WATER-QUALITY DATA FOR THE MILLSTONE RIVER AT WESTON, NEW JERSEY, AND THE SHARK RIVER AT REMSEN MILL, NEW JERSEY, MARCH - SEPTEMBER 1992

by Debra E. Buxton and Paul Dunne

U.S. GEOLOGICAL SURVEY
Open-File Report 93-444

Prepared in cooperation with the
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY

West Trenton, New Jersey
1993

U.S. DEPARTMENT OF THE INTERIOR

Bruce Babbitt, *Secretary*

U.S. GEOLOGICAL SURVEY

Robert M. Hirsch, *Acting Director*

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
Mountain View Office Park
810 Bear Tavern Road
West Trenton, NJ 08628

Copies of this report can be
purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Reports Section
Denver Federal Center
Box 25286, MS 517
Denver, CO 80225

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

Multiply	By	To obtain
	Length	
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Flow	
cubic foot per second (ft^3/s)	0.0283	cubic meter per second
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram
pound, avoirdupois (lb)	0.4536×10^6	microgram
	Pressure	
pound per square inch (lb/in^2)	0.0703	kilogram per square centimeter
	Temperature	
degrees Fahrenheit (°F)	°C = 5/9 (°F-32)	degrees Celsius (°C)

WATER-QUALITY DATA FOR THE MILLSTONE RIVER AT WESTON, NEW JERSEY, AND THE SHARK RIVER AT REMSEN MILL, NEW JERSEY, MARCH - SEPTEMBER 1992

by Debra E. Buxton and Paul Dunne

ABSTRACT

Water-quality samples collected from the Millstone River at Weston, N.J., and the Shark River at Remsen Mill, N.J., during March-September 1992 were analyzed for 20 pesticides. Temperature, specific conductance, and pH were measured at the sampling site. Stream-discharge measurements were obtained from records of the continuous water-stage recorders. Eight base-flow samples and 24 stormflow samples were collected from the Millstone River. Four trip blanks and two duplicate samples also were analyzed to maintain quality assurance. Nine base-flow samples and 13 stormflow samples were collected from the Shark River. One trip blank and one duplicate sample also were analyzed.

Results of analyses indicated that four pesticides--alachlor, atrazine, metolachlor, and simazine--were present in low concentrations in the water samples collected from the Millstone River. No pesticides were present in samples collected from the Shark River. In general, concentrations of pesticides were higher in samples collected from the Millstone River during stormflows than in samples collected during base flows.

INTRODUCTION

The wide variety of crops grown in New Jersey requires the application of numerous pesticides. Considerable research has been conducted to assess the effects of pesticides on ground water, but minimal information is available on concentrations of pesticides in surface water used for public supply. A reconnaissance study was conducted by the U.S. Geological Survey (USGS) in 1990 to investigate application rates of pesticides in New Jersey (Ivahnenko and Buxton, in press). Surface-water samples from six drainage basins were analyzed for the presence of pesticides from agricultural runoff. Results of analyses showed that pesticides were present, but only one compound in one stormflow sample was present in a concentration that exceeded the U.S. Environmental Protection Agency's recommended Lifetime Health Advisory Limit (U.S. Environmental Protection Agency, 1991).

The potential toxic effect of agricultural pesticides in surface water is an environmental and health concern for the New Jersey Department of Environmental Protection and Energy (NJDEPE). In addition, effective January 1993, the U.S. Environmental Protection Agency (USEPA), Office of Drinking Water, imposed strict regulations to protect public water supplies from pesticide contamination (U.S. Environmental Protection Agency, 1989).

In response to these new regulations, the USGS, in cooperation with the NJDEPE, conducted a study to assess the vulnerability of public surface-water supplies to pesticides. The purpose of the assessment study was to compare water-quality data for the Millstone and Shark Rivers with a recently developed numerical vulnerability index that assesses the probability of contamination of the surface water in the basins by agricultural pesticides. The vulnerability index is based on three variables for each basin--percentage of agricultural land in the basin, pounds of pesticides applied per square mile in the basin, and soil surface loss potential (a unitless

measure). The soil surface loss potential, which is a rank of the relative potential loss of pesticides from the soil into surface water (Goss, 1988), was obtained from the U.S. Department of Agriculture, Soil Conservation Service (1992).

This report presents the results of water-quality analyses of 17 base-flow and 40 stormflow samples collected during the surface-water assessment study of the Millstone River Basin and the Shark River Basin in central New Jersey during March-September 1992. Data on stream discharge, temperature, specific conductance, pH, and concentrations of detected pesticides are listed in tables. Statistical summaries of data for the two sampling sites also are presented.

Description of the Study Area

The Millstone and Shark River Basins are located in central New Jersey (fig. 1). Surface-water intakes, which divert water for public supply, are present on both rivers. These intakes were operated by purveyors during the sampling period, from March to September 1992.

Millstone River Basin

The Millstone River drains an area of 278 mi^2. Agricultural land is widely dispersed and comprises 54 percent of the basin (fig. 2). Two manmade surface-water bodies, the Delaware-Raritan Canal and Carnegie Lake, lie within the basin boundaries. The Millstone River extends about 36 mi from the headwaters at Sweetman to the discharge point at the Raritan River near Manville. Annual mean discharge recorded at the Blackwells Mills gaging station (station number 01402000) during water years 1922-91 was 378 ft^3/s (Bauersfeld and others, 1991). (A water year is the 12-month period from October 1 through September 30. It is designated by the calendar year in which it ends.)

Shark River Basin

The Shark River Basin is located in east-central New Jersey near the Atlantic Coast and drains an area of about 10 mi^2. Agricultural land is located primarily in the central part of the basin and covers 14 percent of the land area (fig. 3). The reach of the Shark River used in this study is the portion upstream from the surface-water intake. This reach extends about 8 mi from the headwaters in Reevytown to Glendola, where the river widens. The river flows about 3 mi beyond Glendola and discharges into the Atlantic Ocean near Belmar (fig. 1). Annual mean discharge, recorded at the gaging station near Neptune City (station number 01407705) during water years 1967-91, was 14.6 ft^3/s (Bauersfeld and others, 1991).

Sample-Numbering System

The numbering system for samples collected during the study was developed by project personnel. The first letter is the site code, M for Millstone River and S for Shark River; the second letter is the type of discharge, B for base flow and S for stormflow; the first digit is the number of the base-flow or stormflow event; and the digit following the dash is the sequence number of the sample collected during a particular event. For example, MS1-5 is the fifth sample collected during the first stormflow event sampled on the Millstone River.

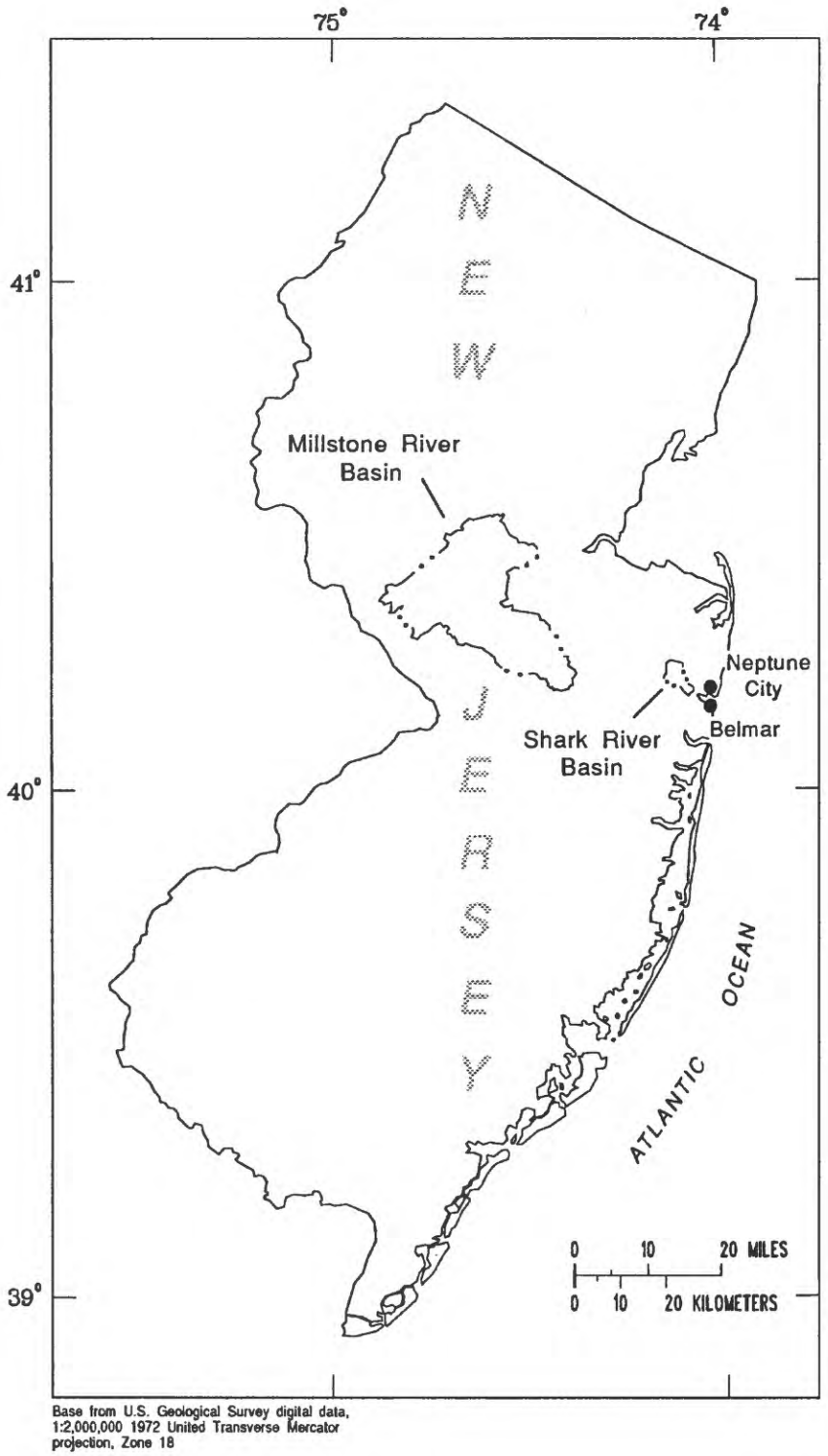
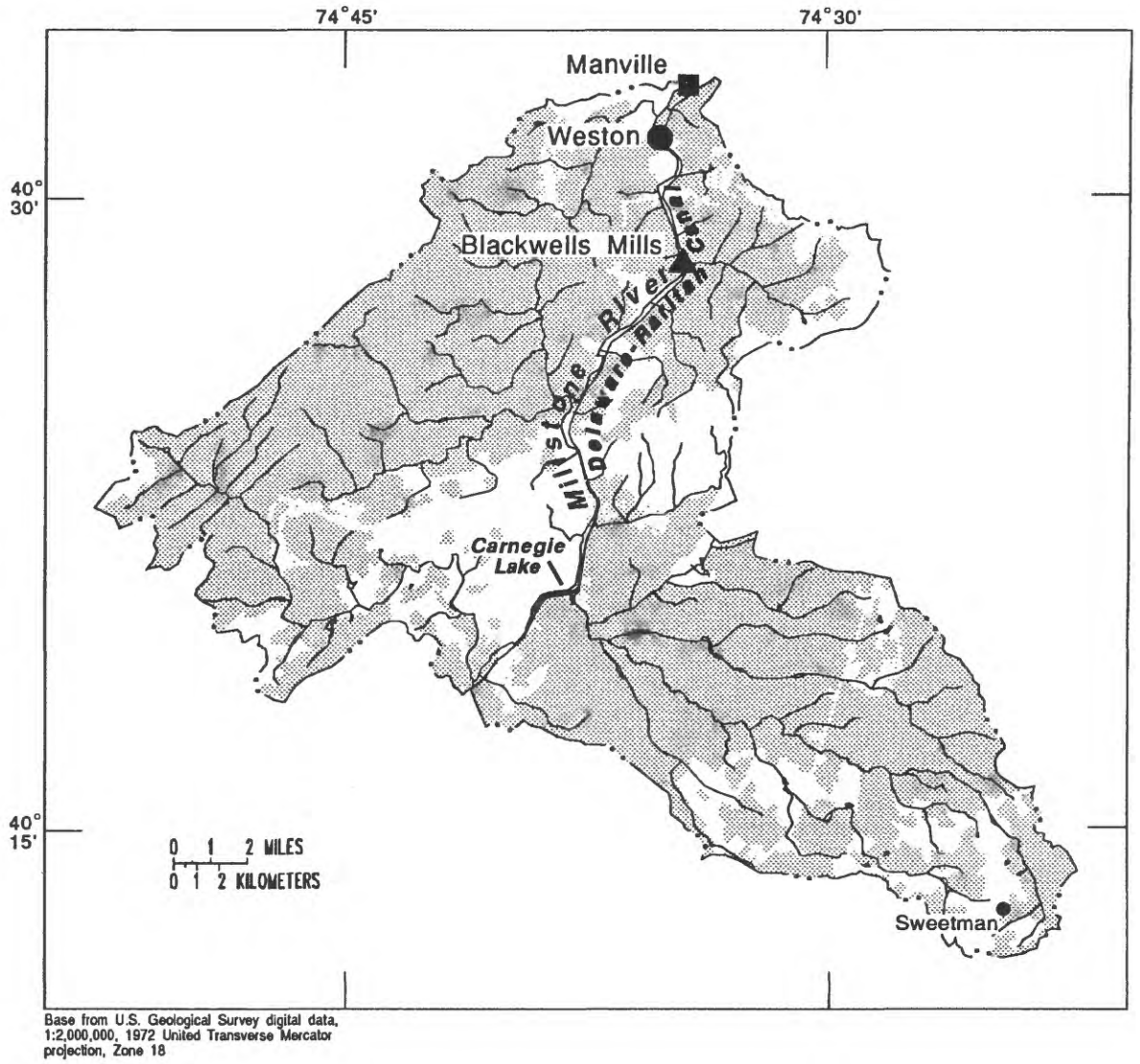


Figure 1.--Location of study area in central New Jersey.



EXPLANATION

- AGRICULTURAL LAND
- DRAINAGE-BASIN BOUNDARY
- SAMPLING POINT--Location in basin where surface-water sample was collected
- SURFACE-WATER INTAKE--Location along stream where water purveyor diverts water for processing
- SURFACE-WATER GAGE

Figure 2.--Locations of public-supply surface-water intake, gaging station, sampling site, and agricultural land in Millstone River Basin.

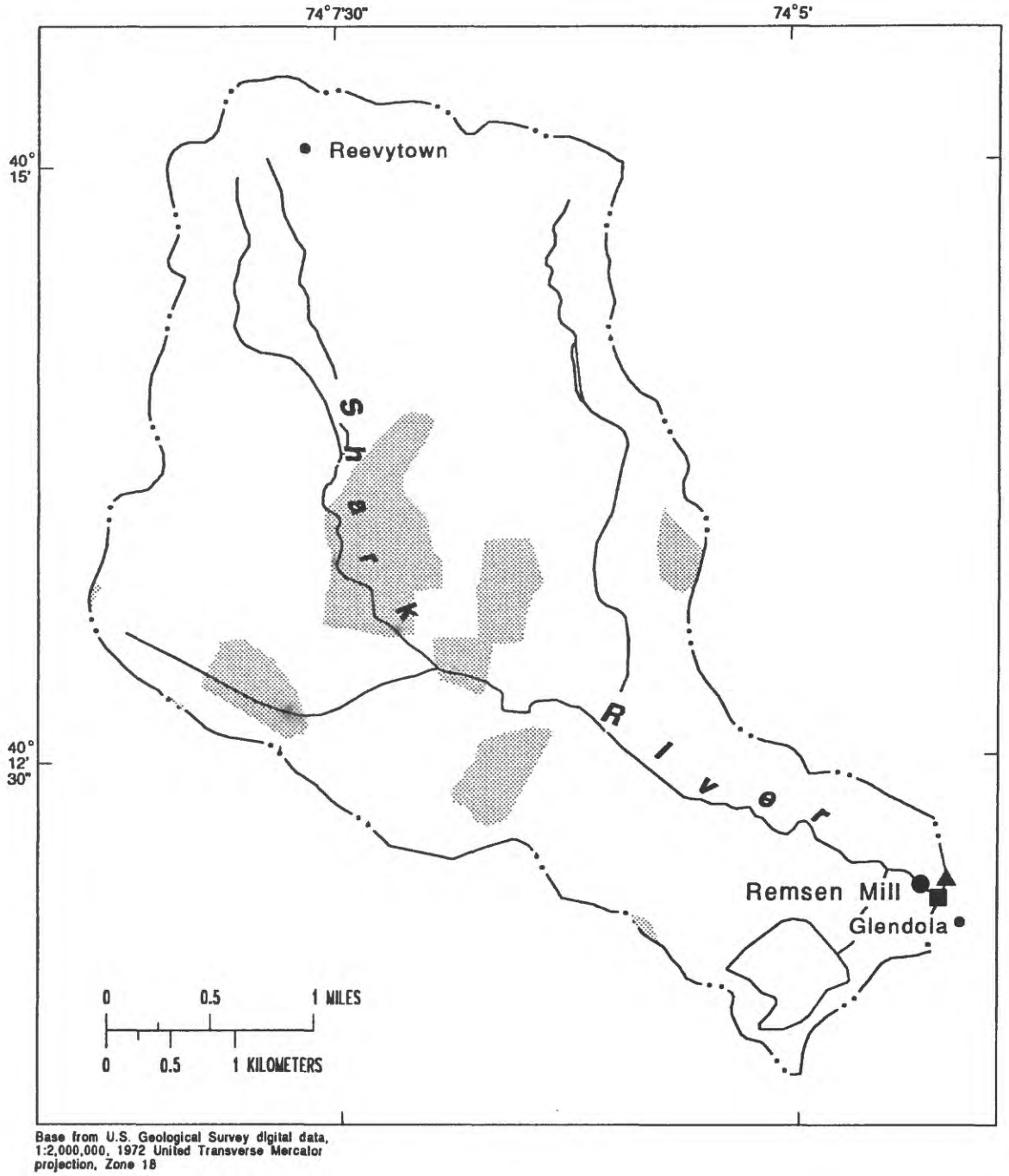


Figure 3.--Locations of public-supply surface-water intake, gaging station, sampling site, and agricultural land in Shark River Basin.

METHODS

The following section describes the sample-collection procedures, sample processing, and laboratory analysis of the samples.

Water-quality samples were collected from and measurements were made at the Millstone River about 4 mi downstream from Blackwells Mills at the Wilhousky Street bridge in Weston. Samples were collected from and measurements were made at the Shark River at the gaging station at Remsen Mill Road in Remsen Mill.

Sample Collection and Processing

Samples were collected at Weston on the Millstone River from March 9, 1992, to September 30, 1992, and at Remsen Mill on the Shark River from March 9, 1992, to September 29, 1992. Samples were collected at both sites on March 9, 1992, to determine background concentrations of pesticides prior to the pesticide-application season. During the pesticide-application season, April through September (with variations based on moderate climatic changes), base-flow and stormflow samples were collected to determine ranges in pesticide concentrations for a variety of flow conditions. Base-flow and stormflow samples were collected with a DH-59 depth-integrating sampler, by using bridge suspension techniques as described by Guy and Norman (1970) and Ward and Harr (1990). Specific conductance, water temperature, and pH also were measured at both sampling sites.

Prior to sampling and upon return from the field, the sampling equipment was cleaned and decontaminated according to established USGS protocols as documented by Ivahnenko and Buxton (1993). Quality assurance (QA) was maintained by submitting duplicate samples and trip blanks for analysis.

Dissolved pesticides were recovered onto 3M[1] EMPORE extraction disks. The disk conditioning and sample extraction from disks were completed by following the protocol that the manufacturer included in each box of disks. Three minor modifications were made to the procedure:

1. A 0.45-micron pore-size silver membrane pre-filter was used to remove suspended material.
2. Twenty milliliters of pesticide-grade methanol was used to pre-wash the combination of pre-filter and disk.
3. The samples were pressure-filtered by using high-purity nitrogen at less than 30 lbs/in^2 rather than vacuum-filtered.

[1] Use of trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 1. Pesticides determined in water-quality samples by means of gas chromatography/chemical ionization mass spectrometry, and detection limits

[Detection limits in micrograms per liter]

Chemical class Pesticide	Detection limit
Triazine	
Atrazine	0.02
Cyanazine	.08
Metribuzin	.08
Simazine	.02
Acetanilide	
Alachlor	.04
Linuron	1.00
Metolachlor	.04
Pendimethalin	.08
Carbamate	
Butylate	.08
Carbaryl	.08
Carbofuran	.08
Organophosphate	
Chlorpyrifos	.08
Diazinon	.02
Fenamiphos	.08
Fonophos	.08
Isofenphos	.08
Parathion	.04
Terbofos	.08
n-Sulfenylphthalimide	
Captan	1.00
Benzonitrile	
Chlorothalonil	1.00

Laboratory Analysis

All samples were analyzed at the Rutgers University Food and Science Department Laboratory in New Brunswick, New Jersey. The water-quality samples were analyzed for 20 pesticides by using gas chromatography/chemical ionization mass spectrometry (GC/CIMS) (table 1). Sample-extraction procedures and analytical methods for GC/CIMS are described in Mogadati and Rosen (1992).

WATER-QUALITY DATA

Results of water-quality analyses of samples from the Millstone River and the Shark River are presented in tables 2 and 3, respectively. The data are listed by date and time of sample collection and are preceded by the sample number. Discharge measurements were obtained from records of the continuous water-stage recorder at each gaging station and are reported in cubic feet per second. The data include water temperature, specific conductance, and pH.

Results of analyses of water samples from the Millstone River, including 8 base-flow samples collected on 8 different days and 24 stormflow samples collected during 4 storms, are listed in table 2. QA was maintained by analyzing one trip blank with the base-flow samples, and three trip blanks and two duplicate samples with the stormflow samples. Only 4 pesticides of the 20 determined--alachlor, atrazine, metolachlor, and simazine--were detected in samples from the Millstone River. Concentrations of the four pesticides were below the U.S. Environmental Protection Agency's recommended Lifetime Health Advisory Limits (U.S. Environmental Protection Agency, 1991).

Results of analyses of water samples from the Shark River, including 9 base-flow samples collected on 9 different days and 13 stormflow samples collected during 3 storms, are listed in table 3. One duplicate sample and one trip blank also were analyzed with the stormflow samples to maintain QA. No pesticides were detected in the samples from the Shark River.

Statistical summaries of selected water-quality data for the Millstone River and the Shark River are shown in tables 4 and 5, respectively. The statistical data are listed by water-quality characteristics and constituents for base-flow samples, stormflow samples, and combined base-flow samples and stormflow samples. The Millstone River data indicate more pesticide detections during stormflow than during base flow. With the exception of simazine, concentrations of pesticides were higher, on average, in stormflow samples than in base-flow samples. Because no pesticides were detected in samples from the Shark River, only water-quality characteristics measured in the field are listed in table 5.

REFERENCES CITED

Bauersfeld, W.R., Moshinsky, E.W., and Pustay, E.A., 1991, Water resources data, New Jersey, water year 1991: U.S. Geological Survey Water-Data Report NJ-91-1, v. 1, p. 496.

Goss, Don, 1988, Pesticide-soil interaction, potentials for loss, original method: Lincoln, Nebraska, U.S. Department of Agriculture, 13 p.

Guy, H.P., and Norman, V.W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C2, 59 p.

Ivahnenko, Tamara, and Buxton, Debra E., in press, Agricultural pesticides in six drainage basins used for public water supply in New Jersey, 1990: U.S. Geological Survey Water-Resources Investigations Report 93-4101.

Mogadati, Paul, and Rosen, J.D., 1992, Determination of pesticide residues in water using a multi-residue analytical method: New Brunswick, N.J., Rutgers University Department of Food Science, 12 p.

U.S. Department of Agriculture, Soil Conservation Service, in press, National soil survey interpretation handbook, Draft Copy, September 1992: 430-VI-NSH, Somerset, New Jersey.

U.S. Environmental Protection Agency, 1989, National primary and secondary drinking water regulations: 40 CFR 141, 142, 143, May 22, 1989.

_____ 1991, National primary drinking water standards: U.S. Environmental Protection Agency, EPA-570/9-91-012FS, 8 p.

Ward, J.R., and Harr, A.C., eds., 1990, Methods for collection and processing of surface-water and bed-material samples for physical and chemical analyses: U.S. Geological Survey Open-File Report 90-140, 71 p.

Table 2. Physical properties of and concentrations of pesticides detected in surface-water samples collected from the Millstone River at Weston, New Jersey, March-September 1992

[ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; b, trip blank; *, duplicate sample; - -, data not available; ND, not detected]

Sample number	Date sampled	Time sampled	Discharge at station 01402000 (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)	pH	Alachlor (µg/L)	Atrazine (µg/L)	Metolachlor (µg/L)	Simazine (µg/L)
MB1-1	3-9-92	1300	324	9.5	237	7.2	ND	ND	ND	ND
MB2-1	5-4-92	1405	127	19.0	273	7.2	ND	ND	ND	.13
MB3-1	5-15-92	1530	114	17.0	281	6.9	ND	ND	ND	ND
MB4-1	5-28-92	0951	98	16.0	260	6.9	ND	.07	ND	.07
MS1-1	5-31-92	1255	162	17.5	293	--	ND	ND	ND	.04
MS1-2	5-31-92	1725	654	17.5	284	--	ND	ND	ND	.07
MS1-3	6-1-92	0020	839	17.0	218	--	ND	ND	ND	ND
MS1-4	6-1-92	0705	777	16.5	213	--	ND	.07	ND	.04
MS1-5	6-1-92	1230	685	17.5	196	--	ND	ND	ND	ND
MS1-6	6-1-92	1805	556	18.0	207	7.2	ND	.04	ND	.04
MS1-7	6-1-92	2345	486	17.5	214	7.2	ND	.05	ND	.03
MS1-8	6-2-92	0705	479	17.0	230	7.2	ND	.04	ND	.03
MS1-9[b]	6-2-92	1100	--	--	--	--	ND	ND	ND	ND
MS1-10	6-2-92	1200	426	18.0	235	7.2	ND	.04	ND	.07

Table 2. Physical properties of and concentrations of pesticides detected in surface-water samples collected from the Millstone River at Weston, New Jersey, March-September 1992 (continued)

[ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; b, trip blank; *, duplicate sample; - -, data not available; ND, not detected]

Sample number	Date sampled	Time sampled	Discharge at station 01402000 (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)	pH	Alachlor (µg/L)	Atrazine (µg/L)	Metolachlor (µg/L)	Simazine (µg/L)
MS1-11	6-2-92	1750	386	19.0	220	7.1	ND	ND	ND	ND
MB5-1	6-4-92	1634	167	21.0	237	7.1	ND	.04	ND	ND
MS2-1	6-6-92	0849	2913	17.0	107	6.9	ND	.47	.29	ND
MS2-2	6-6-92	1358	3764	18.0	121	6.9	ND	.27	.20	ND
MS2-3	6-6-92	1831	4380	19.0	136	6.9	.07	.32	.40	.05
MS2-4[b]	6-6-92	2330	--	--	--	--	ND	ND	ND	ND
MS2-5	6-6-92	1145	3460	18.5	127	6.9	ND	.13	.07	ND
MS2-6	6-7-92	0625	3787	18.0	112	6.9	ND	.19	.20	ND
MS2-7	6-7-92	1205	3150	18.5	110	6.8	.11	.80	.49	ND
MS2-8	6-7-92	1800	2570	19.5	122	6.8	.07	.31	.20	ND
MS2-9	6-7-92	2353	1975	20.0	130	6.8	.11	1.10	1.20	ND
MS2-9*	6-7-92	2353	--	--	--	--	.07	.60	.35	ND
MS3-1	7-9-92	1115	236	23.5	240	7.2	ND	.17	.20	.02
MB6-1	8-4-92	1400	92	23.5	241	7.3	ND	.03	ND	.04
MB6-2[b]	8-4-92	--	--	--	--	--	ND	ND	ND	ND
MB7-1	9-2-92	1520	46	22.5	281	7.4	ND	.05	.07	.03

Table 2. Physical properties of and concentrations of pesticides detected in surface-water samples collected from the Millstone River at Weston, New Jersey, March-September 1992 (continued)

[ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; b, trip blank; *, duplicate sample; - -, data not available; ND, not detected]

Sample number	Date sampled	Time sampled	Discharge at station 01402000 (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)	pH	Alachlor (µg/L)	Atrazine (µg/L)	Metolachlor (µg/L)	Simazine (µg/L)
MS4-1	9-26-92	0950	168	17.0	327	6.5	ND	0.02	ND	0.04
MS4-2	9-26-92	1820	232	17.5	285	6.8	ND	ND	ND	ND
MS4-3	9-27-92	1105	200	17.5	285	6.4	ND	ND	ND	ND
MS4-3*	9-27-92	1105	--	--	--	--	ND	.03	ND	.04
MS4-4	9-27-92	2055	251	18.0	261	7.2	ND	ND	.07	ND
MS4-5[b]	9-28-92	1446	--	--	--	--	ND	ND	ND	ND
MS4-6	9-28-92	1455	204	18.0	--	6.5	ND	ND	ND	ND
MB8-1	9-30-92	0900	110	16.0	267	7.2	ND	ND	ND	ND

Table 3. Physical properties of surface-water samples collected from the Shark River at Remsen Mill, New Jersey, March-September 1992

[ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; b, trip blank; *, duplicate sample; - -, data not available]

Sample number	Date sampled	Time sampled	Discharge at station 01407705 (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)	pH
SB1-1	3-9-92	0830	13	9.5	176	7.6
SB2-1	5-4-92	1530	2.9	14.0	170	7.0
SS1-1	5-8-92	1735	53	11.0	132	6.9
SS1-2	5-8-92	2030	73	11.0	117	6.8
SS1-3	5-8-92	2300	104	11.0	117	6.4
SS1-3*	5-8-92	2300	--	--	--	--
SS1-4	5-9-92	0200	72	10.5	127	6.3
SS1-5	5-9-92	0400	56	10.5	124	6.4
SB3-1	5-15-92	1715	3.6	13.0	169	7.4
SB4-1	5-27-92	0830	2.9	11.5	173	7.9
SS2-1	5-31-92	1445	38	14.5	128	7.0
SS2-2	5-31-92	1715	70	15.0	118	6.7
SS2-3[b]	5-31-92	--	--	--	--	--
SS2-4	5-31-92	2015	45	14.5	134	6.7
SB5-1	6-4-92	1945	2.2	17.0	165	--
SB6-1	7-8-92	0930	6.6	16.5	168	7.8
SB7-1	8-4-92	1130	9.3	18.0	164	7.3
SB8-1	9-2-92	1030	3.6	15.0	171	7.5
SS3-1	9-25-92	2311	62	15.5	145	6.7
SS3-2	9-26-92	0637	138	16.0	122	6.3
SS3-3	9-26-92	1300	69	16.5	125	6.2
SS3-4	9-26-92	1900	35	16.5	133	6.2
SS3-5	9-27-92	1017	21	15.5	156	6.6
SB9-1	9-29-92	1645	8.8	14.5	162	7.3

Table 4. Statistical summary of selected water-quality data for the Millstone River, March-September 1992

[Pesticide concentrations in micrograms per liter; ND, not detected; ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius]

Water-quality characteristic	Number of samples	Minimum	Median	Maximum
Base flow				
Field measurements:				
Discharge (ft^3/s)	8	46	112	324
Temperature (°C)	8	9.5	18.0	23.5
Specific conductance (µS/cm)	8	237	263.5	281
pH	8	6.9	7.2	7.4
Pesticides detected:				
Alachlor	0	ND	ND	ND
Atrazine	4	.03	.045	.07
Metolachlor	1	.07	.07	.07
Simazine	4	.03	.055	.13
Stormflow				
Field measurements:				
Discharge (ft^3/s)	24	162	605	4,380
Temperature (°C)	24	16.5	18.0	23.5
Specific conductance (µS/cm)	23	107	214	327
pH	19	6.4	6.9	7.2
Pesticides detected:				
Alachlor	5	.07	.09	.11
Atrazine	17	.02	.17	1.10
Metolachlor	11	.07	.20	1.20
Simazine	11	.02	.04	.07
Base flow and stormflow combined				
Field measurements:				
Discharge (ft^3/s)	32	46	406	4,380
Temperature (°C)	32	9.5	18.0	23.5
Specific conductance (µS/cm)	31	107	235	327
pH	27	6.4	6.9	7.4

Table 4. Statistical summary of selected water-quality data for the Millstone River, March-September 1992 (continued)

Water-quality characteristic	Number of samples	Minimum	Median	Maximum
Base flow and stormflow combined--Continued				
Pesticides detected:				
Alachlor	5	0.07	0.07	0.11
Atrazine	21	.02	.07	1.10
Metolachlor	12	.07	.20	1.20
Simazine	15	.02	.04	.13

Table 5. Statistical summary of selected water-quality data for the Shark River, March-September 1992

Water-quality characteristic	Number of samples	Minimum	Median	Maximum
Base flow				
Field measurements:				
Discharge (ft^3/s)	9	2.2	3.6	13.0
Temperature (°C)	9	9.5	14.5	18.0
Specific conductance (µS/cm)	9	162	169	176
pH	8	7.0	7.45	7.9
Stormflow				
Field measurements:				
Discharge (ft^3/s)	13	21.0	62.0	138.0
Temperature (°C)	13	10.5	14.5	16.5
Specific conductance (µS/cm)	13	117	127	156
pH	13	6.2	6.6	7.0
Base flow and stormflow combined				
Field measurements:				
Discharge (ft^3/s)	22	2.2	36.5	138.0
Temperature (°C)	22	9.5	14.5	18.0
Specific conductance (µS/cm)	22	117	139.5	176
pH	21	6.2	6.8	7.9