In cooperation with the North Central Texas Council of Governments

Urban Stormwater Quality, Event-Mean Concentrations, and Estimates of Stormwater Pollutant Loads, Dallas-Fort Worth Area, Texas, 1992–93

Water-Resources Investigations Report 98–4158

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

Cover photograph: Stormwater monitoring site 08048505 Pylon Street Outfall at Meacham Road, Fort Worth, Photograph by Harry C. McWreath, U.S. Geological Survey.

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U.S. DEPARTMENT OF THE INTERIOR

Bruce Babbitt, Secretary

U.S. GEOLOGICAL SURVEY

Thomas J. Casadevall, Acting Director

For additional information write to:

District Chief
U.S. Geological Survey
8011 Cameron Rd.
Austin, TX 78754–3898

Copies of this report can be purchased from:
U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225–0286

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Abbreviations

Ah, ampere-hour
°C, degree Celsius
ft^3/s, cubic foot per second
ft, foot
gal, gallon
in., inch
lb, pound
µg/L, microgram per liter
mi, mile
mi^2, square mile
mg/L, milligram per liter

Acronyms

BCF, bias-correction factor
BNA, base/neutral and acid extractable semivolatile organic compound
BOD, biochemical oxygen demand
COD, chemical oxygen demand
DA, total contributing drainage area
EMC, event-mean concentration
EPA, U.S. Environmental Protection Agency
IA, impervious area
LUC, commercial land use
LUI, industrial land use
LUN, nonurban land use
LUR, residential land use
MRL, minimum reporting level
NCTCOG, North Central Texas Council of Governments
NPDES, National Pollutant Discharge Elimination System
NURP, Nationwide Urban Runoff Program
NWQL, National Water Quality Laboratory
PCB, polychlorinated biphenyl
QA/QC, quality assurance/quality control
R^2, coefficient of determination
SE, standard error of estimate
TRN, total storm rainfall
USGS, U.S. Geological Survey
VOC, volatile organic compound
VWEMC, volume-weighted event-mean concentration

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Abstract

The quality of urban stormwater is characterized with respect to 188 properties and constituents. Event-mean concentrations and loads for three land uses (residential, industrial, commercial), and annual loads for 12 selected properties and constituents for 26 gaged basins in the Dallas-Fort Worth study area are presented. During February 1992–June 1993, 182 water samples from the 26 gaged basins (each basin classified as primarily residential, industrial, or commercial) were collected and analyzed. Residential land-use basins had greater median concentrations of bacteria, nutrients, and total arsenic. Industrial land-use basins had greater median concentrations of suspended and dissolved solids, and total recoverable chromium, copper, nickel, and zinc. Diazinon was the most frequently detected pesticide in all three land-use basins. Diazinon was detected in 93 percent of samples from residential land-use basins, 70 percent from commercial land-use basins, and 33 percent from industrial land-use basins. Volatile organic compounds and base/neutral and acid extractable semivolatile organic compounds were detected more frequently in samples from industrial land-use basins than residential or commercial land-use basins.

Event-mean concentrations (EMCs) were computed for each land use for biochemical oxygen demand; chemical oxygen demand; suspended and dissolved solids; total nitrogen and ammonia plus organic nitrogen; total and dissolved phosphorus; total recoverable copper, lead, and zinc; and total diazinon. The EMCs of chemical oxygen demand; total nitrogen and ammonia plus organic nitrogen; total and dissolved phosphorus; and total diazinon were greatest in samples from residential land-use basins. The EMCs of biochemical oxygen demand; suspended and dissolved solids; and total copper, lead, and zinc were greatest in samples from industrial land-use basins.

Loads per square mile for the three land uses were estimated for the same properties and constituents from flow-weighted EMCs and runoff volume on the basis of seven sampled storms at each gaged site. Chemical oxygen demand and dissolved and suspended solids had the greatest mean loads per square mile. Mean loads per square mile were greatest for trace elements in industrial land-use basins and for total diazinon in residential land-use basins. Mean loads per square mile for total nitrogen in the three land-use basins were dissimilar.

Local regression equations were developed to estimate loads produced by individual storms. Mean annual loads were estimated by applying the storm-load equations for all runoff-producing storms in an average climatic year and summing individual storm loads to determine the annual load.

INTRODUCTION

The Federal Water Pollution Control Act amendments of 1972 and 1977, also known as the Clean Water Act, were passed to prohibit the discharge of any pollutant to the Nation’s waters from a point source unless authorized by a National Pollutant Discharge Elimination System (NPDES) permit (U.S. Environmental Protection Agency, 1991). Since implementation of the act, pollutant loads received by water bodies from point sources have been measurably reduced.

Eutrophication rates in the Nation's lakes and reservoirs can be accelerated by pollutant loads from nonpoint sources. Nonpoint-pollutant loads in upstream river segments from a variety of sources, including agricultural and urban lands, might adversely affect public water supplies. Urban areas have been identified as major contributors of nonpoint-pollutant loads (U.S. Environmental Protection Agency, 1990a). In 1987, Congress again amended the Clean Water Act to require the U.S. Environmental Protection Agency (EPA) to establish phased NPDES requirements for various classes of stormwater discharges, including discharges from municipal urban areas (U.S. Environmental Protection Agency, 1992).

According to the Clean Water Act amendments, cities with populations of 100,000 or greater must obtain permits to discharge stormwater into waters of the United States. One of the requirements for an NPDES permit is wet-weather sampling to characterize the quantity and quality of stormwater from watersheds within the city's boundaries and to estimate pollutant concentrations and annual pollutant loads. In 1991, the U.S. Geological Survey (USGS), in cooperation with the North Central Texas Council of Governments (NCTCOG), began a study for the seven applicant cities in the Dallas-Fort Worth area (Arlington, Dallas, Fort Worth, Garland, Irving, Mesquite, and Plano) to do the sampling, stormwater characterization, and load estimation, and also to provide information about pollutant loads relative to land use in the metropolitan area.

Purpose and Scope

The purpose of this report is to present information about stormwater quality in the Dallas-Fort Worth area associated with several topics: (1) Characterization of stormwater quality with respect to 188 properties and constituents; (2) event-mean concentrations (EMC) for 12 properties and constituents (designated for NPDES load estimation by the EPA) for three land uses; (3) computed loads for the 12 properties and constituents for three land uses; and (4) estimated annual loads for the 12 properties and constituents for 26 gaged basins in the study area. Loads categorized by land use were computed from flow-weighted EMCs and runoff volumes for seven sampled storms in each gaged basin. Regression analysis was used to estimate loads for unsampled storms, which allowed annual loads to be estimated for an average climatic year. An average climatic year was selected for each of two climatic stations in the area on the basis of similarity of annual rainfall to 1961–90 mean annual rainfall. Annual rainfall time series of each of the two average climatic years was used to estimate the mean annual loads for gaged sites. Proximity to a climatic station dictated which of the two annual rainfall time series was applied at each gaged site.

Description of Study Area

The approximately 1,700 mi^2 Dallas-Fort Worth area (fig. 1) is in north-central Texas, about 70 mi south of the Red River, which forms most of the boundary between Oklahoma and Texas. The study area is within Collin, Dallas, and Tarrant Counties. Collin and Dallas Counties are in the Blackland Prairies physiographic region, and Tarrant County is in the Cross Timbers and Prairies physiographic regions (Kingston and Crawford, 1991). The metropolitan area has a population of about 3.3 million, according to the 1990 census (Keith Kennedy, North Central Texas Council of Governments, oral commun., 1992). Three cities, Arlington, Dallas, and Fort Worth, have populations greater than 250,000. Four cities, Garland, Irving, Mesquite, and Plano, have populations greater than 100,000 but less than 250,000 (North Central Texas Council of Governments, 1993).

The study area is in the upper one-half of the Trinity River Basin. Three major tributaries to the main stem Trinity River—West Fork Trinity River, Elm Fork Trinity River, and East Fork Trinity River—meet in the Dallas-Fort Worth area (fig. 1). The average annual discharge at USGS streamflow-gaging station 08062500 Trinity River near Rosser, approximately 40 mi downstream from the metropolitan area, is 2,921 ft^3/s (U.S. Geological Survey, 1993).

The study area has varying climatic characteristics. Mean annual rainfall (1961–90) is 30.6 in., and mean minimum January temperature is 1.6 °C at Meacham Airport in Fort Worth. Mean annual rainfall (1961–90) is 33.6 in., and mean minimum January temperature is 2.2 °C at Love Field in Dallas. Mean monthly rainfall (1897–1989) at Love Field (fig. 2) is greatest in April and May (5.0 and 5.8 in., respectively) and least in January (2.8 in.).

Previous Studies

Driver and Tasker (1990) used data collected at 173 urban basins nationwide during 1979–84 to develop four sets of regional multivariable regression models that can be used to estimate stormwater constituent loads. Hoos and Sisolak (1996) documented a procedure that uses local data to adjust the regional regression equations developed by Driver and Tasker.

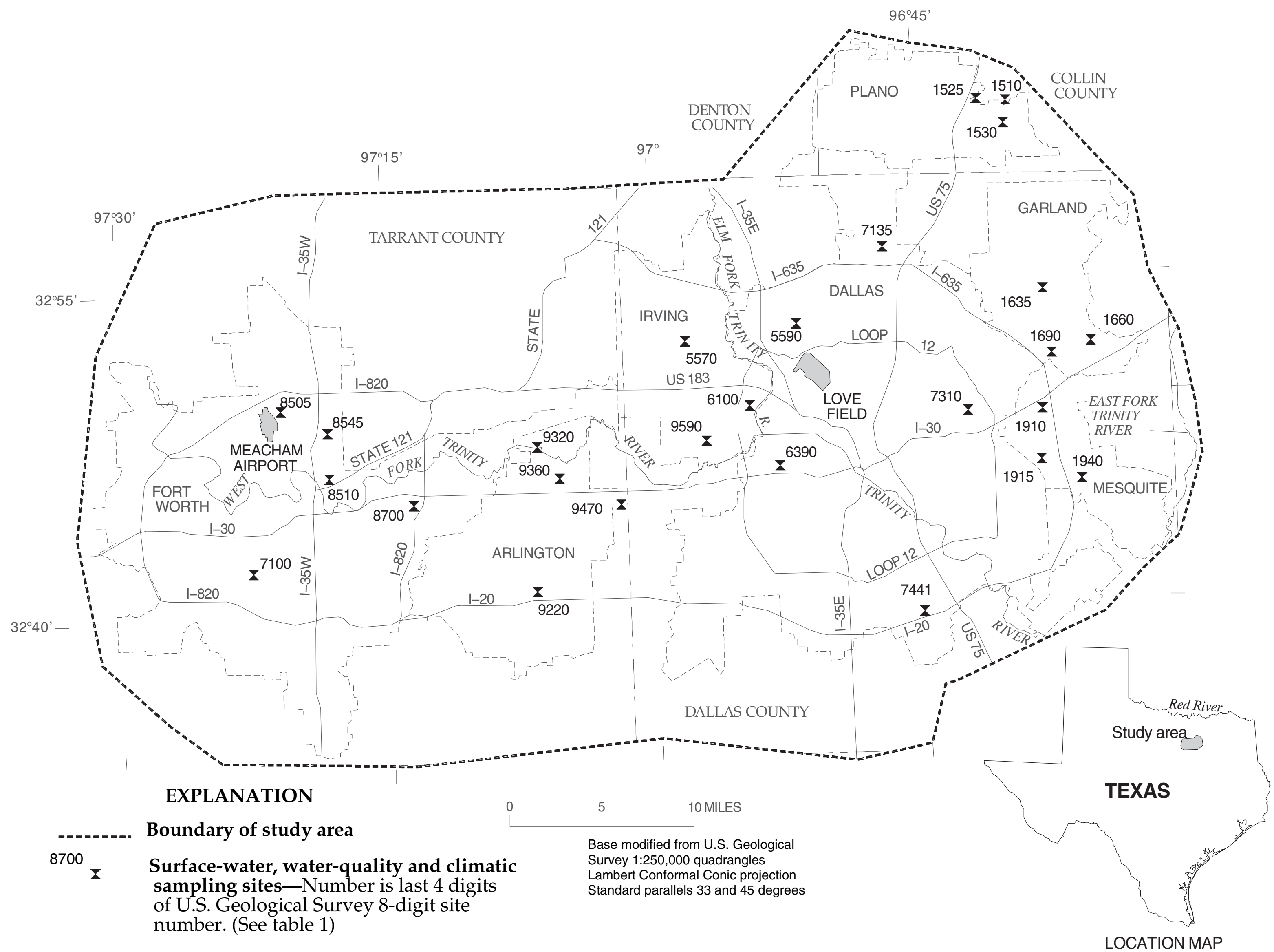

Figure 1. Location of study area and sampling sites.

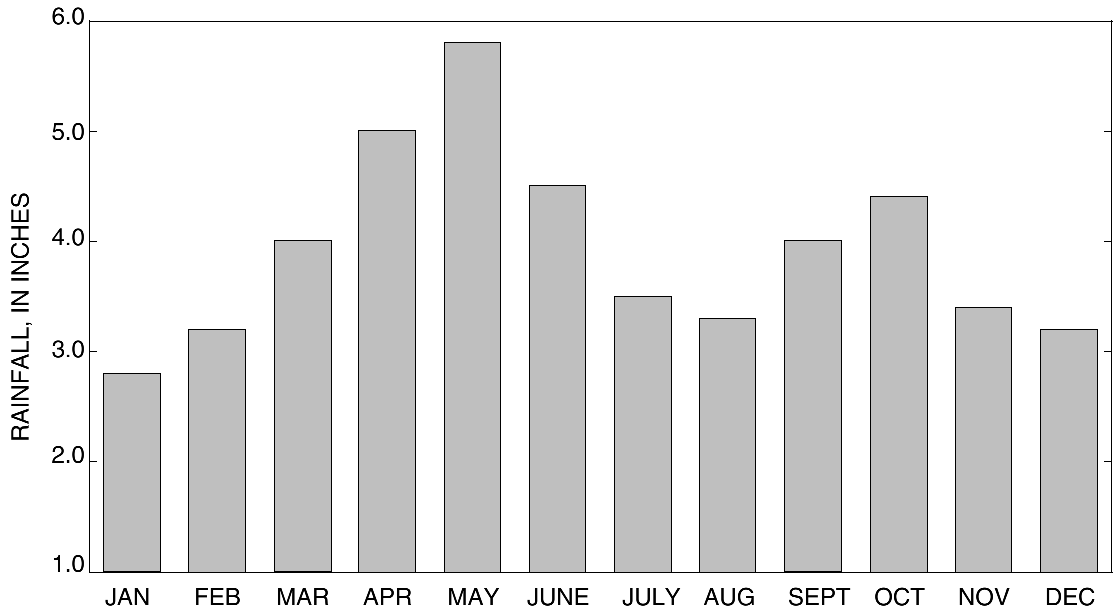

Figure 2. Mean monthly rainfall at Love Field, Dallas, Texas, 1897–1989.

The EPA published the results of the Nationwide Urban Runoff Program (NURP) and the guidelines for sampling urban basins to meet NPDES requirements (U.S. Environmental Protection Agency, 1983, 1992). Kilpatrick and others (1985) documented and verified the formulas used to compute flow volumes in an enclosed storm sewer when a Palmer-Bowlus flume is used as the measuring device. Methods of collection and analysis of water-quality samples have been described by Wershaw and others (1987), Fishman and Friedman (1989), Ward and Harr (1990), and Wells and others (1990).

Acknowledgments

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DATA COLLECTION

In accordance with an agreement between the EPA and the seven cities to use a regional approach to collect the data required by the NPDES regulations, 26 storm-sewer drainage basins (table 1 at end of report) were selected by individuals from each city using a list of desirable site characteristics compiled by the USGS for rainfall and streamflow measurement and for water-quality sampling during seven storms. Under NPDES regulations, each city normally would be required to collect 3 samples at 5 to 10 sites, resulting in a maximum of 210 samples for the seven cities (U.S. Environmental Protection Agency, 1992). However, the EPA approved a reduced number of sites while maintaining the maximum number of samples. When the regional approach to data collection was established, 182 of the 210 samples were designated for the seven municipal applicants, and the remaining 28 samples were reserved for an eighth NPDES applicant, later identified as the Texas Department of Transportation. Those 28 samples were collected in 1993 and 1994 and are not included in this report.

The basins and sampling sites were selected on the basis of catchment characteristics, hydraulic factors, accessibility, and safety. Catchment characteristics used to select drainage basins included a drainage area of 10 to 500 acres and representative land use, where the predominant land use is residential, commercial, or industrial. These characteristics were verified by on-site inspection and by data from a geographic information system provided by NCTCOG.

Several hydraulic factors were considered in the selection of sampling sites. Storm-sewer pipes were limited to those with diameters between 4 and 6 ft. Box culverts were limited in size from 4 by 4 ft to 8 by 8 ft. A straight and uniform pipe slope was required for the length of at least six pipe diameters upstream from the measuring device. Streamflow-gaging stations were installed at sites that were not affected by backwater conditions or unmeasured inflow from sanitary sewers. Adequate distance was maintained from upstream inflows to allow for complete mixing of the stormwater. There were no detected unauthorized connections in the storm-sewer system from which unregulated constituents could be contributed. Stations were located where there was less possibility of high-velocity flow conditions, sewer gases, vehicular traffic, poor lighting, and vandalism. Good accessibility to sampling sites required that the stations be located at outfalls or in pipes accessible through manholes.

Of the 26 predominantly single land-use drainage basins, 11 are classified as residential, 6 as commercial, and 9 as industrial (table 1). Drainage-basin size ranges from 9.0 acres at site 08055590 Joe's Creek Outfall at Denton Drive, Dallas (industrial), to 160 acres at site 08049320 River Legacy Park Outfall at Green Oaks Boulevard, Arlington (residential). The drainage basins are irregular in shape and generally do not follow topographic features. The drainage basin for site 08047100 Clear Fork Trinity River Outfall at Oak Hill Circle, Fort Worth, typifies the irregularities common to urban basins in the study area (fig. 3).

Instrumentation

Stations were constructed with flow-control devices, either a V-notched or sharpcrested weir, or a Palmer-Bowlus flume. Water elevation (stage) was measured using one pressure transducer at weir stations and two pressure transducers at flume stations. The pressure transducers were connected to a gas bubbler system. Rainfall was recorded by a tipping-bucket rain gage measuring 0.01-in. increments. Water samples were collected with a portable automatic sampler powered by a 60-Ah battery. The sampling line to the sampler consisted of a stainless steel intake and Teflon-coated tubing. The automatic sampler contained four 1-gal sample bottles that were cleaned using the protocols outlined in 40 Code of Federal Regulations Part 136. Telephone communication was established to all stations except for 08048545 Dry Branch Outfall at 33d Street, Fort Worth.

A data logger controlled the recording of streamflow and rainfall data and the activation of the sampler. Communication between the data logger and a computer in the office was provided by a modem and relay driver. A data-storage module powered by an 8-Ah battery and connected to the data logger provided a backup repository for the data in the event of power failure. A solar panel and voltage regulator were used to recharge the batteries for the automatic sampler and the data-storage module.

Water-Quality Sampling

Water-quality sampling was conducted when the following meteorologic criteria, defined in the NPDES stormwater regulations (U.S. Environmental Protection Agency, 1990b), were met:

- The storm was preceded by at least 72 hours of dry weather.
- The depth of rainfall over the basin was greater than 0.1 in.
- Where feasible, the storm did not vary by more than 50 percent from the average rainfall volume and duration for the area.

On the basis of rainfall records at long-term climatic stations in Dallas and Fort Worth, the limits of 0.20 and 0.90 in. of rainfall were established as the criteria for sampling. In October 1992, the upper limit was raised from 0.90 to 1.5 in., when permission to do so was requested by the NCTCOG and granted by the EPA. These limits were established to ensure a potential accumulation of pollutants during dry weather, adequate runoff from the storm for sampling, and a storm representative of the area in terms of intensity, amount, and duration.

The hydrograph in figure 4 shows a typical sampled storm with accumulated rainfall, instantaneous discharge, and sample activations (pulses) plotted against time. A sample pulse occurs when the data logger “instructs” the automatic sampler to collect a discrete sample that will be combined with other discrete samples to make a composite sample. The sample pulses are flow weighted and distributed throughout the hydrograph.

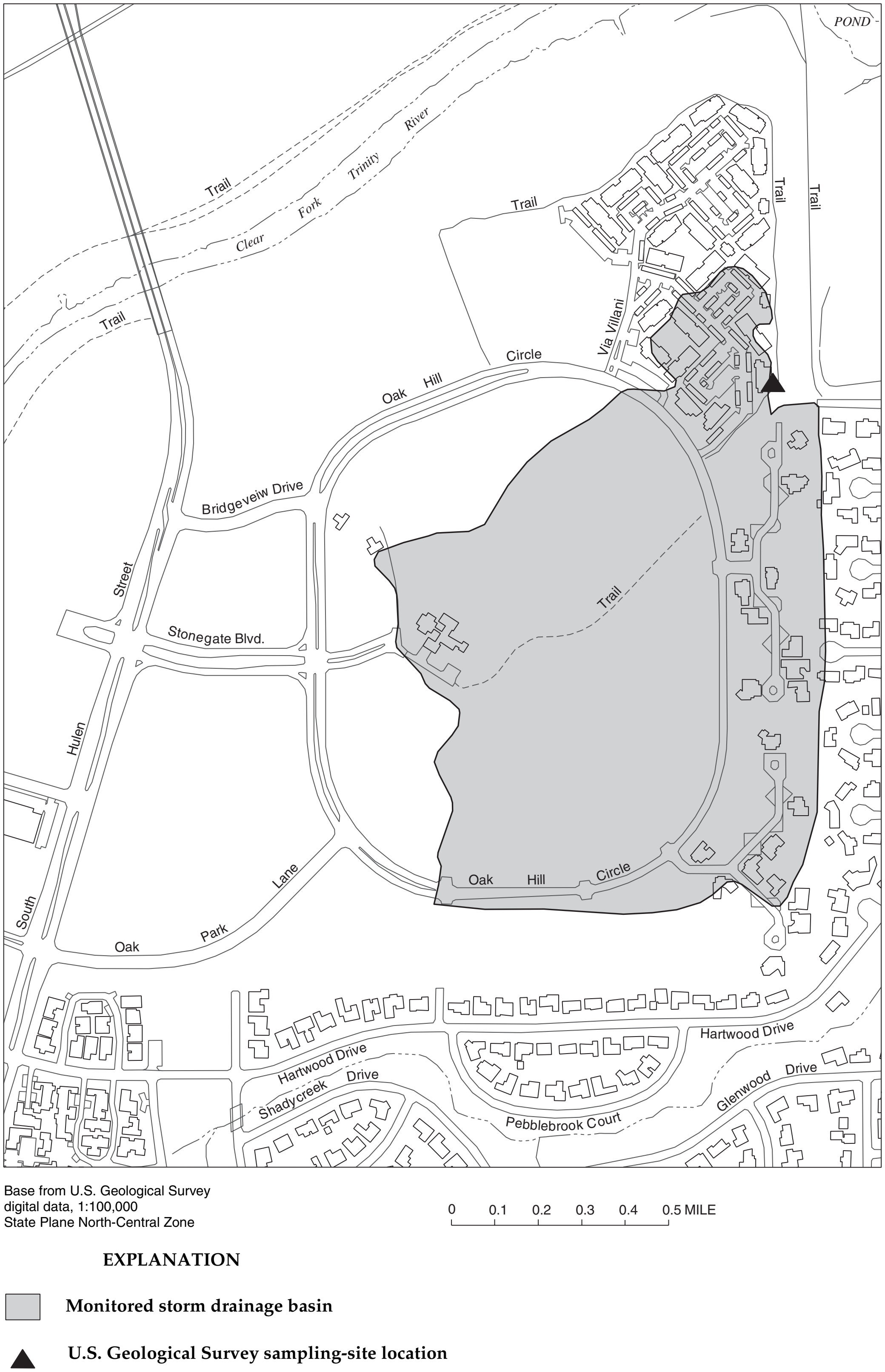

Figure 3. Drainage area for site 08047100 Clear Fork Trinity River Outfall at Oak Hill Circle, Fort Worth, Texas.

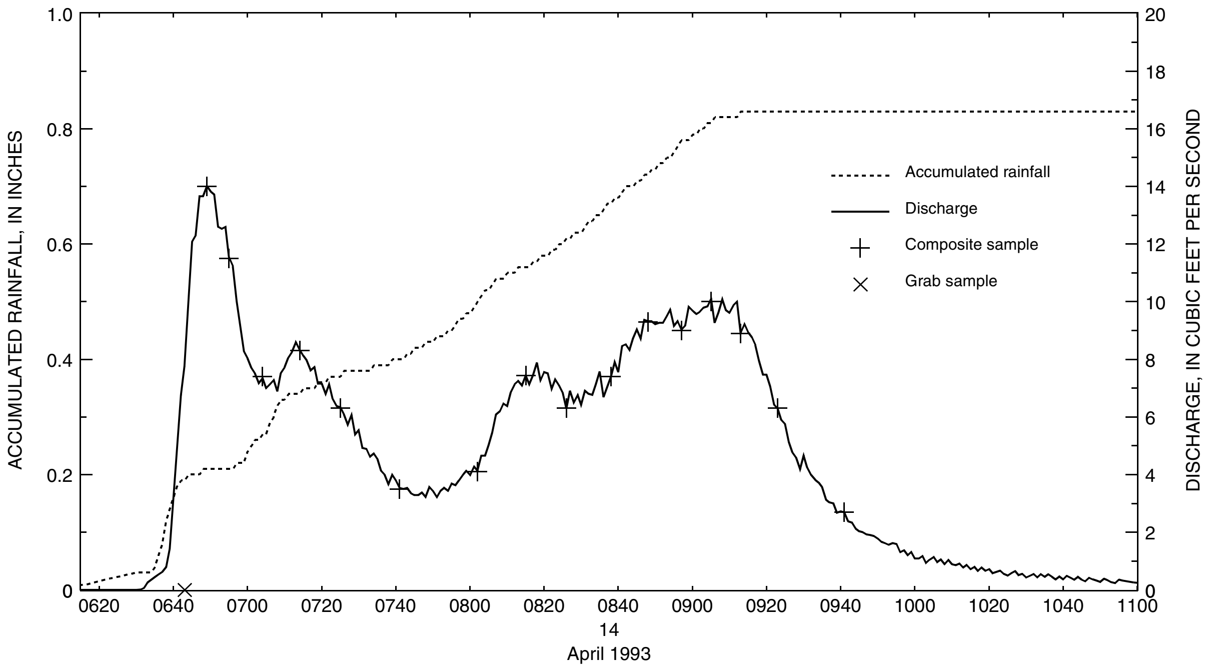

Figure 4. Hydrograph showing discharge and rainfall record of storm at site 08061510 Rowlett Creek Outfall at Willow Creek Park, Plano, Texas, April 14, 1993.

Guidance for the collection of stormwater samples from small urban watersheds was provided in the NPDES Stormwater Sampling Guidance Document (U.S. Environmental Protection Agency, 1992). Samples were collected for properties and constituents that characterize physical, inorganic, organic, and microbiological characteristics of the stormwater. The EPA specified a suite of 138 properties and constituents for sampling and analysis using sampling, preservation, and analytical protocols identified in 40 Code of Federal Regulations Part 136. However, a total of 188 properties and constituents was analyzed for each sample because of the interest in concentrations of the additional 50 properties and constituents by the cooperating agency and the cities involved in this study.

Water-quality samples for analysis of 70 properties and constituents were collected using grab-sampling techniques. The grab sample was collected primarily by hand dipping at the outflow, although some grab samples were collected using a peristaltic pump at sites where safety considerations prohibited hand-dipped samples. Grab-sampling techniques were used to prevent transformations, volatilization, or loss of aseptic conditions during compositing. For example, the volatile organic compound (VOC) sample was collected in specially treated glass-septum vials to prevent the compounds in solution from volatilizing. As shown in figure 4, the grab sample was collected, and the time of collection was plotted.

Residual chlorine was analyzed on-site only to detect its presence in a sample. If residual chlorine was present, the VOC sample and biochemical oxygen demand (BOD) sample were preserved differently than if there was no residual chlorine. Residual chlorine was detected in only 2 of the 182 grab samples. Ascorbic acid was added to the VOC vials, and the BOD bottles were seeded with raw sewage for the two samples with detected residual chlorine that were collected early in the storms that occurred during summer 1992. The residual chlorine possibly resulted from storage in the storm-sewer system of chlorinated water recently released from the municipal water system or a swimming pool.

Grab samples were collected at various times during a storm. EPA guidelines recommend that the grab sample be collected within the first 15 minutes of the storm runoff or as soon thereafter as possible (U.S. Environmental Protection Agency, 1992). Storms in the Dallas-Fort Worth area can be characterized by short periods (less than 15 minutes) of rainfall during which the peak flow of the storm has occurred. To determine the distribution of grab samples collected during a

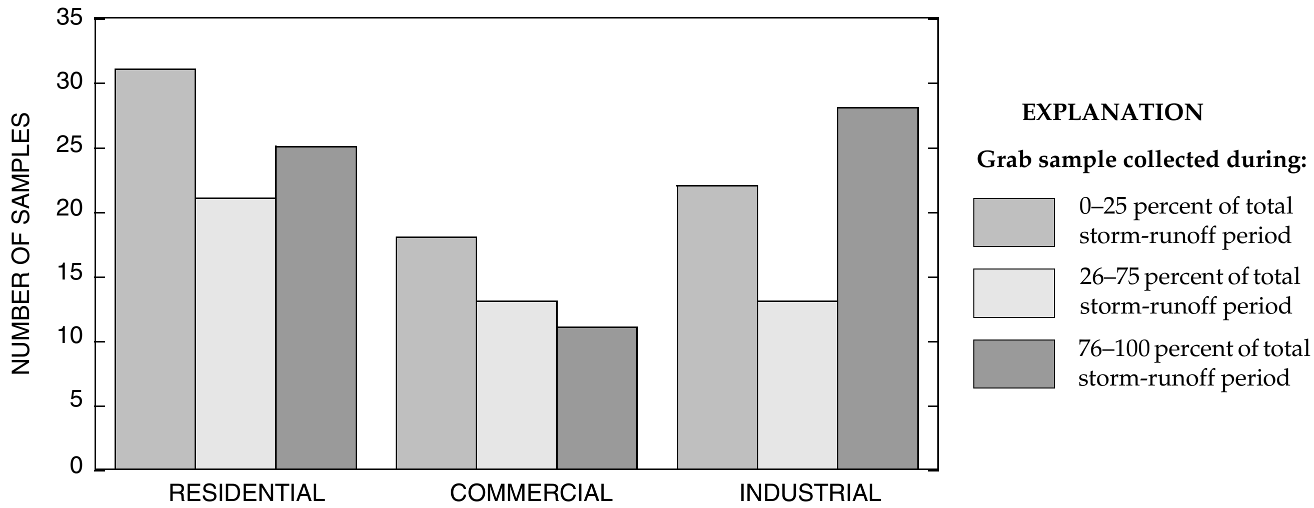

Figure 5. Distributions of grab samples collected during storm runoff by land-use category.

storm, the total storm-runoff period was divided into three intervals: 0 to 25, 26 to 75, and 76 to 100 percent of the total storm-runoff period. The distribution of the grab samples collected during each period and for each land use is plotted in figure 5.

Automatic samplers were used to collect flow-weighted composite samples for analysis of 118 other properties and constituents. Flow-weighted composite samples were collected for a minimum of the first 3 hours of the storm discharge or for the entire discharge if the storm lasted less than 3 hours.

Samples were shipped to the USGS National Water Quality Laboratory (NWQL) in Arvada, Colo., where most constituents were analyzed. Total concentrations of antimony, cyanide, silver, and thallium were determined at the Rocky Mountain Analytical Laboratory in Denver, Colo. Alkalinity, BOD, fecal coliform, and fecal streptococcus concentrations were determined at the USGS laboratory in Fort Worth. Temperature, pH, specific conductance, and the presence of residual chlorine were determined on-site from the grab sample.

Quality Assurance and Quality Control

Strict quality-assurance and quality-control (QA/QC) procedures were followed throughout the study. Chain-of-custody procedures were followed with each sample. Equipment blanks (organic-free water) for organic constituents were passed through the sample-collection equipment at randomly selected stations and analyzed at the NWQL. Organic spike mixtures (predetermined concentrations) for selected organic constituents were added to selected environmental samples in the field office and also at the NWQL to determine recovery rates. Field matrix spikes were used to determine the extent, if any, of sample-quality changes during shipping, and laboratory spikes were used to demonstrate laboratory recovery rates. Both types of spikes were used to determine the extent of matrix bias or interferences for constituent recovery. Reference samples (samples with known concentrations) for nutrient and inorganic constituents were submitted to the NWQL. Trip blanks (to determine if contamination of the VOC samples occurred during transit) and laboratory blanks (to determine if contamination of the organic samples occurred in the field laboratory during compositing) also were submitted to the NWQL. In addition to these QA/QC procedures, the NWQL followed similar in-house procedures (Friedman and Erdmann, 1982; Pritt and Raese, 1992).

URBAN STORMWATER QUALITY

Data from a grab sample provide the concentration of a constituent at a given point in time. Data from a composite sample provide the average concentration of a constituent over a period of time.

Logarithmic plotting distribution estimation techniques (Helsel and Cohn, 1988) were used to compute statistics for constituent concentrations less than the laboratory analytical minimum reporting level (MRL). The logarithmic plotting distribution estimation technique also can be used for constituents with multiple MRLs (Helsel and Cohn, 1988), such as diazinon. The use of the robust probability-plot method has been shown to perform well for estimating summary statistics and reducing errors that would have been caused by simple substitution methods (Helsel and Hirsch, 1992).

Visual summaries of the distribution of constituent concentrations are shown using boxplots. Boxplots show the median, interquartile range (25th to 75th percentile), and outlying values.

Grab-Sample Properties and Constituents

The properties and constituents determined from the grab sample were water temperature, pH, total cyanide, total phenols, total recoverable oil and grease, presence of residual chlorine, fecal coliforms, fecal streptococci, and 63 VOCs.

Summary statistics for properties and constituents analyzed in the grab samples were computed for each land use. Water temperature ranged from 6.5 to 30.0 °C (table 2 at end of report). Water temperature might have been more dependent on ambient air temperature than on land use. Water temperature at sites in different parts of the Dallas-Fort Worth area for samples collected during the same storm event usually did not vary by more than 2 °C. pH ranged from 6.2 (acidic) to 9.9 (alkaline). The maximum pH was in a sample from a site in Garland that drained an area having road-construction activities during the sampling period.

Total cyanide concentrations generally were less than the MRL. Total phenols concentrations ranged from 1.0 µg/L from all three types of land-use basins to 58 µg/L from an industrial land-use basin (site 08061530). Total recoverable oil and grease concentrations generally were about or less than the MRL, although one sample from an industrial land-use basin had a concentration of 120 mg/L.

Bacteria

The two types of bacteria measured in this study, fecal coliforms and fecal streptococci (table 3 at end of report), are strains of bacteria that are present in the intestines or feces of warm-blooded animals. Fecal coliform bacteria are specified in State and Federal standards as indicators of the sanitary quality of the water (U.S. Environmental Protection Agency, 1990a).

Median concentrations of fecal streptococci were equal to or greater than those of fecal coliforms except in those samples collected during 76 to 100 percent of the total storm runoff from industrial land-use basins (fig. 6). Median bacteria concentrations were greatest in residential land-use basins. Bacteria concentrations generally were greater during the first 25 percent of the total storm runoff than during the middle 50 percent and then increased during the last 25 percent.

Volatile Organic Compounds

Samples from sites in industrial land-use basins had substantially more VOC detections than samples from sites in the two other land-use basins (fig. 7). Samples from sites in industrial land-use basins had about twice as many VOC detections during the first 25 percent of the total storm-runoff as during the remaining 75 percent. The frequency of VOC detections in samples collected throughout the storm was similar for sites in residential and commercial land-use basins. Of 151 VOC detections from sites in industrial land-use basins (fig. 8), 64 were from site 08048545 Dry Branch Outfall at 33d Ave., Fort Worth.

The most frequently detected VOC was toluene (33 detections in 181 samples) (table 4 at end of report), the 27th largest volume chemical produced in the United States in 1985 (Sax and Lewis, 1987). Toluene is used for many purposes including aviation, gasoline, industrial solvents, thinner in nitrocellulose lacquers, and detergents. Benzene and substituted benzene (xylenes) were the next most frequently detected VOCs. Several other VOCs (table 5 at end of report) were detected at lesser frequencies and are not listed in table 4. The greatest VOC concentration was 1,200 µg/L of cis-1,2-dichloroethene in a sample collected June 9, 1993, from a site in an industrial land-use basin.

Flow-Weighted Properties and Constituents

Flow-weighted composite samples were analyzed for the following groups of properties and constituents: nutrients (8), oxygen demand (2), inorganics (10), trace elements (13), base/neutral and acid extractable semivolatile organic compounds (BNAs) (57), organochlorine pesticides and polychlorinated biphenyls (PCBs) (27), and diazinon, an organophosphorus insecticide.

Nutrients

Median concentrations of total nitrogen and total ammonia plus organic nitrogen in samples from sites in residential land-use basins were greater (about 0.5 mg/L as nitrogen) than median concentrations in commercial

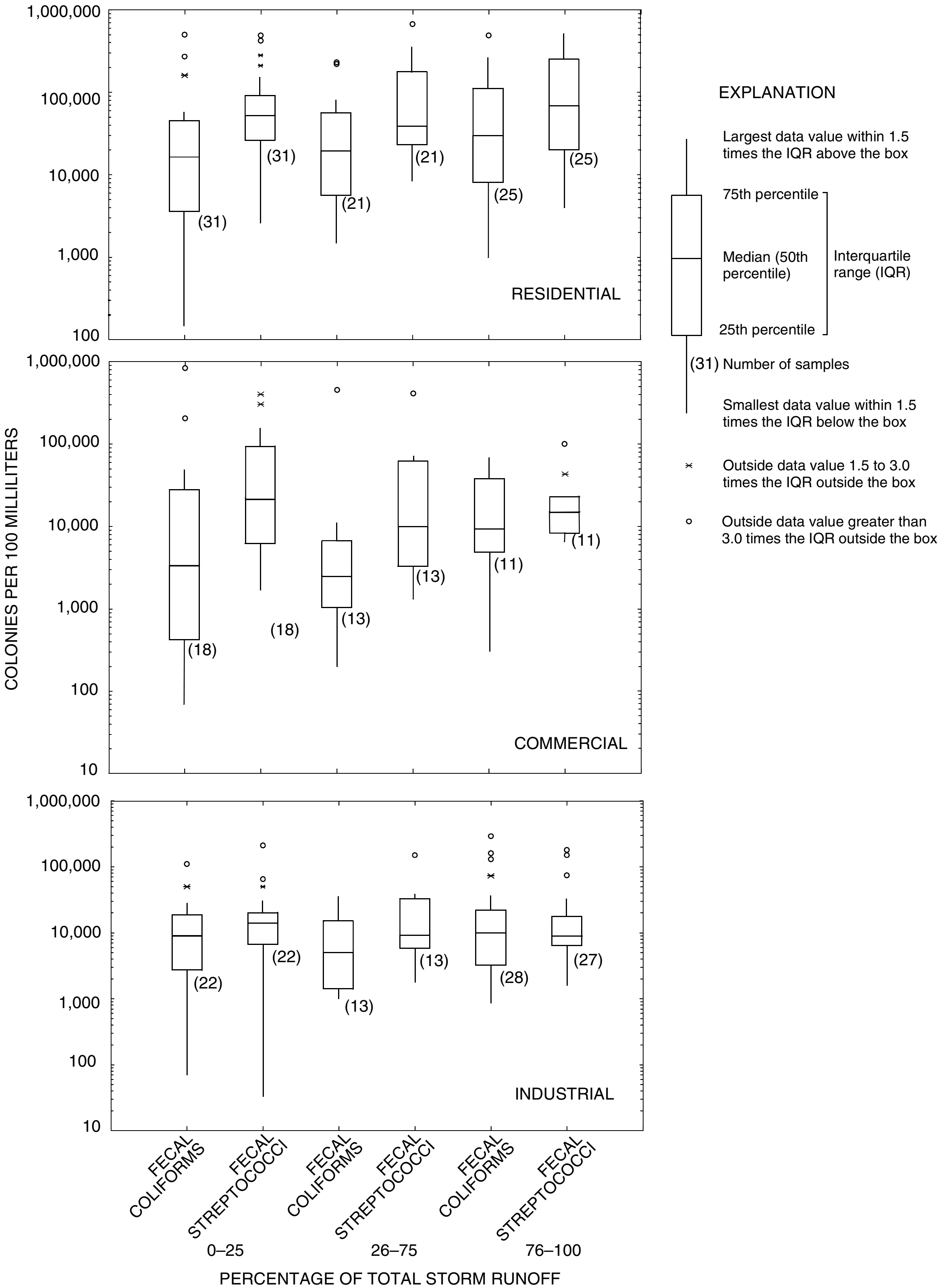

Figure 6. Ranges and distributions of fecal coliform and fecal streptococcus bacteria as a percentage of total storm runoff.

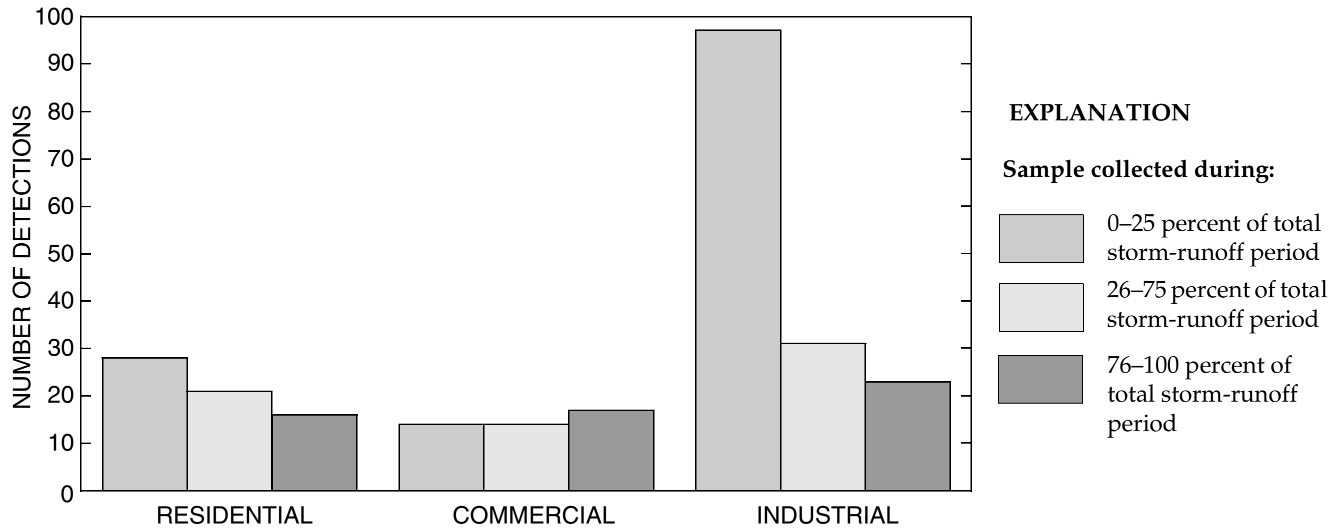

Figure 7. Distributions of volatile organic compound detections during storm runoff period by land-use category.

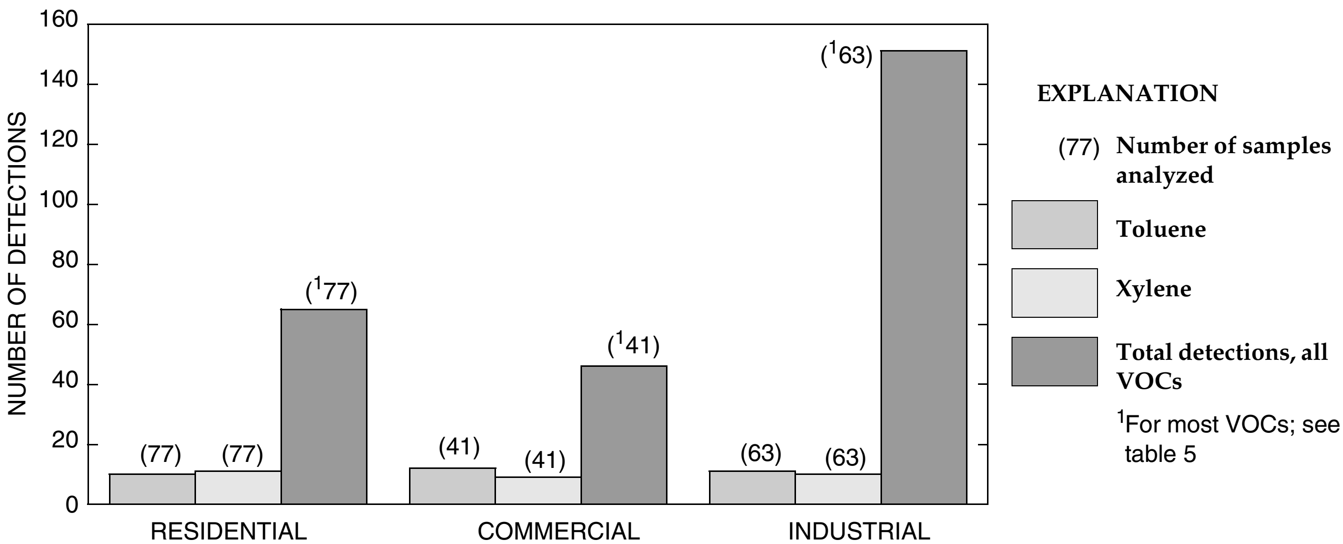

Figure 8. Volatile organic compound detections by land-use category.

and industrial land-use basins (fig. 9). Fertilizer applications to lawns and ornamental plants might be the cause of the greater nitrogen concentrations. Median phosphorus concentrations (total and dissolved) also were greater in samples from sites in residential land-use basins than in commercial or industrial land-use basins (fig. 10). Phosphorus concentrations in samples from sites in commercial and industrial land-use basins were not substantially different. The median total organic carbon concentration was 18.0 mg/L in samples from sites in residential and industrial land-use basins and 12.0 mg/L in commercial land-use basins (table 6 at end of report).

Biochemical and Chemical Oxygen Demand

Two types of oxygen demand analyses were done on the collected samples, BOD and chemical oxygen demand (COD). Samples from sites in industrial land-use basins had a greater median BOD (7.5 mg/L) than in the other types of land-use basins (fig. 11, table 7 at end of report). Samples from sites in residential land-use basins had a greater median COD (70.0 mg/L) than

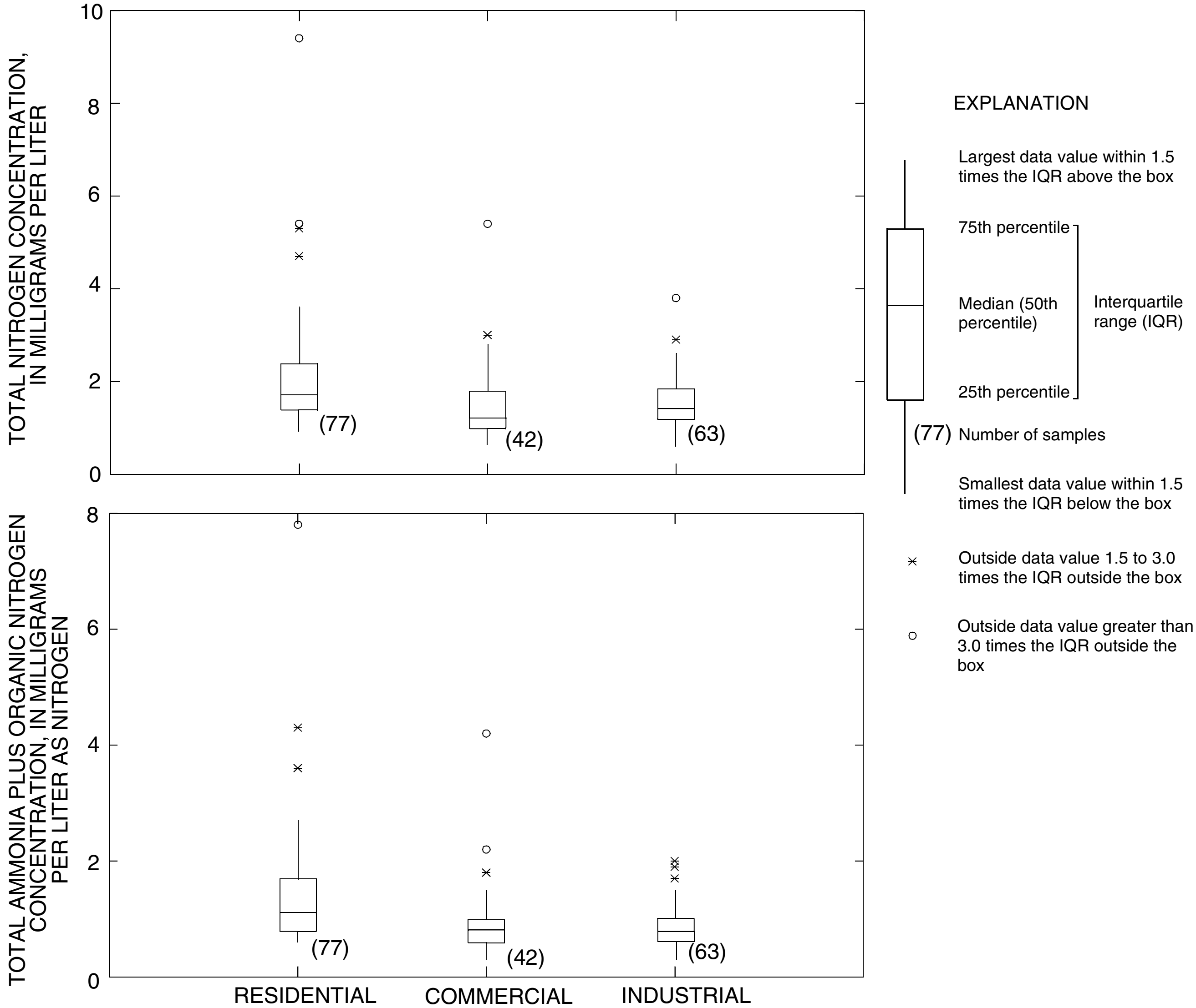

Figure 9. Ranges and distributions of total nitrogen and total ammonia plus organic nitrogen concentrations by land-use category.

samples from sites in industrial (66.0 mg/L) or commercial (56.5 mg/L) land-use basins.

Inorganic Constituents

The median suspended solids concentration in samples from sites in industrial land-use basins (104 mg/L) was substantially greater than in residential (78.0 mg/L) or commercial (42.0 mg/L) land-use basins (fig. 12, table 8 at end of report). The median dissolved solids concentration was greater in samples from sites in industrial land-use basins (69.0 mg/L) than in residential (59.0 mg/L) or commercial (50.0 mg/L) land-use basins. Mean suspended solids and dissolved solids concentrations differ substantially from respective median concentrations. For example, the mean suspended solids concentration for industrial land-use basins (222 mg/L) is more than twice the median (table 8).

The dominant water type for all three land uses is calcium carbonate. Alkalinity concentrations in stormwater samples were very unstable. Concentrations could increase as much as 50 percent from the time of analysis immediately after sample collection until the sample was reanalyzed by the NWQL. The alkalinity values reported in table 8 are those determined nearest to the times of sample collection.

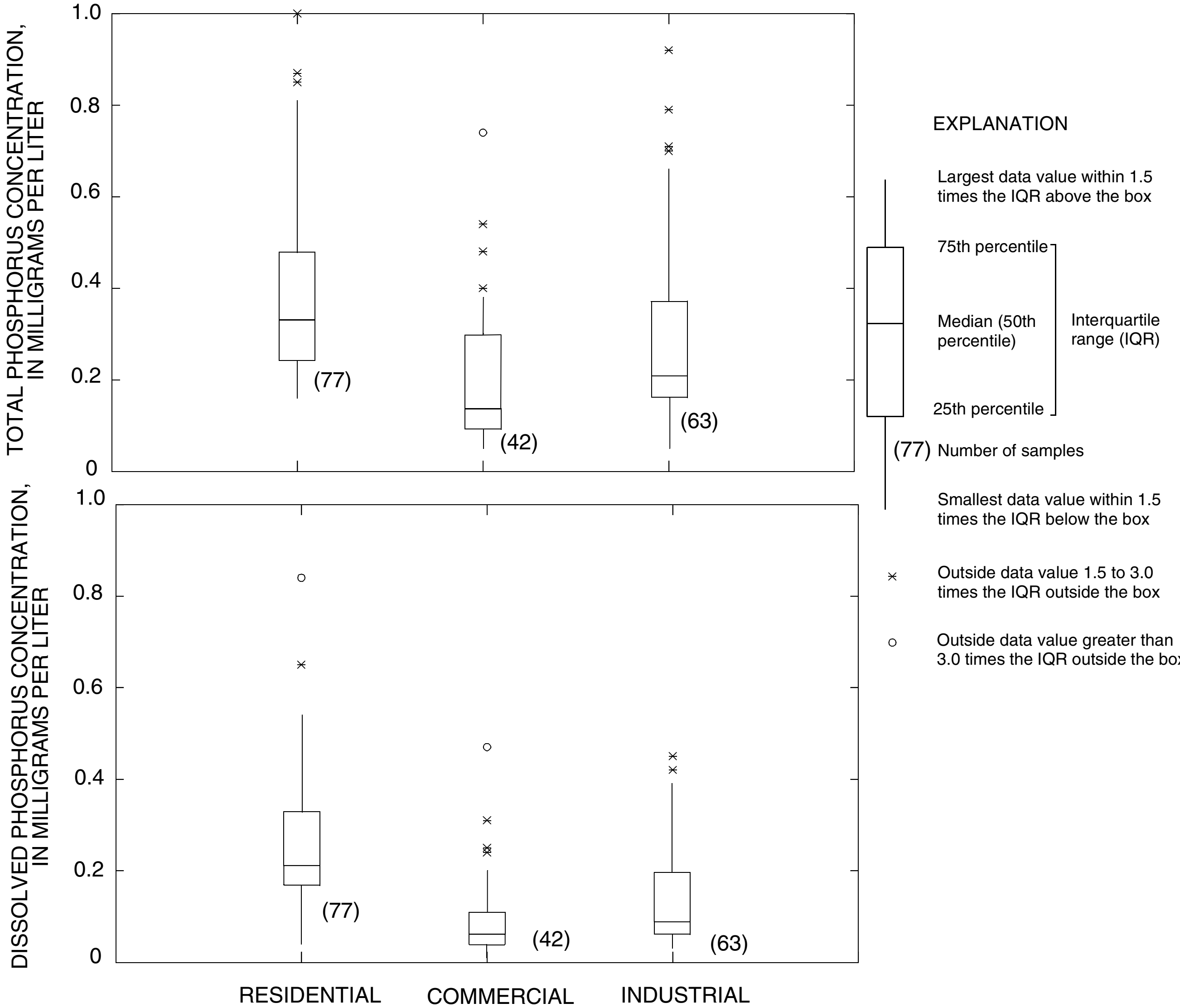

Figure 10. Ranges and distributions of total phosphorus and dissolved phosphorus concentrations by land-use category.

Trace Elements

Median concentrations of total recoverable chromium, copper, nickel, and zinc in samples from sites in industrial land-use basins were greater than in the two other land-use basins (table 9 at end of report). The median total arsenic concentration in samples from sites in residential land-use basins (3.0 µg/L) was greater than in industrial (2.0 µg/L) or commercial (1.0 µg/L) land-use basins. One residential land-use basin in particular (site 08061915 South Mesquite Creek Outfall at South Parkway, Mesquite) had relatively large total arsenic concentrations, ranging from 11.0 to 35.0 µg/L, and a mean of 22.6 µg/L. One industrial land-use basin (site 08061530 Spring Creek Outfall at Avenue F, Plano) had very large mean concentrations of total recoverable copper (732 µg/L), lead (133 µg/L), and zinc (296 µg/L).

Base/Neutral and Acid-Extractable Semivolatile Organic Compounds

Each of approximately[1] 182 composite storm samples was analyzed for 57 BNAs. The most detec-

[1] "Approximately" because 1 or 2 analyses for a few of the 57 compounds were missing.

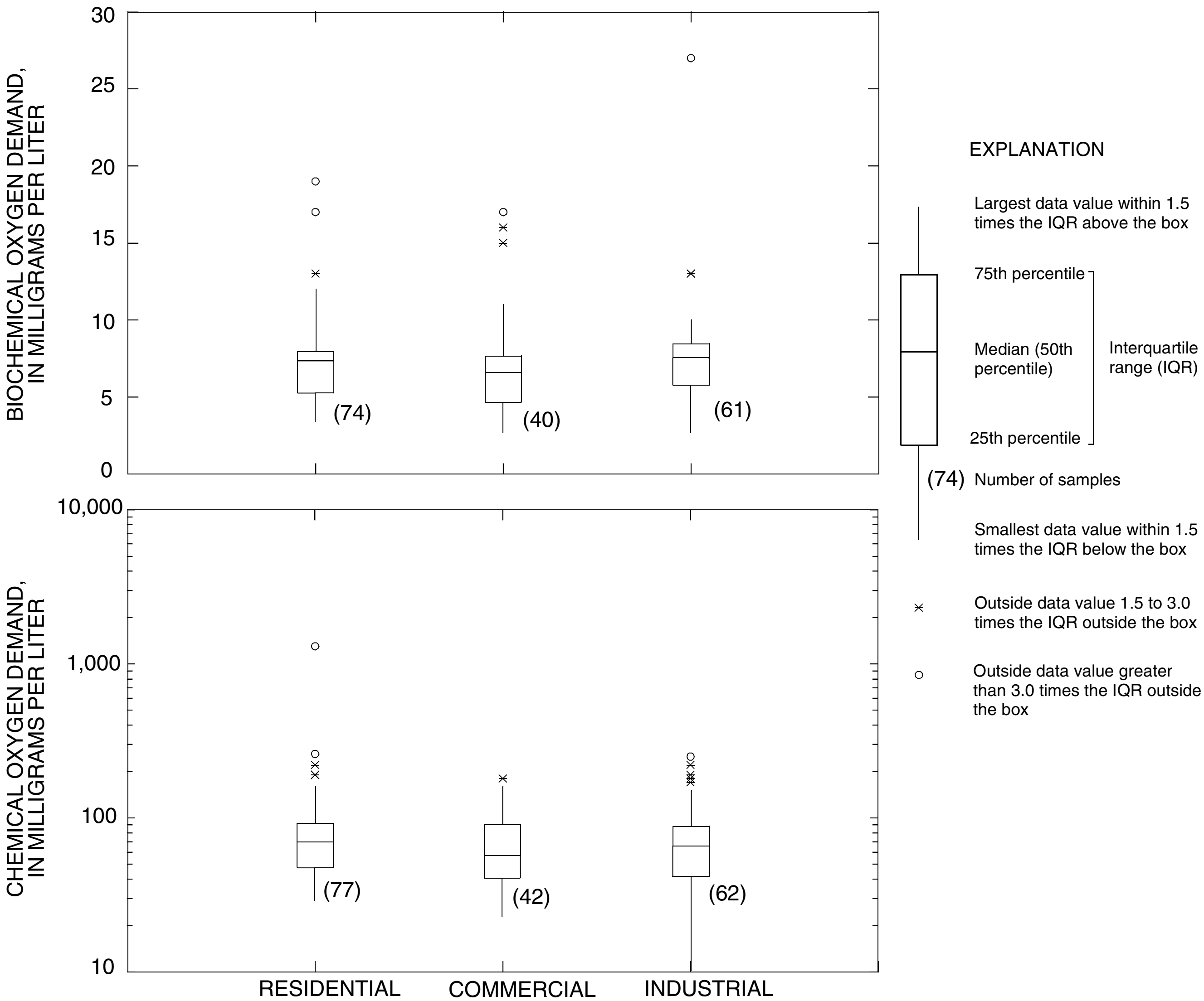

Figure 11. Ranges and distributions of biochemical oxygen demand and chemical oxygen demand by land-use category.

tions of BNAs (98) were in 63 samples from sites in industrial land-use basins (fig. 13). The fewest BNA detections (37) were in samples from 77 sites in residential land-use basins. The most frequently detected BNA from all land-use basins was bis(2-ethylhexyl)phthalate (79 detections in 181 samples) (table 10 at end of report). This compound is used as a plasticizer, added to a high-density polymer to facilitate processing and to increase the flexibility and toughness of the final product by solvation of the polymer molecule (Sax and Lewis, 1987). Bis(2-ethylhexyl)phthalate also is a common laboratory contaminant, and concentrations less than or equal to 10 times the concentration in any associated laboratory blank should not be used without qualification (R.D. Brock, U.S. Geological Survey, written commun., 1994). Concentrations of bis(2-ethylhexyl)phthalate were less than 5.0 µg/L for laboratory blanks. The BNAs such as fluoranthene, phenanthrene, and pyrene are derived from coal tar (Sax and Lewis, 1987) and might be an indicator of leaching from road surfaces or roofing materials. Several other BNAs were detected but not as frequently as those listed in table 10. The greatest BNA concentration detected was 280 µg/L of benzo(k)fluoranthene in a sample from a site in a residential land-use basin (table 11 at end of report).

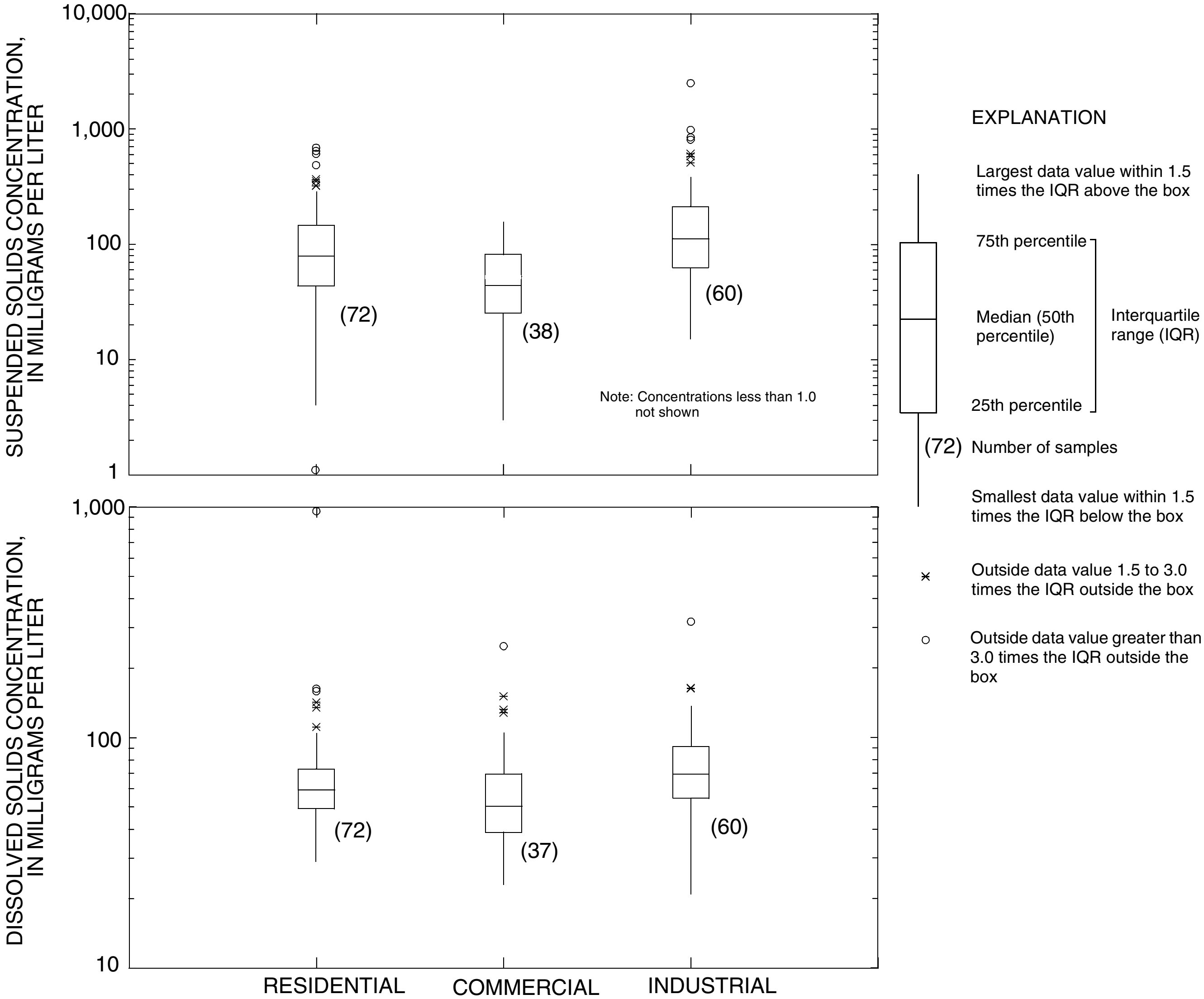

Figure 12. Ranges and distributions of suspended solids and dissolved solids concentrations by land-use category.

Organochlorine Pesticides, Polychlorinated Biphenyls, and Diazinon

Analyses were done for 27 organochlorine pesticides and PCBs (as aroclors) and 1 organophosphorus pesticide, diazinon. Chlordane was reported as "technical" and as two of its isomers. Diazinon was the most frequently detected pesticide (fig. 14, table 12 at end of report)—71 detections in 76 samples from sites in residential land-use basins, 28 detections in 40 samples from commercial land-use basins, and 21 detections in 63 samples from industrial land-use basins. Diazinon is used extensively in the Dallas-Fort Worth area to control fire ants and other insects. Chlordane and dieldrin were the next most frequently detected pesticides. Chlordane was banned for all uses by the EPA in 1988 (Agency for Toxic Substances and Disease Registry, 1994). Between July 1, 1983, and April 14, 1988, the only approved use for chlordane in the United States was for underground termite control (R.D. Brock, U.S. Geological Survey, written commun., 1993). Since April 14, 1988, however, all commercial use of chlordane in the United States has been banned by the EPA (Howard and others, 1991). Dieldrin is an insecticide that is restricted to nonagricultural applications.

Although most pesticide detections are expected during April to September when pesticide application

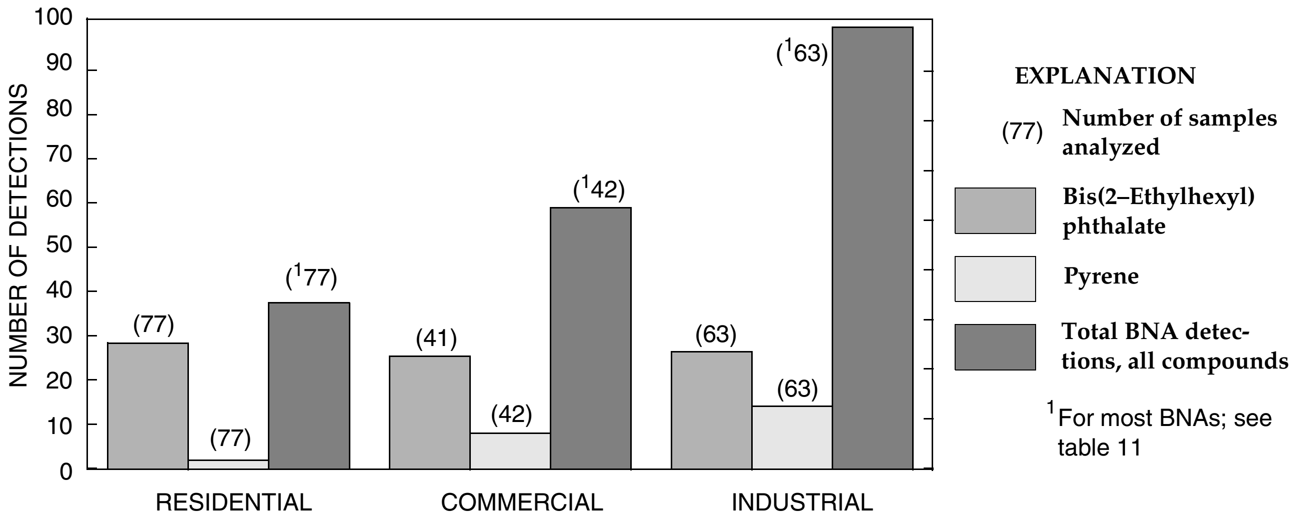

Figure 13. Base/neutral and acid extractable semivolatile organic compound detections by land-use category.

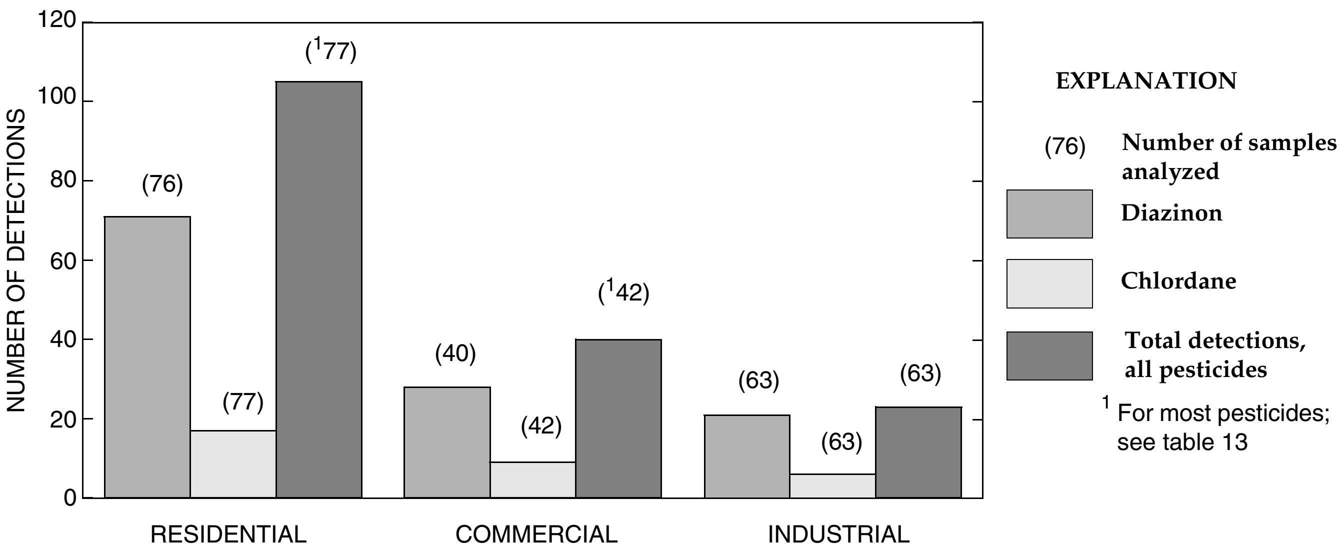

Figure 14. Organochlorine pesticide detections by land-use category.

rates are greater because of the increased activity of fire ants, more pesticides were detected during October to March. This anomaly is explained by the greater number of samples collected in fall and winter, when storms occur with greater frequency and duration than in summer. Median total diazinon concentrations in samples from sites in residential land-use basins (0.50 µg/L) were 500 percent greater than in commercial land-use basins (0.10 µg/L) (table 13 at end of report). The median total diazinon concentration for industrial land-use basins was less than the MRL. The largest total diazinon concentration, 25.0 µg/L, was measured at a site in a residential land-use basin.

EVENT-MEAN CONCENTRATIONS

The EPA designated 12 properties and constituents for load estimation. EMCs for BOD; COD; suspended and dissolved solids; total nitrogen and ammonia plus organic nitrogen; total and dissolved phosphorus; and total recoverable copper, lead, and zinc were computed from the flow-weighted composite samples for each land use by three methods—volume-weighted mean concentration, logarithmic-transformed mean concentration, and arithmetic mean concentration (table 14 at end of report). EMCs for total recoverable cadmium were not computed because concentrations were greater than the MRL (1.0 µg/L) in samples from only a few storms. In addition, EMCs were computed for diazinon (not designated by EPA) because of its numerous detections in the Dallas-Fort Worth area. A median concentration for each constituent by land use also was determined.

Volume-weighted event-mean concentration (VWEMC) was computed for each land use by the equation

$$VWEMC = \frac{\Sigma(EMC_i \times RV_i)}{\Sigma RV_i}, \qquad (1)$$

where

$VWEMC$ = volume-weighted event-mean concentration of constituent (in milligrams per liter or micrograms per liter) for a land-use basin;

EMC_i = event-mean concentration of constituent (in milligrams per liter or micrograms per liter) for storm i; and

RV_i = runoff volume (in cubic feet) for storm i.

The logarithmic-transformed mean concentration was computed by transforming individual storm mean concentrations (measured) to base 10 logarithms, summing the values, and dividing by the number of storms. This value was then retransformed and reported in table 14. The arithmetic mean was computed by summing the EMC for each sampled storm and then dividing the summation by the total number of storms. The median for each constituent by land use is the 50th percentile (central value) for each data set. Industrial land-use median EMCs were not determined during the NURP study (U.S. Environmental Protection Agency, 1983) and therefore were not reported.

The EMCs of COD; total nitrogen and ammonia plus organic nitrogen; total and dissolved phosphorus; and total diazinon were greatest in samples from sites in the residential land-use basins. The EMCs of BOD; suspended and dissolved solids; and total recoverable copper, lead, and zinc were greatest in samples from sites in the industrial land-use basins. The median EMCs computed for this study are substantially less than NURP medians for BOD, total ammonia plus organic nitrogen, and total copper, lead, and zinc.

The question arises as to which value is the best estimator of central tendency for the sample population—mean concentrations or median concentrations. Tests for normality of distributions done on the 12 constituents indicate that the populations are not normally distributed. Therefore, the median and the log-transformed mean are better estimators of the central tendency for these constituents than the arithmetic mean and the volume-weighted mean.

STORMWATER POLLUTANT LOADS

Stormwater pollutant loads for 11 of the 12 designated properties and constituents, plus diazinon, were estimated using two methods: Computing loads directly from measured data and estimating loads using statistical methods. Twelve constituents are required by the EPA for load estimation—BOD; COD; suspended and dissolved solids; total nitrogen and ammonia plus organic nitrogen; total and dissolved phosphorus; and total recoverable cadmium, copper, lead, and zinc. Loads were not estimated for cadmium because of the low frequency of detections (less than 50 percent in samples from sites in industrial land-use basins and less than 5 percent in samples from commercial and residential land-use basins). However, loads for total diazinon were estimated because of its known presence in stormwater in the Dallas-Fort Worth area.

The first method, direct computation from measured data, is basin specific. Measured data from seven storms at each of the 26 sites were used to directly compute storm loads for that site. The second method, a statistical method (regression analysis), was used to estimate storm and annual loads for sites on a regional basis by using the information generated from the basin-specific computations.

Computed Loads for Three Land Uses

Pollutant loads for an individual storm were computed from measured flow-weighted EMCs and runoff volume. The runoff volume is an important factor in the variation of loads. For each land use, the drainage basins with the largest areas generally produced the greatest pollutant loads. A load for a given storm (i) is computed by the equation

$$LOAD_i = EMC_i \times RV_i \times CF, \qquad (2)$$

where

$LOAD_i$ = pollutant load (in pounds) for storm i;

EMC_i = event-mean concentration of constituent (in milligrams per liter or micrograms per liter) for storm i;

RV_i = runoff volume (in cubic feet) for storm i; and

CF = conversion factor (6.2382^{-5} if constituent is in milligrams per liter or 6.2382^{-8} if constituent is in micrograms per liter).

Statistics for rainfall, runoff volume, and percent runoff for each land-use category were computed (table 15 at end of report). The median rainfall was 0.44 in. for commercial land-use basins and 0.45 in. for residential and industrial land-use basins. However, commercial and industrial land-use basins had substantially greater median runoff volume and median percent runoff. The amount of impervious area in a basin had a substantial effect on percent runoff. Those land-use basins identified earlier with larger impervious areas (table 1) had greater percent runoff volumes than those with smaller impervious areas.

Loads for the properties and constituents for each land-use category on the basis of seven sampled storms at each site, were computed using equation 2. The loads were divided by the contributing drainage area to allow comparison between the three land-use categories. Mean loads per square mile were greatest for COD and suspended and dissolved solids for all land uses (table 16 at end of report). Mean loads per square mile were greatest for trace elements at sites in industrial land-use basins and for total diazinon at sites in residential land-use basins. Mean loads per square mile for total nitrogen from the three types of land-use basins were dissimilar, ranging from about 44 lb for residential to slightly more than 70 lb for commercial and industrial.

An analysis of covariance (parametric test) using quantitative and qualitative variables (Thomas, 1982) was done on the loads computed for each constituent by land use to determine if significant differences (at the 95-percent confidence level) existed. Suspended solids loads for commercial land-use basins were not significantly different from loads for the two other land-use basins. Loads for total ammonia plus organic nitrogen and total and dissolved phosphorus did not differ significantly among land-use basins, although median concentrations were significantly different among land-use basins. Loads for the remaining constituents were significantly different among the three land uses.

These results were confirmed by Kruskal-Wallis tests (Iman and Conover, 1983), nonparametric analysis of variance tests on the ranks of the data. The results of the Kruskal-Wallis tests indicate no significant differences in loads among land uses for total ammonia plus organic nitrogen, total phosphorus, and dissolved phosphorus but do indicate significant differences in loads for the remaining constituents.

Regression Analysis to Estimate Loads for All Gaged Basins in the Study Area

Stormwater pollutant loads can be estimated for periods without field data by using statistical procedures (regression analysis) or deterministic models. Regression analysis to estimate loads involves developing a relation between load and a series of quantifiable physical and land-use characteristics (explanatory variables). Deterministic models estimate loads by attempting to simulate the physical processes using measured data to calibrate model parameters. Regression equations were developed as part of this study to estimate loads for gaged basins.

Estimated Storm Loads

Local regression equations were developed to estimate the load produced by individual storms for each of the 12 properties and constituents identified for load computations. Possible explanatory variables were identified on the basis of being easily estimated with available physical, land-use, and climatic data. A subset of the variables used by Driver and Tasker (1990) was selected for the regression analysis. The seven explanatory variables are total storm rainfall (TRN), in inches; total contributing drainage area (DA), in square miles; impervious area (IA), as a percentage of DA; industrial land use (LUI), as a percentage of DA; commercial land use (LUC), as a percentage of DA; residential land use (LUR), as a percentage of DA; and nonurban land use (LUN), as a percentage of DA. The physical and land-use characteristics for the 26 sites in the study basins are listed in table 1 (IA in percent; and LUI, LUC, and LUN in acres). Regional regression equations derived by Driver and Tasker (1990) and the adjustment procedure developed by Hoos and Sisolak (1996) were not used for the following reasons: (1) The EMCs computed from NURP data varied substantially from the EMCs computed from data collected during this study; (2) there was an extensive time span (about 10 years) between the NURP data-collection period and the data-collection period of this study, during which sampling-equipment technology improved and factors that change environmental conditions occurred—for example, the discontinuance of leaded gasoline; and (3) the size of the data set compiled from this study allowed new regression equations to be developed with confidence.

The form of the regression equation, using a logarithmic transformation (log base-10) of the response and explanatory variables, is given by

$$\log(\mathrm{LOAD}) = b_o + b_1\log(\mathrm{TRN}) + b_2\log(\mathrm{DA}) + b_3\log(\mathrm{IA}+1) + b_4\log(\mathrm{LUI}+1) + b_5\log(\mathrm{LUC}+1) + b_6\log(\mathrm{LUR}+1) + b_7\log(\mathrm{LUN}+1). \quad (3)$$

When equation 3 is detransformed it becomes

$$\mathrm{LOAD} = b_{o'} \times (\mathrm{TRN})^{b_1} \times (\mathrm{DA})^{b_2} \times (\mathrm{IA}+1)^{b_3} \times (\mathrm{LUI}+1)^{b_4} \times (\mathrm{LUC}+1)^{b_5} \times (\mathrm{LUR}+1)^{b_6} \times (\mathrm{LUN}+1)^{b_7}, \quad (4)$$

where

$b_{o'} = 10^{b_o}$.

Unity (+1) is added to the IA and land-use percentages to avoid the logarithm of zero, which is undefined.

The detransformation of a regression model provides a consistent estimator of median response but systematically underestimates the mean response (Miller, 1984). A bias-correction factor (BCF) is included to obtain an unbiased estimate of the mean response computed using a parametric method (Miller, 1984) defined by

$$\mathrm{BCF} = 10^{(1.1515(\mathrm{SE})^2)}, \quad (5)$$

where

SE = standard error of estimate (in log units) of the regression equation.

The SE is a measure of deviation about the regression. The final form of the detransformed equation becomes

$$\mathrm{LOAD} = b_{o'} \times (\mathrm{TRN})^{b_1} \times (\mathrm{DA})^{b_2} \times (\mathrm{IA}+1)^{b_3} \times (\mathrm{LUI}+1)^{b_4} \times (\mathrm{LUC}+1)^{b_5} \times (\mathrm{LUR}+1)^{b_6} \times (\mathrm{LUN}+1)^{b_7} \times \mathrm{BCF}. \quad (6)$$

The explanatory variables for each equation were selected with stepwise regression. A regression coefficient was retained in the equation if it was significantly different from zero at the 5-percent confidence level ($p = 0.05$). The SE and the adjusted coefficient of determination (R^2) were also used as means of evaluating the use of a specific explanatory variable. The SE is a measure of the error about the regression. A smaller SE corresponds to a more precise prediction. The R^2 measures the proportion of variation of the response variable (load) explained by the explanatory variables. It depends on the number of parameters in the model and is used to judge the fit of the regression model to the data. A greater R^2 indicates a better fit. In addition, the residuals, the difference between estimated and measured values, were plotted to check the assumptions that the residuals are normally distributed with a mean of zero and have a constant variance over the range of explanatory variables. An example of the estimated loads plotted against the measured loads for BOD is shown in figure 15 for all sampled storms.

Two additional climatic variables, antecedent dry days and maximum 5-minute intensity, were identified as possible variables that would explain substantially more variation in the regression equations. However, because no increase in R^2 or decrease in SE was observed, the two explanatory variables were not used in the regression equations.

The significant explanatory variables, coefficients, BCF, SE, and adjusted R^2 for each local regression equation are listed in table 17 (at end of report). The SE ranges from 48.7 to 210 percent, and the adjusted R^2 ranges from 40.6 to 65.3 percent for the local regression equations. The SE and number of storms for the local regression equations and regional regression equations (Driver and Tasker, 1990) are listed in table 18 (at end of report). For each property or constituent, the local regression equations have a smaller SE than the regional regression equations.

The following example illustrates the computation of a storm load for BOD at site 08049470 Tributary to Johnson Creek Outfall at I–30 East, Arlington:

$$\mathrm{BOD} = b_{o'} \times (\mathrm{TRN})^{b_1} \times (\mathrm{DA})^{b_2} \times (\mathrm{IA}+1)^{b_3} \times (\mathrm{LUI}+1)^{b_4} \times (\mathrm{LUC}+1)^{b_5} \times \mathrm{BCF}. \quad (7)$$

Using a TRN of 0.40 in., the values for the explanatory variables determined from table 1 (0.134-mi^2 DA,

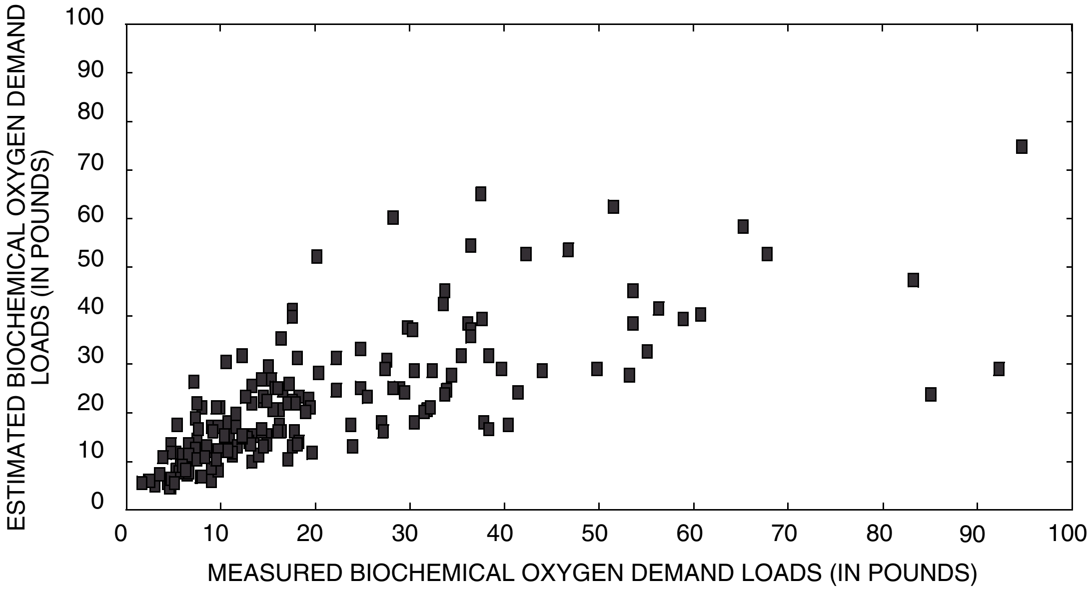

Figure 15. Estimated and measured biochemical oxygen demand storm loads.

80.9-percent IA, 91-percent LUI, and 9.0-percent LUC), and a BCF of 1.11 from table 17, then

$$\begin{aligned} BOD &= 9.01 \times (0.40)^{0.879} \times (0.134)^{0.725} \\ &\times (80.9+1)^{0.656} \times (91.0+1.0)^{0.104} \\ &\times (9.0+1.0)^{0.085} \times 1.11, \\ BOD &= 36.5 \text{ lbs.} \end{aligned}$$

Estimated Mean Annual Loads

Mean annual loads were estimated by applying the storm-load equations for all runoff-producing storms in an average climatic year (a year in which annual rainfall is about the same as mean annual rainfall) and summing individual storm loads to determine the annual load. This procedure requires a time series of rainfall totals for storms that are representative of the mean annual rainfall for each site. To obtain the time series, an average climatic year was selected for each of two climatic stations in the area—Love Field and Meacham Airport—on the basis of similarity of annual rainfall to 1961–90 mean annual rainfall. The mean annual rainfall for 1961–90 was 33.6 in. for Love Field and 30.6 in. for Meacham Airport. The most similar annual rainfall to mean annual rainfall for Love Field was 33.1 in. during 1965; the most similar annual rainfall to mean annual rainfall for Meacham Airport was 30.4 in. during 1975. Either the 1965 annual rainfall time series or the 1975 annual rainfall time series was applied at each of the 26 gaged sites in the study basins to estimate mean annual loads, depending on which of the two climatic stations the gaged site was closest to. The estimated mean annual loads for the 12 properties and constituents of interest at the 26 sites in the study basins are listed in table 19 (at end of report).

SUMMARY

EPA regulations require cities with populations of 100,000 and greater to obtain NPDES permits to discharge stormwater into U.S. waters. Part of the permit-application process requires each city to conduct wet-weather sampling to characterize the quantity and quality of stormwater from watersheds within the city's boundaries and to estimate pollutant concentrations and annual pollutant loads. To address this requirement, the USGS, in cooperation with the NCTCOG, established a wet-weather sampling network in seven cities—Arlington, Dallas, Fort Worth, Garland, Irving, Mesquite, and Plano—to collect data to characterize the quality of urban stormwater, compute EMCs, and estimate annual stormwater pollutant loads from predominantly single land-use urban drainage basins for 12 properties and constituents designated by the EPA.

From February 1992 through June 1993, 26 sites in urban stormwater drainage basins were sampled seven times during storms, for a total of 182 water-quality samples. Of the 26 basins, 11 are predominantly residential land use, 6 are predominantly commercial land use, and 9 are predominantly industrial land use.

Water-quality sampling was conducted when meteorologic criteria described in the EPA NPDES stormwater regulations were met. On-site sampling methods, equipment maintenance, sample preservation and shipping procedures, laboratory analyses, and quality assurance/quality control sampling followed protocols described in 40 Code of Federal Regulations Part 136.

Laboratory analyses were conducted on each sample for 188 properties and constituents, of which 138 properties and constituents were specified by EPA NPDES stormwater regulations. Analyses for 70 constituents were conducted on discrete samples collected by grab methods. Analyses for the remaining 118 constituents were conducted on flow-weighted composite samples collected by automatic sampler.

Grab samples were collected at various times during a storm. Summary statistics for constituent concentrations in the grab samples were computed for each land use. Total cyanide concentrations generally were less than the MRL. Total phenols concentrations ranged from 1.0 µg/L from all three types of land-use basins to 58 mg/L from an industrial land-use basin. Total recoverable oil and grease concentrations generally were about or less than the MRL, although one sample from a site in an industrial land-use basin had a concentration of 120 mg/L. Median bacteria concentrations were greatest in samples from sites in residential land-use basins. Samples from sites in industrial land-use basins had substantially more VOC detections than samples from sites in the two other types of land-use basins. The most frequently detected VOC was toluene.

Flow-weighted composite samples were collected for a minimum of the first 3 hours of the storm discharge or for the entire discharge if the storm duration was less than 3 hours. Flow-weighted composite samples were analyzed for the following groups of properties and constituents: nutrients (8), oxygen demand (2), inorganics (10), trace elements (13), base/neutral and acid extractable semivolatile organic compounds (BNAs) (57), organochlorine insecticides and polychlorinated biphenyls (PCBs) (27), and diazinon, an organophosphorus insecticide.

Median concentrations of total nitrogen and total ammonia plus organic nitrogen in samples from sites in residential land-use basins were greater than in the two other types of land-use basins. Median phosphorus concentrations (total and dissolved) also were greater in samples from sites in residential land-use basins.

Samples from sites in industrial land-use basins had greater median BOD concentrations than samples from sites in the two other land-use basins. Samples from sites in residential land-use basins had greater median COD concentrations.

Median concentrations of suspended solids were substantially greater in samples from sites in industrial land-use basins than in the two other land-use basins. Median dissolved solids concentrations were greater in samples from sites in industrial land-use basins.

Median concentrations of total recoverable chromium, copper, nickel, and zinc were greater in samples from sites in industrial land-use basins than in the two other land-use basins. The median total arsenic concentration was greater in samples from sites in residential land-use basins.

The most BNA detections (98) were in 63 samples from sites in industrial land-use basins, and the fewest detections (37) were in 77 samples from sites in residential land-use basins. The most commonly detected BNA from all land-use basins was bis(2-ethylhexyl)phthalate (79 detections in 181 samples).

Diazinon was the most frequently detected pesticide—71 detections in 76 samples (93 percent) from sites in residential land-use basins, 28 detections in 40 samples (70 percent) from commercial land-use basins, and 21 detections in 63 samples (33 percent) from industrial land-use basins. Chlordane and dieldrin were the next most frequently detected pesticides.

EMCs for the 12 properties and constituents (except total recoverable cadmium) designated by the EPA for load estimation (BOD; COD; suspended and dissolved solids; total nitrogen and ammonia plus organic nitrogen; total and dissolved phosphorus; and total recoverable copper, lead, and zinc) were computed from the flow-weighted composite samples for each land use by three methods—volume-weighted mean concentration, logarithmic-transformed mean concentration, and arithmetic mean concentration. EMCs for cadmium were not computed because concentrations were greater than the MRL (1.0 µg/L) in samples from only a few storms. EMCs also were computed for total diazinon because of its numerous detections in the Dallas-Fort Worth area.

The EMCs of COD, total nitrogen, total ammonia plus organic nitrogen, total phosphorus, dissolved solids, and total diazinon were greatest in samples from sites in residential land-use basins. The EMCs of BOD, suspended solids, dissolved solids, and total recoverable copper, lead, and zinc were greatest in samples from sites in industrial land-use basins. The median EMCs computed for this study are substantially less than NURP medians for BOD, total ammonia plus organic nitrogen, and total copper, lead, and zinc.

Stormwater pollutant loads for 11 of the 12 designated properties and constituents, plus diazinon, were estimated using two methods—computing loads directly from measured data and estimating loads using statistical methods (regression analysis).

Pollutant loads for the properties and constituents for each of the three land-use categories were computed, on the basis of seven sampled storms at each site, from measured flow-weighted EMCs and runoff volume. COD and suspended and dissolved solids had the greatest mean loads per square mile. Mean loads per square mile for trace elements were greatest in industrial land-use basins. Mean loads per square mile for diazinon were greatest in residential land-use basins. Mean loads per square mile for total nitrogen were dissimilar among the three types of land-use basins.

An analysis of covariance was done on the loads for each constituent by land use to determine if significant differences (at the 95-percent confidence level) existed. Suspended solids loads for commercial land-use basins were not significantly different from loads for the two other land-use basins. Loads for total ammonia plus organic nitrogen, total phosphorus, and dissolved phosphorus did not differ significantly among land uses, although median concentrations were significantly different among land uses. Loads for the remaining constituents were significantly different among the three land uses.

Local regression equations were developed to estimate loads produced by individual storms. For each property or constituent, the local regression equations have a smaller standard error of estimate than regional regression equations developed as a part of a previous nationwide study to develop methods to estimate stormwater constituent concentrations. Mean annual loads for gaged basins were estimated by applying the storm-load equations for all runoff-producing storms in an average climatic year and summing individual storm loads to determine the annual load.

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Table 1. Selected characteristics of surface-water and water-quality data-collection sites

Site no. (fig. 1)	Site name	Land-use classification	Total drainage area (acres)	Impervious area (percent)	Land use (acres) Residential	Commercial	Industrial	Nonurban
	Arlington							
08049220	The Parks Mall Outfall at I–20 West	Commercial	38.8	76.2	0	38.3	0	0.5
08049320	River Legacy Park Outfall at Green Oaks Boulevard	Residential	160	47.4	139	3.8	0	17.5
08049360	Tributary to West Fork Trinity River Outfall at Baird's Farm Road	Residential	77.0	89.0	70.5	6.5	0	0
08049470	Tributary to Johnson Creek Outfall at I–30 East	Industrial	85.5	80.9	0	7.7	77.8	0
	Dallas							
08055590	Joe's Creek Outfall at Denton Drive	Industrial	9.0	80.0	0	0	9.0	0
08056390	Bastille Street Outfall at La Reunion Parkway	Industrial	49.5	80.0	0	.2	49.3	0
08057135	White Rock Creek Outfall at Preston Road	Commercial	59.1	84.5	.9	58.2	0	0
08057310	Ash Creek Outfall at Whittier Street	Residential	71.3	50.0	71.3	0	0	0
08057441	Newton Creek Outfall at Tioga Street	Residential	38.9	44.9	33.9	0	0	5.0
	Fort Worth							
08047100	Clear Fork Trinity River Outfall at Oak Hill Circle	Residential	61.7	21.9	13.2	2.7	0	45.8
08048505	Pylon Street Outfall at Meacham Road	Industrial	151	27.7	0	4.8	33.6	113
08048510	West Fork Trinity River Outfall at Highway 121	Commercial	136	66.5	59.7	68.6	0	7.9
08048545	Dry Branch Outfall at 33d Street	Industrial	73.7	79.3	0	0	72.9	.8
08048700	Eastern Hills High School Outfall at Weiler Drive	Residential	151	61.4	97.2	44.8	0	8.7
	Garland							
08061635	Tributary to Duck Creek Outfall at Hightower Road	Industrial	33.9	67.3	0	0	27.8	6.1
08061660	Sleepy Hollow Street Outfall at Northwest Highway	Residential	67.3	55.1	58.7	8.6	0	0
08061690	I–635 Outfall at Centerville Road	Commercial	36.2	84.6	11.3	24.9	0	0
	Irving							
08049590	Bear Creek Outfall at Shady Grove Road	Residential	65.3	41.9	50.4	.8	0	14.1
08055570	Hereford Road Outfall at Walnut Hill Road	Industrial	43.4	77.3	0	16.8	26.5	.1
08056100	Tributary to Elm Fork Trinity River Outfall at Cascade Street	Industrial	43.9	77.8	0	7.7	35.8	.4
	Mesquite							
08061910	South Mesquite Creek Outfall at I–635	Commercial	45.9	89.4	0	45.5	0	.4
08061915	South Mesquite Creek Outfall at South Parkway	Residential	45.4	49.8	44.8	.2	0	.4
08061940	South Mesquite Creek Outfall at Bruton Road	Residential	46.2	49.9	46.1	0	0	.1
	Plano							
08061510	Rowlett Creek Outfall at Willow Creek Park	Residential	51.4	54.3	44.7	5.9	0	.8
08061525	Spring Creek Outfall at Park Boulevard	Commercial	22.7	73.5	0	18.6	0	4.1
08061530	Spring Creek Outfall at Avenue F	Industrial	49.0	81.6	5.1	32.0	11.9	0

Table 2. Summary statistics for physical properties (water temperature and pH) and total cyanide, phenols, and oil and grease by land-use category

[°C, degrees Celsius; mg/L, --, no data or not applicable; mg/L, milligrams per liter; µg/L, micrograms per liter; ND, nondetection]

Property or constituent	Laboratory minimum reporting level if nondetections present	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Water temperature[1] (°C)	--									
Residential		77	29.0	8.0	17.7	26.6	22.5	17.0	13.2	9.5
Commercial		41	24.5	6.5	15.9	23.9	20.5	15.0	13.0	8.0
Industrial		63	30.0	8.5	18.3	27.0	24.0	18.5	13.0	9.0
pH[1] (standard units)	--									
Residential		77	9.9	6.2	([2])	9.0	8.2	7.8	7.4	6.7
Commercial		41	8.7	6.3	([2])	8.5	8.1	7.8	7.6	6.8
Industrial		63	9.2	6.5	([2])	8.9	8.3	8.0	--	--
Cyanide, total[1] (mg/L)	0.01									
Residential		76	.08	ND	--	.01	ND	ND	ND	ND
Commercial		42	.08	ND	--	.01	ND	ND	ND	ND
Industrial		62	.04	ND	--	.01	ND	ND	ND	ND
Phenols, total[1] (µg/L)	--									
Residential		77	21.0	1.0	4.4	11.0	5.0	4.0	3.0	1.0
Commercial		42	17.0	1.0	5.4	14.7	7.0	4.0	2.0	1.0
Industrial		63	58.0	1.0	6.2	17.4	6.0	4.0	3.0	1.2
Oil and grease, total recoverable gravimetric[1] (mg/L)	1.0									
Residential		76	19.0	ND	[3]2.2	8.0	2.0	1.0	ND	ND
Commercial		42	8.0	ND	[3]2.3	6.0	3.0	2.0	ND	ND
Industrial		63	120	ND	[3]3.5	6.0	2.0	ND	ND	ND

[1] Property or constituent mandated by U.S. Environmental Protection Agency (1992).
[2] Mean for pH not reported.
[3] Mean values calculated for censored data by logarithmic probability regression method (Helsel and Cohn, 1988).

Table 3. Summary statistics for bacteria by land-use category

[In colonies per 100 milliliters.]

Bacteria	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Fecal coliforms[1]									
Residential	77	600,000	150	70,000	290,000	75,000	20,000	5,600	1,000
Commercial	42	810,000	67	48,000	400,000	36,000	6,900	970	200
Industrial	63	290,000	70	20,000	100,000	19,000	9,700	2,400	900
Fecal streptococci[1]									
Residential	77	670,000	2,600	120,000	430,000	190,000	56,000	24,000	7,000
Commercial	42	350,000	1,400	50,000	320,000	47,000	18,000	7,100	1,600
Industrial	62	210,000	33	25,000	150,000	20,000	10,000	6,100	1,900

[1] Constituent mandated by U.S. Environmental Protection Agency (1992).

Table 4. Most frequent volatile organic compound detections by land-use category and sampling site

Land-use category	Detected volatile organic compound[1]	Percent detected, all sites in land-use category (no. of detections)	Sampling site(s) with most detections (no. of detections)
Residential	Trimethylbenzene	14 (11)	08049590 (3)
	Xylene	14 (11)	08049590 (3)
	Toluene	13 (10)	08048700 (3)
	Chloroform	10 (8)	08048700 (4)
Commercial	Toluene	29 (12)	08061690 (7)
	Xylene	21 (9)	08061690 (7)
	Benzene	19 (8)	08061690 (6)
	Ethylbenzene	17 (7)	08061690 (6)
Industrial	Trichloroethylene	22 (14)	08048545 (7) 08061530 (5)
	Chloroform	21 (13)	08056100 (7)
	trans-1,2-Dichloroethylene	14 (9)	08061530 (6) 08048545 (3)
	Tetrachloroethylene	13 (8)	08048545 (7)
	1,1,1-Trichloroethylene	13 (8)	08048545 (7)
	cis-1,2-Dichloroethylene	22 (14)	08048545 (7) 08061530 (7)
	Toluene	17 (11)	08048545 (3) 08049470 (3) 08061530 (3)
	Xylene	16 (10)	08061530 (4)
	1,2,4-Trimethylbenzene	13 (8)	08061530 (4) 08056100 (3)

[1] Compounds with detections less than 10 percent not listed.

Table 5. Summary statistics for volatile organic compounds by land-use category

[In micrograms per liter. --, no data; ND, nondetection]

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Acrolein[1]	1,000; 500; 20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Acrylonitrile[1]	1,000; 500; 20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 5. Summary statistics for volatile organic compounds by land-use category—Continued

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Benzene[1]	10; 5.0; 0.20								
Residential		77	0.30	ND	ND	ND	ND	ND	ND
Commercial		41	.80	ND	0.60	ND	ND	ND	ND
Industrial		63	.60	ND	ND	ND	ND	ND	ND
Bromobenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Bromochloromethane	10; 5.0; 0.20								
Residential		49	.20	ND	ND	ND	ND	ND	ND
Commercial		29	ND	ND	ND	ND	ND	ND	ND
Industrial		25	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane[1]	10; 5.0; 0.20								
Residential		77	.20	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	.50	ND	ND	ND	ND	ND	ND
Bromoform[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene	10; 5.0; 0.20								
Residential		77	.20	ND	ND	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
sec-Butylbenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
tert-Butylbenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Chloroethane[1]	10; 5.0; 0.20								
Residential		77	.20	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 5. Summary statistics for volatile organic compounds by land-use category—Continued

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
2-Chloroethyl vinyl ether[1]	50; 30; 2.5; 1.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Chloroform[1]	0.20								
Residential		77	0.70	ND	0.20	ND	ND	ND	ND
Commercial		41	1.10	ND	ND	ND	ND	ND	ND
Industrial		63	.70	ND	.50	ND	ND	ND	ND
Chloromethane[1]	10; 5.0; 0.20								
Residential		77	.40	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,2-Chlorotoluene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	.20	ND	ND	ND	ND	ND	ND
1,4-Chlorotoluene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	.20	ND	ND	ND	ND	ND	ND
Dibromochloromethane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Dibromochloropropane[1]	50; 25; 1.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Dibromomethane	5.0; 0.20								
Residential		77	.20	ND	ND	ND	ND	ND	ND
Commercial		41	.40	ND	ND	ND	ND	ND	ND
Industrial		63	.70	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 5. Summary statistics for volatile organic compounds by land-use category—Continued

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
1,4-Dichlorobenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	8.3	ND	0.50	ND	ND	ND	ND
1,2-Dichloroethane[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,1-Dichlorethylene[1]	10; 5.0; 0.20								
Residential		77	5.9	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	13.0	ND	.50	ND	ND	ND	ND
cis-1,2-Dichloroethene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	1,200	ND	76.0	ND	ND	ND	ND
trans-1,2-Dichlorolethylene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	27.0	ND	2.3	ND	ND	ND	ND
1,2-Dichloropropane[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,3-Dichloropropane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2,2-Dichloropropane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloropropene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 5. Summary statistics for volatile organic compounds by land-use category—Continued

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
cis-1,3-Dichloropropene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene[1]	10; 5.0; 0.20								
Residential		77	0.60	ND	ND	ND	ND	ND	ND
Commercial		41	.60	ND	0.40	ND	ND	ND	ND
Industrial		63	1.5	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	4.6	ND	ND	ND	ND	ND	ND
4-Isopropyltoluene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		38	.90	ND	ND	ND	ND	ND	ND
Industrial		63	.20	ND	ND	ND	ND	ND	ND
Methyl bromide[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Methyl-tert-butyl ether	50; 25; 1.0								
Residential		49	ND	ND	ND	ND	ND	ND	ND
Commercial		41	8.7	ND	8.30	ND	ND	ND	ND
Industrial		25	5.4	ND	ND	ND	ND	ND	ND
Methylene chloride[1]	5.0; 0.20								
Residential		77	.80	ND	ND	ND	ND	ND	ND
Commercial		41	.30	ND	ND	ND	ND	ND	ND
Industrial		63	3.30	ND	.30	ND	ND	ND	ND
Naphthalene	5.0; 0.20								
Residential		77	.60	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	1.3	ND	ND	ND	ND	ND	ND
n-Propylbenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	.50	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 5. Summary statistics for volatile organic compounds by land-use category—Continued

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Styrene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	0.60	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethylene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	42.0	ND	4.90	ND	ND	ND	ND
Toluene[1]	0.20								
Residential		77	1.8	ND	.20	ND	ND	ND	ND
Commercial		41	2.4	ND	1.2	0.20	ND	ND	ND
Industrial		63	1.8	ND	.30	ND	ND	ND	ND
1,2,3-Trichlorobenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane[1]	5.0; 0.20								
Residential		77	.30	ND	ND	ND	ND	ND	ND
Commercial		41	.20	ND	ND	ND	ND	ND	ND
Industrial		63	5.4	ND	2.5	ND	ND	ND	ND
1,1,2-Trichloroethane[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	.20	ND	ND	ND	ND	ND	ND
Trichloroethylene[1]	10; 5.0; 0.20								
Residential		77	.20	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	28.0	ND	7.6	ND	ND	ND	ND
Trichlorofluoromethane	25; 13; 0.50								
Residential		49	ND	ND	ND	ND	ND	ND	ND
Commercial		30	ND	ND	ND	ND	ND	ND	ND
Industrial		25	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 5. Summary statistics for volatile organic compounds by land-use category—Continued

Volatile organic compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
1,2,3-Trichloropropane	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Trichlorotrifluoromethane	10; 5.0; 0.20								
Residential		77	0.40	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	.30	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	5.0; 0.20								
Residential		77	2.0	ND	0.60	ND	ND	ND	ND
Commercial		38	.40	ND	.40	ND	ND	ND	ND
Industrial		63	15.0	ND	.60	ND	ND	ND	ND
1,3,5-Trimethylbenzene	10; 5.0; 0.20								
Residential		77	.30	ND	.20	ND	ND	ND	ND
Commercial		38	ND	ND	ND	ND	ND	ND	ND
Industrial		63	6.30	ND	.30	ND	ND	ND	ND
Vinyl chloride[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	4.80	ND	ND	ND	ND
Xylene, total	5.0; 0.20								
Residential		77	3.70	ND	.90	ND	ND	ND	ND
Commercial		41	1.90	ND	1.0	ND	ND	ND	ND
Industrial		63	10.0	ND	1.50	ND	ND	ND	ND

[1] Constituent mandated by U.S. Environmental Protection Agency (1992).

Table 6. Summary statistics for nutrients in flow-composite samples by land-use category

[In milligrams per liter.]

Nutrient	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Nitrogen, total[1], as nitrogen[2]									
Residential	77	8.4	0.92	2.09	4.8	2.4	1.7	1.4	1.1
Commercial	42	5.4	.64	1.54	3.0	1.8	1.2	1.0	.79
Industrial	63	3.8	.60	1.55	2.6	1.9	1.4	1.2	.92
Nitrogen, total[1] ammonia									
Residential	42	.65	.06	.21	.54	.32	.18	.13	.09
Commercial	20	.73	.08	.28	.73	.43	.18	.12	.08
Industrial	47	.34	.02	.16	.33	.19	.14	.11	.07

Footnotes at end of table.

Table 6. Summary statistics for nutrients in flow-composite samples by land-use category—Continued

Nutrient	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Nitrogen, total[1] ammonia plus organic[2]									
Residential	77	7.8	0.60	1.45	3.60	1.75	1.1	0.80	0.60
Commercial	42	4.2	.30	.96	2.14	1.05	.80	.60	.40
Industrial	63	2.0	.30	.86	1.66	1.00	.80	.60	.40
Nitrogen, total[1] nitrate									
Residential	42	.15	.02	.06	.12	.07	.05	.03	.02
Commercial	20	.12	.02	.06	.12	.08	.06	.03	.02
Industrial	47	.26	.02	.06	.15	.08	.05	.03	.02
Nitrogen, total[1] nitrite plus nitrate[2]									
Residential	77	1.70	.27	.64	1.20	.80	.58	.42	.31
Commercial	42	1.50	.23	.58	1.28	.73	.52	.39	.24
Industrial	63	2.70	.26	.69	1.18	.79	.63	.49	.30
Phosphorus, total[1, 2]									
Residential	77	1.0	.16	.38	.81	.48	.33	.24	.17
Commercial	42	.74	.05	.18	.53	.28	.14	.09	.05
Industrial	63	.92	.05	.28	.71	.38	.21	.16	.06
Phosphorus, dissolved[2, 3]									
Residential	77	.84	.04	.25	.48	.34	.21	.17	.08
Commercial	42	.47	.01	.09	.30	.11	.06	.04	.01
Industrial	63	.45	.03	.14	.39	.20	.09	.06	.04
Carbon, total[1] organic									
Residential	77	370	8.2	25.5	51.9	25.0	18.0	12.0	9.08
Commercial	42	48.0	5.8	16.0	45.8	18.2	12.0	9.3	6.56
Industrial	63	58.0	6.9	19.9	44.2	26.0	18.0	13.0	8.00

[1] "Total" is the total amount of a given constituent in a representative water sample regardless of the physical or chemical form of the constituent.
[2] Constituent mandated by U.S. Environmental Protection Agency (1992).
[3] "Dissolved" refers to that material in a representative water sample that passes through a 0.45-millimeter membrane filter.

Table 7. Summary statistics for oxygen demand properties in flow-composite samples by land-use category
[In milligrams per liter.]

Property	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Biochemical oxygen demand[1]									
Residential	74	19.0	3.4	7.2	12.3	8.0	7.3	5.2	3.9
Commercial	40	17.0	2.7	6.8	16.0	7.7	6.6	4.6	2.8
Industrial	61	27.0	2.7	7.5	12.7	8.5	7.5	5.5	3.6
Chemical oxygen demand[1]									
Residential	77	1,300	29.0	95.0	220	96.0	70.0	48.0	33.8
Commercial	42	180	23.0	70.0	160	91.5	56.5	41.0	23.4
Industrial	62	250	10.0	76.3	190	89.0	66.0	42.8	12.2

[1] Property mandated by U.S. Environmental Protection Agency (1992).

Table 8. Summary statistics for inorganic constituents and specific conductance in flow-composite samples by land-use category

[In milligrams per liter except as indicated. ND, nondetection at 1.0 milligram per liter minimum reporting level; µS/cm, microsiemens per centimeter at 25 degrees Celsius]

Property or constituent	No. of samples	Maxi-mum	Mini-mum	Mean	95th per-centile	75th per-centile	Median 50th per-centile	25th per-centile	5th per-centile
Calcium, dissolved[1]									
Residential	72	33.0	5.4	12.8	24.0	14.8	12.0	9.4	6.8
Commercial	38	32.0	5.5	13.0	25.4	15.5	11.5	9.4	6.5
Industrial	60	59.0	5.1	16.1	35.6	18.8	14.0	11.0	6.1
Chloride, dissolved[1]									
Residential	72	15.0	.60	3.5	9.7	4.5	2.6	1.6	.66
Commercial	37	11.0	.50	2.5	9.6	2.6	1.9	1.0	.59
Industrial	60	50.0	.60	5.3	21.7	5.2	3.0	1.8	.80
Magnesium, dissolved[1]									
Residential	72	5.1	.20	.79	2.7	.86	.55	.33	.21
Commercial	38	1.8	.12	.48	1.8	.53	.37	.26	.14
Industrial	60	2.6	.11	.68	1.6	.90	.60	.37	.14
Potassium, dissolved[1]									
Residential	72	8.6	.70	3.5	5.7	4.1	3.2	2.6	1.9
Commercial	38	4.8	.70	1.8	4.6	2.2	1.6	.98	.70
Industrial	60	3.9	.70	1.9	3.5	2.2	1.8	1.4	.90
Sodium, dissolved[1]									
Residential	72	17.0	.90	3.3	9.8	3.7	2.3	1.5	.90
Commercial	38	20.0	.20	2.8	9.2	3.0	2.0	1.3	.67
Industrial	60	41.0	.70	5.4	18.6	6.2	3.7	2.4	1.0
Sulfate, dissolved[1]									
Residential	72	48.0	2.1	8.6	27.0	10.4	5.5	4.1	2.7
Commercial	38	18.0	.10	6.6	17.0	7.7	5.7	3.5	2.3
Industrial	60	57.0	2.2	11.8	26.8	15.0	10.4	6.2	3.2
Suspended[2] solids[3]									
Residential	72	686	1.0	130	528	151	78.0	41.8	10.2
Commercial	38	156	ND	55.5	146	80	42.0	24.0	ND
Industrial	60	2,490	15.0	222	842	218	104	62.5	23.1
Dissolved[1] solids[3]									
Residential	72	959	29.0	78.8	148	73.8	59.0	49.2	35.6
Commercial	37	249	23.0	64.0	161	70.5	50.0	39.0	28.4
Industrial	60	318	21.0	78.1	162	92.0	69.0	54.5	30.0
Alkalinity, total as $CaCO_3$									
Residential	75	66.0	11.0	29.9	54.4	36.0	28.0	23.0	15.8
Commercial	41	61.0	11.0	28.4	44.9	33.0	27.0	22.0	12.4
Industrial	62	140	9.8	33.3	58.7	38.0	28.5	23.0	15.4
Specific conductance (µS/cm)									
Residential	72	334	58.0	140	265	184	110	99.2	73.3
Commercial	38	258	61.0	114	255	123	106	84.8	70.5
Industrial	60	539	66.0	164	264	201	153	121	83.2

[1] "Dissolved" refers to that material in a representative water sample that passes through a 0.45-millimeter membrane filter.

[2] "Suspended" refers to the amount of a given constituent in the part of a water sample that is retained by a 0.45 millimeter-membrane filter.

[3] Constituent mandated by U.S. Environmental Protection Agency (1992).

Table 9. Summary statistics for trace-element concentrations in flow-composite samples by land-use category

[In micrograms per liter. ND, nondetection; --, no data or not applicable; <, less than]

Trace element	Laboratory minimum reporting level(s), if nondetections present	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Antimony, total[1]	20; 10									
Residential		77	ND	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND	ND
Industrial		63	53.0	ND	4.9	ND	ND	ND	ND	ND
Arsenic, total[1]	1.0									
Residential		76	45.0	1.0	5.6	25.2	5.0	3.0	2.0	1.0
Commercial		41	25.0	ND	1.8	3.0	2.0	1.0	ND	ND
Industrial		62	7.0	ND	2.0	5.0	2.0	2.0	1.0	ND
Beryllium, total recoverable[1]	1.0									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		40	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Cadmium, total recoverable[1]	1.0									
Residential		77	1.0	ND	--	ND	ND	ND	ND	ND
Commercial		40	1.0	ND	--	ND	ND	ND	ND	ND
Industrial		63	8.0	ND	.92	3.0	1.0	ND	ND	ND
Chromium, total recoverable[1]	1.0									
Residential		76	26.0	ND	5.6	15.0	7.0	4.0	3.0	ND
Commercial		40	100	ND	7.1	11.0	7.0	4.0	2.0	ND
Industrial		62	100	1.0	12.9	43.3	16.0	9.0	4.0	2.0
Copper, total recoverable[1]	--									
Residential		76	86.0	1.0	9.7	16.2	12.0	8.0	5.0	3.8
Commercial		38	82.0	2.0	11.4	34.5	11.2	8.0	6.0	3.0
Industrial		61	1,300	4.0	95.4	1,060	19.5	12.0	7.0	4.0
Lead, total recoverable[1]	--									
Residential		76	89.0	1.0	21.4	58.4	29.8	13.0	7.0	4.0
Commercial		40	130	5.0	33.2	98.7	46.8	29.5	13.5	6.0
Industrial		62	320	1.0	53.7	240	60.5	29.0	14.0	6.2
Mercury, total recoverable[1]	0.10									
Residential		76	.40	ND	--	.10	ND	ND	ND	ND
Commercial		40	.10	ND	--	.10	ND	ND	ND	ND
Industrial		62	9.2	ND	--	.20	ND	ND	ND	ND
Nickel, total recoverable[1]	1.0									
Residential		76	18.0	1.0	5.2	16.0	6.0	4.0	3.0	1.0
Commercial		40	9.0	ND	3.5	8.0	4.0	3.0	2.0	ND
Industrial		62	59.0	1.0	8.1	22.4	9.2	6.0	3.8	2.0
Selenium, total[1]	2.0; 1.0									
Residential		76	2.0	ND	ND	ND	ND	ND	ND	ND
Commercial		41	ND	ND	ND	ND	ND	ND	ND	ND
Industrial		63	2.0	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 9. Summary statistics for trace-element concentrations in flow-composite samples by land-use category—Continued

Trace element	Laboratory minimum reporting level(s), if nondetections present	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Silver, total recoverable[1]	1.0									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		40	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Thallium, total[1]	1,000; 500; 50; 25; 10; 5.0									
Residential		77	ND	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND	ND
Zinc, total recoverable[1]										
Residential		76	230	20.0	77.6	170	100	60.0	40.0	30.0
Commercial		40	290	30.0	103	260	130	80.0	52.5	40.0
Industrial		62	1,400	20.0	206	686	230	140	97.5	50.0

[1] Constituent mandated by U.S. Environmental Protection Agency (1992).

Table 10. Most frequent base/neutral and acid-extractable semivolatile organic compound detections in flow-composite samples by land-use category and sampling site

Land-use category	Detected compound[1]	Percent detected, all sites in land-use category (no. of detections)	Sampling site(s) with most detections (no. of detections)
Residential	bis(2-Ethylhexyl)phthalate	36 (28)	08061510 (7) 08057441 (4) 08061660 (4)
Commercial	bis(2-Ethylhexyl)phthalate	61 (25)	08061690 (6) 08049220 (5) 08057135 (4)
	Pyrene	13 (8)	08061690 (5)
Industrial	bis(2-Ethylhexyl)phthalate	41 (26)	08061530 (7) 08048545 (6) 08061635 (5) 08055570 (4)
	Fluoranthene	24 (15)	08061635 (6)
	Pyrene	22 (14)	08061635 (6)
	Phenanthrene	21 (13)	08061635 (6) 08055570 (4)

[1] Compounds with detections less than 13 percent not listed.

Table 11. Summary statistics for base/neutral and acid extractable semivolatile organic compounds in flow-composite samples by land-use category

[In micrograms per liter. ND, nondetection; --, no data]

Compound	Laboratory minimum reporting level(s) if nondections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Acenaphthene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Anthracene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	7.0	ND	ND	ND	ND	ND	ND
Benzidine[1]	40								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	13.0	ND	ND	ND	ND	ND	ND
Industrial		63	26.0	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	11.0	ND	ND	ND	ND	ND	ND
Industrial		63	20.0	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	15.0	ND	ND	ND	ND	ND	ND
Industrial		63	23.0	ND	11.0	ND	ND	ND	ND
Benzo(g,h,i)perylene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	15.0	ND	ND	ND	ND	ND	ND
Industrial		63	25.0	ND	11.0	ND	ND	ND	ND
Benzo(k)fluoranthene[1]	10								
Residential		77	280	ND	ND	ND	ND	ND	ND
Commercial		42	13.0	ND	ND	ND	ND	ND	ND
Industrial		63	22.0	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 11. Summary statistics for base/neutral and acid extractable semivolatile organic compounds in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Butyl benzyl phthalate[1]	5.0								
Residential		77	10.0	ND	ND	ND	ND	ND	ND
Commercial		42	8.0	ND	ND	ND	ND	ND	ND
Industrial		63	14.0	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol[1]	30								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl)ether[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl)ether[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Chrysene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	23.0	ND	12.0	ND	ND	ND	ND
Industrial		63	49.0	ND	16.0	ND	ND	ND	ND
Dibenzanthracene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 11. Summary statistics for base/neutral and acid extractable semivolatile organic compounds in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
1,2-Dichlorobenzene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine[1]	20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Diethyl phthalate[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	6.0	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol[1]	30								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 11. Summary statistics for base/neutral and acid extractable semivolatile organic compounds in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
2,4-Dinitrophenol[1]	20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
1,2-Diphenyl hydrazine[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate[1]	5.0								
Residential		77	24.0	ND	14.0	8.0	ND	ND	ND
Commercial		41	20.0	ND	13.0	8.0	6.0	ND	ND
Industrial		63	130	ND	16.0	7.0	ND	ND	ND
Fluoranthene[1]	5.0								
Residential		77	13.0	ND	ND	ND	ND	ND	ND
Commercial		42	23.0	ND	12.0	ND	ND	ND	ND
Industrial		63	52.0	ND	23.0	ND	ND	ND	ND
Fluorene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 11. Summary statistics for base/neutral and acid extractable semivolatile organic compounds in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondections present	No. of samples	Maximum	Minimum	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Hexachlorocyclopentadiene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene[1]	10								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	15.0	ND	ND	ND	ND	ND	ND
Industrial		63	27.0	ND	11.0	ND	ND	ND	ND
Isophorone[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Naphthalene[1]	5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol[1]	30								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
N-nitrosodi-n-propylamine[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

Footnote at end of table.

Table 11. Summary statistics for base/neutral and acid extractable semivolatile organic compounds in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondections present	No. of sam-ples	Maxi-mum	Mini-mum	95th per-centile	75th per-centile	Median 50th per-centile	25th per-centile	5th per-centile
N-nitrosodimethlyamine[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol[1]	30								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Phenanthrene[1]	5.0								
Residential		77	10.0	ND	ND	ND	ND	ND	ND
Commercial		42	10.0	ND	6.0	ND	ND	ND	ND
Industrial		63	33.0	ND	13.0	ND	ND	ND	ND
Phenol[1]	5.0								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
Pyrene[1]	5.0								
Residential		77	10.0	ND	ND	ND	ND	ND	ND
Commercial		42	18.0	ND	10.0	ND	ND	ND	ND
Industrial		63	43.0	ND	18.0	ND	ND	ND	ND
1,2,4-Trichlorobenzene[1]	10; 5.0; 0.20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol[1]	20								
Residential		77	ND	ND	ND	ND	ND	ND	ND
Commercial		42	ND	ND	ND	ND	ND	ND	ND
Industrial		63	ND	ND	ND	ND	ND	ND	ND

[1] Compound mandated by U.S. Environmental Protection Agency (1992).

Table 12. Pesticide detections in flow-composite samples by land-use category and sampling site

Land-use category	Detected pesticide[1]	Percent detected, all sites in land-use category (no. of detections)	Sampling site(s) with most detections (no. of detections)
Residential	Diazinon	93 (71)	All
	Chlordane	22 (17)	08048700 (4) 08049590 (4)
	Dieldrin	12 (9)	08057310 (5)
Commercial	Diazinon	70 (28)	All
	Chlordane	21 (9)	08061690 (6)
Industrial	Diazinon	33 (21)	All
	Chlordane	10 (6)	08061530 (5)

[1] Pesticides with detections less than 10 percent not listed.

Table 13. Summary statistics for pesticides and polychlorinated biphenyls in flow-composite samples by land-use category

[In micrograms per liter. ND, nondetection; --, no data]

Compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Aldrin, total[1]	0.08; 0.04									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
alpha-BHC, total[1]	0.05; 0.03									
Residential		77	0.03	ND	--	ND	ND	ND	ND	ND
Commercial		42	.03	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
beta-BHC, total[1]	0.40; 0.03									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
delta-BHC, total[1]	0.20; 0.09									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
gamma-BHC (Lindane), total[1]	0.03									
Residential		77	.21	ND	--	ND	ND	ND	ND	ND
Commercial		42	.03	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Chlordane, total[1]	0.10									
Residential		77	1.2	ND	--	0.50	ND	ND	ND	ND
Commercial		42	.50	ND	--	.20	ND	ND	ND	ND
Industrial		63	.10	ND	--	.10	ND	ND	ND	ND
cis-Chlordane, total[1]	0.10									
Residential		77	.10	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
trans-Chlordane, total[1]	0.10									
Residential		77	.10	ND	--	ND	ND	ND	ND	ND
Commercial		42	.10	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
DDD, total (4,4'-Dichlorodiphenyldichloroethane)[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		44	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND

Footnotes at end of table.

Table 13. Summary statistics for pesticides and polychlorinated biphenyls in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
DDE, total (4,4'-Dichlorodiphenyldichloroethylene)[1]	0.08; 0.04									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
DDT, total (4,4'-Dichlorodiphenyltrichloroethane)[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Dieldrin, total[1]	0.20									
Residential		77	0.06	ND	--	0.04	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Endosulfan I, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Endosulfan II, total[1]	0.08; 0.04									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Endosulfan sulfate, total[1]	1.0; 0.60									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Endrin, recoverable[1]	0.10; 0.06									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Endrin aldehyde, total[1]	0.40; 0.20									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Heptachlor, total[1]	0.03									
Residential		77	.20	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND

Footnotes at end of table.

Table 13. Summary statistics for pesticides and polychlorinated biphenyls in flow-composite samples by land-use category—Continued

Compound	Laboratory minimum reporting level(s) if nondetections present	No. of samples	Maximum	Minimum	Mean	95th percentile	75th percentile	Median 50th percentile	25th percentile	5th percentile
Heptachlor epoxide, total[1]	2.0; 0.80									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Toxaphene, total[1]	4.0; 2.0									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Aroclor 1016, PCB, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Aroclor 1221, PCB, total[1]	2.0; 1.0									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Aroclor 1232, PCB, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Aroclor 1242, PCB, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	0.20	ND	--	ND	ND	ND	ND	ND
Aroclor 1248, PCB, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	ND	ND	--	ND	ND	ND	ND	ND
Aroclor 1254, PCB, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	.80	ND	--	ND	ND	ND	ND	ND
Aroclor 1260, PCB, total[1]	0.20; 0.10									
Residential		77	ND	ND	--	ND	ND	ND	ND	ND
Commercial		42	ND	ND	--	ND	ND	ND	ND	ND
Industrial		63	.10	ND	--	ND	ND	ND	ND	ND
Diazinon, total	0.10; 0.05; 0.01									
Residential		76	25.0	ND	[2]1.8	7.4	1.6	0.50	0.20	ND
Commercial		40	4.4	ND	[2].27	.40	.20	.10	ND	ND
Industrial		63	1.8	ND	[2].12	.50	.10	ND	ND	ND

[1] Pesticide mandated by U.S. Environmental Protection Agency (1992).
[2] Mean values calculated for censored data by logarithmic probability regression method (Helsel and Cohn, 1988).

Table 14. Mean and median event-mean concentrations by land-use category

[NURP, Nationwide Urban Runoff Program (U.S. Environmental Protection Agency, 1983); mg/L, milligrams per liter; --, not calculated; µg/L, micrograms per liter]

Property or constituent	No. of samples[1]	Event-mean concentration: Volume-weighted mean	Event-mean concentration: Log-transformed mean	Event-mean concentration: Arithmetic mean[1]	Event-mean concentration: Median[1]	NURP median event-mean concentration
Residential (11 sites)						
Biochemical oxygen demand, mg/L	72	6.7	6.6	7.0	7.3	10
Chemical oxygen demand, mg/L	76	77	71	85	70	73
Suspended solids, mg/L	69	110	83	127	78	101
Dissolved solids, mg/L	70	64	62	66	58	--
Total nitrogen, mg/L	77	2.0	1.9	2.1	1.7	--
Total ammonia plus organic nitrogen, mg/L	77	1.3	1.2	1.5	1.1	1.90
Total phosphorus, mg/L	77	.39	.34	.38	.33	.38
Dissolved phosphorus, mg/L	77	.27	.22	.25	.21	.14
Total recoverable cadmium, µg/L	76	--	--	--	--	--
Total recoverable copper, µg/L	74	8.2	8.0	9.6	8.0	33
Total recoverable lead, µg/L	74	17	15	21	13	144
Total recoverable zinc, µg/L	75	67	66	76	60	135
Total diazinon, µg/L	76	1.8	.54	1.8	.55	--
Commercial (6 sites)						
Biochemical oxygen demand, mg/L	38	7.0	6.2	6.5	6.6	9.3
Chemical oxygen demand, mg/L	42	65	59	68	56	57
Suspended solids, mg/L	35	61	45	60	52	69
Dissolved solids, mg/L	37	59	55	64	50	--
Total nitrogen, mg/L	42	1.5	1.4	1.5	1.2	--
Total ammonia plus organic nitrogen, mg/L	42	.92	.83	.96	.80	1.18
Total phosphorus, mg/L	42	.18	.14	.18	.14	.20
Dissolved phosphorus, mg/L	42	.10	.06	.09	.06	.08
Total recoverable cadmium, µg/L	40	--	--	--	--	--
Total recoverable copper, µg/L	38	12	8.6	11	8.0	29
Total recoverable lead, µg/L	40	36	25	33	30	104
Total recoverable zinc, µg/L	40	102	88	103	80	226
Total diazinon, µg/L	40	.30	.12	.27	.10	--

Footnote at end of table.

Table 14. Mean and median event-mean concentrations by land-use category—Continued

Property or constituent	No. of samples[1]	Event-mean concentration: Volume-weighted mean	Log-transformed mean	Arithmetic mean[1]	Median[1]	NURP median event-mean concentration
Industrial (9 sites)						
Biochemical oxygen demand, mg/L	61	7.1	7.0	7.5	7.5	--
Chemical oxygen demand, mg/L	59	77	69	80	67	--
Suspended solids, mg/L	60	259	121	222	104	--
Dissolved solids, mg/L	60	73	70	78	69	--
Total nitrogen, mg/L	63	1.5	1.5	1.5	1.4	--
Total ammonia plus organic nitrogen, mg/L	63	.83	.80	.86	.80	--
Total phosphorus, mg/L	63	.26	.23	.28	.21	--
Dissolved phosphorus, mg/L	63	.12	.11	.14	.09	--
Total recoverable cadmium, µg/L	63	--	--	--	--	--
Total recoverable copper, µg/L	61	100	17	95	12	--
Total recoverable lead, µg/L	61	64	32	55	29	--
Total recoverable zinc, µg/L	59	173	139	168	130	--
Total diazinon, µg/L	62	.14	.07	.14	.05	--

[1] Values might not match those in tables 6, 7, 8, 9, or 13 because of different computation methods for nondetections.

Table 15. Rainfall-runoff characteristics by land-use category

Land-use category	Rainfall (inches)	Runoff volume (cubic feet)	Percent runoff
Residential			
Mean	0.51	36,200	27.2
Median	.45	28,300	24.0
Minimum	.19	7,270	10.8
Maximum	1.30	175,000	54.6
Commercial			
Mean	.50	62,800	71.6
Median	.44	49,800	76.5
Minimum	.20	13,500	22.3
Maximum	1.50	189,000	96.5
Industrial			
Mean	.51	58,400	65.2
Median	.45	49,400	73.6
Minimum	.20	6,260	10.9
Maximum	1.38	190,000	97.3

Table 16. Computed loads per square mile for all sampled storms by land-use category

[<, less than]

Land-use category	Load (pounds per square mile)					
	Biochemical oxygen demand	Chemical oxygen demand	Suspended solids	Dissolved solids	Total nitrogen	Total ammonia plus organic nitrogen
Residential						
Mean	138	1,830	2,120	1,790	43.7	30.2
Median	121	1,070	1,440	990	31.4	20.2
Minimum	28.3	333	.56	324	8.16	4.47
Maximum	451	16,100	8,302	32,100	214	155
Commercial						
Mean	316	3,000	2,580	3,070	70.9	43.2
Median	245	2,300	2,000	2,320	62.1	34.5
Minimum	74.4	972	.60	1,090	21.6	9.48
Maximum	1,000	10,800	7,850	12,000	232	149
Industrial						
Mean	337	3,577	12,000	3,460	72.9	41.3
Median	294	2,877	4,430	2,570	63.2	31.9
Minimum	40.0	95.40	110	629	7.67	2.40
Maximum	1,241	13,810	125,000	13,800	202	124

Land-use category	Load (pounds per square mile)					
	Total phosphorus	Dissolved phosphorus	Total recoverable copper	Total recoverable lead	Total recoverable zinc	Total diazinon
Residential						
Mean	8.29	5.72	0.17	0.37	1.46	0.05
Median	4.96	3.56	.13	.27	1.09	.01
Minimum	1.19	.30	<.01	<.01	.19	<.01
Maximum	47.0	41.9	.62	1.91	5.69	.73
Commercial						
Mean	7.85	3.72	.57	1.52	4.60	.01
Median	6.23	2.88	.39	1.06	3.88	<.01
Minimum	1.90	.22	.09	.17	1.19	<.01
Maximum	29.8	16.5	5.08	5.39	13.6	.10
Industrial						
Mean	12.6	6.48	4.81	3.08	9.74	.01
Median	8.50	4.19	.47	1.18	6.48	<.01
Minimum	.48	.29	.02	<.01	.10	<.01
Maximum	55.9	46.6	69.2	24.8	60.5	.10

Table 17. Local regression equation coefficients for estimating loads of selected water-quality properties and constituents from individual storm-runoff events

[LOAD, storm-runoff load of property or constituent, in pounds; $b_{o'}$, intercept in regression model; b_1, coefficient for variable TRN (total storm rainfall), in inches; b_2, coefficient for variable DA (drainage area), in square miles; b_3, coefficient for variable IA (impervious area), as percentage of DA; b_4, coefficient for variable LUI (industrial land use), as percentage of DA; b_5, coefficient for variable LUC (commercial land use), as percentage of DA; b_6, coefficient for variable LUR (residential land use), as percentage of DA; b_7, coefficient for variable LUN (nonurban land use), as percentage of DA; BCF, bias correction factor; SE, standard error of regression equation, in percent; R^2 adj, adjusted coefficient of determination, in percent; --, variable not included. Equation form is:

$$LOAD = b_{o'} \times (TRN)^{b_1} \times (DA)^{b_2} \times (IA+1)^{b_3} \times (LUI+1)^{b_4} \times (LUC+1)^{b_5} \times (LUR+1)^{b_6} \times (LUN+1)^{b_7} \times BCF.]$$

Property or constituent	b_o'	b_1	b_2	b_3	b_4	b_5
Biochemical oxygen demand	9.01	0.879	0.725	0.656	0.104	0.085
Chemical oxygen demand	10.2	.711	.593	.961	.176	.123
Suspended solids	5.85	.889	.544	.913	.463	.170
Dissolved solids	104	.764	.745	.568	.131	.124
Total nitrogen	1.14	.838	.597	.725	.072	.056
Total ammonia plus organic nitrogen	.666	.878	.544	.716	.045	.037
Total phosphorus	.955	.932	.475	--	.286	.176
Dissolved phosphorus	.546	1.05	.477	--	.281	.121
Total recoverable copper	.0023	.894	.623	.996	.138	.057
Total recoverable lead	.00000086	1.21	.500	2.55	.371	.210
Total recoverable zinc	.00020	.905	.520	1.85	.363	.198
Total diazinon	.0013	1.47	.305	--	--	--

Property or constituent	b_6	b_7	BCF	SE	R^2 adj
Biochemical oxygen demand	--	--	1.11	48.7	64.0
Chemical oxygen demand	0.130	--	1.16	58.5	53.6
Suspended solids	.328	--	1.52	115	42.0
Dissolved solids	--	--	1.13	52.3	59.2
Total nitrogen	.052	--	1.15	57.1	49.9
Total ammonia plus organic nitrogen	.077	--	1.18	63.0	45.0
Total phosphorus	.272	--	1.20	66.2	51.5
Dissolved phosphorus	.333	--	1.25	75.7	52.7
Total recoverable copper	.012	--	1.24	72.8	49.2
Total recoverable lead	.274	0.265	1.41	99.5	58.8
Total recoverable zinc	.201	.266	1.20	65.8	65.3
Total diazinon	.374	--	2.32	210	40.6

Table 18. Standard error and number of storms for local regression equations and Driver and Tasker regional regression equations

[SE, standard error of estimate for regression equation; --, equation not developed for property or constituent]

Property or constituent	Local regression equations		Driver and Tasker regional regression equations[1]	
	SE (percent)	No. of storms	SE (percent)	No. of storms
Biochemical oxygen demand	48.7	172	--	--
Chemical oxygen demand	58.5	177	97	793
Suspended solids	115	164	165	964
Dissolved solids	52.3	167	69	281
Total nitrogen	57.1	182	97	574
Total ammonia plus organic nitrogen	63.0	182	106	859
Total phosphorus	66.2	182	116	1,091
Dissolved phosphorus	75.7	182	119	469
Total recoverable copper	72.8	167	123	298
Total recoverable lead	99.5	175	131	943
Total recoverable zinc	65.8	174	160	357
Total diazinon	210	179	--	--

[1] Driver and Tasker, 1990.

Table 19. Estimated annual loads for sites in all study basins using 1965 rainfall at Love Field and 1975 rainfall at Meacham Airport

City	Site no. (fig. 1)	Load (pounds)											
		Biochemical oxygen demand	Chemical oxygen demand	Suspended solids	Dissolved solids	Total nitrogen	Total ammonia plus organic nitrogen	Total phosphorus	Dissolved phosphorus	Total recoverable copper	Total recoverable lead	Total recoverable zinc	Total diazinon
		Computed using 1965 rainfall at Love Field (33.1 inches)											
Dallas	08055590	426	4,710	13,300	3,530	112	71.7	18.5	11.0	0.970	4.26	11.1	0.03
	08056390	1,490	13,300	35,000	12,900	314	182	43.3	25.6	2.85	10.7	28.3	.06
	08057135	1,580	13,400	13,700	14,200	350	215	35.1	17.7	2.30	7.84	18.4	.09
	08057310	871	8,310	14,400	6,890	252	184	46.1	37.5	1.24	2.36	6.53	.36
	08057441	529	5,240	9,420	4,190	162	122	34.3	27.6	.780	2.60	6.73	.29
Garland	08061635	974	8,460	21,300	8,360	216	129	32.7	19.6	1.82	10.9	27.7	.05
	08061660	1,110	12,000	22,800	9,650	300	208	68.7	48.0	1.53	4.86	12.4	.34
	08061690	1,070	13,300	22,600	9,440	292	198	51.8	31.1	1.72	11.5	22.1	.19
Irving	08049590	783	7,160	12,400	6,490	218	157	47.8	36.5	1.03	3.66	9.79	.32
	08055570	1,690	16,700	45,100	16,500	332	184	64.8	31.8	2.89	15.8	42.0	.06
	08056100	1,630	15,900	45,100	15,600	324	181	61.7	31.5	2.87	16.4	43.0	.06

Table 19. Estimated annual loads for sites in all study basins using 1965 rainfall at Love Field and 1975 rainfall at Meacham Airport—Continued

City	Site no. (fig. 1)	Load (pounds)											
		Biochemical oxygen demand	Chemical oxygen demand	Suspended solids	Dissolved solids	Total nitrogen	Total ammonia plus organic nitrogen	Total phosphorus	Dissolved phosphorus	Total recoverable copper	Total recoverable lead	Total recoverable zinc	Total diazinon
Computed using 1965 rainfall at Love Field (33.1 inches)—Continued													
Mesquite	08061910	1,360	10,800	9,200	12,200	298	182	24.0	11.4	2.06	6.89	16.2	0.06
	08061915	652	6,700	12,100	5,210	197	146	40.3	31.9	.960	2.28	6.14	.31
	08061940	636	6,410	11,400	4,990	194	145	37.5	30.5	.950	1.94	5.33	.32
Plano	08061510	897	9,910	19,000	7,720	251	177	59.2	41.6	1.27	4.88	12.0	.31
	08061525	708	5,750	5,090	6,300	168	107	16.1	7.98	1.08	5.46	12.8	.05
	08061530	1,810	23,500	80,900	17,600	406	242	112	62.5	3.07	29.5	62.7	.14
Computed using 1975 rainfall at Meacham Airport (30.4 inches)													
Arlington	08049220	1,130	9,510	7,840	10,300	255	155	20.6	9.58	1.73	5.86	14.4	.05
	08049320	1,590	14,300	23,600	13,800	398	269	75.4	55.7	1.96	6.44	17.2	.38
	08049360	1,380	16,600	29,400	11,800	382	262	64.6	45.2	2.10	10.2	21.1	.31
	08049470	2,480	23,100	60,700	24,100	465	251	73.0	37.7	4.22	18.9	52.1	.06
Fort Worth	08047100	504	3,510	4,900	4,690	125	85.6	35.8	23.6	.520	.740	3.50	.17
	08048505	1,520	8,370	14,500	15,300	264	147	55.5	30.3	1.67	2.72	13.6	.07
	08048510	2,200	22,900	37,200	20,600	515	327	93.6	57.2	2.86	17.5	38.3	.28
	08048545	1,820	15,900	38,600	16,200	371	210	46.4	27.2	3.34	12.4	34.1	.06
	08048700	2,150	22,300	38,000	20,000	513	330	99.5	64.0	2.75	14.9	34.1	.34