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Water-Quality, Sediment-Quality, Stream-Habitat, and Biological Data for Mustang Bayou Near Houston, Texas, 2004–05

Data Series 263

U.S. Department of the Interior
U.S. Geological Survey

Cover: U.S. Geological Survey personnel fish shocking at Mustang Bayou at East South Street, Alvin, Texas, September 27, 2005.

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By Debra A. Sneck-Fahrer and Jeffery W. East

Prepared in cooperation with the Houston-Galveston Area Council and the Texas Commission on Environmental Quality under the authorization of the Texas Clean Rivers Act and applicable Federal law

Data Series 263

U.S. Department of the Interior
U.S. Geological Survey

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Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C=(°F-32)/1.8

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm).

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L) or micrograms per liter (µg/L).

E. coli densities in water are given in colonies per 100 milliliters (cols./100 mL).

Datums

Vertical coordinate information is referenced to National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83).

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By Debra A. Sneck-Fahrer and Jeffery W. East

Abstract

The U.S. Geological Survey, in cooperation with the Houston-Galveston Area Council and the Texas Commission on Environmental Quality, collected water-quality, stream-habitat, and biological data from six sites (downstream order M6–M1) primarily in Brazoria County southeast of Houston, Texas, during September 2004–August 2005 and collected bed sediment data from one site in September 2005. Water-quality data collection consisted of continuously monitored (for periods of 24 hours to several days, six times) water temperature, pH, specific conductance, and dissolved oxygen and periodically collected samples of several properties and constituents. Monitored dissolved oxygen measurements were below minimum and 24-hour criteria at all sites except M2. Nitrogen compounds, phosphorus, biochemical oxygen demand, chlorophyll-*a*, *E. coli*, chloride, sulfate, solids, suspended sediment concentration, and pesticides were assessed at all sites. Concentrations of nitrogen compounds and phosphorus did not exceed Texas State screening levels. Biochemical oxygen demand was less than 4.0 milligrams per liter at all sites except M6, where the maximum concentration was 8.1 milligrams per liter. Concentrations of chlorophyll-*a* were less than the State screening level at all sites except M6, where four of eight samples equaled or exceeded the screening level. Twenty of 48 samples from Mustang Bayou had *E. coli* densities that exceeded the State single-sample water-quality standard. Median chloride concentrations from each site were between 42.2 and 123 milligrams per liter. Fifteen pesticide compounds (six herbicides and nine insecticides) were detected in 24 water samples. The most frequently detected pesticide was atrazine, which was found in every sample. Other frequently detected pesticides were 2-chloro-4-isopropylamino-6-amino-s-triazine (CIAT), prometon, tebuthiuron, fipronil, and the pesticide degradates, fipronil sulfide and fipronil sulfone. Sediment samples were collected from the stream bottom at M1 and analyzed for concentrations of trace elements (metals), polycyclic aromatic hydrocarbons, organochlorine pesticides, and polychlorinated biphenyls. No organochlorine pesticides or polychlorinated biphenyls were detected. No concentrations of metals exceeded State screening levels. Measurable concentrations of 11 polycyclic aromatic hydrocarbon (PAH) compounds were detected, and three other PAH compounds were detected but not quantified by the laboratory. Stream habitat and aquatic biota (benthic macroinvertebrates and fish) were surveyed at each site three times during the study to evaluate aquatic life use. Characteristics of habitat measured during each survey were scored using a habitat quality index. Average aquatic-life-use scores were "limited" for M3–M6 and "intermediate" for M1 and M2. A total of 2,557 macroinvertebrate individuals were identified from Mustang Bayou. Benthic macroinvertebrate assemblages were scored using indexes specified by the Texas Commission on Environmental Quality. Average aquatic-life-use scores were "limited" at M1, "intermediate" at M3–M6, and "high" at M2. Forty-six species of fish representing 20 families were collected from Mustang Bayou. A total of 4,115 fish were collected. Sunfish (Centrarchidae) was the most abundant family, accounting for about 28 percent. Aquatic-life-use scores at sites in Mustang Bayou were determined using the regional index of biotic integrity for ecoregion 34 and were "high" for all sites.

Introduction

The Texas Commission on Environmental Quality (TCEQ) administers water-quality management programs with the goal of protecting, maintaining, and restoring water resources in Texas. One program is the Texas Clean Rivers Program (CRP), which was established by the 1991 Texas Legislature. Under the CRP, water-quality monitoring and assessments are conducted in 23 river and coastal basins statewide through contracts with partner agencies. The Houston-Galveston Area Council (H–GAC) is the partner agency for a 13-county service area in southeast Texas that includes the Houston metropolitan area. Biannually, CRP partners may do systematic monitoring studies whereby a variety of data are collected in water bodies that are not monitored routinely. Data from these special studies help to determine whether additional assessment is needed to evaluate human-health concerns, the status of ecological conditions, or designated stream uses.

Mustang Bayou is southeast of Houston, Tex., primarily in Brazoria County, with the northwestern part of the watershed extending into Fort Bend County (fig. 1). With headwaters northwest of Fresno, Mustang Bayou extends approximately 30 miles to the southeast. Mustang Bayou has been extensively modified from its natural state, and many sections have been channelized. No segments of Mustang Bayou are currently (2007) listed on either the State 303(d) list for water-quality impairment or the 305(b) report for water-quality concerns (Texas Commission on Environmental Quality, 2005). However, urban development is occurring in the watershed, increasing the possibility of changes in the water quality, physical stream habitat, and aquatic biota.

Previous studies of Mustang Bayou include two Receiving Water Assessments (Luedke, 1997; Kelly, 2003) and a Use Attainability Assessment (Texas Natural Resource Conservation Commission, 1999a). However, because each study was local and addressed different aspects of water quality, physical stream habitat, and aquatic biota, these studies did not facilitate adoption of water-quality standards or classification of the aquatic life use of the bayou by the TCEQ. The current classification of Mustang Bayou is “high aquatic life use,” which is that assumed for unclassified stream segments.

To better understand the combined effect of channelization and chemical or bacterial input on the ecological health of Mustang Bayou, the U.S. Geological Survey (USGS), in cooperation with H–GAC and TCEQ, conducted an assessment of current conditions at six sites on the stream. Water-quality, stream-habitat, and biological data were collected during September 2004–August 2005. Bed sediment data were collected at one site in September 2005. As a part of this study, these data were used to determine spatial variations in water quality and biological indicators to provide a more complete understanding of the relation between water quality, physical-habitat conditions, and biological metrics. In addition, data were assessed by applying State screening thresholds for selected water- and sediment-quality constituents and indexes for aquatic life use to water-quality results and computed habitat and biological metrics, respectively (Texas Commission on Environmental Quality, 2003a).

Purpose and Scope

The purpose of this report is to present water-quality, sediment-quality, stream-habitat, and biological data collected from selected sites on Mustang Bayou during September 2004–August 2005 and sediment-quality data in September 2005. Water-quality properties at six sites were measured continuously six times each during the study for monitoring periods of 24 hours to several days. Water-quality samples were collected at the six sites approximately bimonthly. Bed sediment data were collected at one site in September 2005. Stream-habitat and biological (benthic macroinvertebrate and fish) data were collected from a representative reach at each of the six sites in September 2004, April 2005, and August 2005.

Methods of assessment used during this study are described, and data are presented to compare water-quality changes at and among sites during the study period. This report evaluates biological data using standard indexes to assess the general health of the aquatic environment. Graphical techniques and computation of coefficients are used to compare data between stream reaches. Stream habitat and biological communities were scored on the basis of appropriate metrics using TCEQ protocol to evaluate aquatic-life-use ratings for each site (Texas Commission on Environmental Quality, 2003a).

Description of Study Area

The Mustang Bayou watershed, a drainage area of slightly more than 100 square miles, is in the Western Gulf Coastal Plain (ecoregion 34) (Griffith and others, 2004), which is characterized by Quaternary-age deltaic sands, silts, and clays. The Coastal Plain has a very low gradient so that streams generally are sluggish and have many meanders (Griffith and others, 2004). Land-cover types in the Mustang Bayou watershed (fig. 2) include grassland (about 51 percent), woody land (about 20 percent), and low-intensity developed (about 12 percent). Land use primarily is rural agriculture where channelized streams and irrigation canals are common. Natural vegetation comprises various grasses. Production of oil and gas is common in the lower part of the watershed. Urban development is occurring in the upper part of the watershed and near the largest city, Alvin, which had a population in 2000 of about 241,700 people (Texas State Data Center, 2005). There are 10 permitted wastewater dischargers in the watershed (fig. 1).

The climate along the Western Gulf Coastal Plain is influenced by the Gulf of Mexico and is classified as humid subtropical (Texas State Climatologist, 2004), which is characterized by cool and temperate winters, long and hot summers, high relative humidity, and prevailing winds from the south and southeast. A weather observation site near the center of the Mustang Bayou watershed (fig. 1; National Weather Service site 80204, Alvin) was used to characterize temperature and rainfall for this study. During the study, temperatures measured at the Alvin site ranged from a mean of about 55 degrees Fahrenheit (°F) in the winter (December–February) to a mean of about 84 °F in the summer (June–August), with maximum temperatures commonly higher than 90 °F (National Climatic Data Center, 2004; 2005). During the study, total rainfall was 43.17 inches (National Climatic Data Center, 2004; 2005); 16.43 inches of this amount occurred in November 2004 (fig. 3).

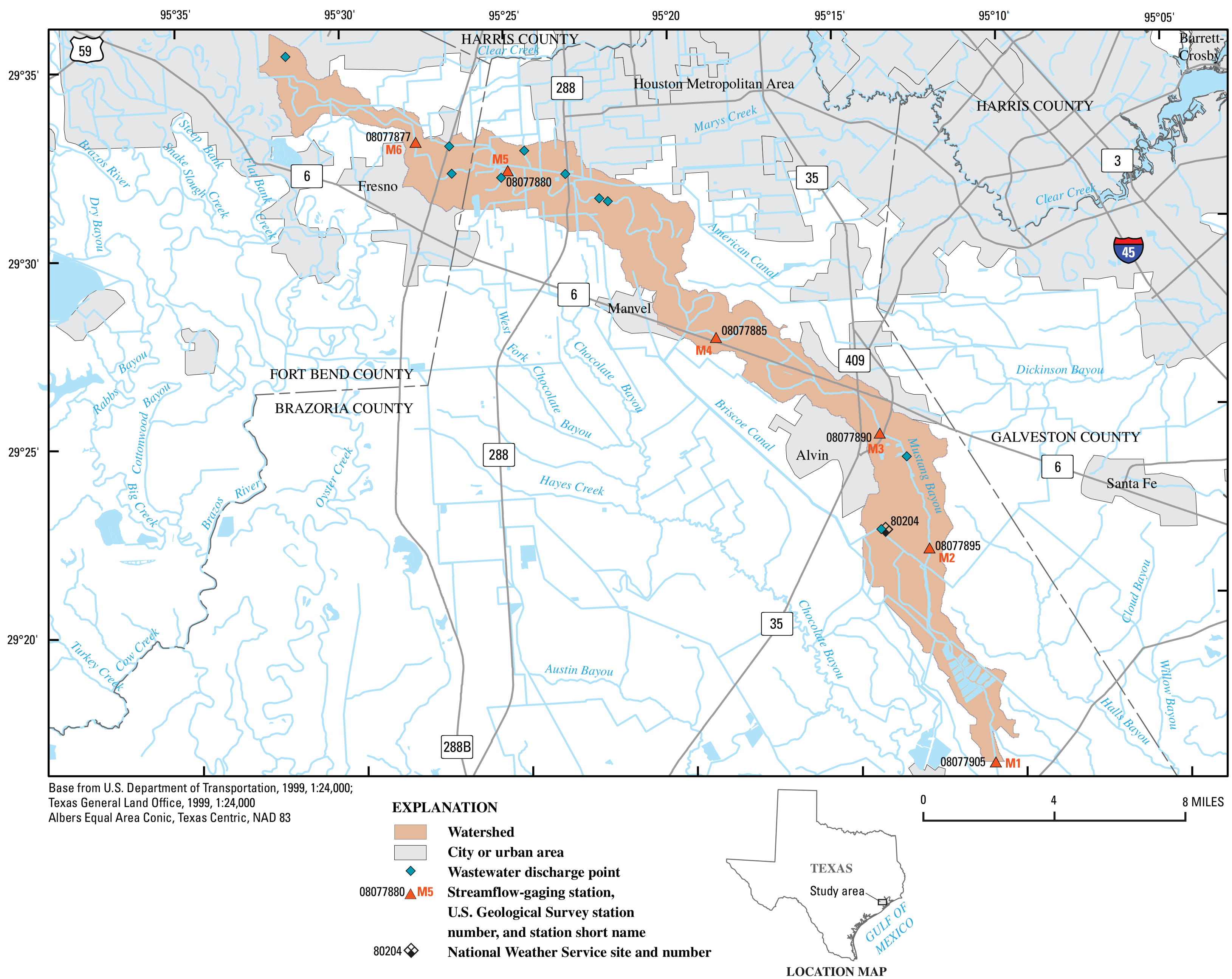

Figure 1. Mustang Bayou watershed (study area) near Houston, Texas.

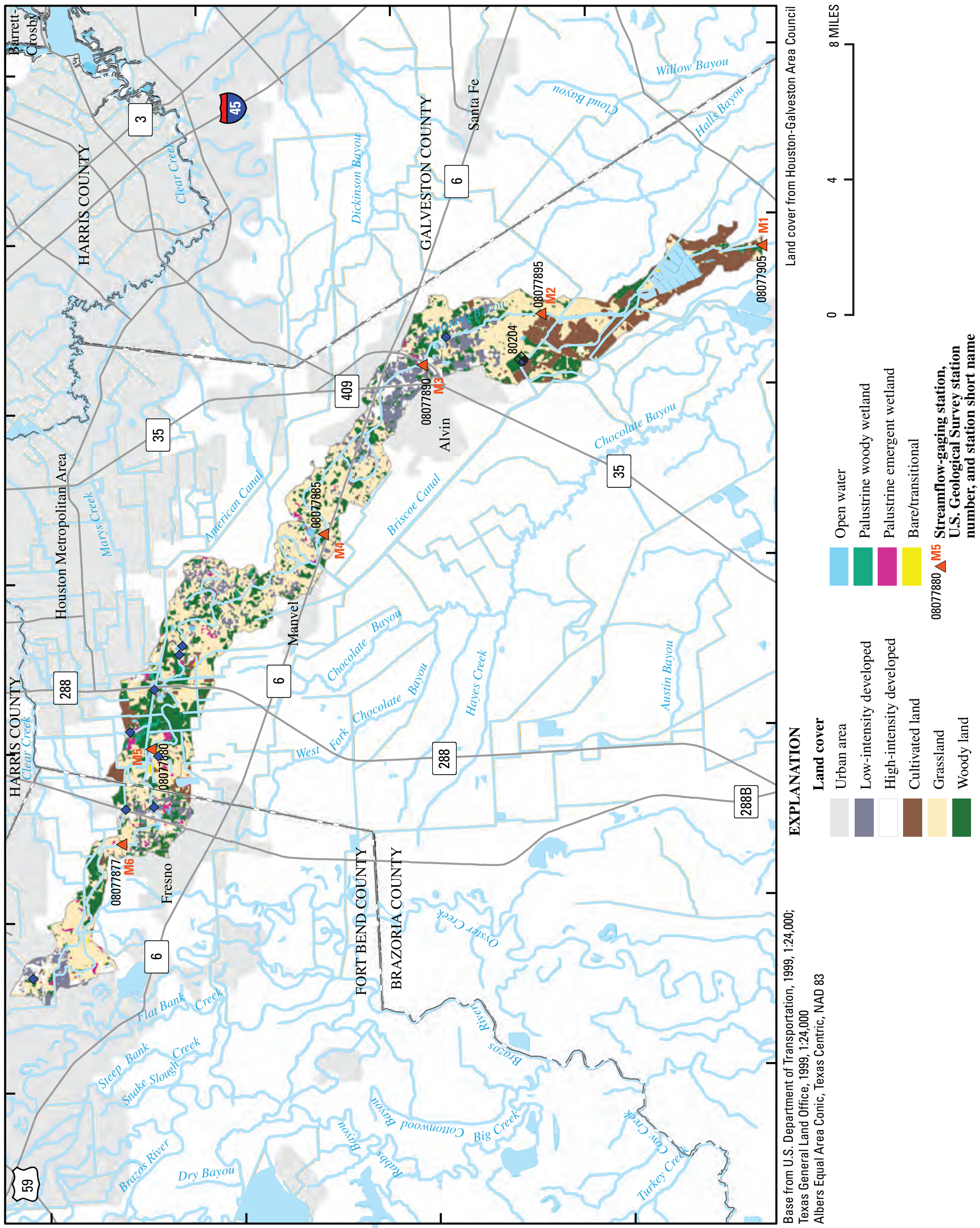

Figure 2. Land-cover distribution in Mustang Bayou watershed near Houston, Texas, 2002.

Acknowledgments

The authors acknowledge the contribution of Jean Wright (Houston-Galveston Area Council), who assisted with the Quality Assurance Project Plan (QAPP) and project planning; and Patrick Horton (Houston-Galveston Area Council), who provided geographic information system feature datasets of the watershed.

Water-Quality Data

Water-quality data were collected to identify differences in physiochemical conditions among six sampling sites on Mustang Bayou (fig. 1; table 1). Data were grouped by (1) continuous water-quality-monitoring data—properties measured with a multiprobe instrument deployed at each site; and (2) water-sampling data—properties and constituents determined from periodically collected samples.

Continuously Monitored Water-Quality Properties

Instream, continuous data were used to characterize diurnal fluctuations in water-quality conditions in Mustang Bayou. Multiprobe, water-quality monitors were deployed at six sites for a minimum of 24 hours to several days in September 2004, and January, April, June, July, and August 2005. At each site, monitors were deployed at sites that were typical of depth and flow conditions of the stream reach used for biological data collection. Instream water temperature, pH, specific conductance, and dissolved oxygen were measured and logged by the monitor every 15 minutes.

Measured water temperatures (table 2) ranged from a minimum of 14.4 degrees Celsius (°C) in January 2005 at M2 to a maximum of 36.8 °C in August 2005 at M6. The average mean water temperature measured from deployments during June–August 2005 for all stations was 27.4 °C. Median pH values (table 3) from all sites varied from 6.9 to 8.0 standard units. The maximum pH of 8.8 standard units was measured at M4 in August 2005. The minimum pH was 6.8 standard units at M5 in September 2004. Specific conductance (table 4) generally was lower at upstream sites, M5 and M6, than at downstream sites. For all sites, values ranged from 372 microsiemens per centimeter at 25 °C (μS/cm) at M3 to 2,050 μS/cm at M4. Because available specific conductance data

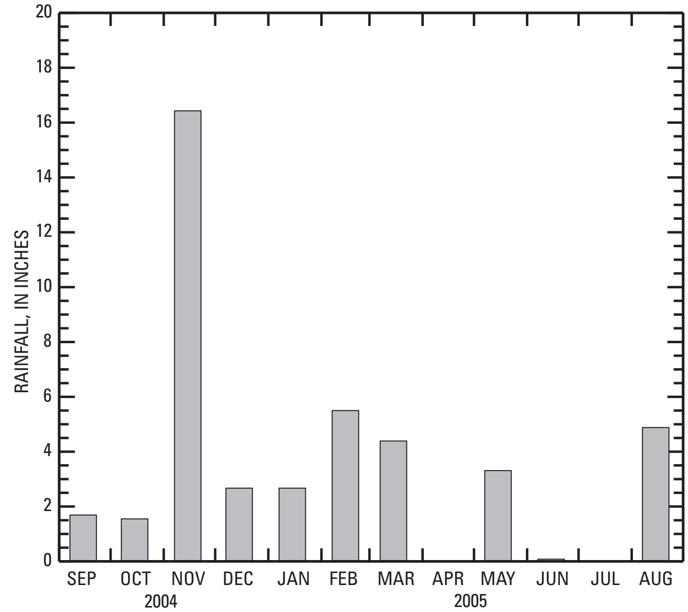

Figure 3. Rainfall at National Weather Service site 80204 (Alvin), September 2004–August 2005 (National Climatic Data Center, 2004, 2005).

Table 1. Data-collection sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[USGS, U.S. Geological Survey; TCEQ, Texas Commission on Environmental Quality; FM, Farm Road; CR, County Road]

Station short name (fig. 1)	USGS station number	TCEQ station number	Station name	Drainage area (square miles)	Altitude (feet above NGVD 29)
[1]M1	08077905	11423	Mustang Bayou at FM 2917 near Liverpool, Tex.	47.1	14.1
M2	08077895	17959	Mustang Bayou at CR 168 near Alvin, Tex.	33.4	20.0
M3	08077890	18554	Mustang Bayou at East South Street at Alvin, Tex.	27.9	38.1
M4	08077885	18553	Mustang Bayou at CR 99 near Alvin, Tex.	20.2	45.0
M5	08077880	18552	Mustang Bayou at CR 48 near Fresno, Tex.	9.11	60.0
M6	08077877	18551	Mustang Bayou at Evergreen Road near Fresno, Tex.	5.64	65.0

[1] Bed sediment samples also collected at this site in September 2005.

Table 2. Summary of 24-hour water temperature data collected at sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[--, no value]

Station short name (fig. 1)	Data type	Measured water temperature (degrees Celsius)					
		Sept. 2004	Jan. 2005	Apr. 2005	June 2005	July 2005	Aug. 2005
M1	Maximum	28.2	20.3	25.0	31.5	32.6	34.1
	Minimum	27.2	14.8	18.9	27.9	29.2	30.1
	Mean	27.7	16.7	22.8	29.4	30.8	32.0
M2	Maximum	32.9	18.2	26.2	--	31.3	34.0
	Minimum	28.0	14.4	21.1	--	28.5	29.7
	Mean	30.2	16.5	23.4	--	29.7	31.6
M3	Maximum	34.2	20.0	27.0	33.2	30.6	34.4
	Minimum	27.0	15.2	21.0	28.1	28.4	29.9
	Mean	30.2	17.1	23.5	30.1	29.6	31.8
M4	Maximum	32.2	23.3	28.9	31.6	34.6	35.0
	Minimum	27.5	20.8	19.8	26.4	29.1	28.6
	Mean	29.4	21.8	23.8	28.7	32.0	31.7
M5	Maximum	29.9	21.9	27.4	--	32.0	32.6
	Minimum	25.6	20.9	20.4	--	29.2	29.2
	Mean	27.4	21.3	23.6	--	30.6	30.7
M6	Maximum	--	22.2	30.2	33.7	35.1	36.8
	Minimum	--	20.0	16.4	24.5	28.0	27.0
	Mean	--	21.0	22.4	28.5	31.3	31.6

reflect only small periods during the year, the true extent of tidal influence, which includes specific conductance equal to or greater than 3,077 µS/cm (Texas Commission on Environmental Quality, 2003a), could not be determined. However, because of the proximity of M1 to the Gulf coast, the fluctuation of water levels caused by tidal activity, and the persistence of saltwater fish collected at the site, water-quality criteria applicable to saltwater are used for this site.

Dissolved oxygen is a primary component used to evaluate the suitability of a stream to sustain aquatic life. Fish that are intolerant of low levels of oxygen become stressed when concentrations of dissolved oxygen are less than about 5 milligrams per liter (mg/L). At concentrations less than 2 mg/L, fish kills can result (Fram, 2006). To maintain dissolved oxygen levels that will support fish, the Texas Commission on Environmental Quality (2003a) has established mean and minimum criteria for dissolved oxygen levels in natural waters, depending on the type of stream (freshwater, M2–M5; intermittent, M6; and tidal, M1) (table 5). The 24-hour mean dissolved oxygen criteria is 5.0 mg/L for perennial freshwater streams, 3.0 mg/L for intermittent streams, and 4.0 for tidally influenced streams. The minimum criteria is 3.0 mg/L for perennial freshwater and tidally influenced streams and 2.0 mg/L for intermittent streams.

Mean dissolved oxygen concentrations from Mustang Bayou (table 5) were less than the 24-hour mean dissolved oxygen criteria in at least one monitoring period at all sites except M2. Minimum dissolved oxygen concentrations were less than the minimum criteria 40 to 67 percent of the time at all sites except M2. The lowest concentrations of dissolved oxygen were measured in July and August when water temperatures exceeded 30 °C and measured streamflows generally were low. Graphed concentrations of dissolved oxygen for M4 and M5 in August 2005 show a diurnal pattern in which concentrations are less than minimum criteria about 25 percent of each day at M4 and 50 percent of each day at M5 (fig. 4).

Periodically Collected Water-Quality Properties and Constituents

Eight discrete water samples were collected at each site. Before sample collection, water temperature, pH, specific conductance, and dissolved oxygen data were collected at three sections in the stream to determine uniformity of physical conditions across the channel. Water (grab) samples were collected at the center of the stream using methods described in a Texas Natural Resource Conservation Commission (1999b)

Table 3. Summary of 24-hour pH data collected at sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[--, no value]

Station short name (fig. 1)	Data type	Measured pH (standard units)					
		Sept. 2004	Jan. 2005	Apr. 2005	June 2005	July 2005	Aug. 2005
M1	Maximum	7.7	8.1	8.5	8.2	8.0	8.1
	Minimum	7.5	7.8	7.4	7.4	7.3	7.0
	Median	7.6	8.0	8.0	7.6	7.6	7.2
M2	Maximum	8.3	7.9	8.2	--	7.9	8.0
	Minimum	7.6	7.7	7.5	--	7.5	7.3
	Median	7.8	7.8	7.8	--	7.6	7.5
M3	Maximum	8.5	7.8	8.0	8.1	7.5	7.7
	Minimum	7.4	7.6	7.4	7.3	7.3	7.3
	Median	7.9	7.7	7.5	7.5	7.4	7.5
M4	Maximum	7.8	8.2	8.3	8.1	8.2	8.8
	Minimum	7.4	7.7	7.6	7.3	7.2	7.3
	Median	7.5	7.8	7.8	7.5	7.5	7.9
M5	Maximum	7.2	7.8	8.3	--	7.7	8.0
	Minimum	6.8	7.7	7.6	--	7.3	7.1
	Median	6.9	7.8	7.8	--	7.5	7.3
M6	Maximum	--	7.7	8.3	8.6	7.8	8.0
	Minimum	--	7.3	7.3	7.0	7.1	7.1
	Median	--	7.5	7.8	7.2	7.4	7.4

procedures manual. All chemical and biological samples were maintained at less than 4 °C until analysis. Thirty-one physical properties, chemical constituents, and biological constituents were measured from each water sample. Concentrations of 52 soluble pesticide compounds were measured in four of the eight water samples from each site (appendix 1). Water-quality constituents quantified in laboratory analyses were

1. Nutrients (total nitrogen, organic nitrogen, ammonia plus organic nitrogen, ammonia nitrogen, nitrite plus nitrate nitrogen, nitrite nitrogen, nitrate nitrogen, orthophosphate phosphorus, total phosphorus)
2. Biochemical oxygen demand (BOD) and carbonaceous biochemical oxygen demand (CBOD)
3. Phytoplankton (pheophytin, chlorophyll-*a*)
4. *E. coli* fecal indicator bacteria
5. Chloride and sulfate
6. Suspended and dissolved solids
7. Suspended sediment concentration
8. Pesticides

Analyses for BOD, CBOD, and fecal indicator bacteria (Myers and Wilde, 2003) were done at the USGS Texas Water Science Center Gulf Coast Program office. Suspended sediment concentrations were analyzed (Guy, 1969) at the USGS Louisiana Water Science Center Sediment Laboratory. All other analyses were done at the USGS National Water Quality Laboratory (NWQL) in Denver, Colo., using methods described in Fishman and Friedman (1989), Patton and Truitt (1992; 2000), Fishman (1993), Zaugg and others (1995), Lindley and others (1996), Sandstrom and others (2001), and Madsen and others (2003).

Concentrations of selected water-quality constituents (nutrients, BOD, chlorophyll-*a*, *E. coli*, chloride, sulfate, suspended solids, dissolved solids, and selected pesticides) were compared among the six sites (figs. 5–8). For some of these constituents, the TCEQ has developed screening levels to identify secondary concerns (table 6) in streams for which water-quality standards have not been adopted (Texas Commission on Environmental Quality, 2003a). Although screening levels do not represent State criteria, exceedances of those levels might indicate a potential water-quality concern. *E. coli* densities are used to evaluate whether a primary concern exists for contact and noncontact recreation. The single-sample water-quality standard for *E. coli* is 394 colonies per

Table 4. Summary of 24-hour specific conductance data collected at sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[--, no value]

Station short name (fig. 1)	Data type	Measured specific conductance (microsiemens per centimeter at 25 degrees Celsius)					
		Sept. 2004	Jan. 2005	Apr. 2005	June 2005	July 2005	Aug. 2005
M1	Maximum	944	1,250	1,130	951	503	589
	Minimum	887	1,200	1,060	844	472	523
	Mean	907	1,220	1,100	887	483	557
M2	Maximum	668	1,250	1,490	--	529	455
	Minimum	625	1,170	1,070	--	424	393
	Mean	645	1,220	1,360	--	479	416
M3	Maximum	653	1,390	1,610	829	461	507
	Minimum	571	1,290	1,170	700	372	389
	Mean	616	1,350	1,350	763	438	457
M4	Maximum	638	1,590	2,050	836	659	532
	Minimum	592	1,560	1,820	756	629	447
	Mean	611	1,580	1,930	787	645	497
M5	Maximum	531	769	707	--	658	575
	Minimum	496	614	661	--	501	533
	Mean	511	688	691	--	563	550
M6	Maximum	--	410	772	--	843	478
	Minimum	--	384	664	--	829	446
	Mean	--	398	712	--	837	464

100 milliliters (cols./100 mL) (Texas Commission on Environmental Quality (2003a).

Nutrients

Distributions of ammonia nitrogen, ammonia plus organic nitrogen, nitrite nitrogen, nitrite plus nitrate nitrogen, orthophosphate phosphorus, and total phosphorus are shown in figure 5. Screening levels were not exceeded in any sample.

Nitrogen compounds naturally occur in the environment, usually in small amounts in surface water, and include ammonia, organic nitrogen, nitrite, and nitrate. The largest concentration of ammonia was 0.21 mg/L, measured at M1 (fig. 5A). The median concentration from all sites combined was 0.04 mg/L. The largest ammonia plus organic nitrogen concentration (2.8 mg/L) was measured at M6 (fig. 5B). Of this amount, organic nitrogen was computed to be 2.7 mg/L. Computations, subtracting ammonia concentrations from ammonia plus organic nitrogen concentrations, showed that organic nitrogen contributed between about 85 to 95 percent of the concentration of ammonia plus organic nitrogen measured at all sites. The median ammonia plus organic nitrogen concentration from all samples was 0.46 mg/L. Nitrite concentrations in Mustang Bayou (fig. 5C) ranged from 0.001 mg/L at M1 and M4–M6 to 0.072 mg/L at M1. The median nitrite concentration was 0.004 mg/L. Nitrite plus nitrate concentrations (fig. 5D) ranged from less than or the reporting level (0.016 mg/L) at all sites to a maximum concentration of 0.67 mg/L at M1. The median nitrite plus nitrate concentration from all sites combined was 0.024 mg/L. Computations, subtracting nitrite concentrations from nitrite plus nitrate concentrations, showed that nitrate contributed about 85 to 92 percent to the combined concentration.

Total phosphorus includes dissolved forms as well as phosphorus attached to sediment particles and in living organisms like algae and bacteria. Phosphorus can be introduced to the water through a variety of sources that include animal waste, domestic and wild waterfowl, tree leaves, and fallout from the atmosphere. Orthophosphate is an inorganic form of phosphorus that is used by plants. It is produced by natural processes and also is found in sewage (Hem, 1985). Orthophosphate concentrations (fig. 5E) were largest at M1 with a maximum concentration of 0.341 mg/L. Maximum concentrations at the remaining sites were less than 0.1 mg/L. The

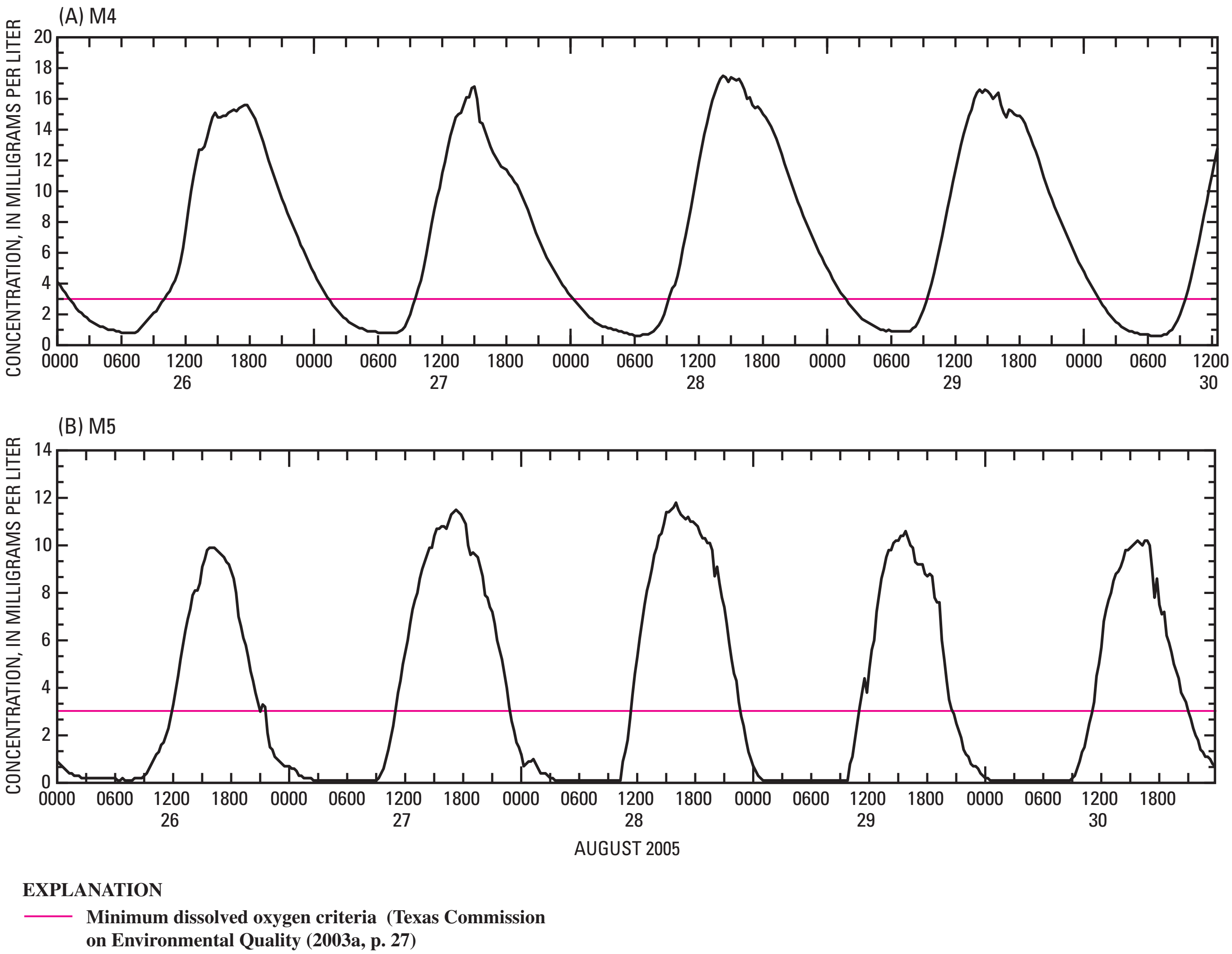

Figure 4. Diurnal dissolved oxygen concentrations at sites (A) M4, Mustang Bayou at County Road 99 near Alvin, and (B) M5, Mustang Bayou at County Road 48 near Fresno, August 2005.

median orthophosphate concentration for all samples from Mustang Bayou was 0.042 mg/L. The contribution of orthophosphate to the total phosphorus concentration ranged from about 4 percent at M6 to 72 percent at M1. Total phosphorus concentrations (fig. 5F) were largest at M1; the maximum concentration was 0.45 mg/L. The median total phosphorus concentration from all sites was 0.11 mg/L.

Biochemical Oxygen Demand, Chlorophyll-*a*, and *E. Coli*

BOD is the measure of oxygen consumption by microorganisms during decomposition of organic material. If the BOD of decomposition is large, dissolved oxygen concentrations can decrease to close to zero. BOD concentrations were less than 4.0 mg/L at all sites except M6 (fig. 6A). At M6, the largest measured BOD (8.1 mg/L) was in July 2005, a period when there was zero streamflow. The combination of no flow, high water temperatures, and abundant organic matter at the site might have contributed to elevated BOD concentrations. The median BOD concentration from all samples was 2.0 mg/L.

Chlorophyll-*a* is a photosynthetic pigment in algae and other green plants. The concentration of chlorophyll-*a* is used to estimate the amount of phytoplankton in a water body (Porter and others, 1993). In Mustang Bayou, concentrations of chlorophyll-*a* were less than the freshwater screening level (11.6 micrograms per liter [μg/L]) at all sites except M6, where four of eight samples exceeded 11.6 μg/L (fig. 6B); all exceedances occurred during the summer (June–September). The maximum chlorophyll-*a* concentration at M6 was 56.6 μg/L; the median concentration was 8.4 μg/L. Median concentrations at the remaining sites ranged from 1.2 μg/L at M5 to 2.6 μg/L at M1. The median concentration from all samples was 1.8 μg/L.

Table 5. Summary of 24-hour dissolved oxygen data collected at sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[n/a, not applicable; --, no value]

Station short name (fig. 1) (stream type)	Data type	Dissolved oxygen criteria[1] (milligrams per liter)	Measured dissolved oxygen (milligrams per liter)						Number of deployments with dissolved oxygen data below criteria
			Sept. 2004	Jan. 2005	Apr. 2005	June 2005	July 2005	Aug. 2005	
M1 (tidal)	Maximum	n/a	5.3	12.2	13.1	11.1	6.2	12.4	n/a
	Minimum	3.0	2.2	7.3	3.3	2.1	.2	.5	4
	Mean	4.0	3.7	9.6	8.4	5.9	2.2	4.8	2
M2 (freshwater)	Maximum	n/a	13.9	12.4	--	--	7.6	9.6	n/a
	Minimum	3.0	4.4	9.0	--	--	3.8	4.1	0
	Mean	5.0	8.4	10.5	--	--	5.2	6.2	0
M3 (freshwater)	Maximum	n/a	16.0	11.4	12.7	10.1	3.4	6.1	n/a
	Minimum	3.0	1.5	7.1	6.2	2.9	1.9	2.8	4
	Mean	5.0	8.2	8.7	8.7	5.9	2.5	4.1	2
M4 (freshwater)	Maximum	n/a	8.5	15.4	15.8	11.9	6.6	16.8	n/a
	Minimum	3.0	2.5	6.3	4.1	0.8	.2	.8	4
	Mean	5.0	4.7	9.7	9.0	4.9	2.7	6.7	3
M5 (freshwater)	Maximum	n/a	7.4	7.8	11.0	--	8.7	11.5	n/a
	Minimum	3.0	2.2	5.9	6.4	--	.2	.1	3
	Mean	5.0	4.1	6.7	8.5	--	4.2	4.4	3
M6 (intermittent)	Maximum	n/a	--	8.9	12.8	10.8	8.2	5.6	n/a
	Minimum	2.0	--	4.5	4.0	2.5	.6	.8	2
	Mean	3.0	--	6.8	8.2	5.9	4.4	2.9	1

[1] Texas Commission on Environmental Quality (2003a, p. 27).

Table 6. Screening levels to identify secondary concerns for selected water-quality constituents and primary standard for contact and noncontact recreation for *E. coli* (Texas Commission on Environmental Quality, 2003a).

[mg/L, milligrams per liter; µg/L, micrograms per liter; cols./100 mL, colonies per 100 milliliters; n/a, not applicable]

Stream type	Screening level					Primary standard, *E. coli* (cols./100 mL)
	Ammonia nitrogen (mg/L)	Nitrite plus nitrate nitrogen (mg/L)	Orthophosphate phosphorus (mg/L)	Total phosphorus (mg/L)	Chlorophyll-*a* (µg/L)	
Freshwater	0.17	2.76	0.50	0.80	11.6	394
Tidal	.58	1.83	.55	.71	19.2	n/a

E. coli is a fecal-indicator bacteria used to signal the potential presence in water of harmful pathogens that come from warm-blooded animals. *E. coli* densities exceeded 394 cols./100 mL, the State standard for contact and noncontact recreation, in 20 of 48 samples from Mustang Bayou (fig. 6C). The largest *E. coli* density (4,000 cols./100 mL) was measured at M6. The largest densities at all sites except M3 came from samples collected during March, when there was increased streamflow from rainfall runoff. At M3, the largest *E. coli* density was measured in July during low-flow conditions. The median density from all samples was 220 cols./100 mL. Median densities at each site ranged from 69 cols./100 mL at M4 to 1,200 cols./100 mL at M3.

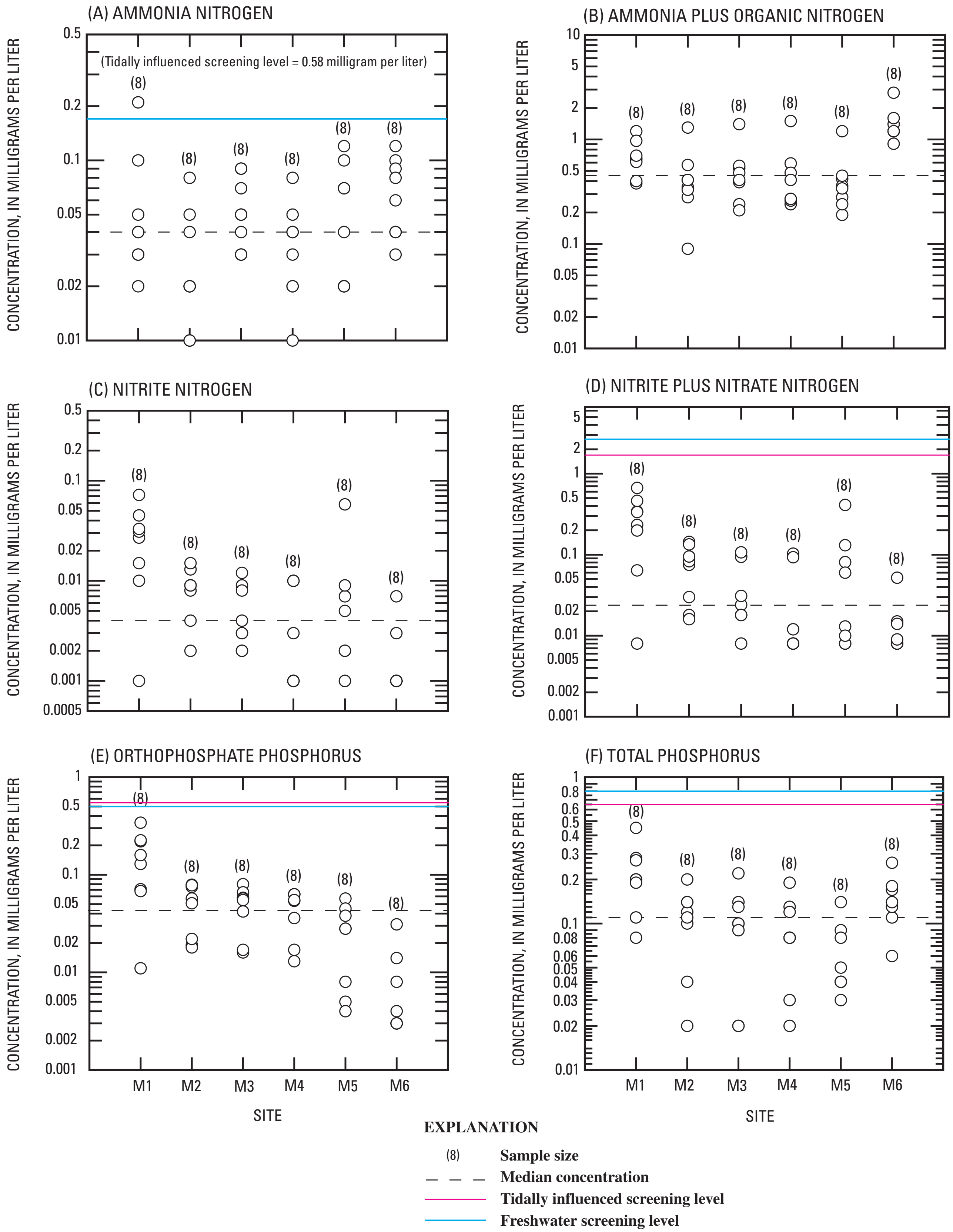

Figure 5. Distribution of (A) ammonia nitrogen, (B) ammonia plus organic nitrogen, (C) nitrite nitrogen, (D) nitrite plus nitrate nitrogen, (E) orthophosphate phosphorus, and (F) total phosphorus concentrations in water samples periodically collected from six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

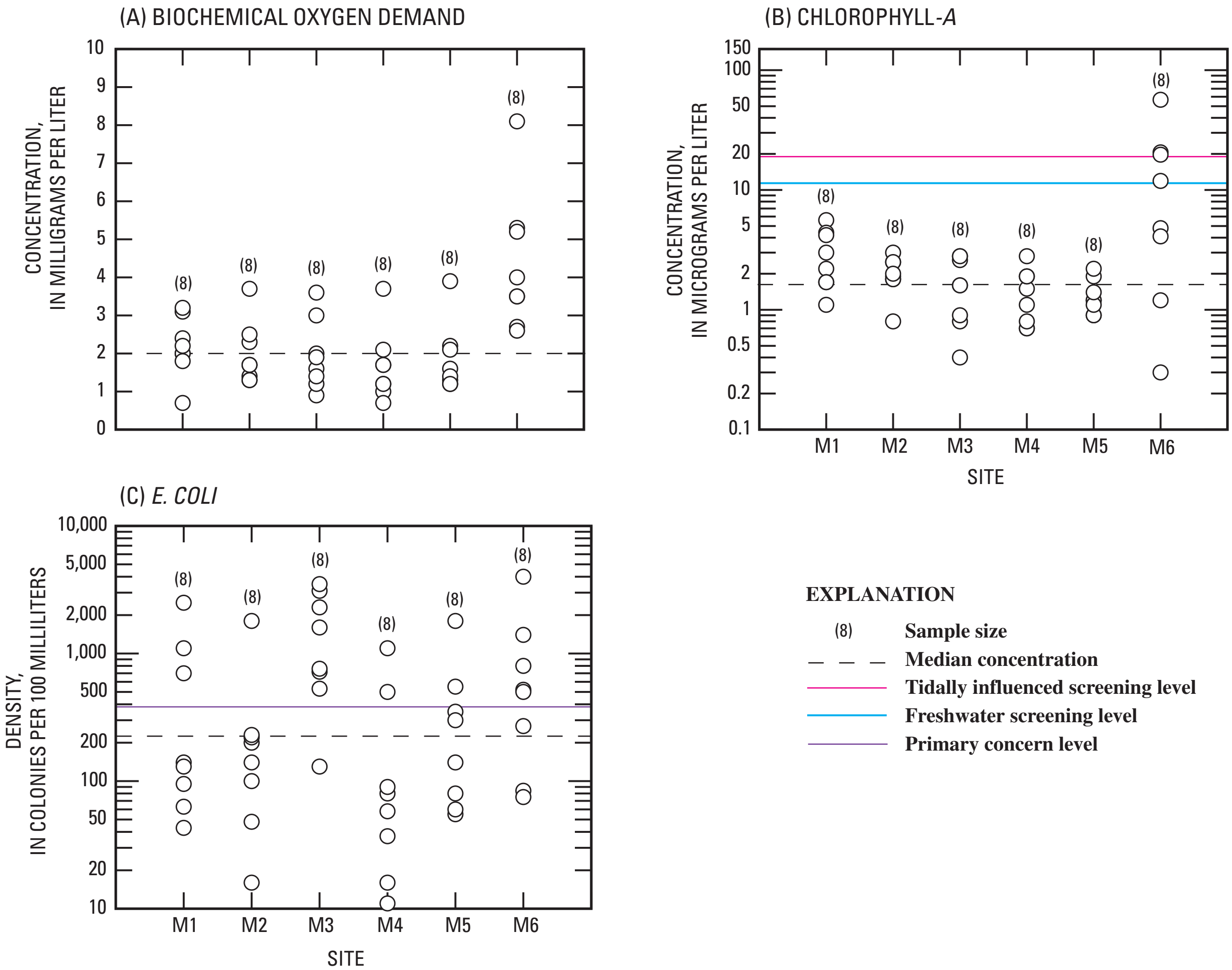

Figure 6. Distribution of (A) biochemical oxygen demand concentrations, (B) chlorophyll-*a* concentrations, and (C) *E. coli* densities in water samples periodically collected from six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

Chloride, Sulfate, Suspended Solids, and Dissolved Solids

Chloride, sulfate, suspended solids, and dissolved solids are not used as indicators for the suitability of streams for aquatic life use; however they do provide additional information on the quality of the water for general uses and the aesthetic appeal of a water body. In Mustang Bayou, chloride concentrations reflected the pattern of specific conductance measurements at the sites. The maximum chloride concentration (fig. 7A) was 454 mg/L at M4. Median chloride concentrations ranged from 42.2 mg/L at M6 to 123 mg/L at M1. The median chloride concentration from all sites was 69.1 mg/L. Both maximum (68.4 mg/L) and minimum (2.7 mg/L) sulfate concentrations were measured at M6 (fig. 7B). Maximum sulfate concentrations were less than 30 mg/L at all other sites. The median sulfate concentration from all sites at Mustang Bayou was 19.8 mg/L.

The largest concentration of suspended solids was 240 mg/L measured at M6 (fig. 7C). Maximum concentrations at all sites except M6 occurred in March during high streamflows (appendix 1). The median concentration of suspended solids from all samples was 16.0 mg/L. The largest concentration of dissolved solids was 1,050 mg/L measured at M4 (fig. 7D). The median concentration of dissolved solids from all samples was 346 mg/L.

Pesticides

Fifteen pesticide compounds (six herbicides and nine insecticides) were detected in 24 water samples collected from Mustang Bayou (four samples at each site) (table 7; appendix 1). The most frequently detected herbicides were atrazine (24 detections), 2-chloro-4-isopropylamino-6-amino-s-triazine (CIAT), a degradation product of atrazine (19 detections), prometon (17 detections), and tebuthiuron (17 detections).

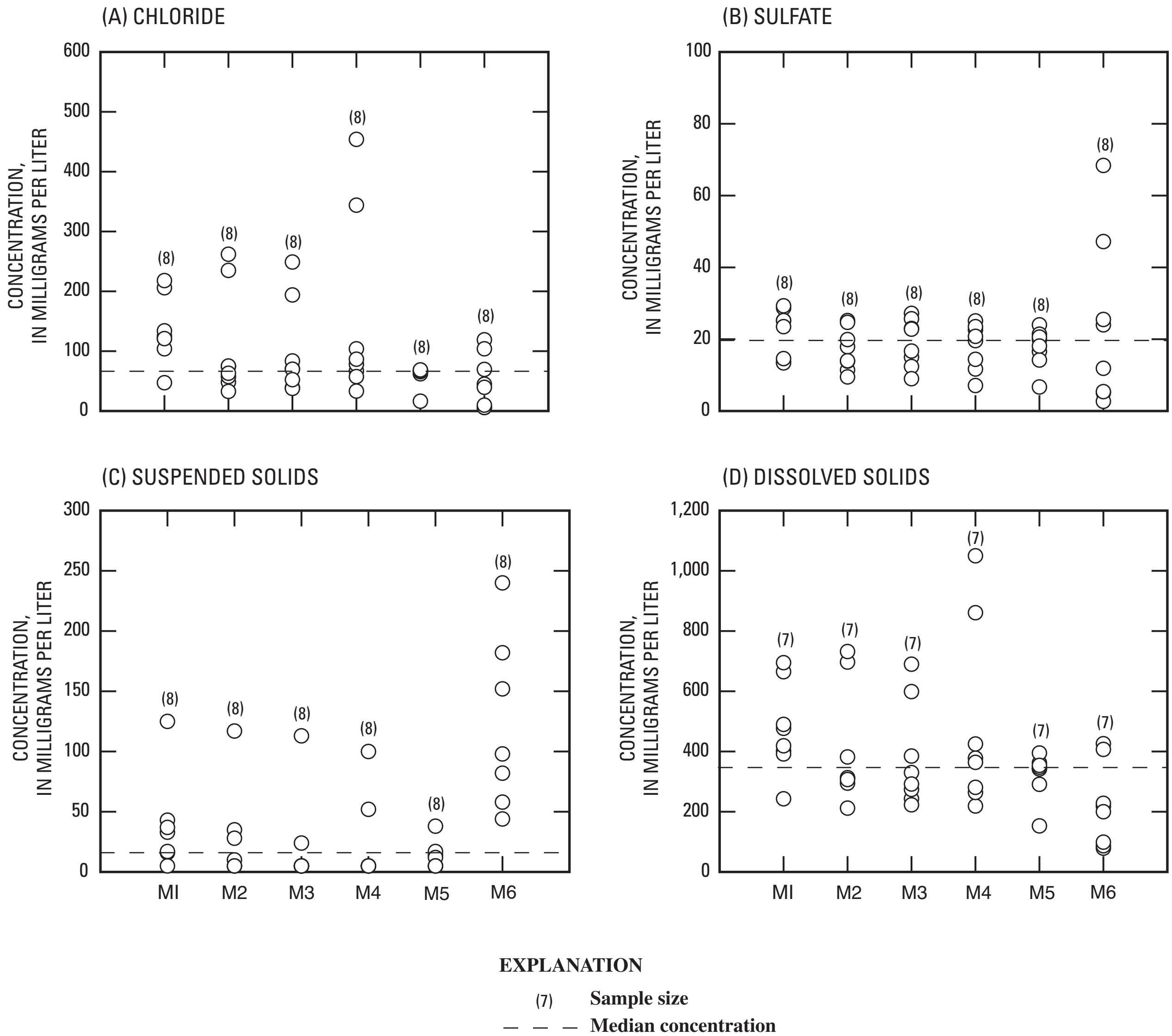

Figure 7. Distribution of (A) chloride, (B) sulfate, (C) suspended solids, and (D) dissolved solids concentrations in water samples periodically collected from six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

The most frequently detected insecticides were fipronil (seven detections) and two of its breakdown products, fipronil sulfide (nine detections) and fipronil sulfone (seven detections). The U.S. Environmental Protection Agency (2004) has established either a maximum contaminant level (MCL) or Health Advisory (HA) for many of these compounds—for atrazine, the MCL is 3.0 µg/L; for prometon, the non-cancer lifetime HA is 100 µg/L; for tebuthiuron, the non-cancer lifetime HA is 500 µg/L. No concentrations of any pesticides detected in Mustang Bayou exceeded their respective MCL or HA.

Atrazine is one of the most widely used herbicides in the United States, and it is the most frequently detected herbicide in streams that flow in agricultural areas (U.S. Geological Survey, 1999). Atrazine was detected in every sample; concentrations ranged from 0.010 µg/L to 1.42 µg/L, with a median concentration of 0.089 µg/L (fig. 8). Concentrations of CIAT ranged from less than the reporting level (0.006 µg/L) to a maximum concentration of 0.167 µg/L at M6. The median CIAT concentration at all sites was 0.008 µg/L (fig. 8).

Prometon and tebuthiuron generally are not used for crops but for weed control around structures and roads. Prometon was detected in low concentrations in samples from Mustang Bayou. The maximum concentration was 0.03 µg/L at M2. The median concentration for all samples was at the reporting level (0.01 µg/L) (fig. 8). The maximum concentration of tebuthiuron (0.09 µg/L) was measured at M3. The median concentration for all samples was 0.03 µg/L. The detection frequency of tebuthiuron increased downstream from 0 at M6 to 100 percent at M1–M3 (appendix 1).

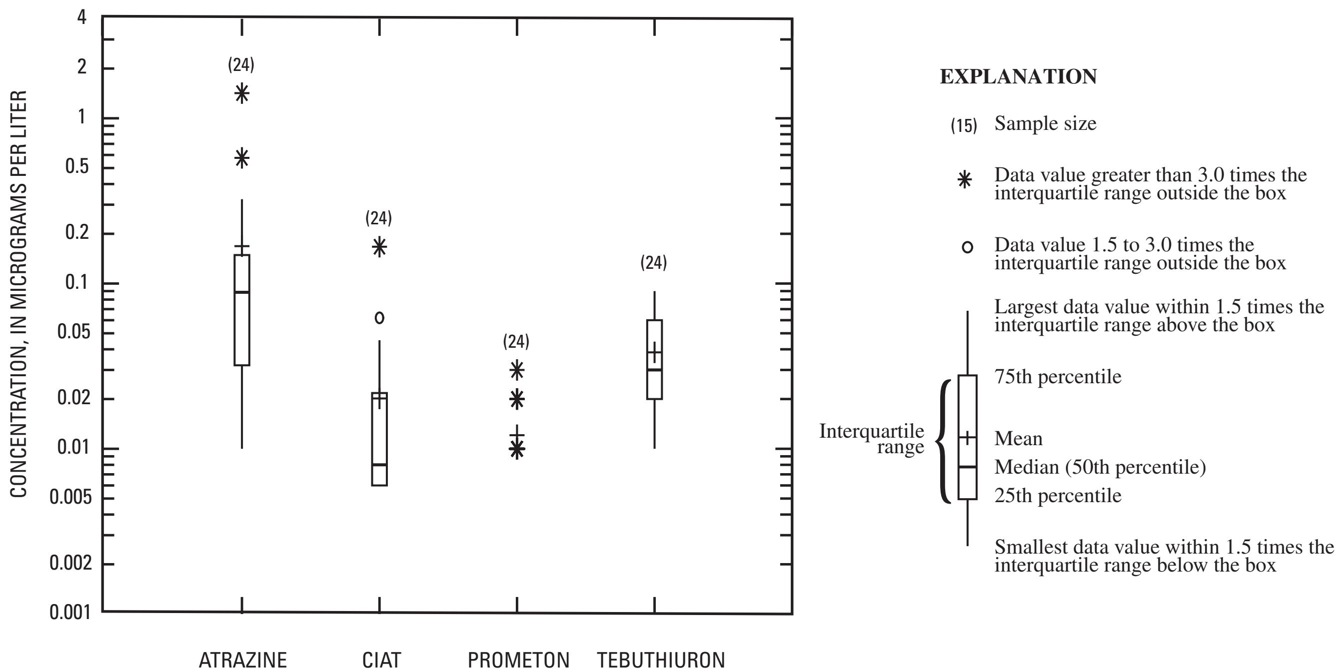

Figure 8. Distribution of selected pesticide concentrations in water samples collected from six sites, combined, in Mustang Bayou near Houston, Texas, September 2004–August 2005.

Table 7. Summary of pesticide detections at sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

Compound	Number of detections					
	M1	M2	M3	M4	M5	M6
Herbicides						
Atrazine	4	4	4	4	4	4
2-Chloro-4-isopropylamino-6-amino-s-triazine (CIAT)	4	4	3	4	1	3
Metolachlor	1	0	0	0	0	1
Prometon	2	4	2	3	4	2
Simazine	2	1	1	0	1	2
Tebuthiuron	4	4	4	3	2	0
Insecticides						
Azinphos-methyl	0	0	2	1	0	0
Carbaryl	1	0	0	0	0	1
Desulfinylfipronil	2	1	2	0	0	1
Desulfinylfipronil amide	2	0	1	0	0	1
Diazinon	0	0	1	0	0	0
Fipronil	3	1	2	0	0	1
Fipronil sulfide	3	2	2	1	0	1
Fipronil sulfone	3	1	2	0	0	1
Malathion	0	0	1	0	1	1

Insecticide concentrations in Mustang Bayou were less than 0.1 µg/L (appendix 1). Fipronil was detected in seven of 24 samples (table 7). All concentrations were reported as estimated because of relatively poor recovery of that compound during analysis (Sandstrom and others, 2001). Fipronil was most frequently detected in water samples from M1 (three of four samples) with a maximum concentration of 0.033 µg/L (appendix 1). Fipronil sulfide and fipronil sulfone also were detected in three of four samples from M1. Maximum concentrations of fipronil sulfide (0.075 µg/L) and fipronil sulfone (0.024 µg/L) were measured at M3.

Quality Assurance and Quality Control

All sample collection and processing procedures, data management, and documentation are described by the Texas Natural Resource Conservation Commission (1999b) and the Texas Commission on Environmental Quality (2003b) and included in the investigation QAPP (Jean Wright, Houston-Galveston Area Council, written commun., 2005).

Quality-control (QC) samples consisting of a field blank, a matrix spike, and replicates (appendix 2) were used to evaluate the extent to which contamination, characteristics of the water (matrix), and measurement variability affected analytical results (Mueller and others, 1997). About 17 percent of the water samples collected were QC samples. Further explanation of QC sample types and their usage are described in Mueller and others (1997).

One field blank was collected and processed at the site, immediately before the associated environmental sample, to identify potential contamination from field activities associated with data collection. No concentrations of any constituent exceeded the minimum reporting level for that constituent. One water sample was spiked with known volumes and concentrations of pesticide compounds. Laboratory recoveries from the matrix-spike sample were within method-acceptance ranges for all constituents. Additional water was collected seven times during the study to split into two samples; one was designated the environmental sample and the other a split replicate of that sample. Analytical results from each sample set were compared by computing the relative percentage difference (RPD) for each constituent. The RPD, specified for this project in the QAPP, was 20 percent and was computed using the equation

$$RPD = |S_1 - S_2| / [(S_1 + S_2)/2] \times 100,$$

where

S_1 = concentration from environmental sample; and
S_2 = concentration from replicate sample.

The RPD exceeded 20 percent for one of six sample pairs of turbidity; one of six sample pairs of *E. coli*; three of seven sample pairs of chlorophyll-*a*, three of seven sample pairs of pheophytin-*a*, one of seven sample pairs of ammonia, two of six sample pairs of suspended solids, and two of six sample pairs of suspended sediment. The RPD exceeded 20 percent for ammonia when constituent concentrations were very low so that even small variability in analytical results caused relatively large RPDs. Most exceedances occurred for biological and sediment-related constituents. Because of inherent heterogeneity of these constituents in water, sample processing, and laboratory analysis, differences in concentrations caused by sampling imprecision (field) or analytical procedures and instrumentation (laboratory) generally were inseparable.

Sediment-Quality Data

Sediment was collected from the stream bottom at M1 using methods described by Radtke (1997) and the Texas Commission on Environmental Quality (2003b). An alternative method of sample collection, large-volume suspended-sediment sampling (Mahler and Van Metre, 2003), was attempted at this site. However, flat topography, low water velocities, and tidal fluctuations at the site made it impossible to collect suspended sediment from high flows. Water temperature, pH, specific conductance, and dissolved oxygen were collected with the samples to characterize water conditions of the overlying water column. The top 1 centimeter of sediment was retained from several subsamples to capture the most recently deposited material. Analyses to determine concentrations of 62 selected organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), trace elements (metals), and polychlorinated biphenyls (PCBs) in the streambed sediment (appendix 3) were completed at the USGS NWQL (Fishman and Friedman, 1989; Garbarino and Struzeski, 1998; U.S. Environmental Protection Agency, 1998; Noriega and others, 2004; Olson and others, 2004).

The Texas Commission on Environmental Quality (2003a) has established guidelines to assess the toxicity of sediment in streams. No organochlorine pesticides or PCBs were detected. No concentrations of metals exceeded State screening levels. Eleven PAH compounds were detected at measurable concentrations, and three other PAH compounds were detected but not quantified by the laboratory. All concentrations were less than respective sediment-quality screening levels. Analytical results are presented in appendix 3.

Habitat Data

Stream-habitat data were collected at each of the six sites three times during the study, in September 2004, April 2005, and August 2005. A representative stream reach was selected at each site (Texas Natural Resource Conservation Commission, 1999b). Within this reach, five evenly spaced stream transects were identified. At each transect, stream-channel attributes (for example, wetted channel width, water depths, bottom materials, instream cover) and riparian attributes (bank slope and erosion potential, width of natural vegetation, types of vegetation, percentage tree canopy) were measured. The number of stream bends and riffles and the overall aesthetic condition also were noted. A habitat quality index (HQI) was computed for each site using aquatic-life-use scoring described by the Texas Commission on Environmental Quality (2003a).

Mustang Bayou has been channelized through much of its length, including parts of the study area. Between September 2004 and August 2005, channel rectification at three sites (M2, M3, and M5) included widening and removal of instream and riparian vegetation. Channel sinuosity generally was poor and characterized by poorly and moderately defined bends; at two sites, M1 and M6, the bayou was straight.

The physical characteristics of a stream channel and riparian characteristics can influence the structure and function of the benthic macroinvertebrate and fish communities (Stauffer and others, 2000; Brasher and others, 2003; Powers and others, 2003). The dominant substrate type noted at all Mustang Bayou sites was silt, with small amounts of sand and clay. Small amounts of gravel or gravel-sized bed material (shells) were at M2, M3, and M4. One riffle was consistently observed at M2 and one also was noted at M3 in August 2005 during very low flow. Instream cover, which provides habitat for benthic macroinvertebrates and fish, consisted primarily of macrophytes, algae, and small amounts of vegetation overhanging from the banks. Data and computed metrics that describe habitat for each site and survey are in appendix 4.

Habitat metrics computed during each survey indicate an HQI aquatic-life-use score of “limited” (8–13) during at least one survey at all sites except M2 (table 8). HQI scores were “limited” for every survey at M6. Highest HQI scores for all sites were “intermediate” (14–19). Average HQI scores for the three surveys were “limited” for sites M3–M6 and “intermediate” for M1 and M2.

Lower HQI scores might not indicate degraded physical habitat compared to the natural condition of small streams in the Western Gulf Coastal Plain ecoregion (such as Mustang Bayou) because some metrics computed as part of the HQI are not naturally characteristic of such streams. Natural attributes of these streams, including soft (sand and clay) substrate, few riffles to complete lack of riffles, relatively uniform channels, and no defined pools, result in a lower score based on the HQI. However, other metrics observed at Mustang Bayou, such as the lack of channel sinuosity, the lack of riparian vegetation, and overall degraded aesthetics, also contributed to the limited and intermediate classifications.

Biological Data

Benthic macroinvertebrate and fish data were collected from the same reaches identified for habitat evaluation. Three surveys were done to account for seasonal differences in biotic distribution.

Benthic Macroinvertebrates

Benthic macroinvertebrate data were collected in a single, 5-minute interval of sampling using a D-frame net with 600-micron mesh to sample available habitats at each site. Samples were preserved in 10-percent buffered formalin solution and shipped to a contract laboratory (EcoAnalysts, Inc., Moscow, Idaho) to be identified and enumerated. At the laboratory, organisms from each site were sorted, subsampled, and identified to the species level where possible (Lester, 2004). A reference collection, with at least one individual of each taxon identified, was provided to the USGS by EcoAnalysts, Inc. A tolerance value and functional feeding-group designation were assigned to each benthic macroinvertebrate taxon as defined by TCEQ classification guidance (Texas Natural Resource Conservation Commission, 1999b). Each macroinvertebrate community was assessed on the basis of metrics described in Texas Commission on Environmental Quality (2006).

As part of the initial biological survey (September 2004), the benthic macroinvertebrate sample from one site was split to create a primary sample and replicate samples. This was done by dividing the sample into subsections and identifying and enumerating all individuals in each subsection until a minimum of 100 individuals was obtained (Texas Natural Resource Conservation Commission, 1999b). The samples were compared to evaluate the efficiency of sample separation. The numbers of taxa in the samples differed by an average of 26 percent and indicate that a potential bias in the data can occur during sample processing.

The composition of an invertebrate community, the relative abundance of tolerant versus intolerant individuals, and the distribution of trophic (feeding) groups reflect the aquatic health of the water (Thomas and others, 2002; Skrobialowski and others, 2004). In Mustang Bayou, characteristic habitat for benthic macroinvertebrate communities include low water velocities, elevated water temperatures, mud and clay substrate, dense algal and macrophyte growth, little to no canopy, and periods of very low (less than 2.0 mg/L) dissolved oxygen.

A total of 2,557 macroinvertebrate individuals from Mustang Bayou were identified (appendix 5) consisting of 1,509 individuals that belong to benthic, non-insect invertebrate taxa and 1,048 individuals that belong to insect taxa. The largest number of taxa (38) was collected at M3 in September 2004. The least number of taxa (12) was collected at M1 in September 2004. Overall, the Dipteran family Chironomidae was the most abundant (500 individuals), followed by gastropods (primarily Hydrobiidae, 362 individuals), segmented worms (Oligochaeta, 316 individuals), amphipods (primarily *Hyalella azteca*, 224 individuals), and mayflies (Ephemeroptera) (primarily *Caenis* sp., 232 individuals) (appendix 5).

Non-insect taxa were more numerous than insect taxa at all sites except M2 and M3 (fig. 9; appendix 5). About 89 percent of the individuals (445 of 502) at M6 were non-insect taxa, primarily *Limnodrilus hoffmeisteri* (Oligochaeta), Hydrobiidae (Gastropoda), and Nematoda. The most abundant non-insect taxa at each of the remaining sites were *Hyalella* sp. (Amphipoda) at M1 and at M4; Hydrobiidae (Gastropoda) at M2 and at M3; and Ostracoda at M5. The smallest number of non-insect taxa identified was from M3.

The number of insect individuals collected during all surveys ranged from 57 at M6 to 292 at M3 (appendix 5). The most frequently collected aquatic insect was the mayfly, *Caenis* sp. (Ephemoptera), which accounted for about 22 percent of all identified insects and was the most abundant insect species at M1, M2, M4, and M5 from the combined surveys. The most abundant insect species at M3 was the *Polypedilum illinoense* gr. (Diptera-Chironomidae). At M6, the most abundant insect was a dragonfly of the family Coenagrionidae (Odonata); although the family Diptera-Chironomidae comprised more species than Coenagrionidae at M6, there were fewer individuals per species (fig. 9).

Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa presence and abundance provide a measure of environmental quality (Moring 2003). The number of EPT taxa (richness) from individual surveys in Mustang Bayou ranged from 0 at M6 to 6 at M2 (appendix 6). Ephemeroptera taxa were relatively abundant at all sites except M6. No Plecoptera were collected from any of the sites. At least one specimen of Tricoptera taxa was found at each site. The most numerous Tricoptera taxon was *Hydroptila* sp.; 12 individuals were collected during all surveys from M2 (appendix 5).

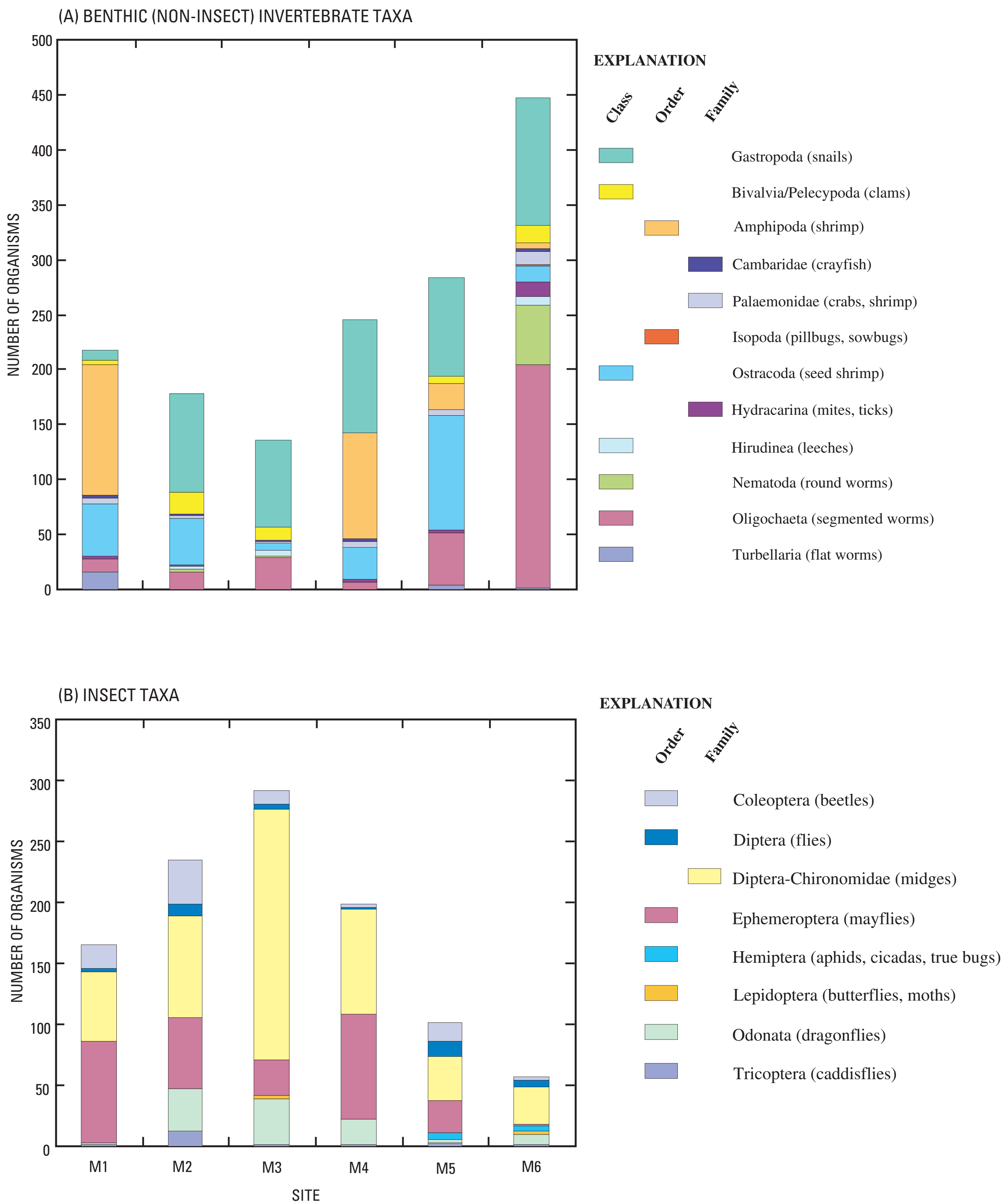

Figure 9. Number of specimens of (A) benthic (non-insect) invertebrate taxa, and (B) insect taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

Table 8. Habitat quality index[1] aquatic-life-use scoring for representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[I, intermediate aquatic life use (14–19); L, limited aquatic life use (8–13)]

Metric	Site and survey								
	M1			M2			M3		
	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005
Primary attributes									
Available instream cover	2	1	3	2	2	2	2	2	3
Bottom substrate stability	1	1	1	1	1	1	1	1	1
Secondary attributes									
Number of riffles	1	1	1	2	2	2	1	1	2
Dimensions of largest pool	1	1	1	1	1	1	1	1	3
Channel flow status	3	3	3	2	2	2	2	2	2
Bank stability	2	1	2	3	3	3	1	1	0
Channel sinuosity	0	0	0	1	1	1	1	1	1
Tertiary attributes									
Riparian buffer vegetation	3	3	3	3	3	3	0	1	1
Aesthetics of reach	1	1	1	2	2	2	1	1	1
Total score	14	12	15	17	17	17	10	11	14
Habitat quality index	I	L	I	I	I	I	L	L	I

Metric	Site and survey								
	M4			M5			M6		
	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005
Primary attributes									
Available instream cover	3	1	2	3	2	2	1	1	2
Bottom substrate stability	1	1	1	1	1	1	1	1	1
Secondary attributes									
Number of riffles	1	1	1	1	1	1	1	1	1
Dimensions of largest pool	1	1	1	1	1	1	1	1	1
Channel flow status	3	3	3	3	2	2	3	3	2
Bank stability	2	2	2	3	1	2	3	3	3
Channel sinuosity	1	1	1	2	1	1	0	0	0
Tertiary attributes									
Riparian buffer vegetation	2	1	1	2	0	1	0	0	0
Aesthetics of reach	1	0	0	1	0	0	1	1	1
Total score	15	11	12	17	9	11	11	11	11
Habitat quality index	I	L	L	I	L	L	L	L	L

[1]Texas Commission on Environmental Quality (2003a, p. 40).

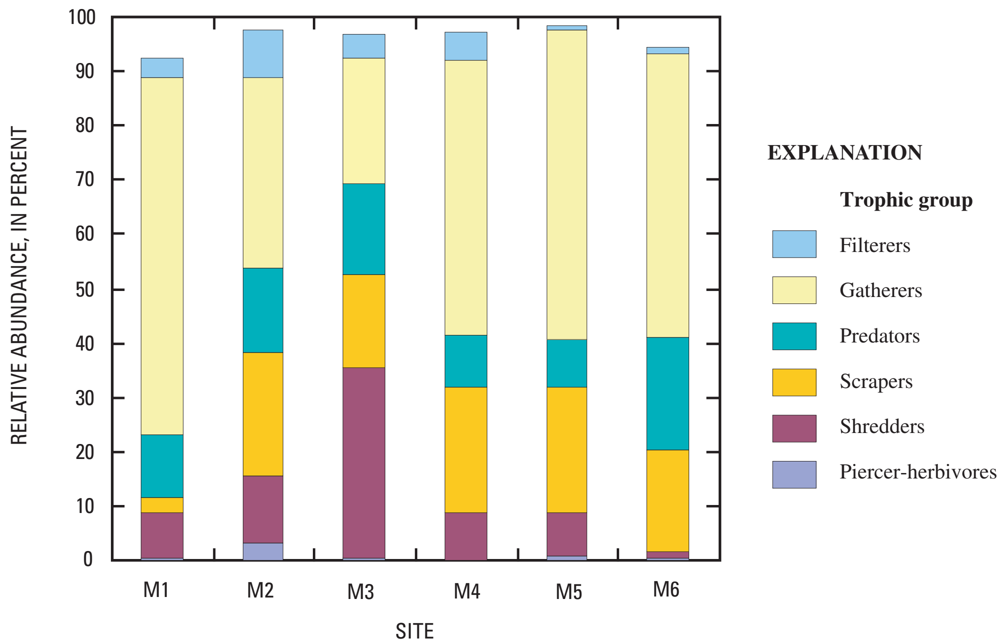

Figure 10. Relative abundance of benthic macroinvertebrate trophic groups from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

From examination of the EPT taxa, the following observations can be made:

1. Because Plecoptera are among the most sensitive of stream insects to low dissolved oxygen levels (Stewart and Stark, 1993) and need a substrate of gravel and cobbles, the lack of Plecoptera taxa is compatible with observed dissolved oxygen and substrate conditions in Mustang Bayou.

2. The genus *Caenis* sp. is one of the more tolerant Ephemeroptera (Texas Natural Resource Conservation Commission, 1999b). Although other Ephemeroptera genera are present, the dominance of a tolerant species and minor occurrence of less tolerant Ephemoptera species might indicate less favorable conditions.

3. Specimens of *Caenis* sp. were relatively abundant in the September and August surveys at most sites (appendix 5) when unfavorable dissolved oxygen, water temperature, and flow conditions prevailed.

Invertebrates were assigned a tolerance value that is measured on a scale from 1 to 10 (Hilsenhoff, 1988); values are inversely related to stream quality (taxa/species with lower values indicate the presence of higher stream quality). Most of the macroinvertebrate community from Mustang Bayou had tolerance values that ranged from 4 to 10. From all surveys, 32 individuals were collected that had tolerance values less than 4; 16 of these were collected at M2. In contrast, 240 individuals were collected that had a tolerance value of 10; 200 of these were collected at M6.

Benthic macroinvertebrate communities were compared by computing the Hilsenhoff biotic index (HBI) (Hilsenhoff, 1988). This index is computed using the equation

$$HBI = \frac{[(TV_i)(n_i)]}{N},$$

where

TV_i = tolerance value for each species;
n_i = number of individuals in the species; and
N = total number of individuals in the collection.

HBIs ranged from 6.12 at M2 to 8.51 at M6 (appendix 6). These scores correlate to water-quality classifications of fair, where there is fairly substantial organic enrichment, to very poor, where there is severe organic enrichment (Hilsenhoff, 1988).

Vannote and others (1980) proposed that the types of macroinvertebrate communities in streams form a continuum from the headwaters to the mouth and are correlated with the sources of nutrition in the streams. Smaller streams of the headwaters would be dominated by macroinvertebrates that are capable of utilizing coarser vegetation (shredders, gatherers, scrapers). Macroinvertebrates that could utilize finer organic particulate matter (filterers, gatherers) would increase in number downstream. Gatherers were the dominant trophic (feeding) group at most sites in Mustang Bayou (fig. 10; appendix 6) and were about 47 percent of the overall invertebrate community; they were most similar to assemblages of gatherers of smaller streams described by Vannote and others (1980). The relative abundances of predators, scrapers, and shredders were similar, ranging on average from about 12 percent (shredders) to about 18 percent (scrapers). On average, filterers were not a large part of assemblages at most sites (4 percent). Overall relative abundance of trophic groups is less than 100 percent because unclassified specimens were omitted.

Benthic macroinvertebrate assemblages were scored using indexes specified by the Texas Commission on Environmental Quality (2003a). Aquatic-life-use scores (table 9) ranged from “limited” at M1 in September 2004 and April 2005 to “exceptional” at M2 in April 2005. Aquatic life use was “intermediate” at M4–M6 during all surveys, at M3 in April and August 2005, and at M1 in August 2005. Aquatic life use was “high” at M2 in September 2004 and August 2005 and at M3 in September 2004.

Fish

Fish surveys involved use of a combination of seining and electrofishing (Texas Natural Resource Conservation Commission, 1999b). After collection and identification at the stream, fish were released. Fish collected using seining were kept separate from fish collected using electrofishing for identification and enumeration so that the effectiveness of each method could be assessed. Unidentified fish were analyzed by Dr. Dean Hendrickson, ichthyologist, Texas Memorial Museum at the University of Texas, for final identification and storage. A tolerance rating and trophic group were assigned to each species (Linam and Kleinsasser, 1998). An index of biotic integrity (IBI) was computed for the combined catch for each site using scoring indexes developed to assess stream fish assemblages in the Western Gulf Coastal Plain (ecoregion 34) (Linam and others, 2002).

Forty-six species of fish (table 10) representing 20 families were collected from Mustang Bayou. Fish taxa and individual counts from each survey are listed in appendix 7. A total of 4,115 fish were collected. Sunfish (Centrarchidae) was the most abundant family with 1,153 individuals collected. The most common sunfish were longear sunfish (*Lepomis megalotis*) with 350 individuals and bluegill (*Lepomis macrochirus*) with 200 individuals. Several families were represented by only one individual. These include Gerridae (mojarras), Gobiidae (gobies), Ophichthidae (snake eels), and Percidae (perches/darters). Except for the family Percidae, these are marine or estuarine species and are not commonly collected from freshwater streams. The presence of these and other marine families reflect the connection of Mustang Bayou to Galveston Bay and the Gulf of Mexico. The family Percidae is represented by the dusky darter (*Percina sciera*), an intolerant species that is less likely to be found in streams that are physically or chemically disturbed, or both (Linam and Kleinsasser, 1998).

The relative abundance of major fish families at each site is shown in figure 11. Relative abundance is less than 100 percent at some sites because several families with low representation were omitted. Sunfishes (Centrachidae) and livebearers (Poeciliidae) composed a large percentage at all sites except M1, where the dominant family (Clupeidae) comprised herrings and shads. Minnows, comprising red shiners (*Cyprinella lutrensis*) and bullhead minnows (*Pimephales vigilax*), were a large part of the fish collected at M5. The presence of red shiners, a tolerant species, might reflect disturbance of the habitat at M5. The majority were collected in April 2005, after the channel and stream banks at this site had been cleared of vegetation and the tree canopy removed. M6 had the least diversity; the fish community was dominated by three families.

Of 46 fish species, 16 were identified as having a specific tolerance or intolerance to pollution (Linam and Kleinsasser, 1998). Twelve of the species identified as tolerant are listed in appendix 7. These included (1) 55 individuals from three species of gar (alligator gar, *Lepisosteus spatula*; longnose gar, *Lepisosteus osseus*; spotted gar, *Lepisosteus oculatus*); (2) 334 individuals from three species of sunfish (bluegill, *Lepomis macrochirus*; green sunfish, *Lepomis cyanellus*; warmouth, *Lepomis gulosus*); (3) 120 individuals from two species of minnows and carp (red shiner, *Cyprinella lutrensis*; common carp, *Cyprinus carpio*); (4) 16 individuals of catfish (channel catfish, *Ictalurus punctatus*); and (5) 1,132 individuals from two species of livebearers (western mosquitofish, *Gambusia affinis*; sailfin molly, *Poecilia latipinna*).

Four species identified as intolerant to pollution (Linam and Kleinsasser, 1998) are listed in appendix 7. In addition to one dusky darter (*Percina sciera*), 10 brook silversides (*Labidesthes sicculus*), 22 tadpole madtoms (*Noturus gyrinus*), and 54 Atlantic croakers (*Micropogonias undulatus*) were collected. Intolerant species were found at all sites except M6.

The presence and relative abundance of tolerant and intolerant fish reflect stream conditions. Intolerant fish species indicate high and moderate quality sites (Linam and Kleinsasser, 1998) and become increasingly scarce with pollution or destruction of suitable habitat. Tolerant fish species have increased distribution and abundance when site conditions are less favorable and become dominant in disturbed sites (Linam and Kleinsasser, 1998). In Mustang Bayou, tolerant species are dominant (1,657 individuals) compared to intolerant species (87 individuals). However, because Mustang Bayou is in the Gulf Coastal Plain (ecoregion 34), the distribution of tolerant and intolerant species does not necessarily reflect pollution. Common, naturally occurring characteristics of coastal streams include mud and sand substrate, slow velocities, absence of riffles, little tree canopy, and variable water quality that might be limiting to intolerant species.

Fish species can be separated into trophic groups, which describe the manner in which they feed. There are three trophic (feeding) groups: (1) omnivores, generalized feeders; (2) piscivores, feed on other fish; and (3) invertivores, feed on invertebrates, mostly insects. At Mustang Bayou sites (fig. 12), the majority of fish were invertivores, ranging from 50.8 percent of the fish at M1 to 90.3 percent at M5. Piscivores were the next most abundant, ranging from 6.4 percent of the fish at M3 to 22.6 percent at M1. Omnivores ranged from 1.2 percent of the fish at M5 to 26.6 percent at M1.

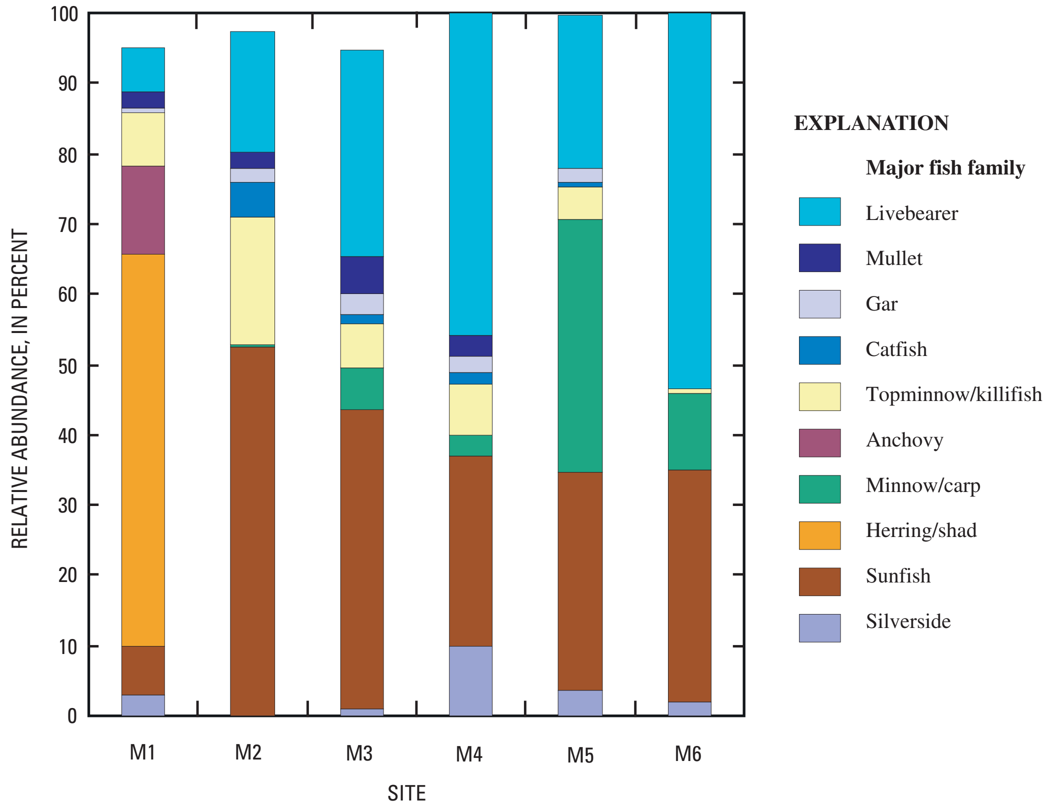

Figure 11. Relative abundance of major fish families from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

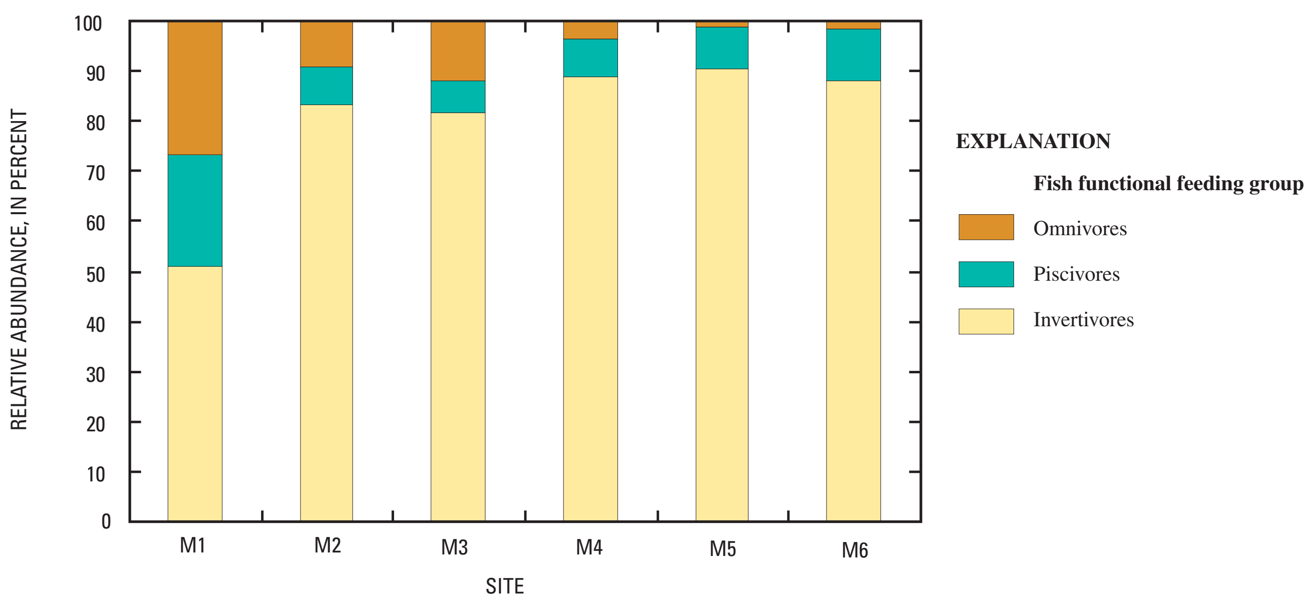

Figure 12. Relative abundance of fish functional feeding groups from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

Table 9. Metrics and aquatic-life-use[1] scoring for benthic macroinvertebrates in representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[EPT, Ephemeroptera, Plecoptera, Trichoptera; L, limited (less than 22); I, intermediate (22–28); H, high (29–36); E, exceptional (greater than 36)]

Metric	Site and survey								
	M1			M2			M3		
	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005
Taxa richness	2	2	2	3	4	3	4	2	3
EPT taxa abundance	1	1	1	2	2	2	2	1	1
Hilsenhoff biotic index (HBI)	1	1	1	1	1	1	1	1	1
Percentage Chironomidae	3	1	2	4	1	3	1	1	1
Percentage dominant taxon	2	2	1	2	4	3	4	3	4
Percentage dominant functional feeding grout (FFG)	1	1	1	3	4	3	3	1	4
Percentage predators	3	4	4	1	4	2	4	4	2
Ratio of intolerant to tolerant taxa	1	1	1	1	1	1	1	1	1
Percentage total Trichoptera as Hydropsychidae	1	1	4	4	4	4	3	1	1
Number of non-insect taxa	3	4	4	4	4	4	4	4	4
Percentage collector-gatherers	1	1	1	1	4	1	2	4	4
Percentage of total number as Elmidae	1	1	1	4	4	3	4	1	1
Total score	20	20	23	30	37	30	33	24	27
Aquatic life use	L	L	I	H	E	H	H	I	I

Metric	Site and survey								
	M4			M5			M6		
	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005
Taxa richness	2	3	2	3	3	2	2	3	3
EPT taxa abundance	1	1	1	1	1	1	1	1	1
Hilsenhoff biotic index (HBI)	1	1	1	1	1	1	1	1	1
Percentage Chironomidae	2	1	3	4	1	4	3	4	2
Percentage dominant taxon	3	4	3	1	4	1	1	3	2
Percentage dominant functional feeding grout (FFG)	1	3	3	2	2	1	2	1	2
Percentage predators	4	1	3	1	3	4	4	1	4
Ratio of intolerant to tolerant taxa	1	1	1	1	1	1	1	1	1
Percentage total Trichoptera as Hydropsychidae	1	1	4	1	4	1	4	1	1
Number of non-insect taxa	4	4	3	4	4	4	4	4	4
Percentage collector-gatherers	1	1	1	2	1	1	1	1	1
Percentage of total number as Elmidae	1	1	1	4	1	1	1	1	1
Total score	22	22	26	25	26	22	25	22	23
Aquatic life use	I	I	I	I	I	I	I	I	I

[1]Texas Commission on Environmental Quality (2003a, p. 39).

Table 10. Fish species collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[F, freshwater; E, estuarine; M, marine; Fa, anadromous (spawn in freshwater, but mature in marine)]

	Site					
	M1	M2	M3	M4	M5	M6
Freshwater fish species						
Alligator gar **(F)**	■				■	■
Banded pygmy sunfish **(F)**		■	■		■	
Blackstripe topminnow **(F)**		■	■	■	■	
Blue catfish **(F)**				■		
Bluegill **(F)**	■	■	■	■	■	■
Brook silverside **(F)**	■		■	■	■	
Bullhead minnow **(F)**			■	■	■	■
Channel catfish **(F)**		■	■	■	■	
Common carp **(F)**				■		
Dusky darter **(F)**		■				
Flathead catfish **(F)**		■				
Golden topminnow **(F)**	■	■	■	■		
Green sunfish **(F)**		■				■
Hogchoker **(F)**		■	■			
Largemouth bass **(F)**	■	■		■	■	■
Longear sunfish **(F)**	■	■	■	■	■	■
Longnose gar **(F)**	■	■	■	■		
Orangespotted sunfish **(F)**	■	■	■	■		
Pugnose minnow **(F)**		■				
Red shiner **(F)**			■	■	■	■
Redear sunfish **(F)**	■		■	■		■
Sailfin molly **(F)**	■	■			■	■
Sheepshead minnow **(F/E/M)**[1]		■				
Skipjack herring **(F)**	■					
Spotted gar **(F)**	■	■	■	■	■	■
Spotted sunfish **(F)**	■	■	■	■	■	■
Tadpole madtom **(F)**		■	■	■		
Warmouth **(F)**	■	■	■	■	■	■
Western mosquitofish **(F)**	■	■	■	■	■	■
Yellow bullhead **(F)**		■			■	
Estuarine/marine fish species						
Amazon molly **(E/F)**	■					
American shad **(M/Fa)**	■					
Atlantic croaker **(M/E)**	■					
Atlantic needlefish **(M/E/F)**	■	■				
Bay anchovy **(M/E)**	■					
Chain pipefish **(M/E)**	■					
Clown goby **(M/E)**	■					
Flat anchovy **(M)**	■					
Gulf killifish **(M/E)**		■				■
Gulf menhaden **(M/E)**	■					
Inland silverside **(E/F)**	■		■	■	■	■
Mojarra **(M/E)**		■				
Rainwater killifish **(E)**	■					
Saltmarsh topminnow **(M/E)**	■	■				
Speckled worm eel **(M/E)**	■					
Striped mullet **(M/E/F)**	■	■	■	■		

[1]First listed is primary habitat.

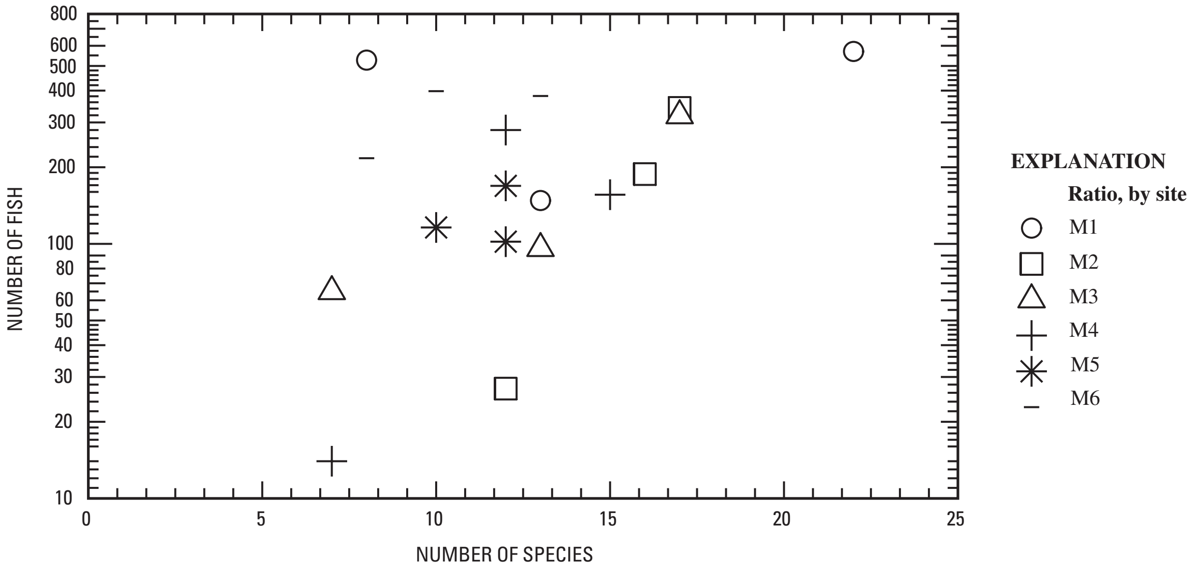

Figure 13 Number of fish collected relative to number of fish species from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

Trophic composition metrics might help to evaluate the quality of the stream habitat and chemical quality in that more generalized feeders (that is, omnivores) become a larger percentage of the population with degradation of conditions (Linam and Kleinsasser, 1998).

The distribution of the total number of fish collected relative to the number of species from each site and survey are shown in figure 13. If the number of species is proportional to the number of individuals collected (high sampling efficiency), a graph of data for the sites would have a linear relation. Departures from a linear relation between the number of fish and species in Mustang Bayou can reflect several factors, including sampling efficiency (bias), seasonality, and local site conditions. For example, a similar number of fish were collected at M1 in both September 2004 (527 fish) and April 2005 (570 fish); however the number of species differed greatly (eight and 22 species, respectively). In the September survey, two marine species, gulf menhaden (*Brevoortia patronus*) and bay anchovy (*Anchoviella mitchilli*), were 500 of 527 fish (appendix 7). In April, freshwater skipjack herring (*Alosa chrysochloris*) were 317 of 570 fish. Because of the complexity of possible factors, it was not possible to differentiate the reasons for variability in fish distribution or if sampling bias existed.

Sorensen's index of similarity (Oklahoma Water Resources Board, 2001) is one index used to compare sites and gain an understanding of the fish data. It is computed using the equation

$$S = \frac{2c}{a + b},$$

where

a = number of taxa in community a;
b = number of taxa in community b; and
c = number of taxa common to both.

To compute this index, the number of fish species assessed at each site was compared with the number of species at the adjacent upstream site (appendix 8). Computed coefficients can range from near 0, when two assemblages are completely dissimilar, to 1, when they are identical. For example, in September 2004, M1 had eight species; M2 had 12 species (appendix 7). Five species were common to both sites. An index of 0.50 is computed by dividing twice the number of common species (2 times 5) by the sum of the numbers of species at both sites (8 plus 12). Both minimum and maximum Sorensen coefficients occurred when comparing M2 and M3 and ranged from 0.47 in August 2005 to 0.76 in April 2005. Coefficients for M1 and M2 had the lowest mean index of similarity (0.52). M3–M4 and M5–M6 were most similar, each having a mean coefficient of 0.68. The mean coefficient for all sites was 0.62.

To minimize potential bias in the number of fish species caused by differences in abundance, Menhinick's species diversity index (D) (Menhinick, 1964) was computed using the equation

$$D = \frac{s}{\sqrt{N}},$$

where

s = number of species in population sampled; and
N = number of individuals in population.

Table 11. Index of biotic integrity[1] aquatic-life-use scoring for ecoregion 34 for fish in representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[I, intermediate aquatic life use (31–38); H, high aquatic life use (39–48); L, limited aquatic life use (less than 31); E, exceptional aquatic life use (equal to or greater than 49)]

Metric	Site and survey								
	M1			M2			M3		
	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005
Total number of fish species	3	5	5	5	5	5	3	5	5
Number of native cyprinid species	1	1	1	1	1	1	1	3	3
Number of benthic invertivore species	5	5	5	5	5	5	5	5	5
Number of sunfish species	3	5	5	5	5	5	5	5	5
Number of intolerant species	5	5	1	1	5	5	1	5	5
Percent individuals as tolerant species (excluding western mosquitofish)	1	5	1	1	1	1	1	1	1
Percent individuals as omnivores	1	5	5	3	3	5	1	5	5
Percent individuals as invertivores	1	3	5	5	5	5	5	5	5
Number of individuals in sample									
Number of individuals per seine haul	1	3	0	1	1	1	1	1	1
Number of individuals per electrofishing minute	5	1	5	1	5	5	1	1	5
Percent individuals as nonnative species	5	5	5	5	5	5	5	5	5
Percent of individuals with disease or other anomaly	5	5	5	5	5	5	1	5	5
Total score	36	48	43	38	46	48	30	46	50
Index of biotic integrity	I	H	H	I	H	H	L	H	E

Metric	Site and survey								
	M4			M5			M6		
	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005	Sept. 2004	Apr. 2005	Aug. 2005
Total number of fish species	3	5	5	5	5	5	3	5	5
Number of native cyprinid species	1	3	1	3	3	1	3	3	3
Number of benthic invertivore species	5	5	5	5	5	5	5	5	5
Number of sunfish species	5	5	5	5	5	5	5	3	5
Number of intolerant species	5	5	5	1	5	1	1	1	1
Percent individuals as tolerant species (excluding western mosquitofish)	1	1	1	1	1	1	1	1	1
Percent individuals as omnivores	5	3	5	5	5	5	5	5	5
Percent individuals as invertivores	5	5	5	5	5	5	5	5	5
Number of individuals in sample									
Number of individuals per seine haul	1	1	1	1	1	0	1	1	1
Number of individuals per electrofishing minute	1	3	5	1	1	3	5	3	5
Percent individuals as nonnative species	5	5	5	5	5	5	5	5	5
Percent of individuals with disease or other anomaly	5	5	5	3	5	5	5	5	5
Total score	42	46	48	40	46	41	44	42	46
Index of biotic integrity	H	H	H	H	H	H	H	H	H

[1]Linam and others (2002).

Table 12. Average aquatic-life-use scores for stream habitat, benthic macroinvertebrates, and fish in representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[I, intermediate; L, limited; H, high]

Category	Site					
	M1	M2	M3	M4	M5	M6
Habitat[1]	I	I	L	L	L	L
Benthic macroinvertebrates[2]	L	H	I	I	I	I
Fish[3]	H	H	H	H	H	H

[1] Habitat quality index aquatic-life-use scores (Texas Commission on Environmental Quality, 2003a, p. 40).

[2] Aquatic-life-use scores for benthic macroinvertibrates (Texas Commission on Environmental Quality, 2003a, p. 39).

[3] Index of biotic integrity aquatic-life-use scores for ecoregion 34 (Linam and others, 2002).

The index is directly proportional to diversity within the fish assemblage. At Mustang Bayou, Menhinick's index ranged from 0.35 at M1 in September 2004 to a maximum of 2.31 at M2, also in September 2004. Average index values were smallest at M6 (0.57) and largest at M2 (1.54). Except for M1 and M6, coefficients were comparable to those computed for other watersheds near Houston and Beaumont, Tex. which were evaluated during previous studies. Average Menhinick's coefficients were 1.15 for Lake Creek, 1.74 for Peach Creek, and 1.46 for Caney Creek (East and Sneck-Fahrer, 2004), all tributaries to Lake Houston, north of Houston. Coefficients for the Neches River watershed north of Beaumont ranged from a minimum of about 1.15 to about 1.60 (Moring, 2003, p. 4, fig. 11).

Fish assemblages from each survey were scored (table 11) on the basis of selected metrics. Because fish assemblages naturally differ in streams throughout Texas in response to climate, geography, and other factors, a single set of indexes could not adequately compare assemblages and rank aquatic life use in those streams. Fish from sites in Mustang Bayou were scored using the regional IBI proposed for ecoregion 34 (Linam and others, 2002). Fish communities supported a "high" aquatic life use for all surveys at sites M4–M6. Individual scores at M1 and M2 ranged from "intermediate" to "high" aquatic life use. Scores ranged from "limited" to "exceptional" aquatic life use at M3.

Average scores of aquatic life use from the three habitat, macroinvertebrate, and fish surveys completed between September 2004 and August 2005 are presented in table 12. Average HQI classifications range from "limited" (M3–M6) to "intermediate" (M1–M2) aquatic life use. Classifications obtained from macroinvertebrate surveys range from "limited" at M1 to "high" at M2. Classifications at M3–M6 are "intermediate." Average IBI aquatic-life-use scores for fish assessments are "high" at all sites.

Summary

The Mustang Bayou watershed is primarily in Brazoria County southeast of Houston, Tex. Although no State 303(d) or 305(b) water-quality standards have been adopted by the Texas Commission on Environmental Quality (TCEQ) for Mustang Bayou, urban development is occurring in the watershed, increasing the possibility of changes in the water quality, physical stream habitat, and aquatic biota. Previous assessments of Mustang Bayou have been of a localized nature and narrow focus; therefore, these studies did not facilitate adoption of water-quality standards or classification of the aquatic life use of the bayou.

This report, prepared in cooperation with the Houston-Galveston Area Council and the TCEQ, presents water-quality, stream-habitat, and biological data collected during September 2004–August 2005 and bed sediment data collected in September 2005.

Water-quality, stream-habitat, benthic-macroinvertebrate, and fish data were collected at six sites (downstream order M6–M1) along Mustang Bayou. Water-quality data consisted of continuously monitored (for periods of 24 hours to several days, six times) water temperature, pH, specific conductance, and dissolved oxygen and periodically collected samples of selected properties and constituents. Concentrations of nutrients, biochemical oxygen demand, chlorophyll-*a*, *E. coli*, chloride, sulfate, dissolved and suspended solids, suspended sediment concentration, and pesticides were assessed eight times at all sites. Selected water-quality constituents were compared to State screening levels to evaluate potential water-quality concerns. Stream habitat and aquatic biota (benthic macroinvertebrates and fish) were assessed at each site three times during the study. Aquatic-life-use classifications were obtained from these assessments.

Dissolved oxygen is a primary component used to evaluate the suitability of a stream to sustain life and is a component of stream classification. The assumed aquatic-life-use classification of Mustang Bayou is "high," which means that dissolved oxygen must not fall below criteria based on streamflow characteristics (perennial or intermittent) and on salinity. Mean dissolved oxygen concentrations were below the 24-hour average standard in at least one monitoring period at all sites except M2. Minimum dissolved oxygen concentrations were below the minimum standards 40 to 67 percent of the time at all sites except M2.

No concentrations of nitrogen compounds and phosphorus exceeded State screening levels. The largest ammonia plus organic nitrogen concentration was 2.8 mg/L; the organic nitrogen contribution was computed to be between about 85 to 95 percent of the concentration of ammonia plus organic nitrogen measured at all sites. Nitrite plus nitrate nitrogen concentrations ranged from less than or the reporting level (0.016 mg/L) at all sites to a maximum concentration of 0.67 mg/L at M1. Orthophosphate phosphorus concentrations were largest at M1 with a maximum concentration of 0.341 mg/L. The contribution of orthophosphate to the total phosphorus concentration ranged from about 4 percent at M6 to 72 percent at M1. The median total phosphorus concentration from all sites was 0.11 mg/L.

Biochemical oxygen demand, the measure of oxygen consumption by microorganisms during decomposition, was less than 4.0 mg/L at all sites except M6, where the maximum concentration was 8.1 mg/L. Concentrations of chlorophyll-*a* were less than the screening level (11.6 μg/L) at all sites except M6, where four of eight samples exceeded 11.6 μg/L. In 20 of 48 samples from Mustang Bayou, *E. coli* densities were greater than 394 cols./100 mL, the State single-sample water-quality standard. The median density from all samples was 220 cols./100 mL.

There are no aquatic-life-use criteria for chloride, sulfate, suspended solids, and dissolved solids; however they provide additional information on the quality of water for general uses or aesthetic appeal. Median chloride concentrations from each site were between 42.2 and 123 mg/L. The median sulfate concentration from Mustang Bayou was 19.8 mg/L. The median concentration of suspended solids from all samples was 16.0 mg/L. The largest dissolved solids concentration was 1,050 mg/L measured at M4; the median concentration of dissolved solids from all samples was 346 mg/L.

Fifteen pesticide compounds (six herbicides and nine insecticides) were detected in 24 water samples. The most frequently detected pesticide was atrazine, which was measured in every sample. Concentrations ranged from 0.010 to 1.42 μg/L. Other frequently detected pesticides were CIAT, prometon, tebuthiuron, fipronil, fipronil sulfide, and fipronil sulfone.

Sediment samples were collected from the stream bottom at M1 and analyzed for concentrations of organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), trace elements (metals), and polychlorinated biphenyls (PCBs). No organochlorine pesticides or PCBs were detected. No concentrations of metals exceeded State screening levels. Concentrations of 11 PAH compounds were detected at measurable concentrations, and three other PAH compounds were detected but not quantified by the laboratory. All concentrations were less than respective sediment-quality screening levels.

Characteristics of habitat measured during each survey were scored using a habitat quality index (HQI). The HQI indicated an aquatic-life-use score of "limited" (8–13) during at least one survey at all sites except M2 and were "limited" for every survey at M6. Highest HQI scores were "intermediate" (14–19). Average scores were "limited" for M3–M6 and "intermediate" for M1 and M2.

A total of 2,557 macroinvertebrate individuals were identified from Mustang Bayou consisting of 1,509 individuals that belong to benthic, non-insect invertebrate taxa and 1,048 individuals that belong to insect taxa. Overall, the Dipteran family Chironomidae was the most abundant, followed by gastropods, segmented worms, amphipods, and mayflies (Ephemeroptera). Benthic macroinvertebrate assemblages were scored using indexes specified by the Texas Commission on Environmental Quality. Aquatic-life-use scores ranged from "limited" at M1 in September 2004 and April 2005 to "exceptional" at M2 in April 2005. Average scores were "limited" at M1, "intermediate" at M3–M6, and "high" at M2.

Forty-six species of fish representing 20 families were collected from Mustang Bayou. A total of 4,115 fish were collected. Sunfish (Centrarchidae) was the most abundant family with 1,153 individuals collected. Of 46 fish species, 16 were identified as having a specific tolerance or intolerance to pollution. Twelve of the species (1,657 individuals) were tolerant; four (87 individuals) were intolerant. Fish from sites in Mustang Bayou were scored using the regional index of biotic integrity (IBI) proposed for ecoregion 34. Fish communities supported a "high" aquatic life use for all surveys at sites M4–M6. Individual scores at M1 and M2 ranged from "intermediate" to "high" aquatic life use. Scores ranged from "limited" to "exceptional" at M3. Average IBI aquatic-life-use scores for fish assessments are "high" at all sites.

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Appendix 1—Periodically Collected Water-Quality Properties and Constituents

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Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[cfs, cubic feet per second; deg C, degrees Celsius; mm, millimeters; Hg, mercury; mg/L, milligrams per liter; unf (unfltrd), unfiltered; us/cm, microsiemens per centimeter; flt (fltrd), filtered; inc tit (incrm. titr.), incremental titration; $CaCO_3$, calcium carbonate; --, property or constituent not analyzed for in this sample; Pt-Co, platinum-cobalt; NTRU, nephelometric turbidity ratio units; N, nitrogen; BOD, biochemical oxygen demand; CBOD, carbonaceous biochemical oxygen demand; MF, membrane filtration; col/100 mL, colonies per 100 milliliters; P, phosphorus; org-N, organic nitrogen; ug/L, micrograms per liter]

08077905 Mustang Bayou at FM 2917 near Liverpool, TX (M1)

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Time	Instantaneous discharge, cfs	Streamflow severity, code	Sampling depth, meters	Temperature, water, deg C	Temperature, air, deg C	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	Specif. conductance, wat unf uS/cm 25 degC	pH, water, unfltrd field, std units	Alkalinity, wat flt inc tit field, mg/L as CaCO3	Carbonate, wat flt incrm. titr., field, mg/L
SEP 14...	1040	--	3	.30	28.5	32.0	761	4.6	60	854	7.7	192	<1
NOV 08...	1225	13.6	3	.30	22.1	26.0	768	8.0	92	429	7.6	117	<1
JAN 06...	1235	7.02	3	.30	16.6	10.0	760	11.2	116	1,200	8.2	264	2
MAR 09...	1220	54.5	3	.30	19.1	24.5	764	7.9	85	699	7.6	139	<1
APR 13...	0815	1.08	2	.30	20.0	17.0	760	6.8	76	1,260	8.0	276	2
JUN 02...	1250	.00	2	.30	29.1	30.5	762	8.7	113	697	7.4	142	<1
JUL 13...	1220	2.34	2	.30	29.4	31.5	768	6.4	83	767	7.6	151	1
AUG 24...	0755	4.56	3	.30	29.9	28.5	762	.4	6	846	7.1	195	<1

Date	Bicarbonate, wat flt incrm. titr., field mg/L	Color, water, fltrd, Pt-Co units	Turbidity white light, det ang 90+/-30 corrctd NTRU	Suspended sediment concentration mg/L	Ammonia water, unfltrd mg/L as N	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day mg/L	E coli, m-TEC MF, water, col/ 100 mL	Nitrite + nitrate water fltrd, mg/L as N	Nitrate water, fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Total nitrogen, water, unfltrd mg/L	Phosphorus, water, unfltrd mg/L
SEP 14...	232	--	--	17	.03	3.1	--	700w	.341c	.33	.015	1.0	.28
NOV 08...	142	50d	16	39	.05	2.4	2.0	E63k	.462	.45	.010	1.1	.20
JAN 06...	317	18	12	91	.04	2.0	E1.5	E43k	.667	.64	.027	1.0	.11
MAR 09...	168	150d	99	121	.10	3.2	2.3	2,500	.336	.31	.031	1.5	.20
APR 13...	333	25	20	71	.02	E.7	E1.3	E140k	.064	.02	.045	.46	.27
JUN 02...	172	50d	40	23	.21	2.0	E1.8	E95k	.233	.16	.072	1.2	.45
JUL 13...	182	25	60	41	E.03n	E1.8	E1.6	1,100	<.016	--	E.001n	--	.08
AUG 24...	237	40d	<2.0	5	E.04n	2.2	2.0	E130k	.199	.17	.033	.90	.19

Date	Orthophosphate, water, fltrd, mg/L as P	Ammonia + org-N, water, unfltrd mg/L as N	Organic nitrogen, water, unfltrd mg/L	Chlorophyll a phytoplankton, fluoro ug/L	Pheophytin a, phytoplankton ug/L	Chloride, water, fltrd mg/L	Sulfate water, fltrd mg/L	Solids, total, suspended mg/L	Solids, dissolved, fltrd mg/L	alpha-HCH, water, fltrd ug/L	2,6-Diethylaniline water fltrd ug/L	Acetochlor, water, fltrd ug/L	Alachlor, water, fltrd ug/L
SEP 14...	.220dc	.66	.63	5.6w	3.0w	125	25.2	--	477	<.005	<.006	<.006	<.005
NOV 08...	.129	.64	.59	2.2	2.4	47.3	13.7	33	243	--	--	--	--
JAN 06...	.071	.38	.34	4.4	2.1	206	28.7	16	665	<.005	<.006	<.006	<.005
MAR 09...	.068	1.2	1.1	1.7	2.8	121	13.4	125	402	--	--	--	--
APR 13...	.225d	.40	.38	3.0	1.0	218	29.3	17	695	--	--	--	--
JUN 02...	.341d	.97	.76	1.7	2.0	104	25.2	43	392	<.005	<.006	<.006	<.005
JUL 13...	.011	.61	--	4.2	1.9	134	14.6	37	419	--	--	--	--
AUG 24...	.159	.70	--	1.1	1.2	121	23.5	<10	490	<.005	<.006	<.006	<.005

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077905 Mustang Bayou at FM 2917 near Liverpool, TX (M1)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Atrazine, water, fltrd ug/L	CIAT, water, fltrd ug/L	Azinphos-, methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos, water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Diazinon, water, fltrd ug/L	Dieldrin, water, fltrd ug/L
SEP 14...	.087	E.015	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	.090	E.008	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	.576	E.062mc	<.050mc	<.010	<.004	E.022mnc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	.118	E.011mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009

Date	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinyl-fipronil, amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos, water, fltrd ug/L	Lindane, water, fltrd ug/L	Linuron, water, fltrd ug/L	Malathion, water, fltrd ug/L
SEP 14...	<.02	<.004	<.009	<.005	E.002t	E.008n	E.009t	E.005t	E.006t	<.003	<.004	<.035	<.027
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	<.02	<.004	<.009	<.005	<.029	E.004t	E.004t	<.012	E.009n	<.003	<.004	<.035	<.027
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.02	<.004	<.009	<.005	E.004mtc	.030	E.017n	.014	E.033mc	<.003	<.004	<.035	<.027
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.02mc	<.004	<.009	<.005	<.029mc	<.013	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027

Date	Methyl parathion, water, fltrd, ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd, ug/L	Napropamide, water, fltrd, ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd, ug/L	Pendimethalin, water, fltrd, ug/L	Phorate, water, fltrd, ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd, ug/L	Propachlor, water fltrd, ug/L
SEP 14...	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	<.01	<.004	<.025
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	E.01n	<.004	<.025
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.015	.033	<.006	<.005	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	<.01	<.004	<.025

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077905 Mustang Bayou at FM 2917 near Liverpool, TX (M1)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Pro- panil, water, fltrd ug/L	Propar- gite, water, fltrd ug/L	Sima- zine, water, fltrd ug/L	Tebu- thiuron, water, fltrd ug/L	Terbu- cil, water, fltrd ug/L	Terbu- fos, water, fltrd ug/L	Thio- bencarb, water, fltrd ug/L	Tri- allate, water, fltrd ug/L	Tri- flur- alin, water, fltrd ug/L
SEP									
14...	<.011	<.02	<.015	.03	<.034	<.02	<.010	<.002	<.009
NOV									
08...	--	--	--	--	--	--	--	--	--
JAN									
06...	<.011	<.02	E.005n	.08	<.034	<.02	<.010	<.006	<.009
MAR									
09...	--	--	--	--	--	--	--	--	--
APR									
13...	--	--	--	--	--	--	--	--	--
JUN									
02...	<.011	<.02	.014	.03	<.034mc	<.02	<.010	<.006	<.009
JUL									
13...	--	--	--	--	--	--	--	--	--
AUG									
24...	<.011	<.02	<.005	.03	<.034mc	<.02	<.010	<.006	<.009

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077895 Mustang Bayou at CR 168 near Alvin, TX (M2)

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Time	Instantaneous discharge, cfs	Streamflow severity, code	Sampling depth, meters	Temperature, water, deg C	Temperature, air, deg C	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	Specif. conductance, wat unf uS/cm 25 degC	pH, water, unfltrd field, std units	Alkalinity, wat flt inc tit field, mg/L as CaCO3	Carbonate, wat flt incrm. titr., field, mg/L
SEP 13...	1130	9.44	3	.30	29.3	33.0	766	8.6	112	532	8.0	163	E<1
NOV 08...	1145	19.9	3	.30	20.7	26.0	769	7.9	87	367	7.5	112	<1
JAN 06...	1115	13.5	3	.12	16.6	9.0	761	8.6	89	1,260	7.8	246	1
MAR 09...	1125	126	3	.30	18.7	21.0	762	8.3	89	485	7.5	111	<1
APR 13...	0930	14.7	2	.13	21.8	20.5	762	9.8	113	1,360	8.0	253	2
JUN 02...	1200	7.10	2	.24	29.9	29.5	762	14.2	188	661	8.2	188	4
JUL 13...	1140	4.17	2	.08	31.7	33.0	767	14.6	198	542	8.4	173	5
AUG 24...	0905	11.3	3	.12	30.0	29.5	762	5.2	69	542	7.5	161	<1

Date	Bicarbonate, wat flt incrm. titr., field, mg/L	Color, water, fltrd, Pt-Co units	Turbidity white light, det ang 90+/-30 corrctd NTRU	Suspended sediment concentration mg/L	Ammonia water, unfltrd mg/L as N	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day, mg/L	E coli, m-TEC MF, water, col/ 100 mL	Nitrite + nitrate water fltrd, mg/L as N	Nitrate water, fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Total nitrogen, water, unfltrd mg/L	Phosphorus, water, unfltrd mg/L
SEP 13...	E198	--	--	19	.01	2.3	--	E48k	.075	.07	.004	.49	.12
NOV 08...	136	50d	36	48	.05	2.5	2.2	200	.144	.14	.008	.71	.14
JAN 06...	298	12	12	60	.01	E1.7	E1.6	220	.083	.07	.009	--	<.04
MAR 09...	135	200d	110	131	.08	3.7	3.0	1,800	.134	.12	.013	1.4	.20
APR 13...	305	20	2.3	79	.02	E1.4	E1.1	E100k	.018	.02	.002	.30	E.04n
JUN 02...	222	25	5.9	23	<.04	E1.3	E1.1	E16k	.016	.01	.009	.37	.10
JUL 13...	200	18	4.9	8	E.02n	E1.3	E1.3	230	.030	.02	.009	.36	.14
AUG 24...	195	25	6.1	11	E.04n	E1.7	E1.4	140	.095	.08	.015	.50	.11

Date	Orthophosphate, water, fltrd, mg/L as P	Ammonia + org-N, water, unfltrd mg/L as N	Organic nitrogen, water, unfltrd mg/L	Chlorophyll a phytoplankton, fluoro ug/L	Pheophytin a, phytoplankton ug/L	Chloride, water, fltrd mg/L	Sulfate water, fltrd mg/L	Solids, total, suspended mg/L	Solids, dissolved, fltrd mg/L	alpha-HCH, water, fltrd ug/L	2,6-Diethylaniline water fltrd ug/L	Acetochlor, water, fltrd ug/L	Alachlor, water, fltrd ug/L
SEP 13...	.075c	.41	.40	2.5	2.0	48.4	17.9	--	312	<.005	<.006	<.006	<.005
NOV 08...	.079	.57	.51	1.8	1.8	32.8	11.4	35	212	--	--	--	--
JAN 06...	.019	E.09n	--	3.0	2.4	235	25.2	28	697	<.005	<.006	<.006	<.005
MAR 09...	.057	1.3	1.2	1.9	3.5	74.7	9.5	117	295	--	--	--	--
APR 13...	.018	.28	.27	.8	.6	262	24.7	<10	732	--	--	--	--
JUN 02...	.022	.35	--	1.8	1.0	75.2	19.9	10	382	<.005	<.006	<.006	<.005
JUL 13...	.051	.33	--	2.5	2.9	57.6	13.9	<10	313	--	--	--	--
AUG 24...	.078	.41	--	2.0	1.8	63.1	14.0	<10	307	<.005	<.006	<.006	<.005

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077895 Mustang Bayou at CR 168 near Alvin, TX (M2)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Atrazine, water, fltrd ug/L	CIAT, water, fltrd ug/L	Azinphos-, methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos, water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Diazinon, water, fltrd ug/L	Dieldrin, water, fltrd ug/L
SEP 13...	.071	E.008	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	.098	E.009	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	.148	E.024mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	.238	E.011mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009

Date	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinylfipronil, amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos, water, fltrd ug/L	Lindane, water, fltrd ug/L	Linuron, water, fltrd ug/L	Malathion, water, fltrd ug/L
SEP 13...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.02	<.004	<.009	<.005	<.029mc	.015	E.009t	E.006t	E.008mtc	<.003	<.004	<.035	<.027
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.02mc	<.014	<.009	<.005	<.029mc	E.004t	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027

Date	Methyl parathion, water, fltrd, ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd, ug/L	Napropamide, water, fltrd, ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd, ug/L	Pendimethalin, water, fltrd, ug/L	Phorate, water, fltrd, ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd, ug/L	Propachlor, water fltrd, ug/L
SEP 13...	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.03	<.004	<.025
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077895 Mustang Bayou at CR 168 near Alvin, TX (M2)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Pro- panil, water, fltrd ug/L	Propar- gite, water, fltrd ug/L	Sima- zine, water, fltrd ug/L	Tebu- thiuron, water, fltrd ug/L	Terbu- cil, water, fltrd ug/L	Terbu- fos, water, fltrd ug/L	Thio- bencarb, water, fltrd ug/L	Tri- allate, water, fltrd ug/L	Tri- flur- alin, water, fltrd ug/L
SEP									
13...	<.011	<.02	<.010	.06	<.034	<.02	<.010	<.002	<.009
NOV									
08...	--	--	--	--	--	--	--	--	--
JAN									
06...	<.011	<.02	<.005	.08	<.034	<.02	<.010	<.006	<.009
MAR									
09...	--	--	--	--	--	--	--	--	--
APR									
13...	--	--	--	--	--	--	--	--	--
JUN									
02...	<.011	<.02	.013	.06	<.034mc	<.02	<.010	<.006	<.009
JUL									
13...	--	--	--	--	--	--	--	--	--
AUG									
24...	<.011	<.02	<.005	.04	<.034mc	<.02	<.010	<.006	<.009

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077890 Mustang Bayou at East South Street at Alvin, TX (M3)

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Time	Instantaneous discharge, cfs	Streamflow severity, code	Sampling depth, meters	Temperature, water, deg C	Temperature, air, deg C	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	Specif. conductance, wat unf uS/cm 25 degC	pH, water, unfltrd field, std units	Alkalinity, wat flt inc tit field, mg/L as CaCO3	Carbonate, wat flt incrm. titr., field, mg/L
SEP 13...	1053	6.97	3	.30	28.5	31.0	763	3.9	51	423	7.4	124	<1
NOV 08...	1105	18.6	3	.12	19.9	25.0	770	7.7	84	395	7.5	--	--
JAN 06...	1010	9.48	3	.30	17.1	9.5	763	9.0	94	1290	7.8	235	<1
MAR 09...	1050	99.4	3	.30	18.2	20.0	763	7.6	80	445	7.5	96	<1
APR 13...	1030	15.1	2	.11	22.6	25.5	762	8.7	101	1,110	7.8	230	1
JUN 02...	1120	5.83	2	.21	28.2	29.0	759	9.0	116	703	7.6	184	<1
JUL 13...	1100	6.01	2	.15	30.5	32.5	767	8.1	108	586	7.5	162	1
AUG 24...	0950	9.55	3	.30	30.8	32.0	762	3.5	48	520	7.6	183	<1

Date	Bicarbonate, wat flt incrm. titr., field, mg/L	Color, water, fltrd, Pt-Co units	Turbidity white light, det ang 90+/-30 corrctd NTRU	Suspended sediment concentration mg/L	Ammonia water, unfltrd mg/L as N	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day, mg/L	E coli, m-TEC MF, water, col/ 100 mL	Nitrite + nitrate water fltrd, mg/L as N	Nitrate water, fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Total nitrogen, water, unfltrd mg/L	Phosphorus, water, unfltrd mg/L
SEP 13...	150	--	--	16	.07	3.6	--	3,100	.096c	.09	.009c	.62	.14
NOV 08...	--	50d	39	44	.05	2.0	1.7w	130	.094	.09	.008	.65	.13
JAN 06...	285	12	3.5	59	.03	1.6	1.5	720	.024	.02	.002	.27	E.02n
MAR 09...	116	175d	110	126	.09	3.0	3.4	1,600	.107	.10	.012	1.5	.22
APR 13...	278	15	2.4	102	.03	.9	.5	530	<.016	--	.002	--	<.04
JUN 02...	223	30d	5.4	18	.05	1.2	1.0	E760k	.018	.01	.003	.41	.10
JUL 13...	196	15	<2.0	6	E.04n	1.4	1.4	3,500	.018	.01	.004	.50	.10
AUG 24...	221	25	8.8	14	.09	1.9	1.9	2,300	.031	.03	.003	.44	.09

Date	Orthophosphate, water, fltrd, mg/L as P	Ammonia + org-N, water, unfltrd mg/L as N	Organic nitrogen, water, unfltrd mg/L	Chlorophyll a phytoplankton, fluoro ug/L	Pheophytin a, phytoplankton ug/L	Chloride, water, fltrd mg/L	Sulfate water, fltrd mg/L	Solids, total, suspended mg/L	Solids, dissolved, fltrd mg/L	alpha-HCH, water, fltrd ug/L	2,6-Diethylaniline water fltrd ug/L	Acetochlor, water, fltrd ug/L	Alachlor, water, fltrd ug/L
SEP 13...	.080c	.53	.46	1.6	1.4	39.0	15.0	--	243	<.005	<.006	<.006	<.005
NOV 08...	.066	.56	.51	.8	1.4	37.8	12.4	24	223	--	--	--	--
JAN 06...	.016	.24	.21	2.8	1.1	249	27.2	<10	690	<.005	<.006	<.006	<.005
MAR 09...	.058	1.4	1.3	.9	2.6	70.6	9.0	113	274	--	--	--	--
APR 13...	.017	.21	.19	.4	.4	194	25.7	<10	599	--	--	--	--
JUN 02...	.057	.39	.34	2.6	1.2	83.7	23.0	<10	385	<.005	<.006	<.006	<.005
JUL 13...	.042	.48	--	2.8	1.2	69.9	22.8	<10	330	--	--	--	--
AUG 24...	.055	.41	.33	1.6	1.6	52.4	16.7	<10	292	<.005	<.006	<.006	<.005

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004—August 2005—Continued.

08077890 Mustang Bayou at East South Street at Alvin, TX (M3)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Atrazine, water, fltrd ug/L	CIAT, water, fltrd ug/L	Azinphos-, methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos, water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Diazinon, water, fltrd ug/L	Dieldrin, water, fltrd ug/L
SEP 13...	.050	E.006	E.119	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	.775	<.009
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	.086	<.006	<.050	<.010	<.004	<.041	<.020	<.010	<.006	<.018	<.003	<.010	<.009
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	.072	E.024mc	E.082mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	.144	E.007mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009

Date	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinylfipronil, amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos, water, fltrd ug/L	Lindane, water, fltrd ug/L	Linuron, water, fltrd ug/L	Malathion, water, fltrd ug/L
SEP 13...	<.02	<.004	<.009	<.005	<.029	E.003t	E.003t	E.003t	E.008n	<.003	<.004	<.035	.091
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.02	<.004	<.009	<.005	E.003mtc	.075	.024	E.011n	E.060mc	<.003	<.004	<.035	<.027
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.02mc	<.004	<.009	<.005	<.029mc	<.013	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027

Date	Methyl parathion, water, fltrd, ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd, ug/L	Napropamide, water, fltrd, ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd, ug/L	Pendimethalin, water, fltrd, ug/L	Phorate, water, fltrd, ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd, ug/L	Propachlor, water fltrd, ug/L
SEP 13...	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 06...	<.015	<.006	<.006	<.003	<.007	<.005	<.010	<.004	<.022	<.011	<.01	<.004	<.025
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.02	<.004	<.025
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	<.01	<.004	<.025

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077890 Mustang Bayou at East South Street at Alvin, TX (M3)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Pro-panil, water, fltrd ug/L	Propar-gite, water, fltrd ug/L	Sima-zine, water, fltrd ug/L	Tebu-thiuron, water, fltrd ug/L	Terbu-cil, water, fltrd ug/L	Terbu-fos, water, fltrd ug/L	Thio-bencarb, water, fltrd ug/L	Tri-allate, water, fltrd ug/L	Tri-flur-alin, water, fltrd ug/L
SEP									
13...	<.011	<.02	.016	.07	<.034	<.02	<.010	<.002	<.009
NOV									
08...	--	--	--	--	--	--	--	--	--
JAN									
06...	<.011	<.02	<.005	.09	<.034	<.02	<.010	<.006	<.009
MAR									
09...	--	--	--	--	--	--	--	--	--
APR									
13...	--	--	--	--	--	--	--	--	--
JUN									
02...	<.011	<.02	<.010	.07	<.034mc	<.02	<.010	<.006	<.009
JUL									
13...	--	--	--	--	--	--	--	--	--
AUG									
24...	<.011	<.02	<.005	.05	<.034mc	<.02	<.010	<.006	<.009

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077885 Mustang Bayou at CR 99 near Alvin, TX (M4)

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Time	Instantaneous discharge, cfs	Streamflow severity, code	Sampling depth, meters	Temperature, water, deg C	Temperature, air, deg C	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	Specif. conductance, wat unf uS/cm 25 degC	pH, water, unfltrd field, std units	Alkalinity, wat flt inc tit field, mg/L as CaCO3	Carbonate, wat flt incrm. titr., field, mg/L
SEP 13...	1000	5.78	3	.30	28.2	28.0	761	6.1	79	654	7.5	196	<1
NOV 08...	1025	17.2	3	.30	19.3	24.5	768	6.7	72	381	7.3	111	<1
JAN 04...	1255	7.53	3	.12	21.9	23.5	765	7.0	80	1,570	8.0	207	1
MAR 09...	1005	63.6	3	.30	17.6	18.5	762	6.6	69	445	7.4	83	<1
APR 13...	1115	7.65	2	.12	22.5	25.5	762	11.5	133	1,920	8.1	222	1
JUN 02...	1030	3.72	3	.16	27.8	28.0	759	7.7	99	759	7.6	--	--
JUL 13...	1020	1.12	2	.11	30.2	33.0	766	5.4	71	651	7.5	173	<1
AUG 24...	1035	5.08	3	.13	30.8	31.0	762	5.6	75	497	7.9	159	<1

Date	Bicarbonate, wat flt incrm. titr., field, mg/L	Color, water, fltrd, Pt-Co units	Turbidity white light, det ang 90+/-30 corrctd NTRU	Suspended sediment concentration mg/L	Ammonia water, unfltrd mg/L as N	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day, mg/L	E coli, m-TEC MF, water, col/ 100 mL	Nitrite + nitrate water fltrd, mg/L as N	Nitrate water, fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Total nitrogen, water, unfltrd mg/L	Phosphorus, water, unfltrd mg/L
SEP 13...	237	--	--	7	.01	1.2	--	80	<.016c	--	E.001n	--	.08
NOV 08...	134	50d	70	--b	.05	2.1	1.7	58k	.103	.09	.010	.69	.13
JAN 04...	250	5	3.1	27	.03	1.7	1.2	E11k	E.008n	--	E.001n	--	<.04
MAR 09...	100	250d	120	96	.08	3.7	3.3	1,100	.093	.08	.010	1.6	.19
APR 13...	268	15	6.6	27	.04	1.0	.5	E90k	E.012n	--	.003	--	E.03n
JUN 02...	--	25	4.6	11	E.02n	.7	.5	E16k	<.016	--	<.002	--	.08
JUL 13...	209	25	4.0	33	E.04n	E1.2	E.9	500	<.016	--	E.001n	--	.12
AUG 24...	192	25	9.1	11	E.02n	1.7	1.7	E37k	<.016	--	<.002	--	.08

Date	Orthophosphate, water, fltrd, mg/L as P	Ammonia + org-N, water, unfltrd mg/L as N	Organic nitrogen, water, unfltrd mg/L	Chlorophyll a phytoplankton, fluoro ug/L	Pheophytin a, phytoplankton ug/L	Chloride, water, fltrd mg/L	Sulfate water, fltrd mg/L	Solids, total, suspended mg/L	Solids, dissolved, fltrd mg/L	alpha-HCH, water, fltrd ug/L	2,6-Diethylaniline water fltrd ug/L	Acetochlor, water, fltrd ug/L	Alachlor, water, fltrd ug/L
SEP 13...	.063c	.24	.23	.7	.7	66.8	22.6	--	378	<.005	<.006	<.006	<.005
NOV 08...	.063	.59	.54	1.5	2.1	33.3	11.7	52	219	--	--	--	--
JAN 04...	.017	.26	.23	1.9	1.0	344d	25.1	<10	861	<.005	<.006	<.006	<.005
MAR 09...	.036	1.5	1.4	1.9	4.2	78.2	7.1	100	264	--	--	--	--
APR 13...	.013	.27	.23	.7	.6	454d	23.5d	<10	1050	--	--	--	--
JUN 02...	.054	.27	--	1.1	1.2	104	19.6	<10	425	<.005	<.006	<.006	<.005
JUL 13...	.063	.48	--	2.8	2.7	86.6	20.8	<10	364	--	--	--	--
AUG 24...	.055	.41	--	.8	1.1	57.5	14.4	<10	281	<.005	<.006	<.006	<.005

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077885 Mustang Bayou at CR 99 near Alvin, TX (M4)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Atrazine, water, fltrd ug/L	CIAT, water, fltrd ug/L	Azinphos-, methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos, water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Diazinon, water, fltrd ug/L	Dieldrin, water, fltrd ug/L
SEP 13...	.035	E.007	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	.115	E.007	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	.149	E.025mc	E.056mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	.218	E.010mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009

Date	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinylfipronil, amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos, water, fltrd ug/L	Lindane, water, fltrd ug/L	Linuron, water, fltrd ug/L	Malathion, water, fltrd ug/L
SEP 13...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.02	<.004	<.009	<.005	<.029mc	E.004t	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.02mc	<.004	<.009	<.005	<.029mc	<.013	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027

Date	Methyl parathion, water, fltrd, ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd, ug/L	Napropamide, water, fltrd, ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd, ug/L	Pendimethalin, water, fltrd, ug/L	Phorate, water, fltrd, ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd, ug/L	Propachlor, water fltrd, ug/L
SEP 13...	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	E.01n	<.004	<.025
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	E.01n	<.004	<.025
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	<.01	<.004	<.025

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077885 Mustang Bayou at CR 99 near Alvin, TX (M4)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Propanil, water, fltrd ug/L	Propargite, water, fltrd ug/L	Simazine, water, fltrd ug/L	Tebuthiuron, water, fltrd ug/L	Terbacil, water, fltrd ug/L	Terbufos, water, fltrd ug/L	Thiobencarb, water, fltrd ug/L	Triallate, water, fltrd ug/L	Trifluralin, water, fltrd ug/L
SEP									
13...	<.011	<.02	<.005	E.01n	<.034	<.02	<.010	<.002	<.009
NOV									
08...	--	--	--	--	--	--	--	--	--
JAN									
04...	<.011	<.02	<.005	E.01n	<.034	<.02	<.010	<.006	<.009
MAR									
09...	--	--	--	--	--	--	--	--	--
APR									
13...	--	--	--	--	--	--	--	--	--
JUN									
02...	<.011	<.02	<.005	E.01n	<.034mc	<.02	<.010	<.006	<.009
JUL									
13...	--	--	--	--	--	--	--	--	--
AUG									
24...	<.011	<.02	<.005	<.02	<.034mc	<.02	<.010	<.006	<.009

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077880 Mustang Bayou at CR 48 near Fresno, TX (M5)

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Time	Instan- taneous dis- charge, cfs	Stream- flow sever- ity, code	Sam- pling depth, meters	Temper- ature, water, deg C	Temper- ature, air, deg C	Baro- metric pres- sure, mm Hg	Dis- solved oxygen, mg/L	Dis- solved oxygen, percent of sat- uration	Specif. conduc- tance, wat unf uS/cm 25 degC	pH, water, unfltrd field, std units	Alka- linity, wat flt inc tit field, mg/L as CaCO3	Carbon- ate, wat flt incrm. titr., field, mg/L
SEP 14...	0935	3.98	3	.30	27.2	29.0	758	5.6	71	625	7.5	177	E<1
NOV 08...	0940	7.65	3	.30	18.9	23.0	768	6.8	73	603	7.3	185	<1
JAN 04...	1135	4.38	2	.30	21.3	23.5	765	6.8	77	678	7.9	228	1
MAR 09...	0845	--	3	.30	16.8	17.0	760	7.1	74	233	7.4	80	<1
APR 13...	1210	3.39	2	.14	24.7	27.0	762	13.4	162	624	8.3	200	2
JUN 02...	0940	4.21	3	.30	27.0	27.5	757	5.2	67	617	7.5	179	<1
JUL 13...	0945	.965	2	.30	29.7	32.0	765	2.5	33	527	7.3	133	<1
24...	1210	3.80	3	.30	31.1	33.0	762	5.1	69	625	7.4	100	<1

Date	Bicar- bonate, wat flt incrm. titr., field, mg/L	Color, water, fltrd, Pt-Co units	Turbidity white light, det ang 90+/-30 corrctd NTRU	Sus- pended sedi- ment concen- tration mg/L	Ammonia water, unfltrd mg/L as N	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day, mg/L	E coli, m-TEC MF, water, col/ 100 mL	Nitrite + nitrate water fltrd, mg/L as N	Nitrate water, fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Total nitro- gen, water, unfltrd mg/L	Phos- phorus, water, unfltrd mg/L
SEP 14...	E216	--	--	31	.12	2.2	--	550	.411c	.35	.058c	.83	.09
NOV 08...	224	20	42	19	.07	1.6	1.2	E55k	.081	.07	.007	.44	.08
JAN 04...	276	15	12	102	.04	1.3	1.1	80	.131	.13	.005	.32	E.04n
MAR 09...	97	250d	78	56	.10	3.9	3.4	1,800	.060	.05	.009	1.3	.14
APR 13...	238	18	11	21	.07	1.2	1.1	E140k	<.016	--	.002	--	E.03n
JUN 02...	216	25	8.7	17	<.04	1.4	.8	350	E.013n	--	.002	--	.05
JUL 13...	161	20	3.9	7	<.04	E1.2	E1.1	300	<.016	--	E.001n	--	E.04n
AUG 24...	122	12	<2.0	6	<.04	2.1	1.8	E60k	E.010n	--	E.001n	--	.04

Date	Ortho- phos- phate, water, fltrd, mg/L as P	Ammonia + org-N, water, unfltrd mg/L as N	Organic nitro- gen, water, unfltrd mg/L	Chloro- phyll a phyto- plank- ton, fluoro ug/L	Pheo- phytin a, phyto- plank- ton ug/L	Chlor- ide, water, fltrd mg/L	Sulfate water, fltrd mg/L	Solids, total, sus- pended mg/L	Solids, dis- solved, fltrd mg/L	alpha- HCH, water, fltrd ug/L	2,6-Di- ethyl- aniline water fltrd ug/L	Aceto- chlor, water, fltrd ug/L	Ala- chlor, water, fltrd ug/L
SEP 14...	.057c	.42	.30	.9	1.4	65.9	24.0	--	362	<.005	<.006	<.006	<.005
NOV 08...	.045	.36	.29	1.9	1.4	62.2	16.6	14	343	--	--	--	--
JAN 04...	.028	.19	.14	1.2	.7	66.0	19.9	17	395	<.005	<.006	<.006	<.005
MAR 09...	.038	1.2	1.1	1.2	3.0	16.4	6.7	38	153	--	--	--	--
APR 13...	.008	.28	.22	2.2	1.6	65.9	21.4	12	342	--	--	--	--
JUN 02...	E.005n	.34	--	.9	1.4	67.7	20.6	<10	348	<.005	<.006	<.006	<.005
JUL 13...	E.004n	.45	--	1.1	1.6	68.4	14.2	<10	291	--	--	--	--
AUG 24...	.028	.24	--	1.4	1.0	68.7	18.1	<10	354	<.005	<.006	<.006	<.005

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077880 Mustang Bayou at CR 48 near Fresno, TX (M5)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Atrazine, water, fltrd ug/L	CIAT, water, fltrd ug/L	Azinphos-, methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos, water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Diazinon, water, fltrd ug/L	Dieldrin, water, fltrd ug/L
SEP 14...	.014	<.006	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	.010	<.006	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	.209	E.041mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	.017	<.006mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009

Date	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinylfipronil, amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos, water, fltrd ug/L	Lindane, water, fltrd ug/L	Linuron, water, fltrd ug/L	Malathion, water, fltrd ug/L
SEP 14...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.02	<.004	<.009	<.005	<.029mc	<.013	<.024	<.012	<.016mc	<.003	<.004	<.035	E.019n
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.02mc	<.004	<.009	<.005	<.029mc	<.013	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027

Date	Methyl parathion, water, fltrd, ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd, ug/L	Napropamide, water, fltrd, ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd, ug/L	Pendimethalin, water, fltrd, ug/L	Phorate, water, fltrd, ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd, ug/L	Propachlor, water fltrd, ug/L
SEP 14...	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.02	<.004	<.025
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	.02	<.004	<.025
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	E.01n	<.004	<.025

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077880 Mustang Bayou at CR 48 near Fresno, TX (M5)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Pro-panil, water, fltrd ug/L	Propar-gite, water, fltrd ug/L	Sima-zine, water, fltrd ug/L	Tebu-thiuron, water, fltrd ug/L	Terbu-cil, water, fltrd ug/L	Terbu-fos, water, fltrd ug/L	Thio-bencarb, water, fltrd ug/L	Tri-allate, water, fltrd ug/L	Tri-flur-alin, water, fltrd ug/L
SEP									
14...	<.011	<.02	<.005	<.02	<.034	<.02	<.010	<.002	<.009
NOV									
08...	--	--	--	--	--	--	--	--	--
JAN									
04...	<.011	<.02	<.020	.03	<.034	<.02	<.010	<.006	<.009
MAR									
09...	--	--	--	--	--	--	--	--	--
APR									
13...	--	--	--	--	--	--	--	--	--
JUN									
02...	<.011	<.02	E.003n	.03	<.034mc	<.02	<.010	<.006	<.009
JUL									
13...	--	--	--	--	--	--	--	--	--
AUG									
24...	<.011	<.02	<.005	<.02	<.034mc	<.02	<.010	<.006	<.009

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077877 Mustang Bayou at Evergreen Road near Fresno, TX (M6)

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Time	Instantaneous discharge, cfs	Streamflow severity, code	Sampling depth, meters	Temperature, water, deg C	Temperature, air, deg C	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	Specif. conductance, wat unf uS/cm 25 degC	pH, water, unfltrd field, std units	Alkalinity, wat flt inc tit field, mg/L as CaCO3	Carbonate, wat flt incrm. titr., field, mg/L
SEP 14...	0845	.103	3	.30	26.2	29.0	758	3.2	40	378	7.1	81	<1
NOV 08...	0910	.647	3	.08	17.3	22.0	768	4.7	48	108	6.3	30	<1
JAN 04...	1040	.290	2	.04	20.3	22.5	765	4.7	52	391	7.1	88	<1
MAR 09...	0800	16.4	3	.30	16.2	15.0	760	6.0	61	105	6.5	35	<1
APR 13...	1245	.223	2	.12	26.3	27.0	767	10.5	130	786	7.8	154	<1
JUN 02...	0900	3.14	3	.30	25.6	26.0	758	4.9	60	159	7.0	51	<1
JUL 13...	0855	.00	1	.08	29.1	31.0	764	2.8	36	655	7.2	79	<1
AUG 24...	1140	.00	3	.06	30.3	32.5	763	1.8	24	343	7.0	207	1

Date	Bicarbonate, wat flt incrm. titr., field, mg/L	Color, water, fltrd, Pt-Co units	Turbidity white light, det ang 90+/-30 corrctd NTRU	Suspended sediment concentration mg/L	Ammonia water, unfltrd mg/L as N	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day, mg/L	E coli, m-TEC MF, water, col/ 100 mL	Nitrite + nitrate water fltrd, mg/L as N	Nitrate water, fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Total nitrogen, water, unfltrd mg/L	Phosphorus, water, unfltrd mg/L
SEP 14...	99	--	--	87	.10	5.3	--	800	<.016	--	E.001n	--	.11
NOV 08...	37	175d	110	66	.03	4.0	3.2	270	E.015n	--	.003	--	.17
JAN 04...	108	175d	120	149	.06	2.7	2.1	84	E.008n	--	E.001n	--	.13
MAR 09...	43	300d	96	30	.09	3.5	2.6	4,000	.052	.04	.007	1.5	.14
APR 13...	186	50d	32	164	.08	2.6	2.1	E75k	<.016	--	E.001n	--	.06
JUN 02...	62	200d	94	75	.04	5.2	4.4	1,400	E.014n	--	E.001n	--	.18
JUL 13...	96	80d	140	176	.04	8.1	6.4	520	<.016	--	E.001n	--	.26
AUG 24...	251	200d	92	90	.12	3.5	2.4	500	E.009n	--	E.001n	--	.14

Date	Orthophosphate, water, fltrd, mg/L as P	Ammonia + org-N, water, unfltrd mg/L as N	Organic nitrogen, water, unfltrd mg/L	Chlorophyll a phytoplankton, fluoro ug/L	Pheophytin a, phytoplankton ug/L	Chloride, water, fltrd mg/L	Sulfate water, fltrd mg/L	Solids, total, suspended mg/L	Solids, dissolved, fltrd mg/L	alpha-HCH, water, fltrd ug/L	2,6-Diethylaniline water fltrd ug/L	Acetochlor, water, fltrd ug/L	Alachlor, water, fltrd ug/L
SEP 14...	<.006	1.2	1.1	20.6	12.6	69.5	24.0	--	218	<.005	<.006	<.006	<.005
NOV 08...	.014	1.2	1.2	4.8	5.9	5.81	5.1	44	79	--	--	--	--
JAN 04...	E.003n	1.2	1.1	4.1	6.1	44.8	25.5	152d	228	<.005	<.006	<.006	<.005
MAR 09...	.031	1.4	1.4	1.2	5.8	5.95	2.7	58	87	--	--	--	--
APR 13...	<.006	.91	.83	.3	.4	119	47.2	98d	426	--	--	--	--
JUN 02...	.008	1.6	1.5	19.7	10.3	9.88	5.4	82d	99	<.005	<.006	<.006	<.005
JUL 13...	E.004n	2.8	2.7	56.6	21.9	104	68.4	182d	407	--	--	--	--
AUG 24...	<.006	1.2	1.1	11.9	8.8	39.6	11.9	240d	200	<.005	<.006	<.006	<.005

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077877 Mustang Bayou at Evergreen Road near Fresno, TX (M6)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Atrazine, water, fltrd ug/L	CIAT, water, fltrd ug/L	Azinphos-, methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos, water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Diazinon, water, fltrd ug/L	Dieldrin, water, fltrd ug/L
SEP 14...	.031	E.006	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	.029	E.006n	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.005	<.009
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	1.42	E.167mc	<.050mc	<.010	<.004	E.041mc	<.020mc	<.005	<.006	<.018	<.003	<.010	<.009
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	.016	<.006mc	<.050mc	<.010	<.004	<.041mc	<.020mc	<.005	<.006	<.018	<.003	<.005	<.009

Date	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinylfipronil, amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos, water, fltrd ug/L	Lindane, water, fltrd ug/L	Linuron, water, fltrd ug/L	Malathion, water, fltrd ug/L
SEP 14...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.012	<.016	<.003	<.004	<.035	<.027
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.02	<.004	<.009	<.005	E.002mtc	E.003t	E.006t	E.005t	E.003mtc	<.003	<.004	<.035	.097
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.02mc	<.004	<.009	<.005	<.029mc	<.013	<.024	<.012	<.016mc	<.003	<.004	<.035	<.027

Date	Methyl parathion, water, fltrd, ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd, ug/L	Napropamide, water, fltrd, ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd, ug/L	Pendimethalin, water, fltrd, ug/L	Phorate, water, fltrd, ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd, ug/L	Propachlor, water fltrd, ug/L
SEP 14...	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	<.01	<.004	<.025
NOV 08...	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN 04...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	<.01	<.004	<.025
MAR 09...	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
JUN 02...	<.015	E.005n	<.006	<.010	<.007	<.003	<.010	<.004	<.022	<.011	.01	<.004	<.025
JUL 13...	--	--	--	--	--	--	--	--	--	--	--	--	--
AUG 24...	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004	<.022	<.011	E.01n	<.004	<.025

Appendix 1. Periodically collected water-quality properties and constituents at six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

08077877 Mustang Bayou at Evergreen Road near Fresno, TX (M6)--Continued

WATER-QUALITY DATA, SEPTEMBER 2004 TO AUGUST 2005

Date	Pro-panil, water, fltrd ug/L	Propar-gite, water, fltrd ug/L	Sima-zine, water, fltrd ug/L	Tebu-thiuron, water, fltrd ug/L	Terbu-cil, water, fltrd ug/L	Terbu-fos, water, fltrd ug/L	Thio-bencarb, water, fltrd ug/L	Tri-allate, water, fltrd ug/L	Tri-flur-alin, water, fltrd ug/L
SEP									
14...	<.011	<.02	<.005	<.02	<.034	<.02	<.010	<.002	<.009
NOV									
08...	--	--	--	--	--	--	--	--	--
JAN									
04...	<.011	<.02	.015	<.02	<.034	<.02	<.010	<.006	<.009
MAR									
09...	--	--	--	--	--	--	--	--	--
APR									
13...	--	--	--	--	--	--	--	--	--
JUN									
02...	<.011	<.02	.028	<.02	<.034mc	<.02	<.010	<.006	<.009
JUL									
13...	--	--	--	--	--	--	--	--	--
AUG									
24...	<.011	<.02	<.005	<.02	<.034mc	<.02	<.010	<.006	<.009

Remark codes used in this table:
- < -- Less than.
- E -- Estimated.

Value qualifier codes used in this table:
- c -- See laboratory comment
- d -- Diluted sample: method hi range exceeded
- k -- Counts outside acceptable range
- m -- Value is highly variable by this method
- n -- Below the LRL and above the LT-MDL
- t -- Below the long-term MDL
- w -- High variability: questionable precision

Appendix 2—Quality-Control Data

Appendix 2. Quality-control (QC) data associated with periodically collected water-quality samples from Mustang Bayou near Houston, Texas, September 2004–August, 2005.

[mg/L, milligrams per liter; fltrd (flt), filtered; N, nitrogen; unfltrd (usf), unfiltered; P, phosphorus; ug/L, micrograms per liter; cfs, cubic feet per second; deg C, degrees Celsius; mm, millimeters; Hg, mercury; mg/L, milligrams per liter; us/cm, microsiemens per centimeter; inc tit, incremental titration; $CaCO_3$, calcium carbonate; Pt-Co, Platinum-Cobalt; NTRU, nephelometric turbidity ratio units; BOD, biochemical oxygen demand; CBOD, carbonaceous biochemical oxygen demand; MF, membrane filtration; col/100 mL, colonies per 100 milliliters; org-N, organic nitrogen; --, property or constituent not analyzed for in this sample]

FIELD BLANK DATA

Station	Station name	Date	Time	Chloride, water, fltrd, mg/L	Sulfate water, fltrd, mg/L	Solids, dissolved, wat flt mg/L	Ammonia + org-N, water, unfltrd mg/L as N
08077877	Mustang Bayou at Evergreen Rd nr Fresno, TX	07-13-05	0850	<.20	<.2	<10	<.10

Station number	Date	Ammonia water, unfltrd mg/L as N	Nitrite + nitrate water fltrd, mg/L as N	Nitrite water, fltrd, mg/L as N	Orthophosphate, water, fltrd, mg/L as P	Phosphorus, water, unfltrd mg/L	Pheophytin a, phytoplankton, ug/L	Chlorophyll a phytoplankton, fluoro, ug/L
08077877	07-13-05	<.04	<.016	<.002	<.006	<.04	<.03	<.03

MATRIX SPIKE DATA

Station number	Station name	Date	Time	Instantaneous discharge, cfs	Sampling depth, meters	Barometric pressure, mm Hg
08077905	Mustang Bayou at FM 2917 nr Liverpool, TX	08-24-05	0815	4.6	.30	762

Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	pH, water, unfltrd field, std units	Specif. conductance, wat unf uS/cm 25 degC	Temperature, air, deg C	Temperature, water, deg C	2,6-Diethylaniline water fltrd 0.7 u GF ug/L	Acetochlor, water, fltrd, ug/L	alpha-HCH, water, fltrd, ug/L	Alachlor, water, fltrd ug/L	Atrazine, water, fltrd, ug/L
.4	6	7.1	846	28.5	29.9	.090	.144	.131	.134	.255

CIAT, water, fltrd ug/L	Azinphos-methyl, water, fltrd ug/L	Benfluralin, water, fltrd ug/L	Butylate, water, fltrd ug/L	Carbaryl, water, fltrd ug/L	Carbofuran, water, fltrd ug/L	Chlorpyrifos water, fltrd ug/L	cis-Permethrin, water, fltrd ug/L	Cyanazine, water, fltrd ug/L	DCPA, water, fltrd ug/L	Desulfinyl fipronil, water, fltrd, ug/L	Diazinon, water, fltrd ug/L
E.037	E.096	.097	.120	E.105	E.098	.110	.046	.096	.138	.137	.139

Appendix 2. Quality-control (QC) data associated with periodically collected water-quality samples from Mustang Bayou near Houston, Texas, September 2004–August, 2005—Continued.

MATRIX SPIKE DATA--Continued

Dieldrin, water, fltrd, ug/L	Disulfoton, water, fltrd ug/L	EPTC, water, fltrd ug/L	Ethalfluralin, water, fltrd ug/L	Ethoprop, water, fltrd ug/L	Desulfinylfipronil amide, wat flt ug/L	Fipronil sulfide water, fltrd ug/L	Fipronil sulfone water, fltrd ug/L	Desulfinyl fipronil, water, fltrd ug/L	Fipronil, water, fltrd ug/L	Fonofos water, fltrd ug/L	Lindane water, fltrd ug/L	Linuron water, fltrd ug/L
.146	E.09	.099	.099	.101	E.070	.137	.109	.137	E.148	.119	.131	.156

Malathion, water, fltrd ug/L	Methyl parathion, water, fltrd ug/L	Metolachlor, water, fltrd ug/L	Metribuzin, water, fltrd ug/L	Molinate, water, fltrd ug/L	Napropamide, water, fltrd ug/L	p,p'-DDE, water, fltrd ug/L	Parathion, water, fltrd ug/L	Pebulate, water, fltrd ug/L	Pendimethalin, water, fltrd ug/L	Phorate, water, fltrd ug/L	Prometon, water, fltrd ug/L	Propyzamide, water, fltrd ug/L
.108	.151	.128	.084	.102	.131	.068	.145	.106	.107	.100	.12	.130

Propachlor, water, fltrd ug/L	Propanil, water, fltrd ug/L	Propargite, water, fltrd ug/L	Simazine, water, ug/L	Tebuthiuron water fltrd ug/L	Terbacil, water, fltrd ug/L	Terbufos, water, fltrd ug/L	Thiobencarb water fltrd ug/L	Triallate, water, fltrd ug/L	Trifluralin, water, fltrd ug/L
.130	.117	.11	.112	.12	E.060	.10	.133	.125	.096

SPLIT REPLICATE DATA

Station number	Station name	Date	Time	Instantaneous discharge, cfs	Color, water, fltrd, Pt-Co units	Sampling depth, meters	Turbidity white light, det ang 90+/-30 corrctd NTRU
08077877	Mustang Bayou at Evergreen Rd nr Fresno, TX	03-09-05	0801	16	300	.30	95
08077880	Mustang Bayou at CR 48 nr Fresno, TX	01-04-05	1136	4.4	12	.30	11
08077885	Mustang Bayou at CR 99 nr Alvin, TX	06-02-05	1031	3.7	25	.16	5.4
08077890	Mustang Bayou at E South St, Alvin, TX	11-08-04	1106	19	50	.12	39
08077905	Mustang Bayou at FM 2917 nr Liverpool, TX	09-14-04	1041	--	--	.30	--
	Mustang Bayou at FM 2917 nr Liverpool, TX	04-13-05	0816	1.1	50	.30	19
	Mustang Bayou at FM 2917 nr Liverpool, TX	08-24-05	0756	4.6	50	.30	<2.0

Station number	Date	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	pH, water, unfltrd field, std units	Specif. conductance, wat unf uS/cm 25 degC	Temperature, air, deg C	Temperature, water, deg C	Alkalinity, wat flt inc tit field, mg/L as CaCO3	Bicarbonate, wat flt incrm. titr., field, mg/L	Carbonate, wat flt incrm. titr., field, mg/L	Chloride, water, fltrd, mg/L
08077877	03-09-05	760	6.0	61	6.5	105	15.0	16.2	36	44	<1	5.95
08077880	01-04-05	765	6.8	77	7.9	678	23.5	21.3	226	273	2	65.3
08077885	06-02-05	759	7.7	99	7.6	759	28.0	27.8	199	240	2	104
08077890	11-08-04	770	7.7	84	7.5	395	25.0	19.9	--	--	--	39.0
08077905	09-14-04	761	4.6	60	7.7	854	32.0	28.5	192	232	<1	125
	04-13-05	760	6.8	76	8.0	1,260	17.0	20.0	274	331	2	217
	08-24-05	762	.4	6	7.1	846	28.5	29.9	195	237	<1	127

Appendix 2. Quality-control (QC) data associated with periodically collected water-quality samples from Mustang Bayou near Houston, Texas, September 2004–August, 2005—Continued.

SPLIT REPLICATE DATA--Continued

Station number	Date	Sulfate water, fltrd mg/L	Solids, dis-solved, fltrd mg/L	Solids, total, sus-pended mg/L	Ammonia + org-N, water, unfltrd mg/L as N	Ammonia water, unfltrd mg/L as N	Nitrate water, fltrd mg/L as N	Nitrite + nitrate water, fltrd mg/L as N	Nitrite water, fltrd mg/L as N	Organic nitro-gen, water, unfltrd mg/L	Total nitro-gen, water, unfltrd mg/L	Ortho-phos-phate, water, fltrd mg/L as P
08077877	03-09-05	2.7	87	42	1.4	.10	.04	.050	.007	1.3	1.5	.031
08077880	01-04-05	19.8	395	25	.18	.04	.13	.132	.005	.14	.31	.029
08077885	06-02-05	19.5	423	<10	.28	<.04	--	<.016	<.002	--	--	.054
08077890	11-08-04	12.9	228	36	.57	.05	.09	.094	.008	.52	.66	.067
08077905	09-14-04	25.4	479	--	.67	.03	.33	.342	.015	.63	1.0	.240
	04-13-05	29.4	695	20	.41	.03	.01	.059	.044	.39	.47	.229
	08-24-05	23.5	487	<10	.70	E.04	.17	.203	.034	--	.90	.160

Station number	Date	Phos-phorus, water, unfltrd mg/L	BOD, water, unfltrd 5 day, 20 degC mg/L	CBOD, water, unfltrd 5 day, mg/L	Pheo-phytin a, phyto-plank-ton, ug/L	E coli, m-TEC MF, water, col/ 100 mL	Chloro-phyll a phyto-plank-ton, fluoro, ug/L	2,6-Di-ethyl-aniline water fltrd 0.7u GF ug/L	CIAT, water, fltrd, ug/L	Aceto-chlor, water, fltrd, ug/L	Ala-chlor, water, fltrd, ug/L	alpha-HCH, water, fltrd, ug/L
08077877	03-09-05	.15	3.7	2.8	3.7	3,500	1.2	--	--	--	--	--
08077880	01-04-05	E.04	1.3	1.1	1.4	--	1.9	<.006	<.006	<.006	<.005	<.005
08077885	06-02-05	.08	.8	.5	1.3	<7	1.1	<.006	E.026	<.006	<.005	<.005
08077890	01-08-04	.13	2.3	2.1	1.5	140	.8	--	--	--	--	--
08077905	09-14-04	.27	3.0	--	3.7	620	6.7	<.006	E.015	<.006	<.005	<.005
	04-13-05	.27	E.7	E1.4	1.2	E120	3.3	--	--	--	--	--
	08-24-05	.19	2.2	2.1	1.9	E120	1.9	--	--	--	--	--

Station number	Date	Atra-zine, water, fltrd, ug/L	Azin-phos-methyl, water, fltrd 0.7u GF ug/L	Ben-flur-alin, water, fltrd 0.7u GF ug/L	Butyl-ate, water, fltrd, ug/L	Car-baryl, water, fltrd 0.7u GF ug/L	Carbo-furan, water, fltrd 0.7u GF ug/L	Chlor-pyrifos water, fltrd, ug/L	cis-Per-methrin water fltrd 0.7u GF ug/L	Cyana-zine, water, fltrd, ug/L	DCPA, water fltrd 0.7u GF ug/L	Desulf-inyl fipro-nil, water, fltrd, ug/L
08077877	03-09-05	--	--	--	--	--	--	--	--	--	--	--
08077880	01-04-05	.011	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.012
08077885	06-02-05	.150	<.060	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	<.012
08077890	11-08-04	--	--	--	--	--	--	--	--	--	--	--
08077905	09-14-04	.084	<.050	<.010	<.004	<.041	<.020	<.005	<.006	<.018	<.003	E.006
	04-13-05	--	--	--	--	--	--	--	--	--	--	--
	08-24-05	--	--	--	--	--	--	--	--	--	--	--

Station number	Date	Diazi-non, water, fltrd, ug/L	Diel-drin, water, fltrd, ug/L	Disul-foton, water, fltrd 0.7u GF ug/L	EPTC, water, fltrd 0.7u GF ug/L	Ethal-flur-alin, water, fltrd 0.7u GF ug/L	Etho-prop, water, fltrd 0.7u GF ug/L	Desulf-inyl-fipro-nil amide, wat flt ug/L	Fipro-nil sulfide water, fltrd, ug/L	Fipro-nil sulfone water, fltrd, ug/L	Fipro-nil, water, fltrd, ug/L	Fonofos water, fltrd, ug/L
08077877	03-09-05	--	--	--	--	--	--	--	--	--	--	--
08077880	01-04-05	<.005	<.009	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.016	<.003
08077885	06-02-05	<.005	<.009	<.02	<.004	<.009	<.005	<.029	<.013	<.024	<.016	<.003
08077890	11-08-04	--	--	--	--	--	--	--	--	--	--	--
08077905	09-14-04	<.005	<.009	<.02	<.004	<.009	<.005	<.029	E.009	E.011	E.005	<.003
	04-13-05	--	--	--	--	--	--	--	--	--	--	--
	08-24-05	--	--	--	--	--	--	--	--	--	--	--

Appendix 2. Quality-control (QC) data associated with periodically collected water-quality samples from Mustang Bayou near Houston, Texas, September 2004–August, 2005—Continued.

SPLIT REPLICATE DATA--Continued

Station number	Date	Lindane water, fltrd, ug/L	Linuron water fltrd 0.7u GF ug/L	Malathion, water, fltrd, ug/L	Methyl parathion, water, fltrd 0.7u GF ug/L	Metolachlor, water, fltrd, ug/L	Metribuzin, water, fltrd, ug/L	Molinate, water, fltrd 0.7u GF ug/L	Napropamide, water, fltrd 0.7u GF ug/L	p,p'-DDE, water, fltrd, ug/L	Parathion, water, fltrd, ug/L	Pebulate, water, fltrd 0.7u GF ug/L
08077877	03-09-05	--	--	--	--	--	--	--	--	--	--	--
08077880	01-04-05	<.004	<.035	<.027	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004
08077885	06-02-05	<.004	<.035	<.027	<.015	<.006	<.006	<.003	<.007	<.003	<.010	<.004
08077890	11-08-04	--	--	--	--	--	--	--	--	--	--	--
08077905	09-14-04	<.004	<.035	<.027	<.015	<.013	<.006	<.003	<.007	<.003	<.010	<.004
	04-13-05	--	--	--	--	--	--	--	--	--	--	--
	08-24-05	--	--	--	--	--	--	--	--	--	--	--

Station number	Date	Pendimethalin, water, fltrd 0.7u GF ug/L	Phorate water fltrd 0.7u GF ug/L	Prometon, water, fltrd, ug/L	Propyzamide, water, fltrd 0.7u GF ug/L	Propachlor, water, fltrd, ug/L	Propanil, water, fltrd 0.7u GF ug/L	Propargite, water, fltrd 0.7u GF ug/L	Simazine, water, fltrd, ug/L	Tebuthiuron water fltrd 0.7u GF ug/L	Terbacil, water, fltrd 0.7u GF ug/L	Terbufos, water, fltrd 0.7u GF ug/L
08077877	03-09-05	--	--	--	--	--	--	--	--	--	--	--
08077880	01-04-05	<.022	<.011	.03	<.004	<.025	<.011	<.02	<.005	.03	<.034	<.02
08077885	06-02-05	<.022	<.011	E.01	<.004	<.025	<.011	<.02	<.005	E.01	<.034	<.02
08077890	11-08-04	--	--	--	--	--	--	--	--	--	--	--
08077905	09-14-04	<.022	<.011	M	<.004	<.025	<.011	<.02	.012	.03	<.034	<.02
	04-13-05	--	--	--	--	--	--	--	--	--	--	--
	08-24-05	--	--	--	--	--	--	--	--	--	--	--

Station number	Date	Thiobencarb water fltrd 0.7u GF ug/L	Triallate, water, fltrd 0.7u GF ug/L	Trifluralin, water, fltrd 0.7u GF ug/L	Suspended sediment concentration mg/L	Streamflow severity, code
08077877	03-09-05	--	--	--	26	3
	07-13-05	--	--	--	--	--
08077880	01-04-05	<.010	<.006	<.009	73	2
08077885	06-02-05	<.010	<.006	<.009	13	3
08077890	11-08-04	--	--	--	38	3
08077905	09-14-04	<.010	<.002	<.009	--	3
	04-13-05	--	--	--	51	2
	08-24-05	--	--	--	4	3
	08-24-05	.133	.125	.096	--	3

Remark codes used in this table:
- < -- Less than.
- E -- Estimated.
- M -- Presence verified but not quantified.

Appendix 3—Water-Quality Properties and Sediment-Quality Constituents

Appendix 3. Water-quality properties and sediment-quality constituents at site M1 in Mustang Bayou near Houston, Texas, September 2005.

[mm, millimeters; Hg, mercury; mg/L, milligrams per liter; unfltrd, unfiltered; us/cm, microsiemens per centimeter; deg C, degrees Celsius; sedimnt (sed), sediment; ug/kg, micrograms per kilogram; ug/g, micrograms per gram]

08077905 Mustang Bayou at FM 2917 near Liverpool, TX

SEDIMENT-QUALITY DATA, SEPTEMBER 2005

Date	Time	Barometric pressure, mm Hg	Dissolved oxygen, mg/L	Dissolved oxygen, percent of saturation	pH, water, unfltrd field, std units	Specif. conductance, wat unf uS/cm 25 degC	Temperature, water, deg C	alpha-HCH, bed sedimnt ug/kg	beta-HCH, bed sedimnt ug/kg	Aldrin, bed sedimnt ug/kg	Hexachlorobenzene bed sedimnt ug/kg	cis-Chlordane, bed sedimnt ug/kg	Dieldrin, bed sedimnt ug/kg
SEP 27...	0845	762	1.3	16	7.3	674	28.8	<1.5	<.5	<2.0	<3.0	<1.0	<.5

Date	alpha-Endosulfan, bed sedimnt ug/kg	Endrin, bed sedimnt ug/kg	Heptachlor, bed sedimnt ug/kg	Heptachlor epoxide bed sedimnt ug/kg	Lindane bed sedimnt ug/kg	p,p'-Methoxychlor, bed sedimnt ug/kg	Mirex, bed sedimnt ug/kg	p,p'-DDD, bed sedimnt ug/kg	p,p'-DDE, bed sedimnt ug/kg	p,p'-DDT, bed sedimnt ug/kg	Aroclor 1016 + 1242, bed sedimnt ug/kg	Aroclor 1254, bed sedimnt ug/kg	Aroclor 1260, bed sedimnt ug/kg
SEP 27...	<.5	<1.0	<1.0	<1.5	<.5	<4mc	<1.5	<2.5	<1.5	<1.0	<5.0	<5	<5

Date	Toxaphene, bed sedimnt ug/kg	trans-Chlordane, bed sedimnt ug/kg	trans-Nonachlor, bed sedimnt ug/kg	Dibenzo [a,h]-anthracene, bed sedimnt ug/kg	Chrysene, bed sedimnt ug/kg	2-Methylanthracene, bed sedimnt ug/kg	4H-Cyclopenta-[def]-phenanthrene, bed sed ug/kg	9H-Fluorene, bed sedimnt ug/kg	1-Methyl 9H-fluorene, bed sedimnt ug/kg	Acenaphthene, bed sedimnt ug/kg	Acenaphthylene bed sedimnt ug/kg	Anthracene, bed sedimnt ug/kg	Benzo-[a]-anthracene, bed sedimnt ug/kg
SEP 27...	<200mc	<.5	<1.0	<20	20	<10	<10	<10	<10	<10	Mn	Mn	20

Date	Benzo-[a]-pyrene, bed sedimnt ug/kg	Benzo-[b]-fluoranthene bed sedimnt ug/kg	Benzo-[e]-pyrene, bed sedimnt ug/kg	Benzo-[ghi]-perylene, bed sedimnt ug/kg	Benzo-[k]-fluoranthene, bed sedimnt ug/kg	Fluoranthene, bed sedimnt ug/kg	Indeno-[123cd] pyrene, bed sedimnt ug/kg	Naphthalene bed sedimnt ug/kg	1,2-Dimethylnaphthalene, bed sedimnt ug/kg	1,6-Dimethylnaphthalene, bed sedimnt ug/kg	2,3,6-Trimethylnaphthalene, bed sed ug/kg	2,6-Dimethylnaphthalene, bed sedimnt ug/kg	2-Ethylnaphthalene, bed sedimnt ug/kg
SEP 27...	20	30	20	<20	20	20	20	<10	<10	<10	<10	20	<10

Date	Perylene, bed sedimnt ug/kg	Phenanthrene, bed sedimnt ug/kg	1-Methylphenanthrene, bed sedimnt ug/kg	Pyrene, bed sedimnt ug/kg	1-Methylpyrene, bed sedimnt ug/kg	Arsenic bed sedimnt recoverable, ug/g	Cadmium bed sedimnt recoverable, ug/g	Chromium, bed sedimnt recoverable, ug/g	Cobalt bed sedimnt recoverable, ug/g	Copper, bed sedimnt recoverable, ug/g	Iron, bed sedimnt total, ug/g	Lead, bed sedimnt recoverable, ug/g	Manganese, bed sedimnt recoverable, ug/g
SEP 27...	40	Mn	<10	20	<10	2.1	.120	21	8.1	13	17000d	18	450

Date	Mercury bed sedimnt recoverable, ug/g	Nickel, bed sedimnt recoverable, ug/g	Selenium, bed sedimnt recoverable, ug/g	Zinc, bed sedimnt recoverable, ug/g
SEP 27...	.008	15	.2	59

Remark codes used in this table:
- < -- Less than.
- M -- Presence verified but not quantified.

Value qualifier codes used in this table:
- c -- See laboratory comment
- d -- Diluted sample: method hi range exceeded
- m -- Value is highly variable by this method
- n -- Below the LRL and above the LT-MDL

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Appendix 4—Stream-Habitat Data and Computed Metrics

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Appendix 4. Stream-habitat data and computed metrics for representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[km^2, square kilometers; m, meters; km, kilometers; ft^3/s, cubic feet per second; --, no value; ft/s, feet per second; <, less than; >, greater than]

Metric	Site and survey								
	M1			M2			M3		
	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005
Site characteristics									
Drainage area above location (km^2)	122	122	122	86.5	86.5	86.5	72.3	72.3	72.3
Altitude of land surface at reach (m)	4.3	4.3	4.3	6.1	6.1	6.1	11.6	11.6	11.6
Number of permitted dischargers above reach	10	10	10	10	10	10	8	8	8
Dominant land use at reach	agriculture	agriculture	agriculture	agriculture	agriculture	agriculture	urban	urban	urban
Land development impact	low	low	low	moderate	moderate	moderate	high	high	high
Aesthetics	common	common	common	natural	natural	natural	common	common	common
Reach length (km)	.183	.183	.183	.152	.152	.152	.155	.155	.155
Stream slope at reach (m/m)	.00022	.00022	.00022	.00045	.00045	.00045	.00048	.00048	.00048
Stream-channel attributes									
Average width (m)	12.2	10.0	10.8	4.4	3.8	4.0	6.2	6.9	7.7
Average depth (m)	1.04	.36	.57	.33	.39	.38	.33	.39	.38
Streamflow, instantaneous (ft^3/s)	--	1.08	4.56	9.44	14.7	11.3	6.97	15.1	9.55
Average velocity (ft/s)	--	.04	.07	.82	1.05	.74	.45	.76	.36
Number of pools	0	0	0	0	0	0	0	0	1
Total number of stream bends	0	0	0	3	3	3	1	1	1
Number of well-defined bends	0	0	0	0	0	0	0	0	0
Number of moderately-defined bends	0	0	0	1	1	1	0	0	0
Number of poorly-defined bends	0	0	0	2	2	2	1	1	1
Number of riffles	0	0	0	1	1	1	0	0	1
Dominant substrate type	silt	silt	silt	silt	silt	clay	sand	silt	sand
Average percentage of gravel	0	0	0	6.0	4.2	<5.0	<2.0	0	<1.0
Number of instream cover types	2	2	3	2	2	3	1	1	2
Average percentage instream cover	10.0	5.6	54.0	17.6	11.4	7.6	19.0	19.0	52.0
Riparian attributes									
Average bank slope (degrees)	39.5	50.7	30.2	39.5	48.2	49.2	35.5	31.3	24.6
Average bank erosion potential percentage	<5	22.0	21.0	4.0	4.0	6.0	25.5	33.0	54.0
Mean width of natural buffer vegetation (m)	>30.5	>30.5	>30.5	>30.5	>30.5	>30.5	<2.6	7.3	6.7
Riparian vegetation: percentage trees	2.5	2.0	0	10.3	9.8	9.0	0	0	0
Riparian vegetation: percentage shrubs	19.0	15.0	15.0	48.7	52.5	44.0	3.0	3.5	1.5
Riparian vegetation: percentage grasses	69.5	78.0	84.0	41.0	37.7	47.0	85.5	83.5	49.5
Riparian vegetation: percentage cultivated fields	0	0	0	0	0	0	0	0	0
Riparian vegetation: percentage other	9.0	5.0	1.0	0	0	0	11.5	13.0	49.0
Average percentage tree canopy	0	0	0	0	0	0	0	0	0

Appendix 4. Stream-habitat data and computed metrics for representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

Metric	Site and survey								
	M4			M5			M6		
	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005
Site characteristics									
Drainage area above location (km^2)	52.3	52.3	52.3	23.6	23.6	23.6	14.6	14.6	14.6
Altitude of land surface at reach (m)	13.7	13.7	13.7	18.3	18.3	18.3	19.8	19.8	19.8
Number of permitted dischargers above reach	8	8	8	4	4	4	1	1	1
Dominant land use at reach	grassland	grassland	grassland	quarry	quarry	quarry	pasture	pasture	pasture
Land development impact	moderate	moderate	moderate	moderate	high	high	low	low	low
Aesthetics	common	common	offensive	common	offensive	offensive	common	common	common
Reach length (km)	.305	.305	.305	.244	.244	.244	.219	.219	.219
Stream slope within reach (m/m)	.00018	.00018	.00018	.00025	.00025	.00025	.00043	.00043	.00043
Stream-channel attributes									
Average width (m)	8.47	7.32	9.08	5.42	5.91	14.57	6.04	3.96	6.46
Average depth (m)	.43	.36	.46	.29	.30	.44	.19	.17	.25
Streamflow, instantaneous (ft^3/s)	5.78	7.65	5.08	3.98	3.39	3.80	.103	.223	.00
Average velocity (ft/s)	.21	.28	.16	.31	.20	.07	.10	.02	.00
Number of pools	0	0	0	0	0	0	0	0	0
Total number of stream bends	2	2	2	8	1	1	0	0	0
Number of well-defined bends	0	0	0	0	0	0	0	0	0
Number of moderately-defined bends	0	0	0	4	1	1	0	0	0
Number of poorly-defined bends	2	2	2	4	0	0	0	0	0
Number of riffles	0	0	0	0	0	0	0	0	0
Dominant substrate type	silt	silt	silt	silt	silt	silt	silt	silt	silt
Average percentage of gravel	0	2.0	8.0	0	0	0	0	0	0
Number of instream cover types	3	1	2	1	1	1	1	1	1
Average percentage instream cover	46.0	4.4	22.0	49.0	35.0	84.0	9.0	4.8	14.0
Riparian attributes									
Average bank slope (degrees)	36.3	28.4	30.5	16.5	10.2	20.1	11.5	18.0	8.0
Average bank erosion potential percentage	10.5	4.0	6.5	<5	21.5	6.0	7.5	13.0	19.8
Mean width of natural buffer vegetation (m)	14.6	4.6	5.7	19.5	4.4	6.1	0	0	0
Riparian vegetation: percentage trees	6.0	.1	5.5	27.0	0	9.8	1.2	0	0
Riparian vegetation: percentage shrubs	14.5	9.0	5.0	14.5	0	46.2	0	0	0
Riparian vegetation: percentage grasses	79.5	85.0	89.5	58.5	64.0	40.0	98.8	100.0	100.0
Riparian vegetation: percentage cultivated fields	0	0	0	0	0	0	0	0	0
Riparian vegetation: percentage other	0	5.9	0	0	36.0	4.0	0	0	0
Average percentage tree canopy	0	0	0	21.0	0	0	0	0	0

Appendix 5—Benthic Macroinvertebrate Taxa and Counts of Individual Taxa

Appendix 5. Benthic macroinvertebrate taxa and counts of individual taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[Combined number of individuals per taxon for each site]

Class	Order	Family	Subfamily	Genus or species	Site and survey																		Total
					M1			M2			M3			M4			M5			M6			
					SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	
Arachnida	Acari	Hydracarina (suborder)			--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	3	5
		Arrenuridae		*Arrenurus* sp.	1	1	1	2	--	--	--	--	--	--	--	--	--	--	--	1	1	1	8
		Hydryphantidae		*Hydryphantes* sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	3
		Unionicolidae		*Neumania* sp.	--	--	--	--	--	--	--	--	--	1	--	--	2	--	--	4	--	--	7
Bivalvia/Pelecypoda	Veneroidea	Corbiculidae		*Corbicula* sp.	--	3	--	8	5	4	1	3	2	1	--	--	2	2	2	--	--	--	33
		Sphaeriidae			--	--	--	3	--	--	6	--	--	--	--	--	--	--	--	--	--	--	9
				Musculium sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	4	--	7
	Unionoidea	Unionidae			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	2
			Anadontinae	*Utterbackia* sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	7	--	8
Malacostraca	Amphipoda	Talitridae		*Hyalella azteca*	17	47	36	1	--	--	--	--	--	48	20	28	2	19	1	--	3	2	224
(phylum Crustacea)	Decapoda	Cambaridae			--	--	--	--	--	--	--	--	1	--	2	--	--	--	--	--	--	1	4
				Procambarus sp.	--	3	--	--	1	--	1	--	--	--	--	--	--	--	--	--	2	--	7
		Palaemonidae		*Macrobranchium ohione*	--	--	2	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	4
				Palaemonetes kadiakensis	--	3	--	2	--	--	1	--	--	3	3	--	2	3	--	2	4	5	28
	Isopoda	Asellidae		*Caecidotea* sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	2
	Mysidacea				--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	2
		Mysidae		*Taphromysis louisianae*	--	19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19
Gastropoda	Architaenioglossa	Ampullariidae		*Pomacea sp.*	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1	2
				Pomacea canaliculata	--	--	--	--	1	3	4	--	--	--	--	--	3	2	--	15	7	2	37
	Basommatophora	Ancylidae			--	--	--	--	2	--	--	1	2	--	1	--	1	--	--	--	--	--	7
		Physidae		*Physella* sp.	--	--	2	1	2	2	1	--	4	18	6	11	1	--	--	1	--	22	71
		Planorbidae		*Menetus* sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	3
				Planorbella sp.	--	--	--	--	--	--	2	--	--	--	1	--	1	--	--	--	--	--	4
				Planorbula sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
	Neotaenioglossa	Hydrobiidae			--	2	6	54	19	5	32	5	27	13	13	40	60	16	6	40	1	23	362
Hirudinea					--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
	Rhynchobdellida	Glossiphoniidae			--	--	--	--	--	--	3	1	--	--	--	--	--	--	--	--	4	--	8
				Helobdella sp.	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	2

Appendix 5. Benthic macroinvertebrate taxa and counts of individual taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

Class	Order	Family	Subfamily	Genus or species	Site and survey																		Total
					M1			M2			M3			M4			M5			M6			
					SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	
Insecta	Coleoptera	Dytiscidae		*Liodessus* sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
		Elmidae		*Dubiraphia* sp.	--	--	--	3	--	13	2	--	1	1	--	--	3	--	--	--	--	--	23
.				*Stenelmis* sp.	--	--	--	--	2	4	--	1	--	--	--	--	--	--	--	--	--	--	7
		Gyrinidae		*Gyretes* sp.	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
		Haliplidae		*Haliplus* sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1	--	2
				Peltodytes sp.		1	3	--	--	11	1	--	3	--	1	--	--	8	2	--	--	--	30
		Hydrophilidae		*Berosus* sp.	14	1	--	--	--	1	1	--	2	--	--	--	--	--	--	--	--	2	21
	Diptera	Ceratopogonidae			1	--	1	1	4	--	2	--	--	--	--	--	1	7	--	--	5	--	22
				Bezzia sp.	--	--	--	1	3	1	--	--	--	--	--	--	--	--	2	--	--	--	7
				Dasyhelea sp.	--	--	--	--	--	--	--	--	--	--	--	1	--	--	2	--	--	--	3
			Forcipomyiinae	*Forcipomyia* sp.	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
		Chironomidae			--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
			Chironominae		--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
				Apedilum sp.	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
				Chironomus sp.	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--	--	--	3
				Cladotanytarsus sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	2
				Cryptochironomus sp.	--	1	--	--	--	--	1	3	1	--	--	--	--	--	--	--	--	--	6
				Dicrotendipes sp.	1	--	--	--	1	--	23	--	--	--	--	--	--	1	--	3	--	2	31
				Dicrotendipes neomodestus	--	4	3	--	--	--	--	--	3	--	4	--	--	--	--	--	--	--	14
				Einfeldia sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	7
				Glyptotendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	2
				Parachironomus sp.	1	--	--	--	--	--	1	--	1	--	--	--	--	--	2	--	--	1	6
				Polypedilum sp.	--	--	--	--	2	--	27	--	2	4	--	--	3	--	--	--	--	--	38
				Polypedilum illinoense gr.	--	3	--	--	12	--	--	13	23	--	20	--	--	12	--	--	1	--	84
				Polypedilum scalaenum gr.	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	1	3
				Rheotanytarsus sp.	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	7
				Rheotanytarsus exiguus gr.	--	3	--	--	18	4	--	--	--	--	13	--	--	--	--	--	--	--	38
				Tanytarsus sp.	7	--	3	--	--	--	4	--	--	3	5	1	2	--	1	--	--	--	26
				Zavreliella sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	2	3
			Orthocladiinae	*Corynoneura* sp.	--	--	--	--	2	--	--	--	--	--	8	--	--	2	--	--	--	--	12
				Cricotopus sp.	--	5	--	--	17	--	1	30	3	--	4	--	--	--	--	--	--	--	60
				Cricotopus bicinctus gr.	--	4	--	--	8	--	1	28	1	1	6	--	--	5	--	--	--	--	54
				Nanocladius sp.	--	1	--	--	2	--	--	--	1	--	--	--	--	--	--	--	1	--	5

Appendix 5. Benthic macroinvertebrate taxa and counts of individual taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

Class	Order	Family	Subfamily	Genus or species	Site and survey																		Total
					M1			M2			M3			M4			M5			M6			
					SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	
				Thienemanniella sp.	--	--	--	--	3	1	--	8	--	--	--	--	--	--	--	--	--	--	12
Insecta—Cont.	Diptera—Cont.	Chironomidae—Cont.	Tanypodinae	*Ablabesmyia* sp.	--	--	7	--	--	1	4	--	1	--	--	--	--	--	1	--	--	--	14
				Ablabesmyia mallochi	--	--	--	--	3	--	--	1	--	--	--	--	--	--	--	--	--	--	4
				Axarus sp.	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
				Clinotanypus sp.	--	--	--	--	--	--	--	--	--	1	--	--	--	3	--	1	--	--	5
				Labrundinia sp.	--	7	5	--	5	1	1	6	1	6	--	8	--	--	1	--	--	--	41
				Larsia sp.	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
				Pentaneurini	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	1
				Tanypus sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	4	1	2	9
				Thienemannimyia gr. sp.	--	--	--	--	--	2	2	2	1	--	--	--	--	--	--	--	--	--	7
		Psychodidae			--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	1
		Simuliidae		*Simulium* sp.	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	2
	Ephemeroptera	Baetidae			--	--	--	--	--	--	--	5	--	--	--	--	2	--	--	--	--	--	7
				Baetis sp.	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
				Callibaetis sp.	1	--	5	--	1	--	4	--	2	1	5	3	--	--	1	--	--	--	23
				Fallceon quilleri	--	2	--	--	4	2	1	--	--	--	--	--	--	--	--	--	--	--	9
		Caenidae		*Caenis* sp.	15	5	55	7	2	30	4	--	14	43	6	29	3	14	4	--	--	1	232
		Ephemeridae		*Hexagenia* sp.	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	2
		Heptageniidae			--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	1
		Tricorythidae		*Tricorythodes* sp.	--	--	--	3	1	6	--	--	--	--	--	--	--	--	--	--	--	--	10
	Hemiptera	Belostomatidae		*Belostoma* sp.	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
		Corixidae			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	2
				Trichocorixa sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	3	--	7
	Lepidoptera				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	2
		Pyralidae		*Acentria* sp.	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	2
	Odonata	Aeshnidae			--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
		Coenagrionidae			1	--	1	--	--	23	1	2	22	2	1	13	--	--	1	--	--	8	75
				Argia sp.	--	--	--	--	2	8	--	--	11	--	1	1	1	--	--	--	--	--	24
		Gomphidae			--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	1
				Aphylla sp.	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1
		Libellulidae			--	--	--	--	1	--	--	--	--	--	--	2	--	--	--	--	--	1	4

Appendix 5. Benthic macroinvertebrate taxa and counts of individual taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

Class	Order	Family	Subfamily	Genus or species	Site and survey																		Total
					M1			M2			M3			M4			M5			M6			
					SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	
	Tricoptera	Hydropsychidae		*Cheumatopsyche* sp.	--	--	--	1	--	--	1	--	--	--	--	--	--	--	--	--	--	--	2
Insecta—Cont.	Tricoptera—Cont.	Hydroptilidae—Cont.		*Hydroptila* sp.	--	--	--	4	2	6	1	--	--	--	--	--	--	--	--	--	--	--	13
				Oxyethira sp.	--	--	1	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	4
		Leptoceridae			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1
				Oecetis sp.	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
Nematoda (phylum)					--	--	--	--	2	--	--	1	1	--	--	--	--	1	--	--	52	2	59
Oligochaeta	Branchiobdellida				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	2
	Lumbricina	Lumbricidae		Lumbricidae	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
	Lumbriculida	Lumbriculidae			--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	3
	Tubificida	Enchytraeidae			--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	1
		Naididae			--	--	--	--	--	1	--	--	1	--	--	--	--	--	--	--	--	1	3
				Dero sp.	--	4	--	--	--	1	--	--	1	--	--	--	--	--	11	--	--	2	19
				Dero digitata	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	1	--	--	6
				Nais sp.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	1
				Nais pardalis	--	1	--	--	7	--	--	--	--	--	3	--	--	--	--	--	--	--	11
				Nais variabilis	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	9	--	10
				Pristina sp.	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	2	--	4
				Pristina leidyi	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19	--	--	--	19
				Stylaria lacustris	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	3
		Tubificidae			--	--	--	3	--	--	7	--	--	--	--	--	--	--	--	--	--	--	10
				Aulodrilus pigueti	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	8	10
				Aulodrilus pluriseta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	5
				Limnodrilus hoffmeisteri	--	7	--	2	--	--	8	1	--	--	3	--	4	9	--	75	45	54	208
Ostracoda (phylum Crustacea)					43	--	4	38	1	3	3	--	4	16	12	1	33	13	58	--	13	1	243
Turbellaria					16	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	1	21
Number of individuals					118	129	136	142	140	133	172	115	141	167	138	139	129	133	123	154	174	174	2,557
Number of taxa					12	23	17	23	33	23	38	21	30	20	22	13	21	25	20	15	24	33	413

Appendix 6—Benthic Macroinvertebrate Data and Computed Metrics

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Appendix 6. Benthic macroinvertebrate data and computed metrics for representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[EPT, Ephemeroptera, Plecoptera, Trichoptera]

Metric	Site and survey								
	M1			M2			M3		
	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005
Richness measures									
Number of taxa[1]	10	13	14	20	23	18	23	11	18
Total number of individuals	118	129	136	142	140	133	172	115	141
Number of EPT taxa[1] (richness)	2	2	3	5	6	4	5	1	2
Number of Ephemeroptera taxa[1]	2	2	2	3	5	3	3	1	2
Number of Plecoptera taxa[1]	0	0	0	0	0	0	0	0	0
Number of Trichoptera taxa[1]	0	0	1	2	1	1	2	0	0
Composition measures									
Percentage[2] EPT taxa	13.56	5.43	44.85	11.27	7.86	33.08	6.40	4.35	11.35
Percentage[2] Ephemeroptera	13.56	5.43	44.12	7.75	6.43	28.57	5.23	4.35	11.35
Percentage[2] Baetidae	0.85	1.55	3.68	0.70	3.57	1.50	2.91	4.35	1.42
Percentage[2] Plecoptera	0	0	0	0	0	0	0	0	0
Percentage[2] Tricoptera	0	0	0.74	3.52	1.43	4.51	1.16	0	0
Percentage[2] Coleoptera	11.86	1.55	2.20	3.52	1.43	21.80	2.32	0.87	4.26
Percentage[2] Elmidae	0	0	0	2.11	1.43	12.78	1.16	0.87	0.71
Percentage[2] Diptera	8.47	23.26	14.70	2.82	57.14	7.52	45.35	80.00	28.37
Percentage[2] Chironomidae	7.63	23.26	13.23	1.41	52.14	6.77	43.02	80.00	28.37
Percentage[2] Odonata	0.85	0	0.74	0	2.14	23.31	0.58	2.61	23.40
Percentage[2] Oligochaeta	0	9.30	0	4.93	5.00	1.50	13.95	2.61	1.42
Number of non-insect taxa[1]	4	8	6	10	11	6	11	6	9
Percentage non-insect individuals[1]	65.25	69.77	37.50	82.39	31.43	14.28	45.35	12.17	31.20
Dominance measures									
First dominant taxon	Ostracoda	*Hyalella azteca*	*Caenis* sp.	Hydrobiidae	Hydrobiidae	*Caenis* sp.	Hydrobiidae	*Cricotopus* sp.	Hydrobiidae
Second dominant taxon	*Hyalella azteca*	*Taphromysis louisianae*	*Hyalella azteca*	Ostracoda	*Rheotanytarsus exiguus* gr.	Coenagrionidae	*Polypedilum* sp.	*Cricotopus bicinctus* gr.	*Polypedilum illinoense* gr.
Third dominant taxon	Turbellaria	*Limnodrilus hoffmeisteri*	*Ablabesmyia* sp.	*Corbicula* sp.	*Cricotopus* sp.	*Dubiraphia* sp.	*Dicrotendipes* sp.	*Polypedilum illinoense* gr.	Coenagrionidae
Percentage[2] first dominant taxon	36.44	36.43	40.44	38.03	13.57	22.56	18.60	26.09	19.15
Percentage[2] two dominant taxa	50.85	51.16	66.91	64.79	26.43	39.85	34.30	50.43	35.46
Percentage[2] three dominant taxa	64.41	56.59	72.06	70.42	38.57	49.62	47.67	61.74	51.06
Tolerance measures									
Number of intolerant taxa[3]	3	3	5	7	9	7	8	3	5
Number of tolerant taxa[3]	6	8	7	12	12	9	14	7	10
Percentage[2] tolerant individuals	84.62	93.46	88.80	51.43	73.13	67.19	73.21	90.26	76.47
Hilsenhoff biotic index (HBI)	7.37	7.55	6.93	6.26	6.12	6.60	6.89	6.75	6.96
Trophic/habitat measures									
Percentage[2] dominant functional feeding group[3]	66.10	55.83	74.63	43.57	28.68	44.44	36.90	61.74	27.54
Percentage[2] filterers[3]	5.93	2.50	2.24	8.57	13.97	3.17	12.50	0	0
Percentage[2] gatherers[3]	66.10	55.83	74.63	43.57	17.65	44.44	36.90	14.78	17.39
Percentage[2] predators[3]	16.11	7.50	11.93	3.57	14.71	28.57	8.33	14.78	27.54
Percentage[2] scrapers-grazers[3]	0	1.67	5.97	39.29	19.11	8.73	19.64	6.09	25.36
Percentage[2] shredders[3]	11.86	11.67	2.24	0	28.68	9.52	18.45	61.74	26.09
Percentage[2] piercer-herbivores[3]	0	0	0.75	2.86	1.47	4.76	0.60	0	0
Percentage[2] unclassified	0	20.83	2.24	2.14	4.41	0.81	3.58	2.61	3.62

Appendix 6. Benthic macroinvertebrate data and computed metrics for representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

Metric	Site and survey								
	M4			M5			M6		
	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005
Richness measures									
Number of taxa[1]	13	15	12	20	19	14	10	17	20
Total number of individuals	167	138	139	129	133	123	154	174	174
Number of EPT taxa[1] (richness)	2	2	3	3	3	2	1	0	1
Number of Ephemeroptera taxa[1]	2	2	2	3	2	2	0	0	1
Number of Plecoptera taxa[1]	0	0	0	0	0	0	0	0	0
Number of Trichoptera taxa[1]	0	0	1	0	1	0	1	0	0
Composition measures									
Percentage[2] EPT taxa	26.35	7.97	23.74	4.65	13.54	4.06	0.65	0	0.57
Percentage[2] Ephemeroptera	26.35	7.97	23.02	4.65	11.28	4.06	0	0	0.57
Percentage[2] Baetidae	0.60	3.62	2.16	1.55	0	0.81	0	0	0
Percentage[2] Plecoptera	0	0	0	0	0	0	0	0	0
Percentage[2] Tricoptera	0	0	0.72	0	2.26	0	0.65	0	0
Percentage[2] Coleoptera	0.60	0.72	0	2.32	7.52	1.63	0	0.57	1.15
Percentage[2] Elmidae	0.60	0	0	2.32	0	0	0	0	0
Percentage[2] Diptera	10.18	43.48	7.19	4.65	24.81	8.13	5.84	5.75	9.77
Percentage[2] Chironomidae	10.18	43.48	6.47	3.88	19.55	4.06	5.84	2.87	9.77
Percentage[2] Odonata	1.80	1.45	11.51	1.55	0	0.81	0	0	5.17
Percentage[2] Oligochaeta	0	4.35	0	3.10	6.77	27.64	49.35	33.33	40.23
Number of non-insect taxa[1]	7	9	4	11	10	6	8	13	13
Percentage non-insect individuals[1]	61.08	46.38	57.55	86.05	51.13	85.36	93.51	91.95	81.03
Dominance measures									
First dominant taxon	*Hyalella azteca*	*Hyalella azteca*	Hydrobiidae	Hydrobiidae	*Hyalella azteca*	Ostracoda	*Limnodrilus hoffmeisteri*	Nematoda	*Limnodrilus hoffmeisteri*
Second dominant taxon	*Caenis* sp.	*Polypedilum illinoense gr.*	*Caenis* sp.	Ostracoda	Hydrobiidae	*Pristina leidyi*	Hydrobiidae	*Limnodrilus hoffmeisteri*	Hydrobiidae
Third dominant taxon	*Physella* sp.	Hydrobiidae	*Hyalella azteca*	*Limnodrilus hoffmeisteri*	*Caenis* sp.	*Dero* sp.	*Pomacea canaliculata*	Ostracoda	*Physella* sp.
Percentage[2] first dominant taxon	28.74	14.49	28.78	46.51	14.28	47.15	48.70	29.88	31.03
Percentage[2] two dominant taxa	54.49	28.98	49.64	72.09	26.32	62.60	74.68	55.75	44.25
Percentage[2] three dominant taxa	65.27	38.40	69.78	75.19	36.84	71.54	84.42	63.22	56.90
Tolerance measures									
Number of intolerant taxa[3]	4	4	5	5	5	4	4	5	5
Number of tolerant taxa[3]	8	11	6	12	8	10	5	7	11
Percentage[2] tolerant individuals	89.16	83.33	60.58	44.72	75.41	88.07	65.92	56.29	78.67
Hilsenhoff biotic index (HBI)	7.29	7.03	6.78	6.22	7.06	7.95	8.51	7.41	7.72
Trophic/habitat measures									
Percentage[2] dominant functional feeding group[3]	65.87	41.91	44.29	51.24	47.58	85.12	52.63	54.67	50.00
Percentage[2] filterers[3]	2.40	13.24	0.71	1.65	0	0.83	3.29	0	0
Percentage[2] gatherers[3]	65.87	41.91	44.29	38.84	47.58	85.12	52.63	54.67	50.00
Percentage[2] predators[3]	8.38	1.47	18.57	3.31	15.32	7.44	6.58	43.99	11.76
Percentage[2] scrapers-grazers[3]	18.56	14.71	36.43	51.24	12.90	4.96	26.97	0.67	28.24
Percentage[2] shredders[3]	2.99	22.79	0	2.48	20.16	1.65	0	0.67	2.94
Percentage[2] piercer-herbivores[3]	0	0	0	0	2.42	0	0	0	1.18
Percentage[2] unclassified	1.80	5.88	0	2.48	1.62	0	10.53	0	5.88

[1]Taxa designation determined from guidance for identification of specimens collected in Rapid Bioassessment Protocol kicknet and snag samples (Texas Natural Resource Conservation Commission, 1999b).

[2]Percentage computed as ratio of number of individuals in a category to total number of benthic macroinvertebrates collected at site.

[3]Categorization of taxa determined from Texas Natural Resource Conservation Commission (1999b, table B–11).

Appendix 7—Fish Taxa and Counts of Individual Taxa

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Appendix 7. Fish taxa and counts of individual taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[**I**, intolerant species; --, not found; **T**, tolerant species; **N**, nonnative species]

Scientific name	Common name and status[1]	Site and survey: M1 SEP 2004	M1 APR 2005	M1 AUG 2005	M2 SEP 2004	M2 APR 2005	M2 AUG 2005	M3 SEP 2004	M3 APR 2005	M3 AUG 2005	M4 SEP 2004	M4 APR 2005	M4 AUG 2005	M5 SEP 2004	M5 APR 2005	M5 AUG 2005	M6 SEP 2004	M6 APR 2005	M6 AUG 2005	Total
Atherinidae	(silversides)																			
Labidesthes sicculus	Brook silverside **I**	4	1	--	--	--	--	--	--	2	--	1	--	--	2	--	--	--	--	10
Menidia beryllina	Inland silverside	--	33	--	--	--	--	--	--	2	--	7	36	2	--	10	--	1	18	109
Belonidae	(needlefishes)																			
Strongylura marina	Atlantic needlefish	--	1	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	4
Centrarchidae	(sunfishes)																			
Lepomis sp.	Sunfish	--	--	1	--	--	119	--	--	--	--	--	--	--	--	--	--	--	--	120
Lepomis cyanellus	Green sunfish **T**	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	2	--	64	67
Lepomis gulosus	Warmouth **T**	--	1	--	--	2	1	--	2	--	--	6	--	6	5	6	15	12	11	67
Lepomis humilis	Orangespotted sunfish	--	--	19	--	--	14	--	--	9	--	--	4	--	--	--	--	--	--	46
Lepomis macrochirus	Bluegill **T**	2	1	2	3	4	7	11	6	3	4	4	7	10	24	16	40	13	43	200
Lepomis megalotis	Longear sunfish	--	17	8	11	79	37	15	21	57	2	41	12	19	20	3	1	1	6	350
Lepomis microlophus	Redear sunfish	--	--	4	--	--	--	3	--	--	1	3	--	--	--	--	--	--	113	124
Lepomis punctatus	Spotted sunfish	--	18	--	1	12	--	5	7	66	1	28	6	3	2	--	4	--	1	154
Micropterus salmoides	Largemouth bass	2	--	9	1	--	1	--	--	--	--	--	3	1	--	5	--	--	3	25
Clupeidae	(herrings/shads)																			
Alosa chrysochloris	Skipjack herring	--	317	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	317
Alosa sapidissima	American shad	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8
Brevoortia patronus	Gulf menhaden	371	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	371
Cyprinidae	(minnows/carp)																			
Cyprinella lutrensis	Red shiner **T**	--	--	--	--	--	--	--	18	2	--	2	--	6	79	1	2	6	3	119
Cyprinus carpio	Common carp **NT**	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	1
Opsopoeodus emiliae	Pugnose minnow	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	2
Pimephales vigilax	Bullhead minnow	--	--	--	--	--	--	--	6	3	1	10	--	28	25	--	30	44	25	172
Cyprinodontidae	(pupfishes)																			
Cyprinodon variegatus	Sheepshead minnow **T**	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	2
Elassomatidae	(pygmy sunfishes)																			
Elassoma zonatum	Banded pygmy sunfish	--	--	--	1	--	2	--	--	5	--	--	--	--	--	1	--	--	--	9
Engraulidae	(anchovies)																			
Anchoa mitchilli	Bay anchovy	129	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	141
Anchoviella perfasciata	Flat anchovy	--	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13
Fundulidae	(killifishes/topminnows)																			
Fundulus chrysotus	Golden topminnow	--	10	11	--	3	5	--	--	15	--	23	8	--	--	--	--	--	--	75
Fundulus grandis	Gulf killifish	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	4	--	5
Fundulus jenkinsi	Saltmarsh topminnow	--	--	6	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	7
Fundulus notatus	Blackstripe topminnow	--	--	--	1	29	61	--	2	12	--	--	2	2	1	15	--	--	--	125
Lucania parva	Rainwater killifish	--	42	27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	69

Appendix 7. Fish taxa and counts of individual taxa collected from representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005—Continued.

Scientific name	Common name and status[1]	Site and survey																		Total
		M1			M2			M3			M4			M5			M6			
		SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	
Gerridae	(mojarras)																			
Eucinostomus sp.	Mojarra	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	1
Gobiidae	(gobies)																			
Microgobius gulosus	Clown goby	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Ictaluridae	(catfishes)																			
Ameiurus natalis	Yellow bullhead	--	--	--	--	--	2	--	--	--	--	--	--	2	--	--	--	--	--	4
Ictalurus furcatus	Blue catfish	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
Ictalurus punctatus	Channel catfish **T**	--	--	--	3	7	--	--	3	1	--	1	--	--	1	--	--	--	--	16
Noturus gyrinus	Tadpole madtom **I**	--	--	--	--	4	10	--	2	1	3	--	2	--	--	--	--	--	--	22
Pylodictis olivaris	Flathead catfish	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Lepisosteidae	(gars)																			
Lepisosteus oculatus	Spotted gar **T**	3	1	4	2	7	1	3	12	--	2	3	5	2	--	4	--	--	1	50
Lepisosteus osseus	Longnose gar **T**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
Lepisosteus spatula	Alligator gar **T**	--	2	--	--	--	--	--	--	--	--	--	--	--	1	--	--	1	--	4
Mugilidae	(mullets)																			
Mugil cephalus	Striped mullet	8	20	1	1	12	--	18	4	3	--	14	--	--	--	--	--	--	--	81
Ophichthidae	(snake eels)																			
Myrophis punctatus	Speckled worm eel	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Percidae	(perches/darters)																			
Percina sciera	Dusky darter **I**	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1
Poeciliidae	(livebearers)																			
Gambusia affinis	Western mosquitofish **T**	8	3	53	1	18	74	--	6	134	--	12	194	21	7	55	123	303	92	1,104
Poecilia formosa	Amazon molly	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3
Poecilia latipinna	Sailfin molly **T**	--	10	--	--	3	--	--	--	--	--	--	--	--	2	--	--	13	--	28
Sciaenidae	(drums/croakers)																			
Micropogonias undulatus	Atlantic croaker **I**	--	54	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	54
Soleidae	(soles)																			
Trinectes maculatus	Hogchoker	--	--	--	1	2	3	10	7	3	--	--	--	--	--	--	--	--	--	26
Syngnathidae	(pipefishes)																			
Syngnathus louisianae	Chain pipefish	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
Number of fish		527	570	148	27	188	342	65	96	319	14	156	280	102	169	116	217	398	381	4,115
Number of fish species		8	22	13	12	16	17	7	13	17	7	15	12	12	12	10	8	10	13	46

[1]Tolerance classification and non-native status from Linam and Kleinsasser (1998).

Appendix 8—Fish-Community Data and Computed Metrics

Appendix 8. Fish-community data and computed metrics for representative reach at each of six sites in Mustang Bayou near Houston, Texas, September 2004–August 2005.

[--, no value; n/a, not applicable]

Metric	Site and survey																	
	M1			M2			M3			M4			M5			M6		
	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005	SEP 2004	APR 2005	AUG 2005
Species richness and composition																		
Number of species	8	22	12	12	16	17	7	13	17	7	15	12	12	12	10	8	10	13
Menhinick's species diversity index	.35	.89	1.07	2.31	1.17	1.14	.87	1.33	.95	1.87	1.20	.72	1.19	.92	.93	.54	.50	.67
Sorensen's index of similarity	.50	.53	.53	.63	.76	.47	.71	.71	.62	.53	.67	.64	.70	.73	.61	--	--	--
Number of native cyprinid species	0	0	0	0	1	0	0	2	2	1	2	0	2	2	1	2	2	2
Number of darter species	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Number of sunfish species	2	4	5	4	4	6	4	4	4	4	5	5	5	4	4	5	3	7
Number of sucker species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of intolerant species	1	2	0	0	1	1	0	1	3	1	1	1	0	1	0	0	0	0
Number of intolerant individuals	4	55	0	0	4	10	0	2	4	3	1	2	0	2	0	0	0	0
Percentage of intolerant individuals	23.53	75.34	0	0	8.89	10.42	0	4.08	2.78	33.33	3.33	.96	0	1.65	0	0	0	0
Number of tolerant species	3	6	3	4	6	6	2	6	4	2	7	3	5	7	5	5	6	7
Number of tolerant individuals	13	18	59	9	41	86	14	47	140	6	29	206	45	119	82	182	348	215
Percentage of individuals as tolerant species	76.47	24.66	100.0	100.0	91.11	89.58	100.0	95.92	97.22	66.67	96.67	99.04	100.0	98.35	100.0	100.0	100.0	100.0
Percentage of individuals as tolerant species (excluding western mosquitofish)	55.56	21.43	100.0	100.0	85.18	54.54	100.0	93.35	60.00	66.67	94.44	85.71	100.0	98.24	100.0	100.0	100.0	100.0
Percentage of individuals as dominant species	70.40	55.61	35.81	40.74	42.02	34.80	27.69	21.88	42.01	28.57	26.28	69.28	27.45	46.75	47.41	56.68	76.13	29.66
Trophic composition																		
Number of individuals as omnivores	379	30	4	4	23	5	18	7	4	0	16	0	2	3	0	0	17	0
Percentage of individuals as omnivores	71.92	5.26	2.70	14.81	12.24	1.46	27.69	7.29	1.25	0	10.26	0	1.96	1.78	0	0	4.27	0
Number of individuals as benthic invertivores	143	209	131	19	153	333	44	75	315	12	131	271	91	160	101	200	368	301
Number of benthic invertivore species	4	13	8	7	9	11	5	9	15	6	10	9	8	8	7	6	6	8
Percentage of individuals as benthic invertivores	27.13	36.67	88.51	70.38	81.38	97.37	67.69	78.13	98.75	85.71	83.97	96.79	89.22	94.67	87.07	92.17	92.46	79.00
Number of individuals as piscivores	5	331	13	4	12	4	3	14	0	2	9	9	9	6	15	17	13	80
Percentage of individuals as piscivores	.95	58.07	8.79	14.81	6.38	1.17	4.62	14.58	0	14.29	5.77	3.21	8.82	3.55	12.93	7.83	3.27	21.00
Fish abundance and condition																		
Total number of individuals	527	570	148	27	188	342	65	96	319	14	156	280	102	169	116	217	398	381
Number of individuals per seine haul	56.4	101.4	n/a	.5	5.0	4.4	.5	4.2	2.8	1.3	9.7	4.5	11.2	22.8	n/a	12.8	55.4	4.8
Number of individuals per minute electrofishing	11.2	3.6	9.9	1.3	9.0	21.3	3.4	3.6	20.3	.6	4.5	16.7	3.0	3.5	7.6	10.8	6.9	22.5
Percentage of individuals as non-native species	0	0	0	0	0	0	0	0	0	0	.64	0	0	0	0	0	0	0
Percentage of individuals as hybrids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16.8
Percentage of individuals with disease or other anomaly	0	0	0	0	0	0	3.1	0	0	0	0	.4	1.0	0	0	0	0	.5

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