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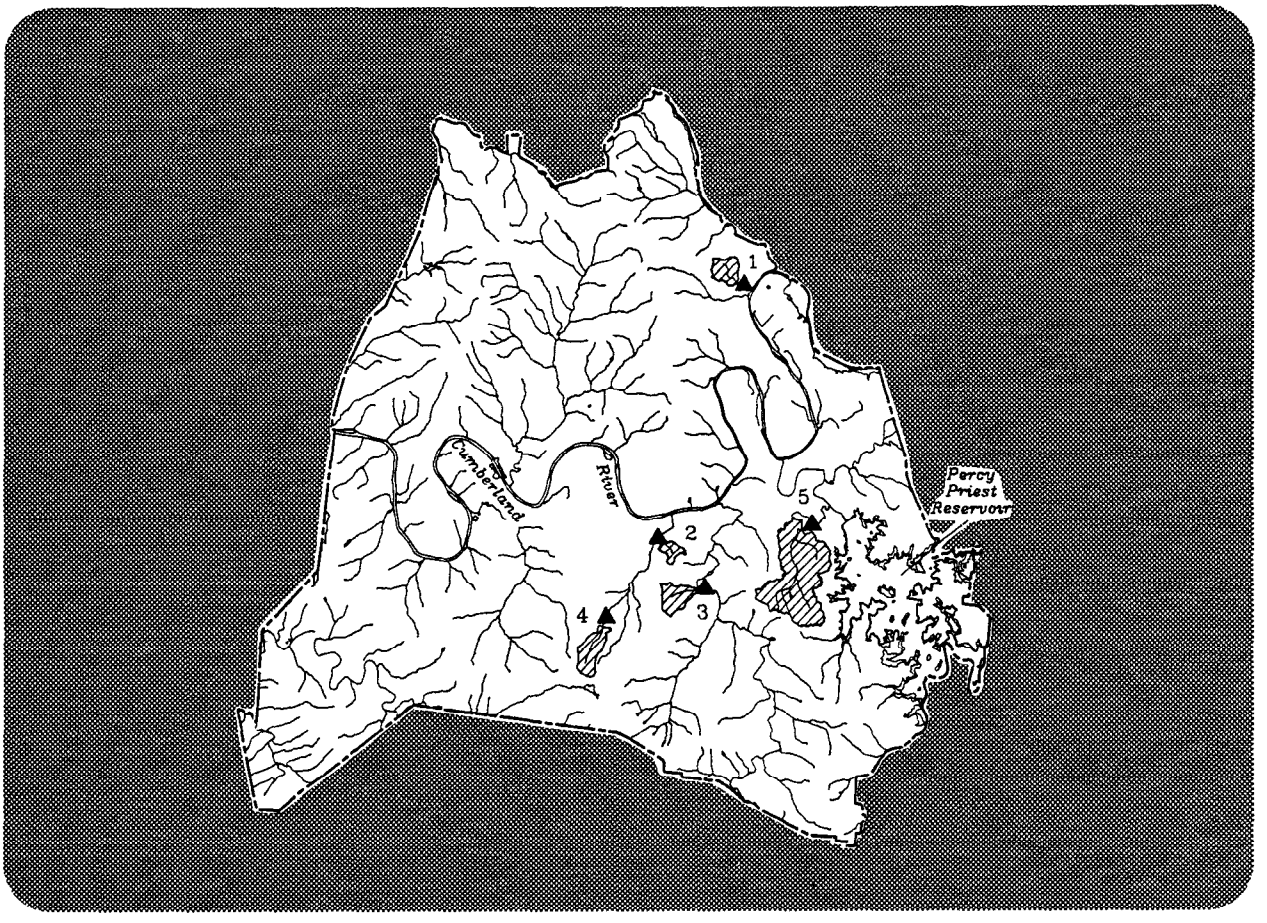
RAINFALL, STREAMFLOW, AND WATER-QUALITY DATA FOR FIVE SMALL WATERSHEDS, NASHVILLE, TENNESSEE, 1990-92



Prepared by the
U.S. GEOLOGICAL SURVEY

in cooperation with the
METROPOLITAN GOVERNMENT OF
NASHVILLE AND DAVIDSON COUNTY

U.S. DEPARTMENT OF THE INTERIOR
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By GEORGE S. OUTLAW, ANNE B. HOOS, and JOHN T. PANKEY

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Nashville, Tennessee
1994

U.S. DEPARTMENT OF THE INTERIOR
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CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
cubic foot (ft^3)	0.02832	cubic meter
cubic foot (ft^3)	28.32	liter
cubic foot (ft^3)	28,320	cubic centimeter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
pound, avoirdupois (lb)	0.4536	kilogram
microsiemens per centimeter at 25° Celsius ($\mu S/cm$)	1.0	microhms per centimeter at 25° Celsius

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

$$°F = 1.8 * °C + 32$$

Rainfall, Streamflow, and Water-Quality Data for Five Small Watersheds, Nashville, Tennessee, 1990-92

By George S. Outlaw, Anne B. Hoos, *and* John T. Pankey

Abstract

Rainfall, streamflow, and water-quality data were collected during storm conditions at five urban watersheds in Nashville, Tennessee. These data can be used to build a database for developing predictive models of the relations between stormwater quality and land use, storm characteristics, and seasonal variations. The primary land use and mix of land uses was different for each watershed. Stormwater samples were collected during three storms at each watershed and analyzed for selected volatile, acidic and base/neutral organic compounds; organic pesticides; trace metals; conventional pollutants; and several physical properties. Storm loads were computed for all constituents and properties with event mean concentration above the minimum reporting level.

None of the samples contained acidic organic compounds at concentrations above the minimum reporting levels. Several constituents in each of the other categories, however, were present at concentrations above this level. For 21 of these, water-quality criteria have been promulgated by the State of Tennessee. For only 8 of the 21 did the value exceed the most restrictive of the criteria: pyrene, dieldrin, and mercury concentrations and counts of fecal coliform exceeded the criteria for recreational use, copper and zinc concentrations and pH value exceeded the criteria for fish and aquatic life, and lead concentrations exceeded for domestic supply.

INTRODUCTION

Contamination of water resources from stormwater is now recognized as a major problem. Many human activities contribute to this problem by producing pollutants that are mobilized by the energy of rainfall and transported in stormwater to streams, rivers, lakes, and ground water. Generally, the pollution carried by storm runoff does not come from a single identifiable source. This type of pollution is referred to as nonpoint source pollution. In recent years, government regulations have been implemented to reduce the severity of nonpoint-source pollution caused by urban stormwater.

Current Federal stormwater regulations (U.S. Environmental Protection Agency, 1990) apply to cities having more than 100,000 residents. These cities are required to identify the type, concentration, and amount of pollutants present in stormwater. Such an analysis is accomplished in part by monitoring the quantity of precipitation and the quantity and quality of storm runoff from watersheds with differing land-use characteristics.

Purpose and Scope

To assist with characterizing stormwater quantity and quality at Nashville, Tennessee, the

U.S. Geological Survey (USGS), in cooperation with the Metropolitan Government of Nashville and Davidson County, established a stormwater monitoring network consisting of five urban watersheds (fig. 1). Each watershed was selected to represent a different type of land use in the Nashville area. Fifteen samples were collected, three at each of the five sites. This report presents rainfall, streamflow, and water-quality data collected at these sites during 1990-92. The water-quality characteristics for which data are reported can be grouped into seven categories: volatile organic compounds; acidic organic compounds; base/neutral organic compounds; organic pesticides; trace metals, cyanide, and phenols; conventional pollutants and pH; and additional constituents and physical properties.

Description of Monitored Watersheds

Land use in the metropolitan Nashville area is composed of approximately 40-percent developed land and 60-percent undeveloped land. The developed land is approximately 70-percent residential; 12-percent commercial; 7-percent industrial; 7-percent public facilities, roads, and streets; and 4-percent other urban, including parks and golf courses. Watersheds selected for the stormwater monitoring network (table 1) allow for characterization of storm runoff from areas of residential, commercial, and industrial land use.

Storm runoff from an area of concentrated commercial development was monitored at Spring Branch near Spring Branch Drive (watershed 1). The monitoring station was located 200 feet upstream from the bridge at Spring Branch Drive about 200 feet from the intersection of Spring Branch Drive and Edgefield Junction Road. Approximately 50 percent of the 1.02-square-mile watershed is occupied by a commercial retail mall and strip commercial development. About 30 percent of the watershed is medium- and high-density residential development. The remaining 20 percent of the watershed is divided equally between industrial development and undeveloped land.

Storm runoff from an area of industrial and wholesale commercial development was monitored at a small tributary to Browns Creek near Lester Avenue (watershed 2). The monitoring station was located at a footbridge approximately 500 feet upstream from the culvert on Lester Avenue about 2,000 feet from the intersection of Lester Avenue and Lafayette Street. Approximately 40 percent of the 0.48-square-mile watershed is industrial development; including chemical storage, truck fueling and maintenance yards, and warehousing. The remaining 60 percent of the watershed is commercial development.

Storm runoff from an area of medium-density residential and strip commercial development was monitored at a tributary to Mill Creek (watershed 3). The monitoring station was located at the bridge on Glenrose Avenue 500 feet west of the Interstate 24 overpass. Approximately 70 percent of the 1.17-square-mile watershed is occupied by medium-density residential development, 15 percent is strip commercial development, and 10 percent is transportation and railroad development. The remaining 5 percent of the watershed is industrial development and warehousing.

Storm runoff from an area of low-density residential development was monitored at West Fork Browns Creek (watershed 4). The monitoring station was located at the bridge on Glendale Lane about 0.5 mile east of the intersection of Glendale Lane and Granny White Pike. The 1.51-square-mile watershed is fully occupied by low-density residential development.

Storm runoff from an area of industrial-transportation development was monitored at McCrory Creek (watershed 5). The monitoring station was located at the bridge on Ironwood Drive. Approximately 25 percent of the 7.31-square-mile watershed is occupied by industrial-transportation development and 20 percent is medium-density residential development with strip commercial development. The remaining 55 percent of the watershed is undeveloped land.

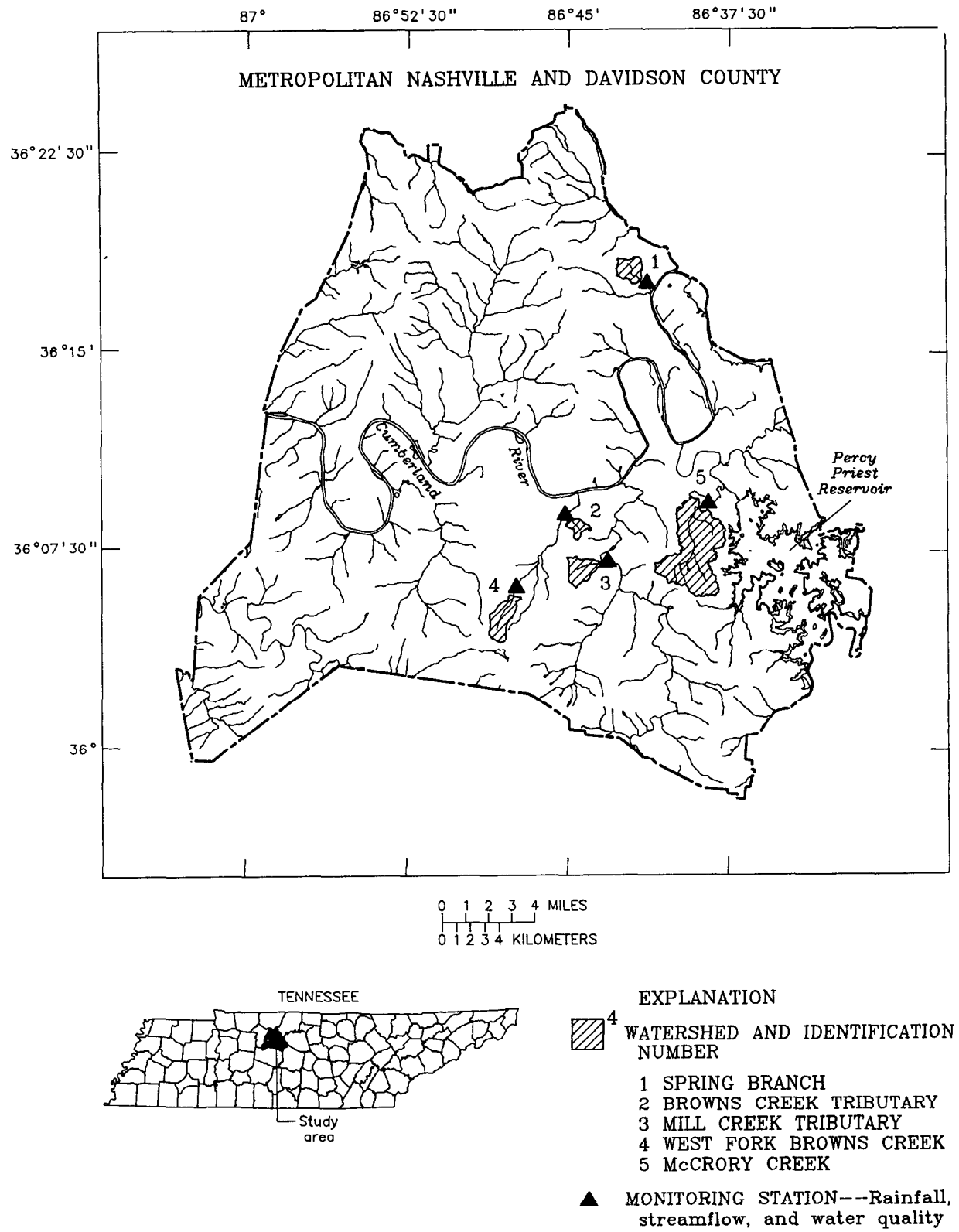

Figure 1. General location of watersheds and monitoring stations in the stormwater monitoring network for Nashville, Tennessee.

Table 1. Watersheds in the stormwater monitoring network for Nashville, Tennessee

Watershed identification number (fig. 1)	Station number	Station name	Drainage area, in square miles	Primary land use
1	03426460	Spring Branch at Edenwold.	1.02	Concentrated commercial
2	03431353	Browns Creek tributary at Nashville.	.48	Industrial with chemical storage and warehousing and wholesale commercial.
3	03431062	Mill Creek tributary at Glenrose Avenue.	1.17	Medium-density residential and commercial.
4	03431100	West Fork Browns Creek at Glendale Lane.	1.51	Low-density residential
5	03430118	McCrory Creek at Ironwood Drive.	7.31	Industrial (transportation) and undeveloped.

METHODS OF STUDY

Collection of hydrologic data during storms and for the purpose of meeting Federal regulations requires specialized procedures. The following is a description of the data collection and quality assurance procedures used for this study.

Data Collection Procedures

Each of the five sites was instrumented with a rain gage and streamflow gage (fig. 1, table 1). Rainfall hyetographs and discharge hydrographs were recorded with automatic instruments. The instruments record rainfall amounts and streamflow discharge every 5 minutes. Rainfall data are used to characterize storm duration, storm intensity, and antecedent moisture conditions. Streamflow data are used with water-quality data to determine event-mean constituent concentrations and storm loads.

Discrete water samples were manually collected at approximately 15-minute intervals for a period from 2 to 4 hours depending on the duration of runoff. A flow-weighted composite sample was prepared for each storm by combining the discrete samples in equivalent proportion to the volume of storm runoff represented by the discrete sample.

The samples were analyzed for numerous constituents and several properties (table 2). The flow-weighted composite sample was analyzed for all constituents except volatile organic compounds, cyanide, phenols, fecal bacteria, field pH, water temperature, oil and grease, field specific conductance, and suspended sediment. Values of the latter constituents were determined from one or more of the discrete samples. Results of these laboratory analyses were assumed to be representative of the mean value for the total amount of runoff produced by the storm.

Samples of stormwater were sent to the USGS National Water Quality Laboratory in Arvada, Colorado, for analysis of all constituents

Table 2. Minimum reporting level for constituents and physical properties

[Laboratory code refers to analytical procedure described by Fishman and Friedman, 1989; µg/L, micrograms per liter; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; cols./100 mL, colonies per 100 milliliters; NA, not applicable]

Constituent	Laboratory code	Minimum reporting level
Volatile organic compounds		
Acrolein, total, in µg/L	1650	20
Acrylonitrile, total, in µg/L	1651	20
Benzene, total, in µg/L	1287	.2
Bromoform, total, in µg/L	1288	.2
Carbontetrachloride, total, in µg/L	1289	.2
Chlorobenzene, total, in µg/L	1290	.2
Chlorodibromomethane, total, in µg/L	1291	.2
Chloroethane, total, in µg/L	1292	.2
[a]2-Chloroethylvinylether, total, in µg/L	1293	.2
	1658	1
Chloroform, total, in µg/L	1294	.2
Dichlorobromomethane, total, in µg/L	1295	.2
1,1-Dichloroethane, total, in µg/L	1297	.2
1,2-Dichloroethane, total, in µg/L	1298	.2
1,1-Dichloroethylene, total, in µg/L	1299	.2
1,2-Dichloropropane, total, in µg/L	1301	.2
1,3-Dichloropropene, total, in µg/L	1302	.2
Ethylbenzene, total, in µg/L	1303	.2
Methylbromide, total, in µg/L	1304	.2
Methylchloride, total, in µg/L	1318	.2
Methylenechloride, total, in µg/L	1305	.2
1,1,2,2-Tetrachloroethane, total, in µg/L	1306	.2
Tetrachloroethylene, total, in µg/L	1307	.2
Toluene, total, in µg/L	1308	.2
1,2-Transdichloroethene, total, in µg/L	1300	.2
1,1,1-Trichloroethane, total, in µg/L	1309	.2
1,1,2-Trichloroethane, total, in µg/L	1310	.2
Trichloroethylene, total, in µg/L	1311	.2
Vinylchloride, total, in µg/L	1313	.2
Acidic organic compounds		
2-Chlorophenol, total, in µg/L	1056	5
2,4-Dichlorophenol, total, in µg/L	1057	5
2,4-Dimethylphenol, total, in µg/L	1059	5
4,6-Dinitroorthocresol, total, in µg/L	1060	30
2,4-Dinitrophenol, total, in µg/L	1061	20
2-Nitrophenol, total, in µg/L	1062	5
4-Nitrophenol, total, in µg/L	1063	30
Parachlorometacresol, total, in µg/L	1055	30
Pentachlorophenol, total, in µg/L	1064	30
Phenol, total, in µg/L	1065	5
2,4,6-Trichlorophenol, total, in µg/L	1058	20

Table 2. Minimum reporting level for constituents and physical properties--Continued

Constituent	Laboratory code	Minimum reporting level
Base/neutral organic compounds		
Acenaphthylene, total, in µg/L	1067	5
Acenaphthene, total, in µg/L	1066	5
Anthracene, total, in µg/L	1068	5
Benzidine, total, in µg/L	1069	40
Benzo (A) anthracene, total, in µg/L	1070	10
Benzo (A) pyrene, total, in µg/L	1073	10
Benzo (B) fluoranthene, total, in µg/L	1071	10
Benzo (GHI) perylene, total, in µg/L	1074	10
Benzo (K) fluoranthene, total, in µg/L	1072	10
BIS (2-Chloroethoxy) methane, total, in µg/L	1076	5
BIS (2-Chloroethyl) ether, total, in µg/L	1077	5
BIS (2-Chloroisopropyl) ether, total, in µg/L	1078	5
BIS (2-Ethylhexyl) phthalate, total, in µg/L	1094	5
4-Bromophenyl phenyl ether, total, in µg/L	1079	5
N-Butyl benzyl phthalate, total, in µg/L	1075	5
2-Chloronaphthalene, total, in µg/L	1080	5
4-Chlorophenyl phenyl ether, total, in µg/L	1081	5
Chrysene, total, in µg/L	1082	10
1,2,5,6-Dibenzanthracene, total, in µg/L	1083	10
[a]1,2-Dichlorobenzene, total, in µg/L	1085	5
	1314	.2
[a]1,3-Dichlorobenzene, total, in µg/L	1086	5
	1315	.2
[a]1,4-Dichlorobenzene, total, in µg/L	1087	5
	1316	.2
3,3-Dichlorobenzidine, total, in µg/L	1088	20
Diethyl phthalate, total, in µg/L	1089	5
Dimethyl phthalate, total, in µg/L	1090	5
Di-N-butyl phthalate, total, in µg/L	1084	5
2,4-Dinitro toluene, total, in µg/L	1091	5
2,6-Dinitro toluene, total, in µg/L	1092	5
Di-N-octyl phthalate, total, in µg/L	1093	10
Fluoranthene, total, in µg/L	1096	5
Fluorene, total, in µg/L	1095	5
Hexachlorobenzene, total, in µg/L	1097	5
[a]Hexachlorobutadiene, total, in µg/L	1098	5
	1675	.2
Hexachlorocyclopentadiene, total, in µg/L	1099	5
Hexachloroethane, total, in µg/L	1100	5
Indeno (1,2,3) pyrene, total, in µg/L	1101	10
Isophorone, total, in µg/L	1102	5
[a]Naphthalene, total, in µg/L	1103	5
	1677	.2
Nitrobenzene, total, in µg/L	1104	5
N-Nitrosodimethylamine, total, in µg/L	1105	5
N-Nitrosodi-N-propylamine, total, in µg/L	1107	5
N-Nitrosodiphenylamine, total, in µg/L	1106	5

Table 2. Minimum reporting level for constituents and physical properties--Continued

Constituent	Laboratory code	Minimum reporting level
Base/neutral organic compounds--Continued		
Phenanthrene, total, in µg/L	1108	5
Pyrene, total, in µg/L	1109	5
[a]1,2,4-Trichlorobenzene, total, in µg/L	1111	5
	1673	.2
Organic pesticides		
[a]Aldrin, total, in µg/L	0350	0.01
	1624	.04
[a]Alpha benzene hexachloride, total, in µg/L	0806	.01
	1619	.03
[a]Beta benzene hexachloride, total, in µg/L	0807	.01
	1620	.03
[a]Lindane, total, in µg/L	0359	.01
	1621	.03
[a]Delta benzene hexachloride, total, in µg/L	0808	.01
	1622	.09
Chlordane, cis isomer, total, in µg/L	1628	.1
Chlordane, trans isomer, total, in µg/L	1626	.1
[a]Chlordane, total, in µg/L	0351	.1
	1637	.1
P,P' DDT, total, in µg/L	1636	.1
P,P' DDE, total, in µg/L	1630	.04
P,P' DDD, total, in µg/L	1633	.1
[a]Dieldrin, total, in µg/L	0355	.01
	1629	.02
Endosulfan I alpha, total, in µg/L	1627	.1
Endosulfan II beta, total, in µg/L	1632	.04
Endosulfan sulfate, total, in µg/L	1635	.6
[a]Endrin, total, in µg/L	0356	.01
	1631	.06
Endrin aldehyde, total, in µg/L	1634	.2
[a]Heptachlor, total, in µg/L	0357	.01
	1623	.03
[a]Heptachlor epoxide, total, in µg/L	0358	.01
	1625	.8
[a]Arochlor 1016 PCB, total, in µg/L	0809	.1
	1641	.1
[a]Arochlor 1221 PCB, total, in µg/L	0810	.1
	1639	1
[a]Arochlor 1232 PCB, total, in µg/L	0811	0.1
	1640	.1
[a]Arochlor 1242 PCB, total, in µg/L	0812	.1
	1642	.1
[a]Arochlor 1248 PCB, total, in µg/L	0813	.1
	1643	.1

Table 2. Minimum reporting level for constituents and physical properties--Continued

Constituent	Laboratory code	Minimum reporting level
Organic pesticides--Continued		
[a]Arochlor 1254 PCB, total, in µg/L	0814	.1
	1644	.1
[a]Arochlor 1260 PCB, total, in µg/L	0815	.1
	1645	.1
[a]Toxaphene, total, in µg/L	0360	1
	1638	2
Toxic metals, cyanide, and phenols		
[a]Antimony, total, in µg/L as Sb	0080	1
	1646	10
Arsenic, total, in µg/L as As	1584	1
Beryllium, total, in µg/L as Be	0236	10
Cadmium, total, in µg/L as Cd	1555	1
Chromium, total, in µg/L as Cr	0762	1
Copper, total, in µg/L as Cu	1559	1
[a]Cyanide, total, in mg/L as Cn	0023	.01
	1648	.01
Lead, total, in µg/L as Pb	1561	1
Mercury, total, in µg/L as Hg	0227	.1
Nickel, total, in µg/L as Ni	1563	1
Phenols, total, in µg/L	0052	1
[a]Selenium, total, in µg/L as Se	0286	1
	1585	1
[a]Silver, total, in µg/L as Ag	1553	1
	1647	.5
Thallium, total, in µg/L as Tl	1569	5
Zinc, total, in µg/L as Zn	0296	10
Conventional pollutants, pH, and water temperature		
Biological oxygen demand, in mg/L	NA	NA
Chemical oxygen demand, in mg/L	0076	10
Coliform, fecal, cols./100 mL	NA	NA
Streptococci, fecal, cols./100 mL	NA	NA
Residue at 180° Celsius, dissolved, in mg/L	0027	1
Residue at 105° Celsius, suspended, in mg/L	0169	1
pH, field, standard units	NA	NA
pH, laboratory, standard units	0068	.1
Water temperature, field, degrees Celsius	NA	NA
Nitrogen, NO2 + NO3, total, in mg/L as N	0304	.05
[a]Nitrogen, NH4 + organic, total, in mg/L as N	0084	.2
	1688	.2
[a]Phosphorus, dissolved, in mg/L as P	0128	.01
	1685	.01
[a]Phosphorus, total, in mg/L as P	0129	.01
	1686	.01
Oil and grease, total, in mg/L	0127	1

Table 2. Minimum reporting level for constituents and physical properties--Continued

Constituent	Laboratory code	Minimum reporting level
Additional constituents and physical properties		
Specific conductance, field, in µS/cm	NA	NA
Specific conductance, laboratory, in µS/cm	0069	1
Alkalinity, laboratory, in mg/L as CaCO3	0070	1
Calcium, dissolved, in mg/L as Ca	0659	.02
[a]Chloride, dissolved, in mg/L as Cl	0015	.1
	1571	.1
Magnesium, dissolved, in mg/L as Mg	0663	.01
Potassium, dissolved, in mg/L as K	0054	.1
Sodium, dissolved, in mg/L as Na	0675	.2
[a]Sulfate, dissolved, in mg/L as SO4	1551	.1
	1572	.1
Carbon, organic, total, in mg/L as C	0114	.1
Sediment, suspended, in mg/L	NA	NA

[a] Two laboratory methods were used to analyze this constituent.

presented in this report except suspended sediment, biological oxygen demand, and fecal bacteria. Suspended-sediment concentrations were measured at the USGS Alabama District sediment laboratory; biological oxygen demand was determined at the Metropolitan Nashville Central Wastewater Treatment Plant Laboratory; and fecal bacteria counts were determined by the USGS Tennessee District.

Laboratory codes and minimum reported values (table 2) are provided to document methods used to determine constituent values presented in this report (Fishman and Friedman, 1989). During this study, several constituents were analyzed using two methods. The change in laboratory methods was the result of a revision of laboratory analytical schedules, which was implemented in late 1991 to provide a more thorough and economical water-quality testing program. In most instances where a constituent was analyzed by two methods, the first laboratory code applies to storms sampled from January 1990 through August 1991 and the second laboratory code applies to storms sampled from September 1991 through the end of the study.

Quality Assurance Procedures

A program of quality control and quality assurance of the field and laboratory methods used to collect and analyze all water samples was executed throughout this study. A procedures manual was developed to provide field personnel with a standard operating procedure for collecting, handling, processing, and shipping water samples. Standard forms were developed and used for field data collection, to request analytical services, and to provide a chain of custody when shipping water samples. The purpose of the quality assurance and control program is to ensure the accuracy of the data presented in this report.

Quality-control samples collected during the course of this study included field-equipment blanks, trip blanks, and replicate samples. These samples were collected, handled, processed, and shipped to the laboratory following guidelines set forth in the procedures manual.

Field equipment blanks had concentrations below the minimum reporting level (MRL) for all constituents, indicating there was no field

contamination of the samples. Trip blanks also had concentrations below the MRL for all constituents, indicating no contamination occurred during transport of the sample from the field to the analytical laboratory. There was no significant difference between regular storm samples and replicate samples, indicating that the field techniques used to prepare the sample were performed with precision. Furthermore, the U.S. Geological Survey National Water Quality Laboratory performs continuous quality assurance and quality control of the laboratory equipment and techniques used to determine the values presented in this report.

Laboratory spikes for organochlorine pesticides were done to evaluate potential analytical recoveries. Average percent recovery was 92 percent, indicating possible matrix effects on certain spiked concentrations, or slight variation in the degree of precision of the analytical technique used in the analysis.

RAINFALL AND STREAMFLOW

The location; date and time of storm and sampling; rainfall amounts before, during, and after sampling for storm; volume of storm runoff; and the volume of runoff sampled are provided for each storm (table 3). Storm-runoff volume was computed as the area under the streamflow hydrograph during the period considered to be a

Table 3. Date and time of storm and sampling; rainfall amounts before, during, and after sampling for storm; volume of storm runoff; and volume of runoff sampled

[e, estimated; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek; see Supplemental Data for incremental rainfall and discharge values]

Watershed identification number (fig. 1)	Storm number	Date of storm	Time of storm runoff		Time of sampling		Rainfall amounts, in inches			Volume of storm runoff, in cubic feet	Volume of runoff sampled, in cubic feet
			Start	End	Start	End	Before sampling	During sampling	After sampling		
1	SP1	06-18-90	0900	1255	0940	1240	0.52e	0.00	0.00	222,000	69,600
	SP2	03-09,10-92	1740	0500	1800	2145	.09	1.05	1.95	1,820,000	293,000
	SP3	09-02-92	1130	1505	1215	1430	.05	.15	0	66,000	60,900
2	BR1	02-09-90	1130	1435	1150	1410	.08	.01	0	41,200	38,700
	BR2	02-15-90	1210	1425	1215	1405	.02	.06	0	27,000	26,600
	BR3	11-05-90	0730	1130	0830	1130	.07	.16	0	20,700	19,500
3	ML1	01-17-90	1405	2400	1420	1725	.04	.32	.38	337,000	84,500
	ML2	12-09-91	0530	1555	0610	0955	.19e	.45e	.33e	375,000	201,000
	ML3	05-19-92	1515	2000	1535	1835	.27	.15	0	106,000	98,200
4	WB1	06-03-92	1320	1920	1320	1620	.56	.72	0	132,000	66,400
	WB2	09-26-92	0810	1420	0945	1330	.47	.57	0	173,000	145,000
	WB3	11-12-92	0610	1600	0800	1200	.33e	.46e	.20e	240,000	111,000
5	MC1	06-18-90	0925	1505	0935	1300	.54	.32	.01	688,000	634,000
	MC2	12-13-91	0230	1350	0425	0810	.22	.51	.17	2,100,000	723,000
	MC3	06-18-92	0530	0835	0545	0800	.81	.13	0	189,000	186,000

storm event, minus volume of baseflow. Baseflow was assigned the value of streamflow immediately before storm runoff began, and was held constant throughout the storm. Daily rainfall amounts for 4 days preceding the day of sample collection (table 4) provide information about antecedent moisture conditions.

Table 4. *Daily rainfall amounts for 4 days preceding the day of sample collection*

[e, estimated; SP, Spring Creek; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek]

Watershed identification number (fig. 1)	Storm number	Daily rainfall amounts for preceding days, in inches			
		1	2	3	4
1	SP1	0	0.00	0.00	0.30e
	SP2	0	0	0	0
	SP3	0	0	0	0
2	BR1	0	.08	0	0
	BR2	0	0	0	0
	BR3	0	0	0	0
3	ML1	0	.08	0	0
	ML2	0	0	0	0
	ML3	0	0	0	0
4	WB1	0	0	0	0
	WB2	0	0	.43	.45
	WB3	0	0	0	0
5	MC1	0	0	0	.60
	MC2	0	0	0	.94
	MC3	0	0	.17	0

The Supplemental Data section in this report provides incremental rainfall and instantaneous streamflow values for the monitored storms. Information about rainfall amount, duration, and intensity, and volume of storm runoff is provided by these values.

WATER QUALITY

Event mean concentrations and values determined from laboratory and field analyses are reported for 28 volatile organic compounds (table 5), 11 acidic organic compounds (table 6), 45 base/neutral organic compounds (table 7), 27 organic pesticides and polychlorinated biphenyls (table 8), 13 trace metals, cyanide, and phenols (table 9), 11 conventional pollutants, pH, and water temperature (table 10), and 11 additional constituents and physical properties (table 11).

None of the samples contained acidic organic compounds at concentrations above the minimum reporting levels. Several constituents in each of the other categories, however, were present at concentrations above this level. For 21 of these, water-quality criteria for waters of the State have been promulgated by the State of Tennessee. For only 8 of the 21, did the value exceed the most restrictive of the criteria: pyrene, dieldrin, and mercury concentrations and counts of fecal coliform exceeded the criteria for recreational use, copper and zinc concentrations and pH value exceeded the criteria for fish and aquatic life, and lead concentrations exceeded the criteria for domestic supply.

Storm loads (table 12) are provided for constituents with event mean concentrations above minimum reported values. These loads, reported in pounds, were computed by multiplying the constituent concentration by the volume of storm runoff (table 3) and a conversion factor.

Table 5. Event mean concentrations of volatile organic compounds for sampled storms

[All concentrations were determined from discrete samples and are reported as micrograms per liter; <, below minimum reporting level; --, no data; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek; Water-quality criteria limits are cited only for those constituents with one or more values above the minimum reporting level and for which numerical limits have been promulgated by the Tennessee Department of Environment and Conservation (1991); all cited limits are for recreational use, except in cases where limits for another use are more restrictive; DS, criteria for domestic supply]

Storm number	Acrolein, total	Acrylonitrile, total	Benzene, total	Bromoform, total	Carbon tetrachloride, total	Chlorobenzene, total	Chlorodibromomethane, total	Chloroethane, total	2-Chloroethylvinylether, total	Chloroform, total	Dichlorobromomethane, total	1,1-Dichloroethane, total	1,2-Dichloroethane, total	1,1-Dichloroethylene, total
SP1	--	--	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.5	<0.2	<0.2	<0.2	<0.2
SP2	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	.6	<.2	<.2	<.2	<.2
SP3	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	.3	<.2	<.2	<.2	<.2
BR1	--	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	2.8	.4	<.2	<.2	<.2
BR2	--	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	2.1	.2	<.2	<.2	<.2
BR3	--	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	.2	<.2	<.2	<.2	<.2
ML1	--	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	.2	<.2	<.2	<.2	<.2
ML2	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2	<.2	<.2	<.2
ML3	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2	<.2	<.2	<.2
WB1	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	.4	<.2	<.2	<.2	<.2
WB2	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	.3	<.2	<.2	<.2	<.2
WB3	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	.4	<.2	<.2	<.2	<.2
MC1	--	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
MC2	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2	<.2	<.2	<.2
MC3	<20	<20	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2	<.2	<.2	<.2	<.2
Water-quality criteria										4700	4700			

Table 5. Event mean concentrations of volatile organic compounds for sampled storms--Continued

Storm number	1,2-Dichloropropane, total	1,3-Dichloropropene, total	Ethylbenzene, total	Methylbromide, total	Methylchloride, total	Methylenechloride, total	1,1,2,2 Tetrachloroethane, total	Tetrachloroethylene, total	Toluene, total	1,2-Transdichloroethene, total	1,1,1-Trichloroethane, total	1,1,2-Trichloroethane, total	Trichloroethylene, total	Vinylchloride, total
SP1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
SP2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
SP3	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
BR1	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	.7	<.2
BR2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	.3	<.2	<.2	2	<.2
BR3	<.2	<.2	<.2	<.2	<.2	.2	<.2	<.2	<.2	.2	<.2	<.2	.2	<.2
ML1	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
ML2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
ML3	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
WB1	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
WB2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
WB3	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
MC1	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
MC2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
MC3	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
Water-quality criteria													5 DS	

Table 6. Event mean concentrations of acidic organic compounds for sampled storms

[All concentrations were determined from flow-weighted composite samples and are reported as micrograms per liter; <, below minimum reporting level; --, no data; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek]

Storm number	2-Chloro-phenol, total	2,4-Di-chloro-phenol, total	2,4-Di-methyl-phenol, total	4,6-Di-nitro-ortho-cresol, total	2,4-Di-nitro-phenol, total	2-Nitro-phenol, total	4-Nitro-phenol, total	Para-chloro-meta-cresol, total	Penta-chloro-phenol, total	Phenol, total	2,4,6-Tri-chloro-phenol, total
SP1	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
SP2	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
SP3	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
BR1	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
BR2	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
BR3	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
ML1	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
ML2	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
ML3	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
WB1	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
WB2	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
WB3	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
MC1	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
MC2	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20
MC3	<5	<5	<5	<30	<20	<5	<30	<30	<30	<5	<20

Table 7. Event mean concentrations of base/neutral organic compounds for sampled storms

[All concentrations were determined from flow-weighted composite samples and are reported as micrograms per liter; <, below minimum reporting level; --, no data; SP, Spring Creek; BR, Browns Creek tributary; ML, Mill Creek tributary; WB; West Fork Browns Creek; MC, McCrory Creek; Water-quality criteria limits are cited only for those constituents with one or more values above the minimum reporting level and for which numerical limits have been promulgated by the Tennessee Department of Environment and Conservation (1991); all cited limits are for recreational use]

Storm number	Acenaphthylene, total	Acenaphthene, total	Anthracene, total	Benzidine, total	Benzo (A) anthracene, total	Benzo (A) pyrene, total	Benzo (B) fluoranthene, total	Benzo (GHI) perylene, total	Benzo (K) fluoranthene, total	BIS (2-Chloroethoxy) methane, total	BIS (2-Chloroethyl) ether, total	BIS (2-Chloroisopropyl) ether, total	BIS (2-Ethylhexyl) phthalate, total	4-Bromophenyl phenyl ether, total	N-Butyl benzyl phthalate, total	2-Chloronaphthalene, total
SP1	<5	<5	<5	--	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
SP2	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	7	<5	<5	<5
SP3	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
BR1	<5	<5	<5	--	<10	<10	<10	<10	<10	<5	<5	<5	17	<5	<5	<5
BR2	<5	<5	<5	--	<10	<10	<10	<10	<10	<5	<5	<5	8	<5	<5	<5
BR3	<5	<5	<5	--	<10	<10	<10	<10	<10	<5	<5	<5	5	<5	<5	<5
ML1	<5	<5	<5	--	<10	<10	<10	<10	<10	<5	<5	<5	16	<5	<5	<5
ML2	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
ML3	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	7	<5	<5	<5
WB1	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
WB2	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
WB3	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
MC1	<5	<5	<5	--	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
MC2	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
MC3	<5	<5	<5	<40	<10	<10	<10	<10	<10	<5	<5	<5	<5	<5	<5	<5
Water-quality criteria													59			

Table 7. Event mean concentrations of base/neutral organic compounds for sampled storms--Continued

Storm number	4-Chlorophenyl phenyl ether, total	Chrysene, total	1,2,5,6-Dibenzanthracene, total	1,2-Dichlorobenzene, total	1,3-Dichlorobenzene, total	1,4-Dichlorobenzene, total	3,3-Dichlorobenzidine, total	Diethyl phthalate, total	Dimethyl phthalate, total	Di-N-butyl phthalate, total	2,4-Dinitrotoluene, total	2,6-Dinitrotoluene, total	Di-N-octyl phthalate, total	Fluoranthene, total	Fluorene, total	Hexachlorobenzene, total
SP1	<5	<10	<10	<5	<5	<5	--	<5	<5	<5	<5	<5	<10	<5	<5	<5
SP2	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
SP3	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
BR1	<5	<10	<10	<5	<5	<5	--	<5	<5	<5	<5	<5	<10	8	<5	<5
BR2	<5	<10	<10	<5	<5	<5	--	<5	<5	<5	<5	<5	<10	<5	<5	<5
BR3	<5	<10	<10	<5	<5	<5	--	<5	<5	<5	<5	<5	<10	<5	<5	<5
ML1	<5	<10	<10	<5	<5	<5	--	<5	<5	<5	<5	<5	<10	<5	<5	<5
ML2	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
ML3	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
WB1	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
WB2	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
WB3	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
MC1	<5	<10	<10	<5	<5	<5	–	<5	<5	<5	<5	<5	<10	<5	<5	<5
MC2	<5	<10	<10	<.2	<.2	<.2	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
MC3	<5	<10	<10	<5	<5	<5	<20	<5	<5	<5	<5	<5	<10	<5	<5	<5
Water-quality criteria														54		

Table 7. Event mean concentrations of base/neutral organic compounds for sampled storms--Continued

Storm number	Hexachlorobutadiene, total	Hexachlorocyclopentadiene, total	Hexachloroethane, total	Indeno (1,2,3) pyrene, total	Isophorone, total	Naphthalene, total	Nitrobenzene, total	N-Nitrosodimethylamine, total	N-Nitrosodi-N-propylamine, total	N-Nitrosodiphenylamine, total	Phenanthrene, total	Pyrene, total	1,2,4-Trichlorobenzene, total
SP1	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
SP2	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
SP3	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
BR1	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	6	<5
BR2	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
BR3	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
ML1	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
ML2	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
ML3	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
WB1	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
WB2	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
WB3	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
MC1	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
MC2	<.2	<5	<5	<10	<5	<.2	<5	<5	<5	<5	<5	<5	<.2
MC3	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5
Water-quality criteria												.03	

Table 8. Event mean concentrations of organic pesticides and polychlorinated biphenyls (PCB's) for sampled storms

[All concentrations were determined from flow-weighted composite samples and are reported as micrograms per liter; <, less than minimum reporting level; a, sample diluted for analysis; --, no data; SP, Spring Creek; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek; Water-quality criteria limits are cited only for those constituents with one or more values above the minimum reporting level and for which numerical limits have been promulgated by the Tennessee Department of Environment and Conservation (1991); all cited limits are for recreational use, except in cases where limits for another use are more restrictive; AL, criteria on maximum concentrations (CMC) for fish and aquatic life]

Storm number	Aldrin, total	Alpha benzene hexa-chlor-ide, total	Beta benzene hexa-chlor-ide, total	Lindane, total	Delta benzene hexa-chlor-ide, total	Chlor-dane, cis isomer, total	Chlor-dane, trans isomer, total	Chlor-dane, total	P,P' DDT, total	P,P' DDE, total	P,P' DDD, total	Di-eldrin, total	Endo-sul-fan I alpha, total	Endo-sul-fan II beta, total	Endo-sulfan sulfate, total	End-rin, total
SP1	<0.01	<0.01	<0.01	<0.01	<0.01	--	--	<0.1	--	--	--	<0.01	--	--	--	<0.01
SP2	<.04	<.03	<.03	<.03	<.09	<0.1	<0.1	<.1	<0.1	<0.04	<0.1	<.02	<0.1	<0.04	<0.6	<.06
SP3	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
BR1	<.1a	<.1a	<.1a	<.1a	<.1a	--	--	<1a	--	--	--	<.1a	--	--	--	<.1a
BR2	<.1a	<1a	<1a	<.1a	<1a	--	--	<1a	--	--	--	<.1a	--	--	--	.1
BR3	<.1a	<.1a	<.1a	<.1a	<.1a	--	--	<10a	--	--	--	<1a	--	--	--	<1a
ML1	<.01	<.01	<.01	<.01	<.01	--	--	<.1	--	--	--	.01	--	--	--	<.01
ML2	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
ML3	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
WB1	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
WB2	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
WB3	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
MC1	<.01	<.01	<.01	<.01	<.01	--	--	<.1	--	--	--	<.01	--	--	--	<.01
MC2	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
MC3	<.04	<.03	<.03	<.03	<.09	<.1	<.1	<.1	<.1	<.04	<.1	<.02	<.1	<.04	<.6	<.06
Water-quality criteria										.0014						.18 AL

Table 8. Event mean concentrations of organic pesticides and polychlorinated biphenyls (PCB's) for sampled storms--Continued

Storm number	Endrin aldehyde, total	Heptachlor, total	Heptachlor epoxide, total	Aroclor 1016 PCB, total	Aroclor 1221 PCB, total	Aroclor 1232 PCB, total	Aroclor 1242 PCB, total	Aroclor 1248 PCB, total	Aroclor 1254 PCB, total	Aroclor 1260 PCB, total	Toxaphene, total
SP1	--	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1
SP2	<0.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
SP3	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
BR1	--	<.1a	<.1a	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<10a
BR2	--	<.1a	<.1a	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<10a
BR3	--	<.1a	<.1a	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<10a
ML1	--	<.01	<.01	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<1
ML2	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
ML3	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
WB1	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
WB2	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
WB3	<.2	<.03	<.8	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<2
MC1	--	<.01	<.01	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<1
MC2	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
MC3	<.2	<.03	<.8	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2

Table 9. Event mean concentrations of trace metals, cyanide, and total phenols for sampled storms

[All concentrations were determined from flow-weighted composite samples, except cyanide and phenols which were determined from discrete samples; a, sample diluted for analysis; b, value for criteria on maximum concentration (CMC) was calculated assuming a total hardness of 100 mg/L; <, less than minimum reporting level; --, no data; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek; Water-quality criteria limits are cited only for those constituents with one or more values above the minimum reporting level and for which numerical limits have been promulgated by the Tennessee Department of Environment and Conservation (1991); all cited limits are for recreational use, except in cases where limits for another use are more restrictive; DS, criteria for domestic supply; AL, CMC for fish and aquatic life]

Storm number	Antimony, total (µg/L as Sb)	Arsenic, total (µg/L as As)	Beryllium, total (µg/L as Be)	Cadmium, total (µg/L as Cd)	Chromium, total (µg/L as Cr)	Copper, total (µ/L as Cu)	Cyanide, total (µg/L as Cn)	Lead, total (µg/L as Pb)	Mercury, total (µg/L as Hg)	Nickel, total (µg/L as Ni)	Phenols, total (µg/L)	Selenium, total (µg/L as Se)	Silver, total (µg/L as Ag)	Thallium, total (µg/L as Tl)	Zinc, total (µg/L as Zn)
SP1	<1	1	<10	<1	22	11	<0.01	23	0.2	27	6	<1	<1	<5	158
SP2	<20a	<1	<10	<1	6	16	<.01	32	<.1	7	9	<2a	<1a	<10a	170
SP3	<20a	1	<10	<1	5	12	<.01	15	<.1	5	--	<2a	<.5	<5	130
BR1	2	3	<10	4	12	45	<.01	65	<.1	11	3	<1	<1	<5	326
BR2	2	1	<10	4	18	39	<.01	72	.1	11	4	<1	<1	<5	378
BR3	2	3	<10	2	7	22	<.01	43	<.1	11	12	<1	<1	<10a	301
ML1	1	1	<10	<1	7	12	<.01	34	.1	4	<1	<1	<1	<5	188
ML2	<10	<1	<10	<1	2	9	<.01	27	<.1	3	1	<2a	<1a	5	109
ML3	<10	1	<10	<1	3	<1	<.01	<1	.1	<1	10	<2a	<1a	<10a	130
WB1	<20a	<1	<10	<1	4	4	<10a	4	<.1	3	1	<2	<1a	<5	<10
WB2	<10	<1	<10	<1	3	3	.01	5	<.1	3	4	<2	<.5	<5	20
WB3	<10	<1	<10	<1	<1	3	<.01	2	<.1	2	1	<2	<.5	<5	20
MC1	1	1	<10	<1	24	12	<.01	43	.2	24	5	<1	<1	<10a	139
MC2	<10	3	<10	<1	5	38	<.01	8	<.1	5	<1	<2a	<2a	<5	40
MC3	<20a	<1	<10	<1	6	9	<10a	<1	<.1	3	4	<2a	<1a	<10a	100
Water-quality criteria	4310	50 DS		4b AL	50 DS	18b AL	22 AL	50 DS	.15	1400b AL					117 AL

Table 10. Event mean concentrations of conventional pollutants, pH values, and water temperature for sampled storms

[All concentrations were determined from flow-weighted composite samples, except fecal bacteria, and oil and grease, which were determined from discrete samples; pH was determined from flow-weighted composite samples, unless otherwise noted; <, below minimum reporting level; K, results based on colony count outside the acceptable range; G, greater than; L, less than; --, no data; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek; mg/L, milligrams per liter; mL, milliliters; µS/cm; microsiemens per centimeter; °C, degrees Celsius; Water-quality criteria limits are cited only for those constituents with one or more values above the minimum reporting level and for which numerical limits have been promulgated by the Tennessee Department of Environment and Conservation (1991); all cited limits are for recreational use, except in cases where limits for another use are more restrictive; DS, criteria for domestic water supply; AL, criteria on maximum concentration (CMC) fish and aquatic life]

Storm number	Biological oxygen demand (mg/L)	Chemical oxygen demand (mg/L)	Coliform, fecal colonies (per 100 mL)	Streptococci, fecal colonies (per 100 mL)	Residue at 180° Celsius, dissolved (mg/L)	Residue at 105° Celsius, suspended (mg/L)	pH, field units	pH, laboratory units	Water temperature, field, °C	Nitrogen NO2+NO3, total (mg/L as N)	Nitrogen, NH4 and organic, total (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, total (mg/L as P)	Oil and grease, total (mg/L)
SP1	13	90	94,000	160,000	163	--	8.6	7.9	24.5	0.82	0.6	0.23	0.47	<1
SP2	L20	76	2,000	K120,000	67	96	[a]7.5	7.6	15.6	.43	1.3	.15	.48	5
SP3	9	57	26,000	41,000	110	47	[a]7.5	7.2	23.8	.56	.9	.17	.20	4
BR1	G28	228	3,260	14,400	178	--	7.4	7.8	16.0	1.0	1.8	.14	.20	2
BR2	22	201	G100,000	7,500	141	--	7.2	7.2	16.5	.50	.7	.36	4.7	5
BR3	38	162	G100,000	G100,000	139	--	--	7.3	16.5	.70	2.4	.46	1.9	<1
ML1	10	89	420	463	189	--	8.0	8.3	14.5	1.1	1.8	.20	1.4	<1
ML2	5	51	11,000	54,700	137	109	[a]7.7	7.9	14.7	1.0	.5	.20	.57	<1
ML3	26	130	90,000	500,000	181	82	[a]7.6	7.3	21.5	1.3	1.8	.32	1.2	6
WB1	108	240	48,000	110,000	199	74	[a]8.1	7.4	17.9	.70	.9	.27	.76	4
WB2	14	57	22,000	740,000	165	116	[a]7.5	7.7	18.9	.46	1.0	.68	1.4	<1
WB3	18	61	17,400	198,000	217	81	[a]7.5	7.7	15.6	.43	.7	.51	.93	<1
MC1	17	108	214,000	190,000	198	--	8.4	7.4	25.0	.50	.9	.27	.77	<1
MC2	250	260	K2,200	14,800	269	215	[a]7.9	7.7	13.6	.71	.7	.15	1.2	<1
MC3	23	84	41,000	110,000	171	592	[a]7.1	7.3	23.0	.60	1.2	.15	1.2	<1
Water-quality criteria			1,000		500 DS		6.5-8.5 AL							

[a] Value from a discrete sample taken near the peak of storm runoff.

Table 11. Event mean concentrations and values of additional constituents and physical properties for sampled storms

[All concentrations were determined from flow-weighted composite samples except suspended sediment, which was determined from discrete samples; specific conductance was determined from flow-weighted composite samples; --, no data; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter]

Storm number	Specific conductance, field (µS/cm 25°C)	Specific conductance, laboratory (µS/cm 25°C)	Alkalinity, laboratory, (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Chloride, dissolved (mg/L as Cl)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Sulfate, dissolved (mg/L as SO_4)	Carbon, organic, total (mg/L as C)	Sediment, suspended (mg/L)
SP1	281	262	71	37	8.2	4.6	3.0	4.5	55	15	1,150
SP2	[a]92	119	35	17	1.7	1.6	.5	1.5	16	18	252
SP3	[a]165	181	52	25	3.5	2.5	1.2	2.6	27	24	27.8
BR1	283	274	113	35	10	2.5	7.6	18	31	39	302
BR2	245	242	65	32	--	2.3	2.1	8.0	--	31	251
BR3	175	183	79	19	6.8	1.3	2.5	17	20	31	381
ML1	322	321	106	50	10	3.8	2.5	9.5	38	21	189
ML2	[a]211	219	85	35	3.2	2.3	1.0	3.0	26	9.8	108
ML3	[a]263	267	101	43	3.4	3.1	2.4	4.0	32	26	116
WB1	[a]287	308	126	52	6.2	4.4	2.4	3.4	30	66	71.7
WB2	[a]215	266	115	45	4.5	3.6	2.9	2.6	21	18	114
WB3	[a]355	350	143	57	6.2	4.9	2.8	3.9	28	70	63.8
MC1	352	347	113	52	4.0	6.1	3.5	5.8	56	25	1,810
MC2	[a]463	454	164	75	5.8	7.7	2.4	5.9	80	53	256
MC3	[a]319	288	105	45	2.7	4.6	2.6	3.4	42	24	448

[a] Value from a discrete sample taken near the peak of storm runoff.

Table 12. Storm loads for constituents and physical properties with event mean concentrations above minimum reporting level

[All loads are given in pounds; G, greater than; --, load not computed because event mean concentration for this storm was below the minimum reporting level; SP, Spring Branch; BR, Browns Creek tributary; ML, Mill Creek tributary; WB, West Fork Browns Creek; MC, McCrory Creek]

Storm number	Chloroform, total	Dichlorobromomethane, total	Methylene chloride, total	1,2-Transdichloroethene, total	Trichloroethylene, total	BIS (2-Ethylhexyl) phthalate, total	Fluoranthene, total	Pyrene, total	Dieldrin, total	Endrin, total	Antimony, total, as Sb	Arsenic, total, as As	Cadmium, total, as Cd	Chromium, total, as Cr
SP1	0.0069	--	--	--	--	--	--	--	--	--	--	0.014	--	0.30
SP2	.068	--	--	--	--	0.79	--	--	--	--	--	--	--	.68
SP3	.0012	--	--	--	--	--	--	--	--	--	--	.0041	--	.021
BR1	.0072	0.0010	--	--	0.0018	.044	0.021	0.015	--	--	0.0051	.0077	0.010	.031
BR2	.0035	.00034	--	0.00051	.0034	.013	--	--	--	0.00017	.0034	.0017	.0067	.030
BR3	.00026	--	0.00026	.00026	.00026	.0065	--	--	--	--	.0026	.0039	.0026	.0090
ML1	.0042	--	--	--	--	.34	--	--	0.00021	--	.021	.021	--	.15
ML2	--	--	--	--	--	--	--	--	--	--	--	--	--	.047
ML3	--	--	--	--	--	.046	--	--	--	--	--	.0066	--	.020
WB1	.0033	--	--	--	--	--	--	--	--	--	--	--	--	.033
WB2	.0032	--	--	--	--	--	--	--	--	--	--	--	--	.032
WB3	.0060	--	--	--	--	--	--	--	--	--	--	--	--	--
MC1	--	--	--	--	--	--	--	--	--	--	.043	.043	--	1.0
MC2	--	--	--	--	--	--	--	--	--	--	--	.39	--	.23
MC3	--	--	--	--	--	--	--	--	--	--	--	--	--	.071

Table 12. Storm loads for constituents and physical properties with event mean concentrations above minimum reporting level--Continued

Storm number	Copper, total, as Cu	Cyanide total, as Cn	Lead, total, as Pb	Mercury, total, as Hg	Nickel, total, as Ni	Phenols, total	Thallium, total, as Tl	Zinc, total, as Zn	Biological oxygen demand	Chemical oxygen demand	Residue at 180° Celsius, dissolved	Residue at 105° Celsius, suspended	Nitrogen, $NO_2 + NO_3$, total, as N
SP1	0.15	--	0.32	0.0028	0.37	0.083	--	2.2	180	1,200	2,300	--	11
SP2	1.8	--	3.6	--	.79	1.0	--	19	--	8,600	7,600	11,000	49
SP3	.049	--	.062	--	.021	--	--	.54	37	230	450	190	2.3
BR1	.12	--	.17	--	.028	.0077	--	.84	G72	590	460	--	2.6
BR2	.066	--	.12	.00017	.019	.0067	--	.64	37	340	240	--	.84
BR3	.028	--	.056	--	.014	.016	--	.39	49	210	180	--	.90
ML1	.25	--	.71	.0021	.084	--	--	4.0	210	1,900	4,000	--	23
ML2	.21	--	.63	--	.070	.023	0.12	2.6	120	1,200	3,200	2,600	23
ML3	--	--	--	.00066	--	.066	--	.86	170	860	1,200	540	8.6
WB1	.033	--	.033	--	.025	.0082	--	--	890	2,000	1,600	610	5.8
WB2	.032	0.11	.054	--	.032	.043	--	.22	150	620	1,800	1,300	5.0
WB3	.045	--	.030	--	.030	.015	--	.30	270	910	3,200	1,200	6.4
MC1	.52	--	1.8	.0086	1.0	.21	--	6.0	730	4,600	8,500	--	21
MC2	5.0	--	1.0	--	.66	--	--	5.2	33,000	34,000	35,000	28,000	93
MC3	.11	--	--	--	.035	.047	--	1.2	270	990	2,000	7,000	7.1

Table 12. Storm loads for constituents and physical properties with event mean concentrations above minimum reporting level--Continued

Storm number	Nitrogen NH4 and organic, total, as N	Phosphorous dissolved, as P	Phosphorus, total, as P	Oil and grease, total	Alkalinity, laboratory, as $CaCO_3$	Calcium, dissolved, as Ca	Chloride, dissolved, as Cl	Magnesium, dissolved, as Mg	Potassium, dissolved, as K	Sodium, dissolved, as Na	Sulfate, dissolved, as SO_4	Carbon, organic, total, as C	Sediment, suspended
SP1	8.3	3.2	6.5	--	980	510	110	64	42	62	760	210	16,000
SP2	150	17	55	570	4,000	1,900	190	180	5.7	170	1,800	2,000	29,000
SP3	3.7	.70	.82	16	210	100	14	10	4.9	11	110	99	110
BR1	4.6	.36	.51	5.1	290	90	26	6.4	20	46	80	100	780
BR2	1.2	.61	7.9	8.4	110	54	--	3.9	3.5	13	--	52	420
BR3	3.1	.59	2.5	--	100	25	8.8	1.7	3.2	22	26	40	490
ML1	38	4.2	29	--	2,200	1,100	210	80	53	200	800	440	6,100
ML2	12	4.7	13	--	2,000	820	75	54	23	70	610	230	2,500
ML3	12	2.1	7.9	40	670	280	22	21	16	26	210	170	770
WB1	7.4	2.2	6.3	33	1,000	430	51	36	20	28	250	540	590
WB2	11	7.3	15	--	1,200	490	49	39	31	28	230	190	1,200
WB3	10	7.6	14	--	2,100	850	93	73	42	58	420	1,000	960
MC1	39	12	33	--	4,900	2,200	170	260	150	250	2,400	1,100	78,000
MC2	92	20	160	--	21,000	9,800	760	1,000	310	770	10,000	6,900	34,000
MC3	14	14	14	--	1,200	530	32	54	31	40	500	280	5,300

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SUPPLEMENTAL DATA

Incremental rainfall and instantaneous streamflow values for sampled storms

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS

Storm SP1 -- June 18, 1990

Watershed 1 03426460 Spring Branch at Edenwold

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; e, estimated; rainfall amount occurring from 0001 through 0835 was 0.00 inch]

Baseflow--1.4 cubic feet per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
0840	0:00	1.4	1050	0	4.3
0845	0	1.4	1055	0	3.9
0850	0	1.4	1100	0	3.7
0855	.01e	1.4	1105	0	3.4
0900	.05e	1.4	1110	0	3.3
0905	.20e	71	1115	0	3.0
0910	.10e	83	1120	0	3.0
0915	.15e	78	1125	0	2.8
0920	.01e	81	1130	0	2.7
0925	0	78	1135	0	2.7
0930	0	69	1140	0	2.6
0935	0	54	1145	0	2.5
[a] 0940	0	44	1150	0	2.5
0945	0	35	1155	0	2.4
0950	0	27	1200	0	2.4
0955	0	22	1205	0	2.3
1000	0	18	1210	0	2.3
1005	0	15	1215	0	2.2
1010	0	12	1220	0	2.2
1015	0	11	1225	0	2.2
1020	0	9.0	1230	0	2.1
1025	0	7.7	1235	0	2.1
1030	0	6.6	[b] 1240	0	2.0
1035	0	5.8	1245	0	2.0
1040	0	5.1	1250	0	2.0
1045	0	4.9	1255	0	1.9

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm SP2 -- March 9 and 10, 1992

Watershed 1 03426460 Spring Branch at Edenwold

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1715 was 0.01 inch]

Baseflow--1.2 cubic feet per second

Time	Incremental rainfall amount	Streamflow
1720	0.01	1.2
1725	0	1.2
1730	.01	1.2
1735	.01	1.2
1740	.01	1.2
1745	.01	1.6
1750	.02	2.3
1755	.01	4.2
[a] 1800	.01	7.4
1805	0	11
1810	.01	12
1815	0	11
1820	.01	9.3
1825	.01	9.3
1830	.01	8.6
1835	0	8.3
1840	.01	9.3
1845	.01	9.3
1850	0	9.6
1855	0	9.6
1900	.01	9.6
1905	0	9.0
1910	.01	8.6
1915	0	9.0
1920	0	9.0
1925	0	8.6
1930	.01	8.0
1935	.01	7.1
1940	.03	6.8
1945	.03	7.1
1950	.02	11
1955	.01	22
2000	.01	25
2005	.01	25
2010	.01	20
2015	.03	20
2020	.04	19
2025	.03	22
2030	.03	32
2035	.02	36
2040	.03	35
2045	.06	35
2050	.05	41
2055	.04	57
2100	.05	57
2105	.04	58
2110	.04	61
2115	0.03	63
2120	.05	61
2125	.06	64
[b] 2130	.04	68
2135	.06	70
2140	.07	73
2145	.05	82
2150	.03	82
2155	.04	77
2200	.03	76
2205	.04	74
2210	.09	76
2215	.07	86
2220	.08	87
2225	.16	84
2230	.06	96
2235	.08	103
2240	.09	93
2245	.07	97
2250	.08	101
2255	.03	98
2300	.03	101
2305	.03	98
2310	.02	93
2315	.02	95
2320	.03	83
2325	.01	81
2330	.03	73
2335	.03	71
2340	.02	69
2345	.02	71
2350	.02	70
2355	.01	65
2400	.01	59
0005	.02	58
0010	.01	57
0015	.01	57
0020	0	54
0025	.03	52
0030	.02	52
0035	.03	56
0040	.03	59
0045	.04	59
0050	.03	62
0055	.04	64
0100	.03	65
0105	.04	69
0110	0.04	69
0115	.02	71
0120	.02	68
0125	.02	68
0130	.03	69
0135	.04	67
0140	.03	70
0145	.02	69
0150	.03	72
0155	.04	71
0200	.03	69
0205	.03	74
0210	.01	70
0215	.01	69
0220	0	69
0225	.01	68
0230	0	67
0235	0	61
0240	0	56
0245	0	53
0250	0	49
0255	0	45
0300	0	39
0305	0	34
0310	0	34
0315	0	30
0320	0	28
0325	0	27
0330	0	26
0335	0	25
0340	0	23
0345	0	23
0350	0	21
0355	0	21
0400	0	21
0405	0	20
0410	0	20
0415	0	20
0420	0	19
0425	0	19
0430	0	19
0435	0	18
0440	0	18
0445	0	18
0450	0	17
0455	0	17
0500	0	17

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm SP3 -- September 2, 1992

Watershed 1 03426460 Spring Branch at Edenwold

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1025 was 0.00 inch]

Baseflow–1.2 cubic feet per second

Time	Incremental rainfall amount	Streamflow
1030	0.00	1.2
1035	.01	1.2
1040	0	1.2
1045	0	1.2
1050	0	1.2
1055	0	1.2
1100	0	1.2
1105	0	1.2
1110	0	1.2
1115	0	1.2
1120	.01	1.2
1125	0	1.2
1130	.01	1.2
1135	0	1.3
1140	.01	1.5
1145	0	1.6
1150	0	2.1
1155	0	2.7
1200	.01	3.3
1205	0	3.9
1210	0	4.0
[a] 1215	.01	4.0
1220	.08	3.9
1225	.00	7.4
1230	.04	8.6
1235	.01	24
1240	0	27
1245	0	25
1250	0	18
1255	0.00	15.0
1300	0	12
1305	0	10
1310	0	8.6
1315	0	9.6
1320	0	9.0
1325	0	7.4
1330	0	6.3
1335	0	5.3
1340	.01	4.7
1345	0	4.2
1350	0	3.9
1355	0	3.6
1400	0	3.3
1405	0	3.0
1410	0	2.9
1415	0	2.7
1420	0	2.7
1425	0	2.5
[b] 1430	0	2.4
1435	0	2.3
1440	0	2.2
1445	0	2.2
1450	0	2.1
1455	0	2.1
1500	0	2.0
1505	0	1.9
1510	0	1.9
1515	0	1.9

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm BR1 -- February 9, 1990

Watershed 2 03431353 Browns Creek tributary at Nashville

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1115 was 0.00 inch]

Baseflow--0.57 cubic foot per second

Time	Incremental rainfall amount	Streamflow
1120	0.00	0.57
1125	0	.57
1130	.01	.57
1135	.02	.70
1140	.02	1.5
1145	.03	2.8
[a] 1150	0	5.1
1155	0	16
1200	.01	14
1205	0	14
1210	0	11
1215	0	8.6
1220	0	6.7
1225	0	8.7
1230	0	8.6
1235	0	7.7
1240	0	6.3
1245	0	5.1
1250	0	4.1
1255	0	3.4
1300	0	3.10
1305	0	2.8
1310	0	2.5
1315	0	2.3
1320	0	2.0
1325	0	1.8
1330	0	1.6
1335	0	1.6
1340	0	1.5
1345	0	1.5
1350	0	1.3
1355	0	1.3
1400	0	1.1
1405	0	1.1
[b] 1410	0	1.1
1415	0	.96
1420	0	.96
1425	0	.96
1430	0	.96
1435	0	.82

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm BR2 -- February 15, 1990

Watershed 2 03431353 Browns Creek tributary at Nashville

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1155 was 0.01 inch]

Baseflow--0.12 cubic foot per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
1200	0.00	0.12	1315	0	2.50
1205	0	.12	1320	0	2.0
1210	.01	.12	1325	0	1.6
[a] 1215	.02	.82	1330	0	1.3
1220	.01	1.5	1335	0	1.3
1225	.01	3.4	1340	0	.96
1230	.02	10	1345	0	.82
1235	0	12	1350	0	.82
1240	0	12	1355	0	.70
1245	0	11	1400	0	.60
1250	0	8.5	[b] 1405	0	.60
1255	0	6.7	1410	0	.48
1300	0	5.1	1415	0	.48
1305	0	3.8	1420	0	.48
1310	0	3.1	1425	0	.36

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm BR3 -- November 5, 1990

Watershed 2 03431353 Browns Creek tributary at Nashville

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 0655 was 0.00 inch]

Baseflow--0.00 cubic foot per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
0700	0.00	0.00	0920	0.01	6.7
0705	0	.00	0925	0	8.1
0710	0	.00	0930	.01	7.2
0715	0	.00	0935	0	5.4
0720	.01	.00	0940	.01	3.8
0725	0	.00	0945	0	2.5
0730	.01	.06	0950	0	1.8
0735	0	.11	0955	0	1.3
0740	0	.11	1000	0	.82
0745	0	.11	1005	0	.60
0750	0	.08	1010	.01	.55
0755	.01	.08	1015	0	.49
0800	.01	.22	1020	0	.46
0805	.01	.33	1025	0	.41
0810	0	.38	1030	0	.38
0815	.01	.41	1035	0	.36
0820	0	.70	1040	0	.33
0825	.01	1.3	1045	0	.30
[a] 0830	.01	.96	1050	0	.27
0835	0	.82	1055	0	.25
0840	.02	.70	1100	0	.24
0845	0	.70	1105	0	.23
0850	.01	.82	1110	0	.22
0855	.03	1.3	1115	0	.21
0900	.01	2.3	1120	0	.20
0905	.01	3.8	1125	0	.19
0910	.01	5.1	[b] 1130	0	.18
0915	.02	5.1	1135	0	.17

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm ML1 -- January 17, 1990

Watershed 3 03431062 Mill Creek tributary at Glenrose Avenue

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1400 was 0.00 inch]

Baseflow--1.4 cubic feet per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
1405	0.00	1.4	[b] 1725	0.02	13.0	2045	0.00	31.0
1410	0	1.5	1730	.02	12	2050	.01	27
1415	0	1.9	1735	.01	11	2055	0	24
[a] 1420	.01	2.2	1740	.02	10	2100	0	22
1425	.03	2.2	1745	0	9.7	2105	0	20
1430	.03	2.2	1750	.01	9.4	2110	0	19
1435	.02	2.2	1755	.01	9.1	2115	0	18
1440	.02	2.2	1800	.01	8.8	2120	0	16
1445	.01	2.2	1805	0	28	2125	0	15
1450	.02	2.2	1810	.01	25	2130	0	13
1455	.01	2.3	1815	0	21	2135	0	11
1500	.01	2.4	1820	.01	18	2140	0	10
1505	.01	2.4	1825	0	16	2145	0	9.7
1510	0	2.4	1830	0	15	2150	0	8.8
1515	0	17	1835	0	15	2155	0	8.3
1520	.01	19	1840	0	14	2200	0	8.0
1525	0	18	1845	0	13	2205	0	7.3
1530	0	17	1850	0	12	2210	0	6.7
1535	0	15	1855	.02	11	2215	0	6.4
1540	0	13	1900	0	11	2220	0	6.1
1545	.01	12	1905	.01	10	2225	0	5.9
1550	0	11	1910	.01	9.4	2230	0	5.6
1555	0	10	1915	.02	8.8	2235	0	5.3
1600	0	9.7	1920	.04	8.5	2240	.01	5.1
1605	0	9.7	1925	.02	8.3	2245	0	4.9
1610	.01	10	1930	0	8.0	2250	0	4.6
1615	0	9.1	1935	.01	8.0	2255	0	4.6
1620	.01	8.6	1940	0	11	2300	0	4.4
1625	.01	7.7	1945	0	15	2305	0	4.4
1630	.03	7.0	1950	0	32	2310	0	4.2
1635	.02	6.4	1955	0	29	2315	0	4.2
1640	0	5.9	2000	0	24	2320	0	3.9
1645	.01	5.6	2005	.01	21	2325	0	3.9
1650	0	5.4	2010	.05	18	2330	0	3.7
1655	.01	5.4	2015	.01	15	2335	0	3.7
1700	0	5.4	2020	.02	14	2340	0	3.7
1705	.01	14	2025	.01	13	2345	0	3.7
1710	0	21	2030	.01	12	2350	0	3.5
1715	0	18	2035	.01	11	2355	0	3.5
1720	0	16	2040	.01	35	2400	0	3.5

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm ML2 -- December 9, 1991

Watershed 3 03431062 Mill Creek tributary at Glenrose Avenue

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; e, estimated; rainfall amount occurring from 0001 through 0455 was 0.06e inch]

Baseflow--1.5 cubic feet per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
0500	0.00	1.5	0840	0.00	10.0	1220	0.01e	16.0
0505	.01e	1.5	0845	0	44	1225	.01e	15
0510	.01e	1.5	0850	0	38	1230	0	15
0515	.01e	1.5	0855	.01e	32	1235	.01e	15
0520	.01e	1.5	0900	0	27	1240	0	15
0525	0	1.5	0905	0	23	1245	0	14
0530	.01e	1.5	0910	0	20	1250	.01e	13
0535	.01e	1.6	0915	0	17	1255	0	13
0540	0	1.6	0920	0	15	1300	.01e	13
0545	.01e	1.6	0925	0	13	1305	0	13
0550	.01e	1.6	0930	0	11	1310	0	13
0555	.02e	1.6	0935	0	10	1315	.01e	13
0600	.01e	1.6	0940	.01e	9.1	1320	0	12
0605	.02e	1.6	0945	0	8.6	1325	0	11
[a] 0610	.02e	1.7	0950	.01e	8.0	1330	0	10
0615	.03e	2.3	[b] 0955	0	7.3	1335	.01e	9.7
0620	.03e	4.4	1000	0	7.0	1340	0	9.4
0625	.02e	7.0	1005	0	6.4	1345	0	9.1
0630	.02e	8.0	1010	.01e	6.1	1350	0	8.8
0635	.02e	9.1	1015	.01e	6.1	1355	0	8.5
0640	.02e	23	1020	0	5.9	1400	.01e	8.3
0645	.01e	31	1025	.01e	5.6	1405	0	8.0
0650	.01e	30	1030	.01e	5.3	1410	0	7.3
0655	.02e	27	1035	.01e	5.3	1415	0	7.3
0700	.01e	25	1040	0	5.3	1420	.01e	7.0
0705	.01e	23	1045	.01e	5.9	1425	0	6.7
0710	.01e	23	1050	.01e	6.4	1430	0	6.7
0715	0	23	1055	0	7.3	1435	0	6.7
0720	0	22	1100	.01e	8.8	1440	0	6.4
0725	.01e	21	1105	.01e	11	1445	0	6.4
0730	0	20	1110	.01e	11	1450	0	6.4
0735	.01e	18	1115	.02e	11	1455	0	6.1
0740	0	16	1120	.01e	11	1500	0	6.1
0745	.01e	14	1125	.01e	11	1505	.01e	6.1
0750	0	13	1130	0	12	1510	0	6.1
0755	.01e	12	1135	.02e	13	1515	0	6.4
0800	0	11	1140	.01e	14	1520	0	6.4
0805	0	10	1145	0	14	1525	0	6.4
0810	.03e	9.1	1150	.01e	15	1530	.01e	6.4
0815	.03e	8.8	1155	.01e	16	1535	0	6.4
0820	.05e	8.6	1200	.01e	16	1540	0	6.1
0825	.02e	8.6	1205	.01e	15	1545	0	5.9
0830	.01e	9.4	1210	.01e	15	1550	0	5.9
0835	.01e	10	1215	0	16	1555	0	5.6

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm ML3 -- May 19, 1992

Watershed 3 03431062 Mill Creek tributary at Glenrose Avenue

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1445 was 0.00 inch]

Baseflow--1.3 cubic feet per second

Time	Incremental rainfall amount	Streamflow
1450	0.00	1.3
1455	0	1.3
1500	.01	1.3
1505	.01	1.3
1510	.03	1.3
1515	.10	1.4
1520	.07	1.4
1525	.03	1.4
1530	.02	1.6
[a] 1535	.01	1.9
1540	0	1.9
1545	.01	1.7
1550	.01	1.7
1555	.01	1.7
1600	.02	1.9
1605	.01	22
1610	.01	20
1615	.01	17
1620	.02	16
1625	0	14
1630	.01	13
1635	.01	12
1640	0	14
1645	.01	18
1650	0	20
1655	0	18
1700	0	17
1705	0	16
1710	0	14
1715	0	13
1720	0	12
1725	0	11
1730	0.00	10.0
1735	.01	9.7
1740	0	9.1
1745	0	8.7
1750	0	8.3
1755	0	7.7
1800	0	7.0
1805	0	6.4
1810	0	6.2
1815	0	5.9
1820	0	5.6
1825	0	5.4
1830	0	5.1
[b] 1835	0	4.6
1840	0	3.5
1845	0	4.2
1850	0	3.9
1855	0	3.7
1900	0	3.7
1905	0	3.5
1910	0	3.4
1915	0	3.4
1920	0	3.2
1925	0	3.2
1930	0	3.0
1935	0	3.0
1940	0	2.9
1945	0	2.9
1950	0	2.7
1955	0	2.7
2000	0	2.6
2005	0	2.6

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm WB1 -- June 3, 1992

Watershed 4 03431100 West Fork Browns Creek at Glendale Lane

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 1255 was 0.00 inch]

Baseflow--0.10 cubic foot per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
1300	0.00	0.10	1615	0	8.0
1305	0	.10	[b] 1620	0	8.0
1310	0	.10	1625	0	7.8
1315	0	.10	1630	0	7.8
[a] 1320	.06	.10	1635	0	7.8
1325	.08	.20	1640	0	7.8
1330	.09	.30	1645	0	7.5
1335	.06	.47	1650	0	7.5
1340	.06	.63	1655	0	7.2
1345	.03	.85	1700	0	7.0
1350	.05	1.5	1705	0	7.0
1355	.02	2.3	1710	0	6.7
1400	.01	2.4	1715	0	6.7
1405	.04	2.5	1720	0	6.7
1410	.02	2.6	1725	0	6.5
1415	0	2.7	1730	0	6.2
1420	.02	3.0	1735	0	6.2
1425	.01	3.3	1740	0	6.0
1430	.01	4.9	1745	0	6.0
1435	.01	6.5	1750	0	6.0
1440	.01	7.8	1755	0	5.8
1445	.02	10	1800	0	5.8
1450	.01	11	1805	0	5.8
1455	.01	11	1810	0	5.8
1500	.02	11	1815	0	5.6
1505	.02	10	1820	0	5.6
1510	.02	9.9	1825	0	5.6
1515	0	9.6	1830	0	5.3
1520	.01	9.3	1835	0	5.3
1525	0	9.1	1840	0	5.3
1530	.01	8.9	1845	0	5.3
1535	0	8.6	1850	0	5.3
1540	.01	8.5	1855	0	5.1
1545	.01	8.3	1900	0	5.1
1550	0	8.2	1905	0	5.1
1555	0	8.0	1910	0	5.1
1600	0	8.0	1915	0	5.1
1605	0	8.0	1920	0	5.1
1610	0	8.0	1925	0	5.1

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm WB2 -- September 26, 1992

Watershed 4 03431100 West Fork Browns Creek at Glendale Lane

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 0915 was 0.37 inch]

Baseflow--0.47 cubic foot per second

Time	Incremental rainfall amount	Streamflow
0920	0.00	0.47
0925	0	.47
0930	.01	.47
0935	0	.47
0940	.05	.85
[a] 0945	.08	2.2
0950	.07	2.3
0955	.10	2.9
1000	.05	4.0
1005	.02	4.5
1010	0	4.9
1015	.01	5.1
1020	.01	11
1025	.01	15
1030	.02	18
1035	.02	26
1040	.01	25
1045	.02	23
1050	.01	21
1055	.01	19
1100	.02	17
1105	.01	16
1110	.01	15
1115	0	15
1120	.01	13
1125	.01	13
1130	.01	13
1135	.01	12
1140	.01	12
1145	.01	12
1150	.01	12
1155	0.00	11
1200	0	10
1205	0	10
1210	.01	10
1215	0	9.9
1220	0	9.6
1225	0	9.6
1230	0	9.2
1235	0	8.9
1240	0	8.9
1245	0	8.6
1250	0	8.3
1255	0	8.3
1300	.01	8.0
1305	0	8.0
1310	0	7.8
1315	0	7.2
1320	0	7.2
1325	0	7.0
[b] 1330	0	7.0
1335	0	6.7
1340	0	6.5
1345	0	6.5
1350	0	6.5
1355	0	6.2
1400	0	6.2
1405	0	6.0
1410	0	6.0
1415	0	6.0
1420	0	5.8
1425	0	5.8

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm WB3 -- November 12, 1992

Watershed 4 03431100 West Fork Browns Creek at Glendale Lane

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 0555 was 0.00 inch]

Baseflow--0.14 cubic foot per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
0600	0.00	0.14	0925	0.00	11.0	1250	0.02e	4.9
0605	0	.14	0930	.01e	13	1255	.10e	5.8
0610	0	.14	0935	0	13	1300	.05e	5.8
0615	.01e	.14	0940	0	13	1305	.02e	6.5
0620	0	.19	0945	.01e	13	1310	.01e	6.2
0625	0	.19	0950	0	15	1315	0	6.2
0630	.02e	.19	0955	0	16	1320	0	6.5
0635	0	.19	1000	0	16	1325	0	6.5
0640	0	.19	1005	0	16	1330	0	7.5
0645	0	.19	1010	0	15	1335	0	9.9
0650	0	.19	1015	0	15	1340	0	13
0655	.10e	.19	1020	0	14	1345	0	16
0700	.05e	.35	1025	0	13	1350	0	16
0705	.05e	.47	1030	0	13	1355	0	16
0710	0	.47	1035	0	9.6	1400	0	15
0715	0	.47	1040	0	8.6	1405	0	14
0720	0	.47	1045	0	8.6	1410	0	14
0725	0	.47	1050	0	8.3	1415	0	13
0730	0	.47	1055	0	8.0	1420	0	13
0735	0	.47	1100	0	7.8	1425	0	12
0740	0	.47	1105	0	7.5	1430	0	12
0745	.03e	.47	1110	0	7.5	1435	0	12
0750	.02e	.63	1115	0	7.2	1440	0	12
0755	.05e	.85	1120	0	7.0	1445	0	11
[a] 0800	.10e	1.5	1125	0	7.0	1450	0	11
0805	.05e	2.0	1130	0	6.7	1455	0	10
0810	.02e	2.2	1135	0	6.5	1500	0	9.9
0815	.01e	2.2	1140	0	6.5	1505	0	9.2
0820	0	2.2	1145	0	6.2	1510	0	8.9
0825	.02e	2.2	1150	0	6.0	1515	0	8.9
0830	.05e	2.5	1155	0	5.8	1520	0	8.6
0835	.01e	2.5	[b] 1200	0	5.8	1525	0	8.6
0840	.03e	2.7	1205	0	5.6	1530	0	8.3
0845	.05e	2.9	1210	0	5.3	1535	0	8.3
0850	0	2.9	1215	0	5.3	1540	0	8.0
0855	.02e	3.1	1220	0	5.3	1545	0	7.8
0900	.05e	3.3	1225	0	5.1	1550	0	7.8
0905	.01e	3.5	1230	0	5.1	1555	0	7.8
0910	.01e	3.8	1235	0	5.1	1600	0	7.5
0915	.01e	5.1	1240	0	5.1	1605	0	7.5
0920	0	7.2	1245	0	5.1	1610	0	7.2

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm MC1 -- June 18, 1990

Watershed 5 03430118 McCrory Creek at Ironwood Drive

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 0855 was 0.02 inch]

Baseflow--4.0 cubic feet per second

Time	Incremental rainfall amount	Streamflow
0900	0.00	4.0
0905	0	4.0
0910	0	4.0
0915	0	4.0
0920	.01	4.0
0925	.25	4.0
0930	.26	5.8
[a] 0935	.22	6.8
0940	.07	6.2
0945	.02	17
0950	.01	40
0955	0	47
1000	0	47
1005	0	47
1010	0	47
1015	0	45
1020	0	46
1025	0	46
1030	0	44
1035	0	40
1040	0	36
1045	0	32
1050	0	28
1055	0	24
1100	0	22
1105	0	19
1110	0	20
1115	0	77
1120	0	126
1125	0	143
1130	0	144
1135	0	139
1140	0	128
1145	0	116
1150	0	103
1155	0	91
1200	0	78
1205	0.00	70.0
1210	0	61
1215	0	54
1220	0	48
1225	0	43
1230	0	38
1235	0	34
1240	0	31
1245	0	28
1250	0	25
1255	0	23
[b] 1300	0	21
1305	0	19
1310	0	18
1315	0	16
1320	0	16
1325	0	15
1330	0	14
1335	0	13
1340	0	13
1345	0	12
1350	0	12
1355	0	11
1400	0	11
1405	0	10
1410	.01	10
1415	0	9.7
1420	0	9.1
1425	0	8.8
1430	0	8.5
1435	0	8.5
1440	0	8.2
1445	0	7.9
1450	0	7.6
1455	0	7.6
1500	0	7.3
1505	0	7.0

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm MC2 -- December 13, 1991

Watershed 5 03430118 McCrory Creek at Ironwood Drive

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; rainfall amount occurring from 0001 through 0225 was 0.08 inch]

Baseflow--7.0 cubic feet per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
0230	0.00	7.0	0620	0.02	45	1010	0.00	72
0235	0	7.3	0625	.01	50	1015	0	71
0240	0	7.3	0630	.01	56	1020	0	70
0245	0	7.3	0635	.02	63	1025	.01	69
0250	.01	7.3	0640	.01	69	1030	0	68
0255	0	7.6	0645	.01	75	1035	0	67
0300	0	7.6	0650	0	80	1040	0	66
0305	0	7.6	0655	.01	84	1045	0	65
0310	0	7.9	0700	0	89	1050	0	65
0315	0	7.9	0705	0	94	1055	0	64
0320	0	7.9	0710	.01	102	1100	.01	63
0325	.01	7.9	0715	.01	109	1105	0	62
0330	.05	7.9	0720	.01	118	1110	.01	61
0335	.01	7.9	0725	0	124	1115	0	60
0340	.01	7.9	0730	0	128	1120	0	59
0345	0	7.9	0735	.01	132	1125	.01	59
0350	.01	7.9	0740	0	133	1130	0	58
0355	.01	7.9	0745	0	134	1135	0	58
0400	0	8.2	0750	0	136	1140	.01	58
0405	0	8.2	0755	.01	134	1145	0	58
0410	0	8.5	0800	0	134	1150	0	58
0415	.01	9.1	0805	.01	134	1155	0	58
0420	.02	9.7	[b] 0810	.01	134	1200	.01	58
[a] 0425	.01	10	0815	0	134	1205	0	58
0430	.01	10	0820	0	132	1210	0	58
0435	.02	11	0825	.01	131	1215	.01	58
0440	0	11	0830	0	128	1220	0	58
0445	.01	11	0835	0	125	1225	0	58
0450	.02	11	0840	.01	122	1230	0	58
0455	.01	11	0845	0	119	1235	.01	58
0500	.01	11	0850	.01	114	1240	0	57
0505	0	11	0855	0	110	1245	0	57
0510	.01	12	0900	0	107	1250	0	56
0515	.01	12	0905	0	105	1255	0	56
0520	.03	13	0910	0	100	1300	0	55
0525	.02	14	0915	0	97	1305	0	54
0530	.02	14	0920	.01	94	1310	0	54
0535	.02	16	0925	0	91	1315	0	54
0540	.03	17	0930	0	88	1320	0	53
0545	.02	18	0935	.01	85	1325	0	53
0550	.02	19	0940	.01	83	1330	0	52
0555	.02	21	0945	0	81	1335	0	52
0600	.02	24	0950	.01	79	1340	0	51
0605	.01	28	0955	0	77	1345	0	51
0610	.02	34	1000	.01	75	1350	0	50
0615	.01	39	1005	.01	73	1355	0	50

[a] Start of sampling.
[b] End of sampling.

INCREMENTAL RAINFALL AND INSTANTANEOUS STREAMFLOW VALUES FOR SAMPLED STORMS--Continued

Storm MC3 -- June 18, 1992

Watershed 5 03430118 McCrory Creek at Ironwood Drive

[Time is given in hours and minutes; rainfall amount is given in inches; streamflow is given in cubic feet per second; e, estimated; rainfall amount occurring from 0001 through 0455 was 0.00 inch]

Baseflow--5.1 cubic feet per second

Time	Incremental rainfall amount	Streamflow	Time	Incremental rainfall amount	Streamflow
0500	0.01	5.1	0650	0	24
0505	.02	5.1	0655	0	21
0510	.05	5.1	0700	0	18
0515	.10	5.1	0705	0	16
0520	.13	5.1	0710	0	14
0525	.08	5.1	0715	0	13
0530	.07	5.1	0720	0	12
0535	.21	5.3	0725	0	11
0540	.14	7.0	0730	0	10
[a] 0545	.09	11	0735	0	9.4
0550	.03	39	0740	0	8.8
0555	.01	55	0745	0	8.5
0600	0	58	0750	0	7.9
0605	0	60	0755	0	7.3
0610	0	63	[b] 0800	0	7.0
0615	0	58	0805	0	6.8
0620	0	51	0810	0	6.5
0625	0	45	0815	0	6.2
0630	0	41	0820	0	6.0
0635	0	36	0825	0	5.8
0640	0	31	0830	0	5.5
0645	0	28	0835	0	5.3

[a] Start of sampling.
[b] End of sampling.

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