BASIN *Cont.*								
	1008C		C	C				EC, NN, OP, TP
	1008F	C						DO, NN, OP, TP
	1008H			C				NN, TP
Cypress Creek	1009	C	I	C			I	DO, EC, NH, NN, OP, TP, IH, MacroB
	1009C		I	C				EC, NN, TP
	1009D		I	C				EC, NN, TP
	1009E		I	C				EC, NH, NN, TP
Caney Creek	1010		I					EC
Peach Creek	1011		I					EC
Lake Conroe	1012							
Buffalo Bayou Tidal	1013		I	C				Bacteria TMDL, NN, OP, TP
	1013A	I	I					DO, FC, EC
	1013C		I					FC, EC
Buffalo Bayou Above Tidal	1014		I	C				FC, EC, Bacteria TMDL, NH, NN, OP, TP
	1014A		I	C				NN, TP
	1014B		I	C				EC, NN
	1014E		I	C				NN, TP
	1014H		I	C				FC, EC, NN, TP
	1014K		I					FC, EC
	1014L		I	C				FC, EC, NN, TP
	1014M	I	I	C				DO, FC, EC, OP
	1014N	C	I					DO, FC, EC
	1014O		I					FC, EC
Lake Creek	1015							USGS Study
Greens Bayou Above Tidal	1016		I	C				FC, NH, NN, OP, TP
	1016A	I	I	C				DO, FC, EC, NH, TP
	1016B		I					FC
	1016C		I	C				FC, EC, NN, TP
	1016D	C	I					DO, FC, EC
White Oak Bayou	1017		I	C				Bacteria TMDL, NH, NN, OP, TP
	1017A		I	C				DO, FC, EC, Nt
	1017B		I					FC, EC
	1017D	I	I					DO, FC, EC
	1017E		I					FC, EC
SAN JACINTO - BRAZOS COASTAL BASIN								
Clear Creek Tidal	1101	C	I	C				DO, Bacteria TMDL, Nt, OP, CHLa
	1101B		I					FC, Bacteria TMDL
	1101D	C	I					DO, EC

Basin & Segment Name	Number	Field Parameters	Bacteria	Nutrients	Salts / Solids	Metals	Other	Notes
SAN JACINTO - BRAZOS COASTAL BASIN Cont.								
Clear Creek Above Tidal	1102	C	I	C	I		I	DO, Bacteria TMDL, NH, NN, OP, TP, Cl, TDS, Fish, Habitat
	1102A		I					Bacteria
	1102B		I	C				Bacteria TMDL, Nt, OP
	1102C	C	I					DO, Bacteria
	1102D	C	I	C				DO, Bacteria, Nt, OP, TP
	1102E	C	I	C				DO, Bacteria, Nt, OP
Dickinson Bayou Tidal	1103	I	I					DO, FC
	1103A		I					FC
	1103B	C	I					DO, FC
	1103C	C	I					DO, FC
	1103D		I					FC
Dickinson Bayou Above Tidal	1104	C	I					DO TMDL, FC
Bastrop Bayou Tidal	1105							EC, Ent, Bastrop Bayou special project
Chocolate Bayou Tidal	1107			C				CHLa
Chocolate Bayou Above Tidal	1108							
Oyster Creek Tidal	1109							Litigation
Oyster Creek Above Tidal	1110	I	I					DO, Bacteria
Old Brazos River Channel	1111			C				Nt
Armand Bayou Tidal	1113	I	I	C				DO, Bacteria, CHLa
	1113A	I	I					DO, FC
	1113B		I	C				Bacteria, Nt, OP, TP
BRAZOS - COLORADO COASTAL BASIN								
San Bernard River Tidal	1301		I	C				Bacteria, CHLa
San Bernard River Above Tidal	1302	C	I	C				DO, FC, EC, NH
BAYS & ESTUARIES - GULF OF MEXICO								
Upper Galveston Bay	2421		I	C			I	FC-oyster waters, CHLa, Nt, TP, Dioxin TMDL, PCB
East Bay	2423		I					FC-oyster waters
West Bay	2424		I					FC-oyster waters
	2424A	I	I					DO, FC-contact rec
	2424B		I					NH
	2424C	I	I					DO, FC-contact rec
	2424D							
	2424E							
	2424F							
Clear Lake	2425			C				CHLA, Nt
	2425B		I					FC
	2425C							
Tabbs Bay	2426						I	Dioxin TMDL, PCB
San Jacinto Bay	2427			C			I	Nt, TP, Dioxin TMDL,
Black Duck Bay	2428						I	Dioxin TMDL, PCB

Basin & Segment Name	Number	Field Parameters	Bacteria	Nutrients	Salts / Solids	Metals	Other	Notes
SAN JACINTO - BRAZOS COASTAL BASIN Cont.								
Scott Bay	2429						I	Dioxin TMDL, PCB
Burnett Bay	2430			C			I	TP, Dioxin TMDL, PCB
Moses Lake	2431							
BAYS & ESTUARIES - GULF OF MEXICO *Cont.*								
Chocolate Bay	2432		I					FC-oyster waters
	2432B	C						DO
	2432C	C						DO
Bastrop Bay / Oyster Lake	2433		I					FC-oyster waters
Christmas Bay	2434		I					FC-oyster waters
Drum Bay	2435		I					FC-oyster waters
	2435A							
Barbours Cut	2436			C			I	NH, Dioxin TMDL, PCB
Texas City Ship Channel	2437			C				NH, TP
Bayport Channel	2438			C			I	NH, CHLa, Nt, TP, Dioxin TMDL, PCB
Lower Galveston Bay	2439		I	C				FC-oyster waters, Nt
Gulf of Mexico	2501							

Segments

Basin & Segment Name	Number
TRINITY - SAN JACINTO COASTAL BASIN	
Cedar Bayou Tidal	901
Cedar Bayou Above Tidal	902
SAN JACINTO RIVER BASIN	
San Jacinto River Tidal	1001
Lake Houston	1002
East Fork San Jacinto River	1003
West Fork San Jacinto River	1004
Houston Ship Channel / San Jacinto River and Select Bay Segments	1005
Houston Ship Channel	1006
Houston Ship Channel Buffalo Bayou Tidal	1007
Spring Creek	1008
Cypress Creek	1009
Caney Creek	1010
Peach Creek	1011
Lake Conroe	1012
Buffalo Bayou Tidal	1013
Buffalo Bayou Above Tidal	1014
Lake Creek	1015
Greens Bayou Above Tidal	1016
White Oak Bayou	1017
SAN JACINTO - BRAZOS COASTAL BASIN	
Clear Creek Tidal	1101
Clear Creek Above Tidal	1102
Dickinson Bayou Tidal	1103
Dickinson Bayou Above Tidal	1104
Bastrop Bayou Tidal	1105
Chocolate Bayou Tidal	1107
Chocolate Bayou Above Tidal	1108
Oyster Creek Tidal	1109
Oyster Creek Above Tidal	1110
Old Brazos River Channel	1111
Armand Bayou Tidal	1113
BRAZOS-COLORADO COASTAL BASIN	
San Bernard River Tidal	1301
San Bernard River Above Tidal	1302
BAYS & ESTUARIES / GULF OF MEXICO	
Upper Galveston Bay	2421
East Bay	2423
West Bay	2424
Clear Lake	2425
Tabbs Bay	2426
San Jacinto Bay	2427
Black Duck Bay	2428
Scott Bay	2429
Burnett Bay	2430
Moses Lake	2431
Chocolate Bay	2432
Bastrop Bay / Oyster Lake	2433
Christmas Bay	2434
Drum Bay	2435
Barbours Cut	2436
Texas City Ship Channel	2437
Bayport Channel	2438
Lower Galveston Bay	2439
Gulf of Mexico	2501

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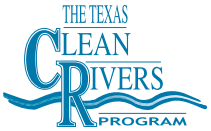

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