

**Briefing Paper on Houston Area Bayous III:
Brays Bayou, Sims Bayou, Houston Ship Channel and Upper Galveston Bay**
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Description of the Watershed

This watershed area includes portions of Fort Bend and Harris counties and is situated south of Buffalo Bayou and the Houston Ship Channel. Progressing from west to east, the watersheds are as follows: Brays Bayou, Sims Bayou, the Houston Ship Channel, and Upper Galveston Bay. The Brays Bayou watershed includes Missouri City, Bellaire, Houston, and West University Place. The Sims Bayou watershed includes portions of Missouri City and South Houston. The Houston Ship channel includes sections of Pasadena, Deer Park, and La Porte. The subwatershed area includes a combined population of more than 1.1 million people. Given the dense residential and commercial development, flooding and nonpoint source water pollution are key issues. Industrial development along the downstream reaches of the Houston Ship Channel leads to concerns about toxic contaminants in sediments and in the tissues of recreationally and commercially harvested finfish and shellfish.

Land Use and Habitat in the Watershed

This watershed area is highly urbanized and consists primarily of residential and commercial development in the upstream reaches and industrial development along the downstream reaches of the Houston Ship Channel near its mouth at Upper Galveston Bay. Much of the area is developed, but at one time consisted of gulf coastal prairies with ribbons of riparian hardwood forests along bayou banks. Remaining undeveloped areas typically consist of grasslands, freshwater wetlands, and some forested lands.

Remaining habitat is highly fragmented. A number of parks are located in the watershed area. However, they are often fairly small in size and widely distributed. The largest parks are 400-acre Hermann Park on Brays Bayou and the 1,200-acre San Jacinto Battleground State Historic Site near La Porte on the Houston Ship Channel.

Both Brays and Sims Bayou flow into the Houston Ship Channel where the surrounding land use then changes from urban to petrochemical industry. The Houston Ship Channel meets the San Jacinto River with waters then flowing past more industry and the San Jacinto Monument before they discharge into Upper Galveston Bay.

Water Quality Issues

Water quality in this watershed area is impacted by the existence of dense urban land use and petrochemical industry. The water quality of some segments is highly degraded with the nature of the contamination relating directly to the surrounding urban or industrial land use. As seen in Table 1, a number of water bodies in this area are listed on the State of Texas 303(d) list of impaired waters and are deemed unsuitable for contact recreation or harvesting fish for consumption due to elevated levels of fecal coliform bacteria in the water or industrial chemicals in sediments or in fish and crab tissue. Finfish and blue crabs should not be harvested from many of the industrialized waterways nor should contact recreation (swimming) be exercised in the urban portions.

	PCBs in Catfish, Spotted Seatrout, and Blue Crab	PCBs in Finfish	Dioxin in Catfish and Blue Crabs	Chlordane, Dieldrin, Heptachlor Epoxide in Finfish	Depressed Dissolved Oxygen	Fecal Coliform Bacteria
Keegans Bayou Above Tidal						▲
Willow Waterhole Bayou Above Tidal						▲
Kuhlman Gully Above Tidal						▲
Brays Bayou Above Tidal						▲
Berry Bayou Above Tidal						▲
Pine Gully Above Tidal						▲
Plum Creek Above Tidal						▲
Sims Bayou Above Tidal						▲
Brays Bayou Tidal				▲ ▲		
Sims Bayou Tidal				▲ ▲		
Houston Ship Channel/ Buffalo Bayou Tidal				▲ ▲		
San Jacinto River Tidal		▲	▲			
Houston Ship Channel / San Jacinto River Tidal	▲	▲	▲			
Cedar Bayou			▲		▲	
Houston Ship Channel Tidal		▲	▲	▲		
Tabbs Bay Black Duck Bay Scott Bay San Jacinto Bay Burnett Bay	▲		▲			
Upper Galveston Bay	▲		▲			

- ▲ = Total Maximum Daily Load (TMDL) study underway
- ▲ = TMDL to be scheduled; high rank
- ▲ = Additional data to be collected before a TMDL is conducted

Table 1. Summary of water bodies in the area on the Draft 2004 State of Texas 303(d) list of impaired waters. Table created by the Galveston Bay Status and Trends Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Once on the 303(d) list, the waterbody becomes the subject of a Total Maximum Daily Load (TMDL) study. The TMDL process uses stakeholder input, existing data, and additional field studies to determine the amount (or load) of a pollutant that the body of water can receive and still support its beneficial use (e.g. seafood supply, aquatic life, contact recreation). The load is then allocated among all the potential sources of pollution within the watershed. Measures to reduce pollutant loads are developed as necessary. Once the goal of restoring the waterbody to historic use conditions is met, the stream segment is removed from the 303(d) list.

According to the nutrient indicator (based on nitrogen, phosphorus, and phytoplankton concentrations) in Tables 1 and 2 below, the number of surface water samples exceeding nutrient screening limits set by the Texas Commission on Environmental Quality (TCEQ) appears to be elevated in Buffalo Bayou, the Houston Ship Channel and Upper Galveston Bay. Note that Brays and Sims Bayous are not listed; the Galveston Bay Indicators Project looked at tidally influenced waters only.

Rating	Percent of samples exceeding TCEQ screening levels
Very Good	0-5%
Good	6-15%
Moderate	16-30%
Poor	>30%

Table 2. Indicator rating system developed for the nutrients in surface waters indicator. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center.

Subbay or Tributary	1970s	1980s	1990s	2000s
Buffalo Bayou	Red	Red	Yellow	Red
Houston Ship Channel	Red	Red	Yellow	Yellow
Upper & Lower Galveston Bay	Red	Red	Yellow	Yellow

Table 3. Indicator describing the state of nutrients (ammonia, nitrate-nitrite, total phosphorus) and chlorophyll-a concentrations in surface waters as a average proportion of TCEQ screening levels by decade from the 1970s through 2000s. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality and the National Coastal Assessment, Texas Parks and Wildlife Department.

As seen in Table 1, a number of stream segments are listed on Texas 303(d) List for high concentrations of fecal coliform bacteria, an indicator of possible human pathogens in the water. Water bodies in this area included on the 303(d) List for this reason do not meet the designated use of contact recreation (i.e. recreational activities in which the user comes into direct contact with the water). The Galveston Bay Indicators Project found that concentrations of fecal coliform bacteria in surface waters exceeded TCEQ screening levels to a high degree in Buffalo Bayou and the Houston Ship Channel. This will not impact contact recreation in the Houston Ship

Channel, since it is not used for swimming, canoeing, kayaking, etc. However, urban bayous are sometimes used for contact recreation such as swimming, canoeing, and kayaking.

Rating	Proportion of Samples Above Screening Level
Very Good	0% samples above the screening level
Good	1-9% samples above the screening level
Moderate	10-25% samples above the screening level
Poor	>25% samples above the screening level

Table 4. Indicator rating system developed for the fecal coliform bacteria in surface waters indicator. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center.

Tributary or Subbay	1970s	1980s	1990s	2000s
Buffalo Bayou				
Houston Ship Channel				
Upper & Lower Galveston Bay				

Table 5. Indicator describing the state of fecal coliform bacteria in surface waters as a proportion of the TCEQ screening level. Refer to Table 4 for a description of the color system. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality; Texas Department of State Health Services.

As evidenced by the number of stream segments on the Texas 303(d) list in Table 1, this area is also heavily impacted by industrial sources. Analyses by the Galveston Bay Indicators Project in 2004 compared concentrations of organic compounds in sediments to probable effect levels (PELs) established by the TCEQ (TCEQ, 2004). A PEL is defined as the concentration of a contaminant above which adverse biological effects are expected to occur. Major subbays and tributaries of the bay were rated based on the percentage of sediment samples exceeding PELs in a given decade (see Table 6). Areas shown in the tables below as yellow or red have an increased risk of adverse biological effects due to elevated levels of sediment contamination.

Rating	Percent of Samples Exceeding the PEL
Very Good	0%
Good	1-9%
Moderate	10-25%
Poor	>25%

Table 6. Indicator rating system developed for toxic contaminants in sediments. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center.

As seen in tables 7 and 8 below, the majority of sediment quality problems occur in the Houston Ship Channel with the greatest problem being associated with industrial organics. Oddly, there were insufficient data for polychlorinated biphenyls (PCBs) in the Houston Ship Channel. PCBs are legacy pollutants used as a fire retardant; their manufacture, sale, and use were banned in the

United States nearly thirty years ago. PCBs have been detected at high levels in some fish and are a partial cause of the seafood consumption advisories in place for the Houston Ship Channel and Upper Galveston Bay (see Figure 1 below).

Industrial Organics

Tributary or Subbay	1970s	1980s	1990s	2000s
Houston Ship Channel				
Upper & Lower Galveston Bay	ns			

Table 7. Indicator describing the state of industrial organics in sediment as a proportion of Marine Probable Effects Levels (PELs) published by the TCEQ. ns = Insufficient sample size (< 10 samples). Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Houston Ship Channel Detail	2000s
Acenaphthene	
Acenaphthylene	
Anthracene	
Benzo(a)anthracene	
Benzo(a)pyrene	
Chrysene	
1,2,4,6 Dibenanthracene	
Fluoranthene	
Fluorene	
Naphthalene	
PCBs	ns
Phenanthrene	
Pyrene	

Table 8. Detail of industrial organics in sediments of the Houston Ship Channel. ns = Insufficient sample size (< 10 samples). Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

While a number of industrial organics are found in high concentrations in the Houston Ship Channel, the story for metals in sediment is a bit more variable. As one can see in Table 10, the concentrations of several metals have declined significantly over the last three decades. For example, cadmium, lead and silver rarely exceed their PELs. Out of nine metals assessed by the Galveston Bay Indicators Project, mercury and zinc had the highest concentrations in sediments sampled from this area in years since 1999. The summary indicator shown in Table 9 emphasizes the local nature of metal contamination of sediment. The problem is currently limited to the Upper Houston Ship Channel.

Metals

Tributary or Subbay	1970s	1980s	1990s	2000s
Houston Ship Channel	Yellow	Yellow	Green	Yellow
Upper & Lower Galveston Bay	Green	Green	Blue	Blue

Table 9. Indicator describing the state of heavy metals in sediment as a proportion of Marine Probable Effects Levels (PELs) published by the TCEQ (TCEQ, 2004). Refer to Table 4 above for a description of the color system. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

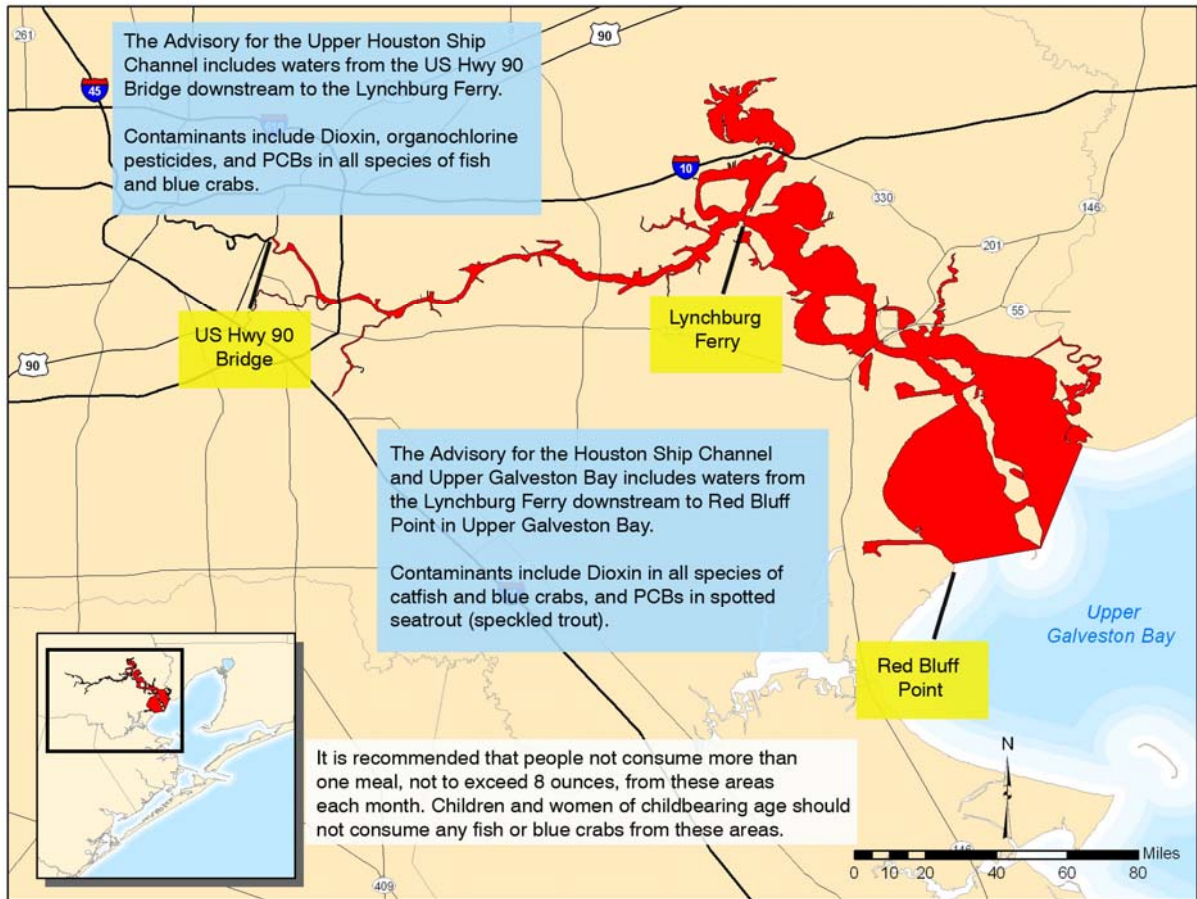
Metal	1970s	1980s	1990s	2000s
Arsenic	Blue	Blue	Blue	Blue
Cadmium	Yellow	Yellow	Blue	Blue
Chromium	Green	Green	Blue	Green
Copper	Green	Green	Green	Green
Lead	Red	Yellow	Green	Green
Mercury	Yellow	Blue	Yellow	Red
Nickel	Green	Green	Green	Yellow
Silver	Red	Yellow	Green	Green
Zinc	Red	Yellow	Yellow	Red

Table 10. Detail of nine heavy metals in sediments of the Houston Ship Channel. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Public Health Issues

Three seafood consumption advisories for Galveston Bay and its tributaries have been issued by the Texas Department of State Health Services (DSHS) since 1990. While the majority of bay and tributary surface waters are not included in seafood consumption advisories, the DSHS advises that consumption of seafood taken from the Houston Ship Channel and portions of Upper Galveston Bay poses an increased risk of adverse human health effects. All three seafood consumption advisories in 1990, 2001, and 2005 were issued for these areas (Figure 1). Contaminants of concern include dioxin, organochlorine pesticides, and PCBs. Species of concern include blue crab, catfish, spotted seatrout, and other species of finfish. Additionally, the DSHS prohibits the commercial harvest of shellfish from this area.

Figure 1. The Area, Species, and Contaminants Included in Galveston Bay Seafood Advisories Issued by the Texas Department of State Health Services in 1990, 2201, and 2005. Map created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Department of State Health Services.



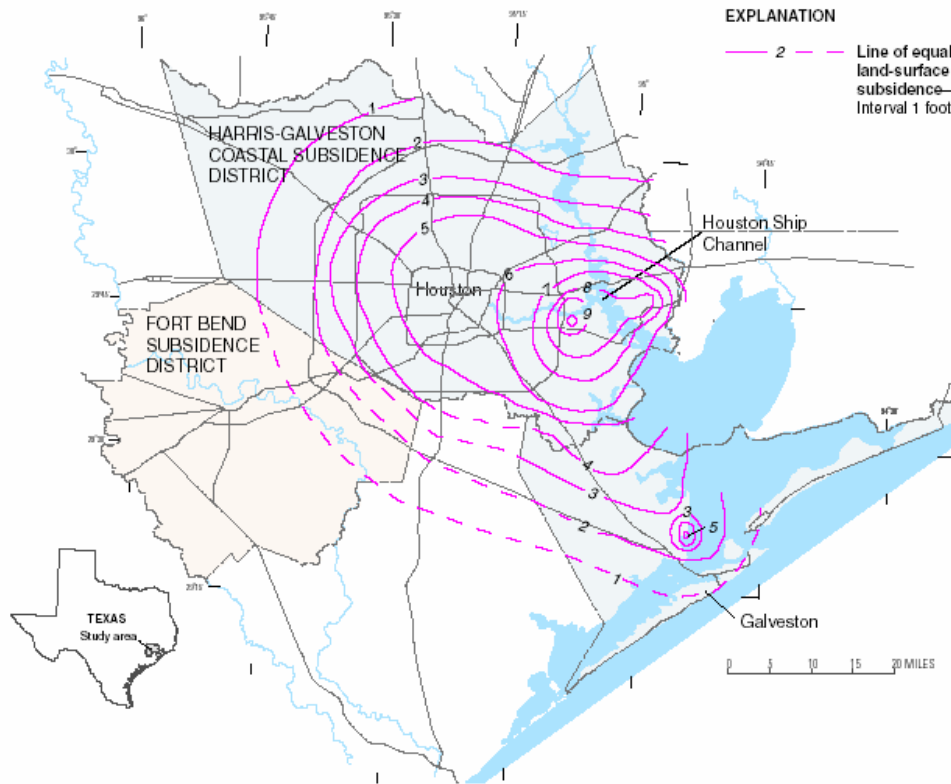
Other Issues

Flooding is a major issue in these urban watersheds. Much of the housing and commercial development along the banks of the bayous in urban Houston was completed before the presence of detailed floodplain mapping. To combat repeated flooding and hasten the movement of water from the urban center to Galveston Bay during extreme weather events, bayous were channelized. Unfortunately, in severe storm events this resulted in flooding problems for downstream residents. The federal, state, and local agencies responsible for building and maintaining the flood control infrastructure are now implementing flood control projects using more green space and less “hard” engineering. Examples include the federal flood reduction project in Sims Bayou and regional water detention projects such as the Willow Waterhole Greenway Project near South Post Oak and U.S. Highway 90.

Land subsidence due to extraction of groundwater has been a major issue in some areas of this subwatershed, particularly near the San Jacinto Monument on the Houston Ship Channel (see Figure 2). Subsidence there has resulted in the conversion of wetland habitat into open water. A

wetland restoration project at the Monument makes beneficial use of dredge material to rebuild the substrate for wetlands vegetation.

Figure 2. Subsidence in the Houston-Galveston region occurring between 1906 and 1987. Map created by the Harris-Galveston Coastal Subsidence District.



As in other areas of the bay, invasive species such as Chinese tallow and fire ants out compete or prey on native species with the potential to reduce biodiversity. A recent study completed by the Texas Parks and Wildlife Department found several species of exotic fish to be abundant in three Houston bayous, including Brays Bayou. Species included *Plecostomus* (armored catfish) and Rio Grande cichlid, popular aquarium fish, and tilapia, a popular food fish. While the ecological impacts of these three species on area bayous are largely unknown, it is thought that *Plecostomus* have the greatest potential to cause harm through their need to burrow into stream banks for nesting. It is thought that the burrows could destabilize the shoreline resulting in erosion and further degrading water quality.

Conclusion

This area of the Lower Galveston Bay Watershed is one of the most heavily impacted in terms of urban and industrial point source and nonpoint source loadings to local waterways. Numerous stream segments are on the state list of impaired waters due to elevated levels of fecal coliform

bacteria in surface water and industrial contaminants in fish and crab tissue. Several seafood consumption advisories have been issued by the Texas DSHS since 1990 due to elevated levels of PCB, pesticide and dioxin in the seafood. Industrial organic compounds in sediment of the Houston Ship Channel are elevated to levels indicative of high risk of adverse impacts to benthic organisms that dwell in or on the sediments. In addition to water and sediment quality problems and elevated health risks due to consumption of seafood, other issues of concern are urban flooding, land subsidence, habitat loss, and invasive species. Much work needs to be done if the trends in environmental contamination in this area of the Lower Galveston Bay watershed are to be reversed.