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Water-Quality Characteristics of Urban Storm Runoff at Selected Sites in East Baton Rouge Parish, Louisiana, February 2006 through November 2009

Scientific Investigations Report 2011–5199
Revised December 2011

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

Front cover: Photograph of urban creek located in southeastern East Baton Rouge Parish, Louisiana. Photograph by C. Paul Frederick, U.S. Geological Survey.

Back cover: Photograph of Interstate–12 bridge across the Mississippi River at Baton Rouge, Louisiana. Photograph by C. Paul Frederick, U.S. Geological Survey.

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KEN SALAZAR, Secretary

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Conversion Factors

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
gallon (gal)	0.003785	cubic meter (m^3)
	Mass	
pound per year (lb/yr)	0.4536	kilogram per year (kg/yr)
	Application rate	
pounds per acre per year [(lb/acre)/yr]	1.121	kilograms per hectare per year [(kg/ha)/yr]

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

$$°F=(1.8\times°C)+32$$

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

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

Colonies per 100 milliliters (cols/100 mL).

Water-Quality Characteristics of Urban Storm Runoff at Selected Sites in East Baton Rouge Parish, Louisiana, February 2006 through November 2009

By C. Paul Frederick

Abstract

Water samples were collected at three watersheds in East Baton Rouge Parish, Louisiana, during February 2006 through November 2009 for continued evaluation of urban storm runoff. The watersheds represented land uses characterized predominantly as established commercial, industrial, and residential. The following water-quality data are reported: physical and chemical-related properties, fecal coliform, nutrients, trace elements, and organic compounds. Results of water-quality analyses enabled calculation of event-mean concentrations and estimated annual contaminant loads and yields of storm runoff from nonpoint sources for 12 water-quality properties and constituents.

Lead met or exceeded the U.S. Environmental Protection Agency Maximum Contaminant Level of 15 micrograms per liter for drinking water standards in 4 of 14 samples. Low level concentrations of mercury were detected in all 14 samples, and half were two to four times above the reporting limit of 0.02 micrograms per liter. The average dissolved phosphorus concentrations from each land use were two to four times the U.S. Environmental Protection Agency criterion of 0.05 milligrams per liter. Diazinon was detected in one sample at a concentration of 0.2 micrograms per liter.

In the residential watershed, the largest at 216 acres, contaminant loads for 5 of the 12 water-quality properties and constituents were highest, with 4 of these being nutrients. The industrial watershed, 97 acres, had the highest contaminant loads for 6 of the 12 water-quality properties and constituents with 3 of these being metals, which is indicative of the type of land use. Zinc had the highest metal load (155 pounds per year) in the industrial watershed, compared to 36 pounds per year in the residential watershed, and 32 pounds per year in the established commercial watershed.

The industrial watershed had the highest yields for 8 of the 12 water-quality properties and constituents, whereas the established commercial watershed had the lowest yield for 5 of the 12. Lower yields from the established commercial and residential watersheds could be from Best Management Practices in place that help control increased runoff from impervious areas and land development. Metal yields from all the watersheds were less than 1 pound per acre per year, except for the zinc from the industrial watershed, which was 2 pounds per acre per year. Nutrient yields in the established commercial watershed were lowest for total nitrogen, ammonia plus organic nitrogen (Kjeldahl nitrogen), and dissolved phosphorus.

Introduction

Since the 1960's, urban storm runoff has been known to have potentially adverse effects on the water quality of receiving waters. The work of Weibel and others (1964) and Makepeace and others (1995) indicated that elevated concentrations of various chemical constituents were present in urban storm runoff. During dry periods, contaminants accumulate on land surfaces until they are mobilized by precipitation, washed into the urban drainage system, and eventually discharged into receiving waters as storm runoff. Generally, the contaminants carried by storm runoff do not come from a single identifiable source but from multiple or diffuse sources and are referred to as nonpoint-source contamination. The volume of urban storm runoff may increase as metropolitan areas expand and as rural land is developed for residences, commercial businesses, industrial facilities, shopping centers, and recreational areas.

The Federal Clean Water Act, which was amended in 1987, mandated that the U.S. Environmental Protection Agency (USEPA) develop a permitting program to mitigate nonpoint-source contamination in urban storm runoff. Consequently, Federal stormwater regulations (U.S. Environmental Protection Agency, 1991), in accordance with the permit application process of the National Pollutant Discharge Elimination System (NPDES), require cities that have a population of 100,000 or more to characterize the quantity and quality of their storm runoff. In 2009, the estimated population of the Baton Rouge metropolitan area was 435,000 (U.S. Census Bureau, 2009).

The urban storm-runoff regulations mandated by the USEPA require continued monitoring of data collection sites following their initial characterization for quantity and quality of storm runoff by the City of Baton Rouge, East Baton Rouge Parish. As in any metropolitan area, Municipal Storm-Sewer Systems (MS4) have been installed to provide drainage for developed areas. Although discharge from the MS4 often has lower concentrations of many pollutants than discharge from industrial and municipal wastewater, the pollutant concentrations associated with discharge from the MS4 can have significant effects on water quality. To meet technical data requirements of the USEPA stormwater permit application for the Baton Rouge metropolitan area, the U.S. Geological Survey (USGS) entered into a cooperative agreement with the City of Baton Rouge and East Baton Rouge Parish government in 1992. With this agreement, a data-collection network was established to characterize the quantity and quality of urban storm runoff from watersheds in different land-use areas within East Baton Rouge Parish. From 1993 to 1995, the USGS collected data used for the initial characterization of storm runoff quantity and quality for the city/parish as required by the USEPA. In 1997, this information (Demcheck and others, 1998) was used for the design of Phase I representative sampling as required by USEPA under the NPDES Permit No. LAS000101. When the original permit was issued in 1997, the incorporated areas of Baker and Zachary (fig. 1) were not regulated MS4s. However, the 2000 U.S. Census-defined Baton Rouge Urbanized Area included the incorporated areas of Baker and Zachary in the regulated area, and as such, they are required to obtain permit coverage for their MS4s. The city/parish has assumed responsibility for complying with the Phase II stormwater-program requirements for the areas of Baker and Zachary. Data collected by the USGS during 1998–2002 (Frederick, 2003) were used to modify the design of Phase II representative sampling and include these previously unregulated MS4s.

Purpose and Scope

This report describes continued evaluation of water-quality characteristics of urban storm runoff from watersheds that represent different types of land use in East Baton Rouge Parish. Three sites were selected in established commercial, industrial, and residential land uses. Streamflow and water-quality data collected at these three sites during storm events are presented. Fourteen samples were collected during February 2006 through November 2009. Phase II representative sampling for this study consisted of a smaller set of water-quality properties and constituents than in the initial characterization of storm runoff. The reported water-quality properties and constituents include physical and chemical-related properties, fecal-coliform indicator bacteria, nutrients, trace metals, and organic compounds. The smaller set provided data useful for generating long-term averages and trends of the collected constituents, along with the amount of storm runoff at each site. Urbanization can change the natural flow of surface water and intrude more sediment, nutrients, and contaminants to the environment. The USGS monitored selected sites to gather information on water-quality conditions in urban watersheds, which could aid other communities in similar environmental settings.

General Description of Study Area

East Baton Rouge Parish (fig. 1) covers an area of approximately 293,000 acres between the Mississippi River and the Amite River. The parish has an extensive levee system along the Mississippi River; therefore, no substantial drainage occurs from East Baton Rouge Parish into the Mississippi River. Most of the parish is within the watershed of the Amite River. The Amite River generally flows southeastward to Lake Maurepas, Lake Pontchartrain, and the Gulf of Mexico.

The climate of East Baton Rouge Parish is humid-subtropical, but subject to continental polar fronts during the winter. Warm, moist air from the Gulf of Mexico provides abundant moisture during late spring and summer. The summer is characterized by hot temperatures and intense but brief thunderstorms generating greater amounts of runoff than in winter. The fall, late September through November, is usually warm and relatively dry. The winter is generally cool and mild. Winter rainfall associated with passing cold fronts can last hours or days, but is less intense than in summer, and the ground may remain saturated for days (J.M. Grymes III, Louisiana Office of State Climatology, written commun., 1993).

Methods of Study

Phase II representative sampling consisted of a smaller set of water-quality properties and constituents as compared to the initial 1997 characterization sampling. Results of the phase II representative sampling and water-quality analyses were used to determine event-mean concentrations (EMCs) and calculate estimated annual contaminant loads and yields for 12 selected water-quality properties and constituents in storm runoff. The EMC was determined by averaging constituent concentrations from the flow-weighted composite samples collected for all storms at each site.

Sampling Criteria

Discharge permit regulations stipulate that runoff must be sampled from a storm greater than 0.1 inch (in.) in magnitude that occurs at least 72 hours from the previously measurable storm (Louisiana Department of Environmental Quality, 2004, part. V, p. 7.4.c). The 72-hour storm interval is waived where discharge is not measurable and rainfall is less than 0.1 in. during the sampling period. Also, for this permit, two sampling periods were defined for this geographic region: November to April and May to October.

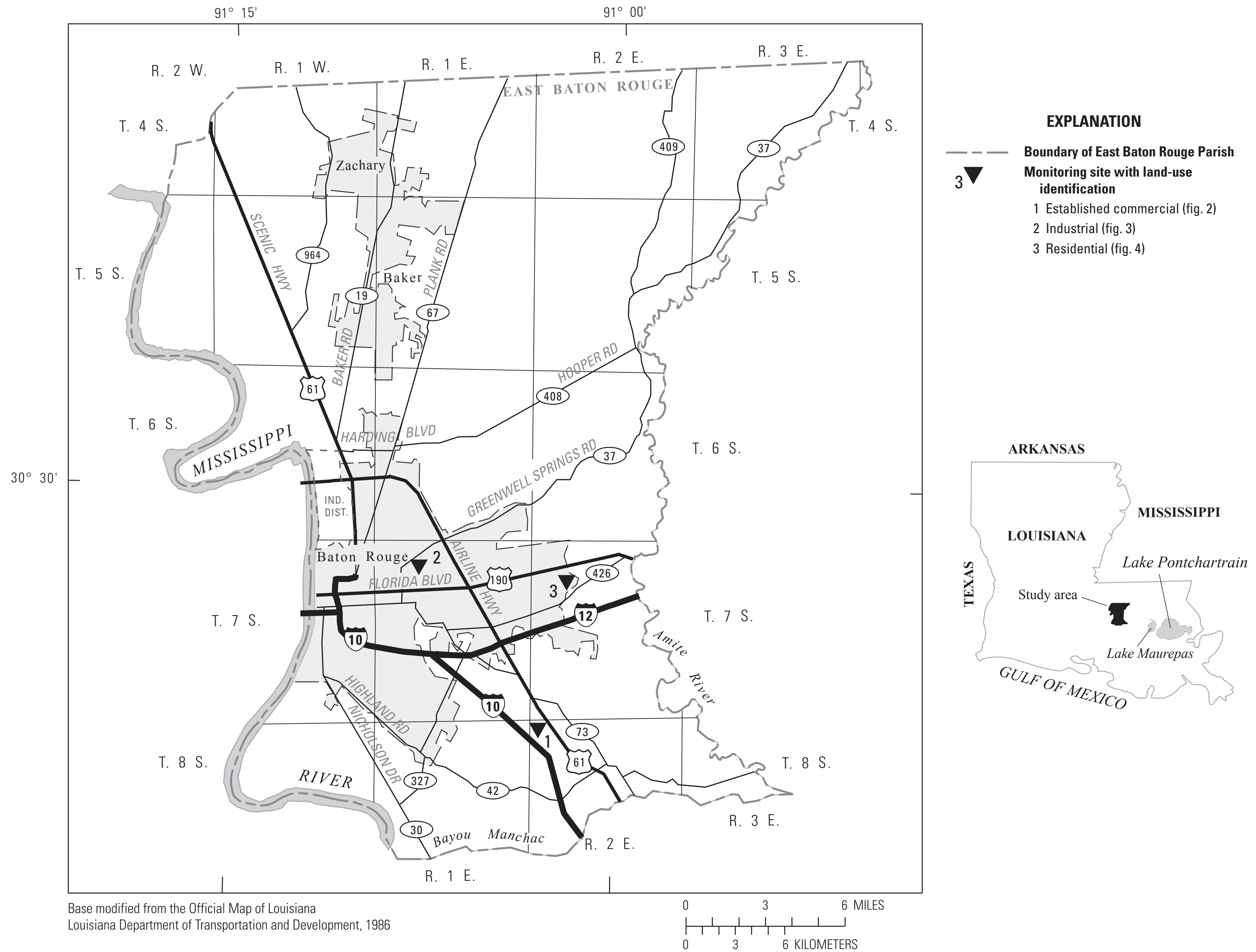

Figure 1. Sites in the storm-runoff monitoring network for East Baton Rouge Parish, Louisiana, 2006–9.

Site Selection

Phase II representative sampling comprises the same land uses that represented established commercial, industrial, new commercial, residential, and highway. The new commercial site in Phase I representative sampling was redesignated as established commercial for Phase II representative sampling by mutual agreement with the city/parish and the USGS. No new major development has occurred within this watershed for over 10 years.

With the addition of the two unregulated MS4s, a new commercial area was chosen in the town of Zachary. However, during the process of establishing a stage-discharge rating, the monitoring station was damaged during Hurricane Rita in 2005 and again by Hurricane Gustav in September 2008. The highway monitoring station established for Phase II sampling was moved to a new location because of high incidence of crime in the area and vandalism to the station. No data were collected for these two land-use sites.

Watershed size is an important factor in site selection. The watershed has to be large enough to provide a minimum 3-hour discharge period for storm runoff but small enough to represent a single dominant land use. To meet these requirements, the selected watersheds are at least 90 acres but no more than 220 acres.

Data Collection and Analysis

Predicting storm characteristics was very difficult. A relation between the amount of precipitation that fell on each watershed and the volume of runoff discharged from each watershed was determined. This relation was used to program automatic samplers during the Phase II representative sampling so that subsamples could be collected and composited to be representative of flow, while ensuring that the capacity of the samplers would not be exceeded during the initial 3 hours of sustained discharge. If the discharge duration was less than 3 hours, subsamples of the discharge were collected until the volume of runoff diminished, or the level of the stream declined below the sample intake line. A lot of trial and error went into programming equipment for each watershed to ensure adequate sample collection.

The water-quality-data-collection network consisted of three monitoring sites that received storm runoff from three watersheds (fig. 1). A monitoring station was constructed at each of the three sites and equipped with a rain gage, data logger, and sampler. Each sampler was programmed according to individual watershed characteristics such as size, amount of impervious area, and land use. Trigger thresholds were programmed for each site. A tipping-bucket rain gage installed at each site transmitted a pulse to the data logger each time 0.01 in. of rainfall was collected. When 0.1 in. of rainfall fell in 0.5 hours or a predetermined stage was reached, the data logger activated the sampler to collect a 0.2-gallon (gal) subsample. This process continued until the capacity of the sampler was met or the volume of runoff diminished. Aeration and exposure of samples to contamination during sample collection were minimized by use of a peristaltic pump. The result was a representative sample proportionally equivalent to the volume of storm runoff from that watershed. To be considered a representative sample, at least a 2-gal sample was collected. The subsamples were stored onsite in as many as four 1-gal containers during the collection process. Once sampling was completed, the four 1-gal containers were removed, chilled, and transported to the USGS laboratory in Baton Rouge for processing and preservation.

Streamflow

Gage height was measured and recorded at each monitoring station using a pressure-sensitive, bubbler-regulated stage gage. The bubbler regulator maintained a constant rate of air flowing through a tube that extended from the monitoring station to an orifice at the bottom of the channel. As stage rose, greater pressure was required to maintain a constant flow rate through the tube. Pressure changes were measured, converted to gage height, and recorded by the data logger. Gage-height measurements with this system are affected minimally by rapid changes in temperature.

Streamflow and storm-runoff volumes were quantified at each monitoring station using a stage-discharge rating. Manual discharge measurements were made at various gage heights using a Price AA meter and the 0.6-depth method (Buchanan and Somers, 1969; Rantz and others, 1982). The various gage heights and their respective discharges were entered into the data logger, and a three-point interpolation method was used to create the stage-discharge rating. Using this stage-discharge rating, the data logger then computed instantaneous discharge and total discharge during an entire storm.

Water Quality

All water samples collected for each storm at each site were composited with a Teflon churn. The churn was used to prepare representative flow-weighted composite subsamples for the appropriate chemical analyses. Samples for dissolved inorganic, nutrient, and trace-element analyses were passed through 0.45-micrometer nitrocellulose filters and treated with the appropriate preservative(s) for later analysis at the USGS National Water-Quality Laboratory in Denver, Colorado, using methods described by Fishman and Friedman (1989). Oil and grease samples were collected in a 1-liter glass amber bottle and preserved using methods described by Wershaw and others (1987).

During the first hour of storm runoff, project personnel collected measurements of specific conductance, pH, alkalinity, water temperature, dissolved oxygen, and a grab sample of oil and grease. Samples for analysis of fecal coliform were collected in a sterilized glass bottle and processed within

4 hours (appendixes 1A–1C). Fecal-coliform indicator bacteria samples were analyzed at the USGS laboratory in Baton Rouge using the membrane-filter method described by Britton and Greeson (1988). These constituents and samples were collected by wading the stream or from bank's edge.

Quality Assurance and Quality Control

The purpose of the quality assurance and control procedures was to ensure the accuracy of the data. These procedures included the collection of a replicate sample and an equipment-blank sample. During the sample-splitting process, a replicate storm-runoff sample was collected simultaneously to check the precision of laboratory techniques and sample splitting. One replicate sample was processed on April 26, 2006, from the industrial site. An equipment blank of inorganic-free and organic-free water was passed through sample-collection equipment to ensure proper cleaning of all equipment in contact with previous storm-runoff samples. Replicate and equipment-blank samples were preserved and processed in the same manner as storm-runoff samples. Standard forms were developed and used to document field-data collection, to request analytical services, and to provide a chain of custody when shipping water samples.

Calculation of Estimated Annual Contaminant Load

An equation referred to as the "simple method" (U.S. Environmental Protection Agency, 1992), adapted from Schueler (1987), was used to estimate annual contaminant loads for urban watersheds in East Baton Rouge Parish. The "simple method" is described in detail and provides a quick and reasonable estimate of loads for the NPDES Permit (U.S. Environmental Protection Agency, 1992, sect. 5.4.3, p. 514). Values of annual rainfall, watershed characteristics, and a selected water-quality concentration are used in the equation to estimate annual contaminant loads. The "simple method" equation for estimation of annual contaminant loads in storm runoff is:

$$L_i = \left[\frac{(P)(CF)(Rv_i)}{12}\right](C_i)(A_i)(2.72)$$

where

L_i is annual contaminant load for site i, in pounds per year;
P is average annual precipitation, in inch per year;
CF is a correction factor that adjusts for storms where no runoff occurs (a value of 0.9 was used);
Rv_i is runoff coefficient for the watershed of site i;
C_i is average event-mean concentration (EMC) of contaminant at site i, in milligrams per liter; and
A_i is watershed area for site i, in acres.

Watershed Characteristics and Site Description

The frequency of sampling for the selected watersheds was determined by the occurrence of storms. Rainfall data obtained for the period 2005–9, showed that East Baton Rouge Parish had an average annual rainfall of 54.5 in., 8.6 in. below the 30-year normal average (1971–2000) of 63.1 in. (J.M. Grymes III, WAFB, written commun., 2010). Based on yearly totals for 2005–8, rainfall data showed a deficit of almost 10 in. below the 30-year average, whereas the 2009 yearly total was 1.2 in. above the 30-year average, with greater than 29 in. of rain measured from October to December.

East Baton Rouge Parish consists of about 20.8 percent developed land (table 1). About 1.75 percent of the developed land is established commercial; 2.3 percent is industrial; and 16.7 percent is residential (Wilbur Smith Associates, 1992). Runoff coefficients used for the three watersheds are presented in table 1.

The three sites selected to represent the watersheds were located in areas that were safely accessible during storms and darkness. At each site, the channel type was documented, as well as any culverts, ditches, and drains that control flow. Project personnel extensively surveyed the watersheds using city and parish maps and onsite observations to determine acreage, land use, and directions of drainage.

Site 1, located in an established commercial area of East Baton Rouge Parish, was at an open-channel, concrete-lined drainage canal (fig. 2). The site received storm runoff from a 96-acre watershed through drains located along Industriplex Boulevard, Sunbelt Court, and Exchequer Drive, as well as small ditches. Runoff from five storms was collected at this site.

Table 1. Coefficient used in the computation of annual contaminant load and summary of land use in East Baton Rouge Parish, Louisiana.

Primary land use[1]	Land use for East Baton Rouge Parish (1988)[2]		Runoff coefficient (Rv_i) for network watershed
	Acres	Percent of total	
Established commercial	4,900	1.75	0.99 (site 1)
Industrial	6,500	2.30	.81 (site 2)
Residential	47,400	16.7	.39 (site 3)
TOTAL[3]	58,800	20.8	N/A[4]

[1] Land used for agriculture is not included in this summary.

[2] Land-use summary from Wilbur Smith Associates (1992).

[3] Rounded number.

[4] N/A, not applicable.

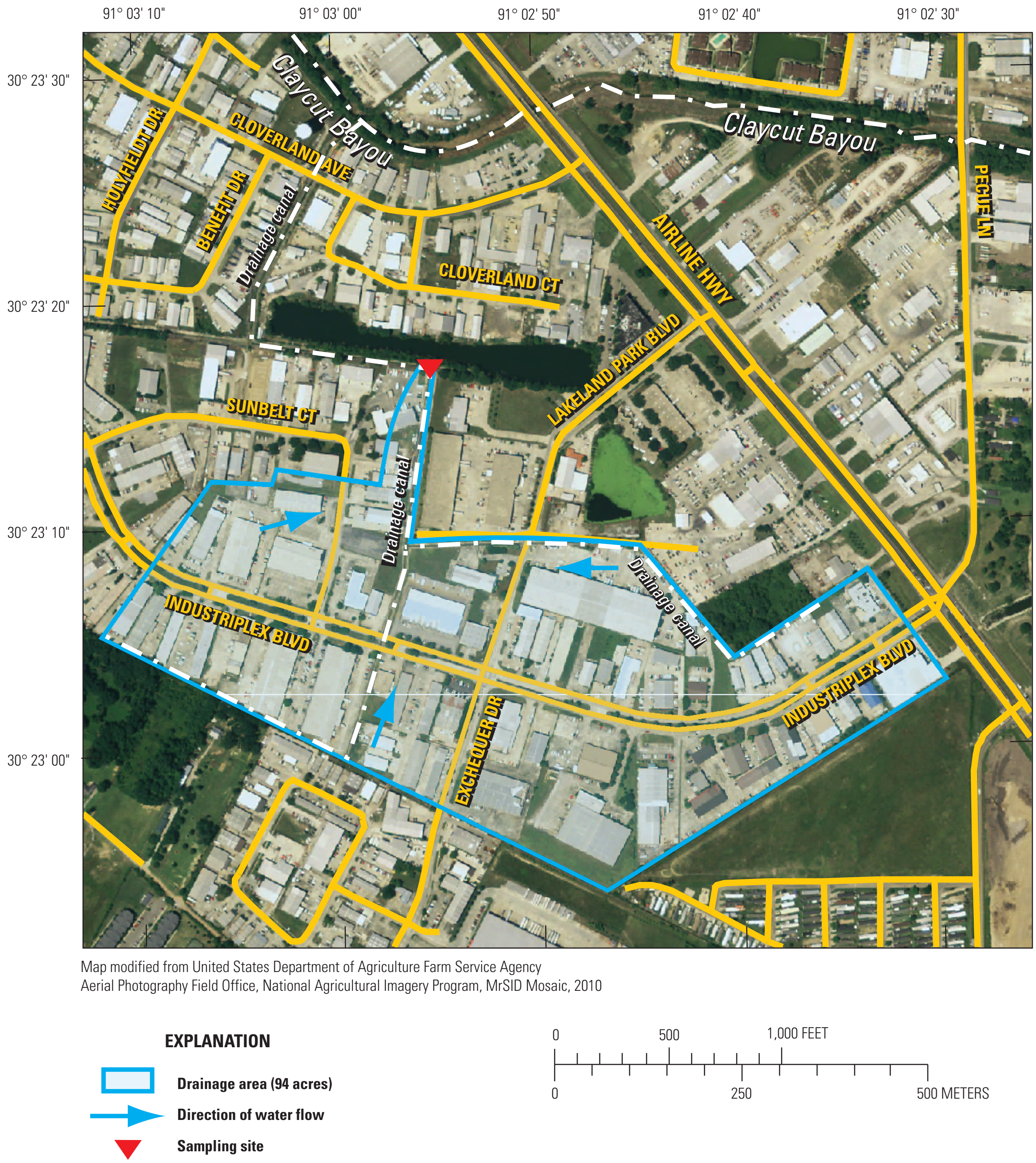

Figure 2. Established commercial land-use area, Sunbelt Court, Baton Rouge, Louisiana, 2006.

Site 2, located in the industrial land-use area, was at an open-channel, unlined drainage canal at Tom Drive, 0.1 mi east of Wooddale Boulevard (fig. 3). The sampling site was downstream from a double 7- by 5-ft box culvert at Tom Drive. The drainage canal received storm runoff from a 97-acre watershed through storm drains located along Wooddale Boulevard, South Choctaw Drive, Tom Drive, and at various industrial businesses, warehouses, and distribution centers. Runoff from four storms was collected at this site.

Site 3, located in the residential land-use area, was at an open-channel, concrete-lined drainage canal at Goodwood Boulevard, about 0.5 mi east of South Sherwood Forest Boulevard (fig. 4). The drainage canal received storm runoff from a 216-acre watershed through storm drains underlying streets. The sampling site was just upstream from a double 9- by 7-ft box culvert under Goodwood Boulevard. Most of the storm drains in this watershed were built from the late 1960's to early 1970's. This area included mostly single-family residences. Runoff from five storms was collected at this site.

Water-Quality Characteristics of Urban Storm Runoff

A total of 14 water-quality samples were collected from the three watersheds in East Baton Rouge Parish during February 2006 through November 2009. Results of the water-quality analyses are listed in appendixes 1A–1C, and the minimum reporting levels of selected water-quality properties and constituents are listed in appendix 2.

A summary of water-quality data from the established commercial land-use is presented in appendix 1A. Nutrient concentrations for total nitrogen ranged from 0.4 to 1.0 mg/L; ammonia plus organic (Kjeldahl) nitrogen, 0.5 to 1.1 mg/L; total phosphorus, 0.2 to 0.4 mg/L; and dissolved phosphorus, 0.1 to 0.3 mg/L. Fecal coliform bacteria are used as indicators of the sanitary conditions of waters because they originate from the intestinal tracts of warm-blooded animals (U.S. Environmental Protection Agency, 1986). Fecal coliform concentrations from three storm events ranged from 2,900 to 6,700 colonies per 100 milliliters (cols/100 mL). Bacteria analyses for the February 02, 2006, and October 30, 2009, storms were unsuccessful because of incubation problems. Lead was detected in four of the five samples, with concentrations ranging from 2.5 to 7 µg/L. No samples exceeded the USEPA Maximum Contaminant Level (MCL) of 15 µg/L for drinking water. Mercury was detected in all five samples with concentrations at or two times the reporting level of 0.02 µg/L. Copper was detected in all five samples, with only one slightly above the reporting level of 10 µg/L. Cadmium was not detected. Diazinon, widely used as a general-purpose insecticide for lawn and gardens, was not detected in any of the samples. Although diazinon was banned from retail sales as of December 31, 2004, consumers may use diazinon if purchased prior to the aforementioned date, provided they follow all label directions (U.S. Environmental Protection Agency, 2005). Oil and grease was detected in four of the five samples with concentrations less than 8 mg/L. Oil and grease is an indicator that oils and petrochemicals were present, but could include thousands of organic compounds, making it difficult to set any criteria. Total polychlorinated biphenyls (PCBs) were not detected.

A summary of water-quality data from the industrial land-use is presented in appendix 1B. Nutrient concentrations for total nitrogen ranged from 1.0 to 1.6 mg/L; ammonia plus organic (Kjeldahl) nitrogen, 1.1 to 2.4 mg/L; total phosphorus, 0.2 to 0.5 mg/L; and dissolved phosphorus, 0.05 to 0.3 mg/L. Fecal coliform bacteria concentrations ranged from 640 to 14,000 cols/100 mL. Lead was detected in all four samples at concentrations ranging from 13 to 50 µg/L, with three samples exceeding the MCL of 15 µg/L. Mercury was detected in all four samples with concentrations two to four times the reporting level of 0.02 µg/L. Cadmium was not detected. Copper was detected in all four samples. Three concentrations were just above the reporting level with one concentration nearly three times the reporting level of 10 µg/L. Diazinon was not detected. Oil and grease was detected three times, one with a concentration at 8 mg/L, and two, less than 7 mg/L. PCBs were not detected.

A summary of water-quality data from the residential land-use is presented in appendix 1C. Nutrient concentrations for total nitrogen ranged from 1.3 to 2.0 mg/L; ammonia plus organic (Kjeldahl) nitrogen, 1.3 to 2.2 mg/L; total phosphorus, 0.3 to 0.5 mg/L; and dissolved phosphorus, 0.2 mg/L. Fecal coliform bacteria concentrations from two storm events ranged from 130,000 to 150,000 cols/100 mL. These high concentrations may be because of small leaks that have developed because of the age of the sewer lines underlying streets and homes. Bacteria analyses for the February 02, 2006, March 26, 2009, and October 30, 2009, storms were unsuccessful incubation problems. Cadmium was not detected. Lead was detected in four of the five samples with none exceeding the MCL of 15 mg/L. Mercury was detected in all five samples with concentrations two to three times the reporting level of 0.02 µg/L. Diazinon was detected in one sample at a concentration of 0.2 µg/L. Oil and grease was detected four times with all concentrations less than 7 mg/L. No PCBs were detected.

Average Event Mean Concentrations for Selected Properties and Constituents

The average EMCs of 12 properties and constituents for which estimated annual contaminant loads were calculated are listed in table 2. The industrial land-use site had the highest average EMCs in 5 of the 12 properties and constituents, including copper, lead, and zinc. The average EMCs of these three metals were more than three times the other land-use sites. The residential land-use site had the highest average EMCs for total suspended solids, 130 mg/L, and two nutrients: ammonia plus organic nitrogen (Kjeldahl nitrogen), 1.7 mg/L;

Figure 3. Industrial land-use area, Tom Drive, Baton Rouge, Louisiana, 2006.

Figure 4. Residential land-use area, Goodwood Boulevard, Baton Rouge, Louisiana, 2006.

Table 2. Average event-mean concentration for selected water-quality properties and constituents for three land-use areas within a storm-runoff monitoring network in East Baton Rouge Parish, Louisiana, 2006–9.

[Concentrations are in milligrams per liter. °C, degrees Celsius; ROE, residue on evaporation; <, less than]

Water-quality property or constituent	Average event-mean concentration		
	Established commercial	Industrial	Residential
Biochemical oxygen demand, 5 day	6.7	6.4	5.3
Chemical oxygen demand	27	67	49
Total dissolved solids, ROE at 180°C	54	98	49
Total suspended solids, residue at 105°C	93	105	130
Nitrogen, total as N	.7	1.6	1.6
Nitrogen, ammonia plus organic (Kjeldahl), total as N	.8	1.5	1.7
Phosphorus, total as P	.2	.3	.4
Phosphorus, dissolved as P	.1	.2	.2
Cadmium, total recoverable as Cd	<.001	<.001	<.001
Copper, total recoverable as Cu	.01	.02	.005
Lead, total recoverable as Pb	.004	.03	.01
Zinc, total recoverable as Zn	.05	.16	.03

and total phosphorus, 0.4 mg/L. The established commercial land-use site had the lowest average EMCs for total suspended solids, 93 mg/L, and the four nutrients: total nitrogen, 0.7 mg/L; ammonia plus organic nitrogen, 0.8 mg/L; total phosphorus, 0.2 mg/L; and dissolved phosphorus, 0.1 mg/L. The average dissolved phosphorus concentrations from each land use were two to four times the USEPA criterion of 0.05 mg/L.

Estimated Annual Contaminant Load and Yields for Selected Properties and Constituents

Estimated annual contaminant loads and yields for selected watersheds are listed in table 3. Generally, a larger watershed could lead to greater annual loading of contaminants, but that is not the case when comparing annual loads from each of the watersheds. In the residential watershed, the largest at 216 acres, contaminant loads for 5 of the 12 water-quality properties and constituents were highest, with 4 of these being nutrients. The higher nutrient loads could be from the amount of fertilizers used by residents in their yards and gardens. The industrial watershed, at 97 acres, had the highest contaminant loads for 6 of the 12 water-quality properties and constituents with 3 of these being metals, which is indicative of this land-use type. Zinc had the highest metal load (155 pounds per year [lbs/yr]) in the industrial watershed, compared to 36 lbs/yr in the residential watershed, and 32 lbs/yr in the established commercial watershed. In the established commercial watershed, the smallest at 96 acres, estimated annual contaminant loads were the lowest of all the watersheds.

Table 3. Estimated annual contaminant loads and yields for selected water-quality properties and constituents for three land-use areas within a storm-runoff monitoring network in East Baton Rouge Parish, Louisiana, 2006–9.

[Loads are in pounds per year. Yields are in pounds per acre per year. °C, degrees Celsius; ROE, residue on evaporation; <, less than]

Water-quality property or constituent	Annual loads and yields for watersheds					
	Established commercial		Industrial		Residential	
	Load	Yield	Load	Yield	Load	Yield
Biochemical oxygen demand, 5 day	4,070	42	6,210	64	5,510	26
Chemical oxygen demand	16,300	170	65,000	671	51,000	236
Total dissolved solids, ROE at 180°C	32,900	343	102,000	1,050	51,200	237
Total suspended solids, residue at 105°C	56,500	588	95,300	982	135,000	627
Nitrogen, total as N	424	4	1,580	16	1,670	8
Nitrogen, ammonia plus organic (Kjeldahl), total as N	457	5	1,460	15	1,800	8
Phosphorus, total as P	154	2	309	3	418	2
Phosphorus, dissolved as P	87	<1	141	1	230	1
Cadmium, total recoverable as Cd	<1	<1	<1	<1	<1	<1
Copper, total recoverable as Cu	4	<1	18	<1	7	<1
Lead, total recoverable as Pb	2	<1	25	<1	9	<1
Zinc, total recoverable as Zn	32	<1	155	2	36	<1

The industrial watershed had the highest yields for 8 of the 12 properties and constituents, whereas the established commercial watershed had the lowest yields for 5 of the 12. Higher concentrations of contaminants in soils can result in higher yields from smaller watersheds. Intense rainfall events can generate greater volumes of runoff that can bring contaminants into suspension if they are present in soils and streambeds. Longer antecedent dry periods between sampled storm events could result in more accumulation of metals and nutrients within each watershed. Lower yields from the established commercial and residential watersheds could be from Best Management Practices in place that help control increased runoff from impervious areas and land development. Metal yields from all the watersheds were less than 1 pound per acre per year (lb/acre/yr), except for the zinc from the industrial watershed, which was 2 lbs/acre/yr. Nutrient yields in the established commercial watershed were lowest for total nitrogen, ammonia plus organic nitrogen (Kjeldahl nitrogen), and dissolved phosphorus.

Analysis of Quality-Control Data

One equipment blank was processed and analyzed using the same protocols and reporting levels as the stormwater samples. Results indicated all constituent concentrations were less than reporting levels. A replicate sample for trace metals and nutrients was collected from the industrial land-use site on April 26, 2006. Stormwater and replicate analyses are presented in table 4.

Table 4. Analysis of quality-control data for the industrial land-use area in East Baton Rouge Parish, Louisiana, April 26, 2006.

[mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than]

Constituent	Concentrations (nutrients, mg/L; trace metals, µg/L)	
	Stormwater	Replicate
Nitrogen, total as N	1.1	1.1
Phosphorus, total as P	.27	.27
Phosphorus, dissolved. as P	.13	.14
Cadmium, total recoverable as Cd	<1	<1
Copper, total recoverable as Cu	16	15
Lead, total recoverable as Pb	22	22
Nickel, total recoverable as Ni	5.2	5.0
Zinc, total recoverable as Zn	148	145

Summary

Water samples were collected at three watersheds in East Baton Rouge Parish, Louisiana, during February 2006 through November 2009 for continued evaluation of urban storm runoff. The watersheds represented land uses characterized predominantly as established commercial, industrial, and residential. The following water-quality data are reported: physical and chemical-related properties, fecal coliform bacteria, nutrients, trace elements, and organic compounds. Results of water-quality analyses enabled calculation of average event-mean concentrations and estimated annual contaminant loads and yields of storm runoff for 12 water-quality properties and constituents.

Automatic samplers were used to collect samples of storm runoff for each land use for at least the initial 3 hours of each storm. If the discharge was less than 3 hours, subsamples of the discharge were collected until the volume of runoff diminished, or until the level of the stream declined below the sample intake line. During the first hour of storm runoff, measurements of specific conductance, pH, alkalinity, water temperature, dissolved oxygen, and a grab sample of oil and grease and fecal coliform were collected. Samples for analysis of fecal coliform were collected in a sterilized glass bottle and processed within 4 hours.

Lead met or exceeded the U.S. Environmental Protection Agency Maximum Contaminant Level of 15 µg/L (micrograms per liter) for drinking water standards in 4 of 14 samples. Low level concentrations of mercury were detected in all 14 samples, and half were two to four times above the reporting level of 0.02 µg/L. The average dissolved phosphorus concentrations from each land use were two to four times the U.S. Environmental Protection Agency criterion of 0.05 milligrams per liter. Diazinon, was detected in one samples at a concentration of 0.2 µg/L.

In the residential watershed, the largest at 216 acres, contaminant loads for 5 of the 12 water-quality properties and constituents were highest, with 4 of these being nutrients. The higher nutrient loads could be from the amount of fertilizers used by residents in their yards and gardens. The industrial watershed, at 97 acres, had the highest contaminant loads for 6 of the 12 water-quality properties and constituents with 3 of these being metals, which is indicative of this land-use type. Zinc had the highest metal load of 155 pounds per year (lbs/yr) in the industrial watershed, compared to 36 lbs/yr in the residential watershed, and 32 lbs/yr in the established commercial watershed.

The industrial watershed had the highest yields for 8 of the 12 water-quality properties and constituents, whereas the established commercial watershed had the lowest yield for 5 of the 12. Lower yields from the established commercial and residential watersheds could be from Best Management Practices in place that help control increased runoff from impervious areas and land development. Metal yields from all the watersheds were less than 1 pound per acre per year (lb/acre/yr), except for the zinc from the industrial watershed, which was 2 lbs/acre/yr. Nutrient yields in the established commercial watershed were lowest for total nitrogen, ammonia plus organic nitrogen (Kjeldahl nitrogen), and dissolved phosphorus.

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Appendixes

Appendix 1A. Summary of runoff and water-quality data from a drainage canal at Sunbelt Court in an established commercial land-use area, Baton Rouge metropolitan area, Louisiana, during selected storms, February 2, 2006–October 30, 2009.

[E, Estimated, result is less than reporting limit; ND, Not Detected; --, no data; <, less than] Childress and others (1999)

Water-quality property or constituent	Beginning date of storm				
	02–02–06	10–26–06	10–22–07	11–12–08	10–30–09
Runoff volume					
Discharge (cubic feet)	262,000	346,000	327,000	142,000	315,000
Specific conductance					
Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	73	68	32	150	54
pH and alkalinity					
pH (standard units)	7.0	7.0	6.1	7.5	7.0
Alkalinity, as calcium carbonate (milligrams per liter)	18	23	8.9	55	33
Temperature					
Temperature, water (degrees Celsius)	17.1	21.0	22.3	18.0	19.5
Dissolved oxygen and oxygen demand (milligrams per liter)					
Dissolved oxygen	--	7.2	--	6.9	--
Chemical oxygen demand	42	10	28	36	18
Biochemical oxygen demand, 5-day	7.4	6.8	6.3	6.3	--
Fecal indicator bacteria (colonies per 100 milliliters)					
Fecal coliform, 0.65-micrometer filter	--	6,700	4,700	2,900	--
Dissolved and suspended solids (milligrams per liter)					
Total dissolved solids, residue on evaporation at 180 degrees Celsius	36	57	33	94	51
Suspended solids, residue at 105 degrees Celsius	139	27	230	36	33
Nutrients (milligrams per liter)					
Nitrogen, total as N	1.0	.4	.8	.7	.5
Nitrogen, ammonia plus organic (Kjeldahl), total as N	1.1	.5	.9	.8	.6
Phosphorus, total as P	.3	.2	.2	.4	.2
Phosphorus, dissolved as P	.1	.1	.1	.3	.1
Trace metals (micrograms per liter)					
Cadmium, total recoverable as Cd	<1	<1	<1	<1	<1
Copper, total recoverable as Cu	2.4	5.4	8	10.6	6
Lead, total recoverable as Pb	<1	5.1	7	5.5	2.5
Mercury, total recoverable as Hg	.04	.02	.03	.02	.03
Nickel, total recoverable as Ni	<1	1.5	3	2.3	1.4
Zinc, total recoverable as Zn	9.9	56	89	70	37
Organic compounds					
Oil and grease, total recoverable, gravimetric (milligrams per liter)	<7	<7	<8	ND	E 2.3
Pesticides (micrograms per liter)					
Diazinon, total	<.1	<.1	<.1	<.1	<.1
Polychlorinated biphenyls, total (micrograms per liter)	<.1	<.1	<.1	<.1	<.1

Appendix 1B. Summary of runoff and water-quality data from a drainage canal at Tom Drive in an industrial land-use area, Baton Rouge, Louisiana, during selected storms, April 26, 2006–November 12, 2008.

[ND, Not Detected; --, no data; <, less than] Childress and others (1999)

Water-quality property or constituent	Beginning date of storm			
	04–26–06	10–26–06	10–22–07	11–12–08
Runoff volume				
Discharge (cubic feet)	696,000	541,000	410,000	235,000
Specific conductance				
Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	107	171	134	352
pH and alkalinity				
pH (standard units)	7.8	7.4	7.1	7.2
Alkalinity, as calcium carbonate (milligrams per liter)	22	77	62	149
Temperature				
Temperature, water (degrees Celsius)	21.4	22.4	22.1	19.2
Dissolved oxygen and oxygen demand (milligrams per liter)				
Dissolved oxygen	--	--	--	7.4
Chemical oxygen demand	44	56	84	83
Biochemical oxygen demand, 5-day	6.6	6.1	6.2	6.6
Fecal indicator bacteria (colonies per 100 milliliters)				
Fecal coliform, 0.65-micrometer filter	[a]14,000	3,800	640	760
Dissolved and suspended solids (milligrams per liter)				
Total dissolved solids, residue on evaporation at 180 degrees Celsius	128	129	104	233
Suspended solids, residue at 105 degrees Celsius	60	78	20	58
Nutrients (milligrams per liter)				
Nitrogen, total as N	1.0	1.1	1.1	1.6
Nitrogen, ammonia plus organic (Kjeldahl), total as N	1.3	1.1	1.2	2.4
Phosphorus, total as P	.3	.2	.3	.5
Phosphorus, dissolved as P	.1	.05	.1	.3
Trace metals (micrograms per liter)				
Cadmium, total recoverable as Cd	<1	<1	<1	<1
Copper, total recoverable as Cu	16	14	29	16
Lead, total recoverable as Pb	22	18	50	13
Mercury, total recoverable as Hg	.06	.04	.08	.04
Nickel, total recoverable as Ni	5	4	12	6
Zinc, total recoverable as Zn	148	123	222	142
Organic compounds				
Oil and grease, total recoverable, gravimetric (milligrams per liter)	8	<7	<7	ND
Pesticides (micrograms per liter)				
Diazinon, total	<.1	<.1	<.1	<.1
Polychlorinated biphenyls, total (micrograms per liter)	<.1	<.1	<.1	<.1

[a] Results based on colony count outside the acceptable range (non-ideal colony count) (Britton and Greeson, 1988).

Appendix 1C. Summary of runoff and water-quality from a drainage canal at Goodwood Boulevard in a residential land-use area, Baton Rouge, Louisiana, during selected storms, February 2, 2006–November 30, 2009.

[E, Estimated, result is less than reporting limit; ND, Not Determined; --, no data; <, less than] Childress and others (1999)

Water-quality property or constituent	Beginning date of storm				
	02–02–06	10–26–06	10–22–07	03–26–09	10–30–09
Runoff volume					
Discharge (cubic feet)	415,000	410,000	535,000	482,000	430,000
Specific conductance					
Specific conductance (microsiemens per centimeter at 25 degree Celsius)	44	58	39	75	57
pH and alkalinity					
pH (standard units)	6.6	6.8	6.4	6.9	6.3
Alkalinity, as calcium carbonate (milligrams per liter)	11	20	13	16	20
Temperature					
Temperature, water (degrees Celsius)	17.1	22.1	22.4	19.5	19.5
Dissolved oxygen and oxygen demand (milligrams per liter)					
Dissolved oxygen	--	7.9	6.8	8.2	--
Chemical oxygen demand	48	35	48	60	53
Biochemical oxygen demand, 5-day	6.7	7.1	6.1	1.2	--
Fecal indicator bacteria (colonies per 100 milliliters)					
Fecal coliform, 0.45-micrometer filter	--	[a]150,000	[a]130,000	--	--
Dissolved and suspended solids (milligrams per liter)					
Total dissolved solids, residue on evaporation at 180 degrees Celsius	34	54	47	64	46
Suspended solids, residue at 105 degrees Celsius	99	75	170	90	214
Nutrients (milligrams per liter)					
Nitrogen, total as N	1.5	1.3	1.5	2.0	1.7
Nitrogen, ammonia plus organic (Kjeldahl), total as N	1.6	1.3	1.7	2.2	1.8
Phosphorus, total as P	.4	.3	.4	.5	.4
Phosphorus, dissolved as P	.2	.2	.2	.2	.2
Trace elements (micrograms per liter)					
Cadmium, total recoverable as Cd	<1	<1	<1	<1	<1
Copper, total recoverable as Cu	6	6	7	9	6
Lead, total recoverable as Pb	<1	8	15	11	10
Mercury, total recoverable as Hg	.06	.03	.03	.04	.03
Nickel, total recoverable as Ni	<1	2	3	3	2
Zinc, total recoverable as Zn	10	31	50	47	37
Organic compounds					
Oil and grease, total recoverable, gravimetric (milligrams per liter)	<7	<7	E5	ND	E2
Pesticides (micrograms per liter)					
Diazinon, total	.2	<.1	<.1	<.1	<.1
Polychlorinated biphenyls, total (micrograms per liter)	<.1	<.1	<.1	<.1	<.1

[a] Results based on a 1:100 dilution.

Appendix 2. Minimum reporting levels of water-quality properties and constituents.

Water-quality property or constituent	Minimum reporting level
Specific conductance	
Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	5
pH and alkalinity	
pH, laboratory (standard units)	.1
Alkalinity, as calcium carbonate (milligrams per liter)	1
Oxygen demand (milligrams per liter)	
Chemical oxygen demand	10
Dissolved and suspended solids (milligrams per liter)	
Total dissolved solids, residue on evaporation at 180 degrees Celsius	10
Suspended solids, residue at 105 degrees Celsius	10
Nutrients (milligrams per liter)	
Nitrogen, total as N	.002
Nitrogen, ammonia plus organic (Kjeldahl), total as N	.14
Phosphorus, total as P	.04
Phosphorus, dissolved as P	.04
Trace metals (micrograms per liter)	
Cadmium, total recoverable as Cd	.02
Copper, total recoverable as Cu	10
Lead, total recoverable as Pb	.05
Mercury, total recoverable as Hg	.02
Nickel, total recoverable as Ni	.1
Zinc, total recoverable as Zn	2
Organic compounds	
Oil and grease, total recoverable, gravimetric (milligrams per liter)	5
Pesticides (micrograms per liter)	
Diazinon, total	.02
Polychlorinated biphenyls, total (micrograms per liter)	.1

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