STREAMBED-MATERIAL CHARACTERISTICS AND SURFACE-WATER QUALITY, GREEN POND BROOK AND TRIBUTARIES, PICATINNY ARSENAL, NEW JERSEY, 1983-90

By Donald A. Storck and Pierre J. Lacombe

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
acre	0.4047	hectare
square mile (mi^2)	2.590	square kilometer
	Volume	
gallon (gal)	3.785	liter
cubic foot (ft^3)	0.02832	cubic meter
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
gallon per day (gal/d)	0.003785	cubic meter per day
	Temperature	
degree Fahrenheit (°F)	°C = 5/9 x (°F-32)	degree Celsius

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviations used in report:

µg/g micrograms per gram
µg/kg micrograms per kilogram
µg/L micrograms per liter
mg/L milligrams per liter
mS/m millisiemens per meter

PAH's polynuclear aromatic hydrocarbons
PCB's polychlorinated biphenyls
TCE trichloroethylene
VOC's volatile organic compounds

USAEHA U.S. Army Environmental Hygiene Agency
USARDEC U.S. Army Armaments Research Development and Engineering Center
USATHAMA U.S. Army Toxic and Hazardous Materials Agency
USEPA U.S. Environmental Protection Agency
USGS U.S. Geological Survey

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ABSTRACT

This report presents the results of a study conducted at Picatinny Arsenal, Morris County, New Jersey, to (1) determine whether streambed sediments in Green Pond Brook and its tributaries are contaminated with inorganic or organic constituents, (2) determine the extent of contamination in those reaches, and (3) characterize the quality of water in the brook. Shallow auger samples and results of an electromagnetic-conductivity and natural-gamma-ray survey were used to describe the distribution of streambed and substreambed sediment types and particle sizes.

Forty-five streambed samples were analyzed for trace elements, base/neutral- and acid-extractable compounds, organochlorine and organophosphorus insecticides, polychlorinated biphenyls, and polychlorinated naphthalenes to determine whether contaminants have migrated to the brook from the surrounding area. Historical results of analyses of 63 surface-water and 27 streambed samples also are presented. Samples of streambed material collected from three areas in Green Pond Brook and its tributaries--Green Pond Brook, from the area near the outflow of Picatinny Lake downstream to Farley Avenue; Bear Swamp Brook, from the area near building 241 downstream to the confluence with Green Pond Brook; and Green Pond Brook, from the open burning area downstream to the dam near building 1178--contained organic and (or) inorganic constituents in concentrations greater than those found under natural conditions and greater than those found in other areas sampled at the arsenal. Contaminants identified include trace elements, polynuclear aromatic hydrocarbons, polychlorinated biphenyls, and organochlorine insecticides.

Surface-water samples from Green Pond Brook contained several volatile organic compounds, including trichloroethylene, tetrachloroethylene, and 1,2-dichloroethylene, at maximum concentrations of 3.8, 4.6, and 11 micrograms per liter, respectively. Volatilization and dilution by surface- water and ground-water inflow reduce concentrations of volatile organic compounds from surface water in the steep, fast-flowing reaches of the brook at the southern end of the arsenal. No organic or inorganic constituents were detected in surface-water samples in concentrations greater than the U.S. Environmental Protection Agency primary drinking-water regulations. Only two constituents, iron and manganese, were detected in concentrations greater than the U.S. Environmental Protection Agency secondary drinking-water regulations.

INTRODUCTION

Picatinny Arsenal is located just north of the Wisconsinan terminal moraine in north-central New Jersey (fig. 1). Since 1986, the installation has been known officially as the U.S. Army Armament Research Development and Engineering Center (USARDEC). The installation previously was known as the U.S. Army Armament Research and Development Command (1978-83) and the U.S. Army Armament Research and Development Center (1983-86). About 5,500 people are employed in research and development of munitions and weapons at the arsenal, which encompasses more than 1,500 buildings on 6,491 acres.

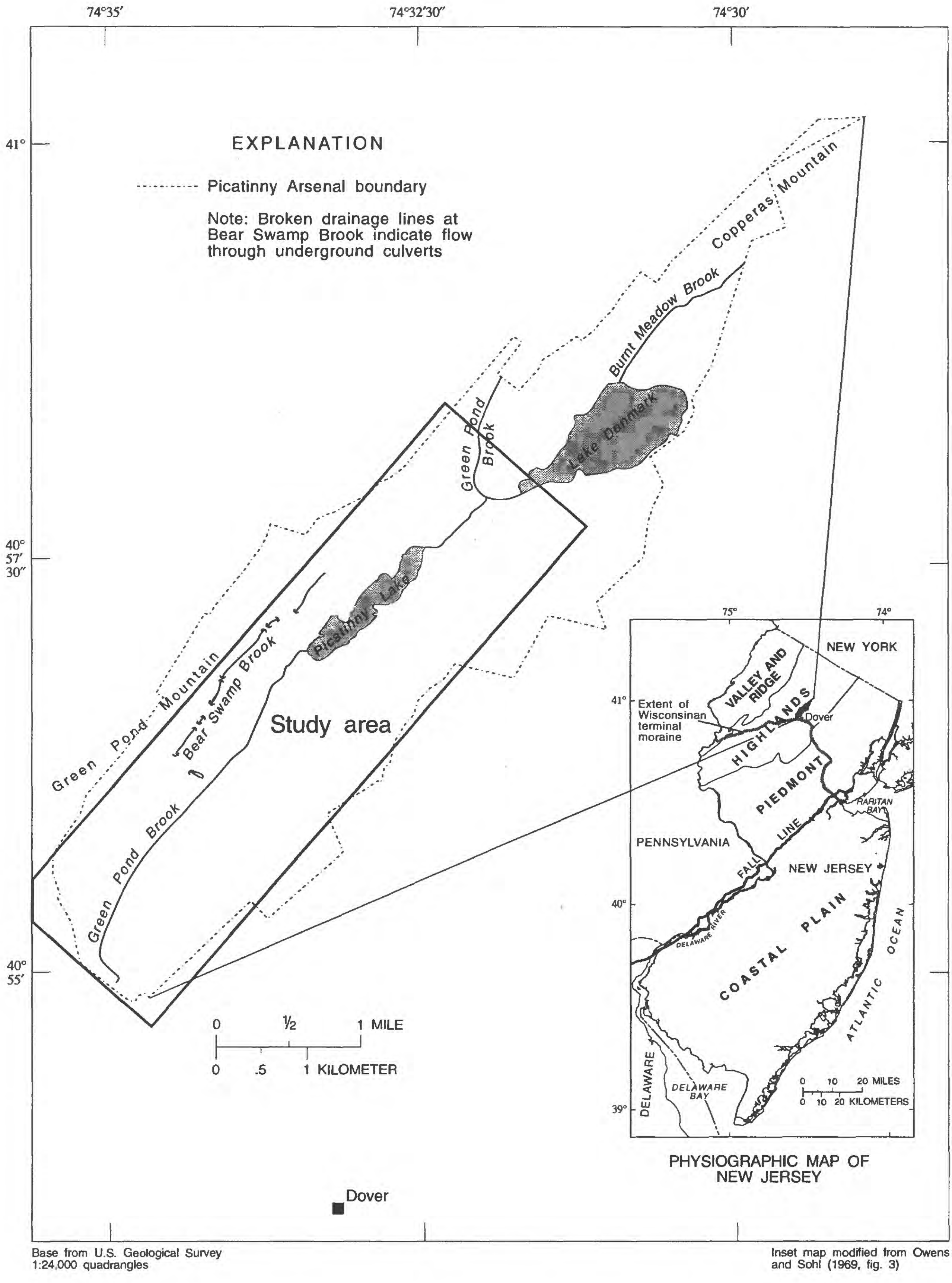


Figure 1. Location of Picatinny Arsenal, New Jersey. (Modified from Sargent and others, 1986, fig.1.)

The arsenal site has a long industrial history. Middle Forge, one of the first forges in New Jersey, was established there in 1749. The forge later became part of Mount Hope Iron Works, which provided cannon shot and other iron implements for the Revolutionary War. In 1880, the U.S. War Department established the Picatinny Powder Works at the site and, since 1907, as a result of expanding activities, the facility has been known as Picatinny Arsenal. During World War I, many types of ammunition were produced at the arsenal; during World War II, production was expanded to include bombs, high explosives, pyrotechnics, and other ordnance items. In recent years, the arsenal's mission has changed to research and development of large-caliber munitions.

Iron ore was mined on the eastern side of the valley, forges were built to smelt the ore, dams were built for water power, and stream channels were straightened and deepened to drain swamps and marshes. Bridges and culverts were built to facilitate crossing the brook, and fill was added to strengthen the foundations of buildings and parking lots adjacent to the brook or over the marshland.

Contamination of ground water, surface water, and soils within the arsenal has been well-documented by the U.S. Army and its contractors. In March 1990, Picatinny Arsenal was placed on the National Priority List as a "Superfund" site.

Green Pond Brook, the major stream flowing through the arsenal, is a tributary of the Rockaway River, which empties into the Boonton Reservoir, a source of drinking water for more than 225,000 residents. Previous analyses of streambed samples from Green Pond Brook in the arsenal have detected organochlorine insecticides, polynuclear aromatic hydrocarbons (PAH's), and elevated concentrations of trace elements. Ground-water withdrawals from water-supply wells adjacent to Green Pond Brook or the Rockaway River could induce surface water to flow into the potable-water supply system.

In 1982, the U.S. Geological Survey (USGS), in cooperation with the U.S. Army, began an assessment of the water resources at the arsenal. The assessment included surface-geophysical surveys, test drilling and installation of monitoring wells, sampling and analysis of surface and ground water, measurement of water levels, aquifer tests, and the development of a computerized data base for hydrogeologic data.

Purpose and Scope

This report describes the results of a study conducted during 1989-90 to (1) determine whether streambed sediments in Green Pond Brook and its tributaries are contaminated with inorganic or organic constituents, (2) determine the areal and vertical extent of contamination in those reaches that are found to be contaminated, and (3) characterize the quality of water in the brook. Historical surface-water-quality and streambed-material- quality data also are presented.

This report presents results of chemical analyses of streambed samples collected from 45 sites during 1989-90. Samples were analyzed for trace elements, base/neutral- and acid-extractable compounds, organochlorine and organophosphorus insecticides, and polychlorinated biphenyls (PCB's). A detailed description of the distribution of particle sizes in streambed and substreambed sediments based on results of an electromagnetic-conductivity and natural-gamma-ray survey also is included.

Data obtained during previous investigations at Picatinny Arsenal and other ongoing investigations of Green Pond Brook and its vicinity are presented in this report. The data include results of analyses of streambed and surface-water samples collected from December 1983 through September 1984, results of analyses of surface-water samples collected from July 1986 through August 1990 as part of an investigation of contamination near building 24 (Sargent and others, 1990), and stream-discharge measurements made at two sites from October 1982 through September 1990 and at a third site from October 1984 through September 1990.

Previous Investigations

The USGS first began studying the ground water at Picatinny Arsenal in 1958. Gill and Vecchioli (1965) presented hydrologic data on the availability of ground water in Morris County. Lacombe and others (1986) used surface-geophysical techniques to investigate ground-water contamination and define the hydrogeologic framework at the arsenal. Electromagnetic conductivity was used to delineate areas of high apparent conductivity, which may indicate ground-water contamination, and seismic refraction and electric resistivity were used to delineate subsurface units.

Sargent and others (1986) compiled ground-water-quality data collected from 1958 through 1985 for 56 wells at the arsenal. A 1982-84 investigation by Harte and others (1986) included test drilling and installation of monitoring wells. Imbrigiotta and others (1988) evaluated sampling devices used to collect ground-water samples for analysis for purgeable organic compounds. Sargent and others (1990) defined the extent of ground-water contamination and rate of contaminant movement in the area of building 24, and identified contamination in the unsaturated zone and in surface water. Their report includes results of test drilling and installation of monitoring wells in 1987.

In addition to work done by the USGS, several other studies have been conducted to determine the geologic framework and hydrology of, and to identify ground-water and surface-water contamination at, Picatinny Arsenal. The U.S. Army Environmental Hygiene Agency (USAEHA) conducted a study of geohydrology and ground-water contamination from 1979 through 1984. J.W. Bauer (U.S. Army Environmental Hygiene Agency, written commun., 1979) presented the geohydrology and the potential effect of wastewater-disposal practices on ground-water quality. D.C. Bayha (U.S. Army Environmental Hygiene Agency, written commun., 1984) presented an assessment of ground- water quality at the arsenal. Results of his investigation at the open burning area in 1983-84 indicated that soils were contaminated with explosives residues, lead, and cadmium.

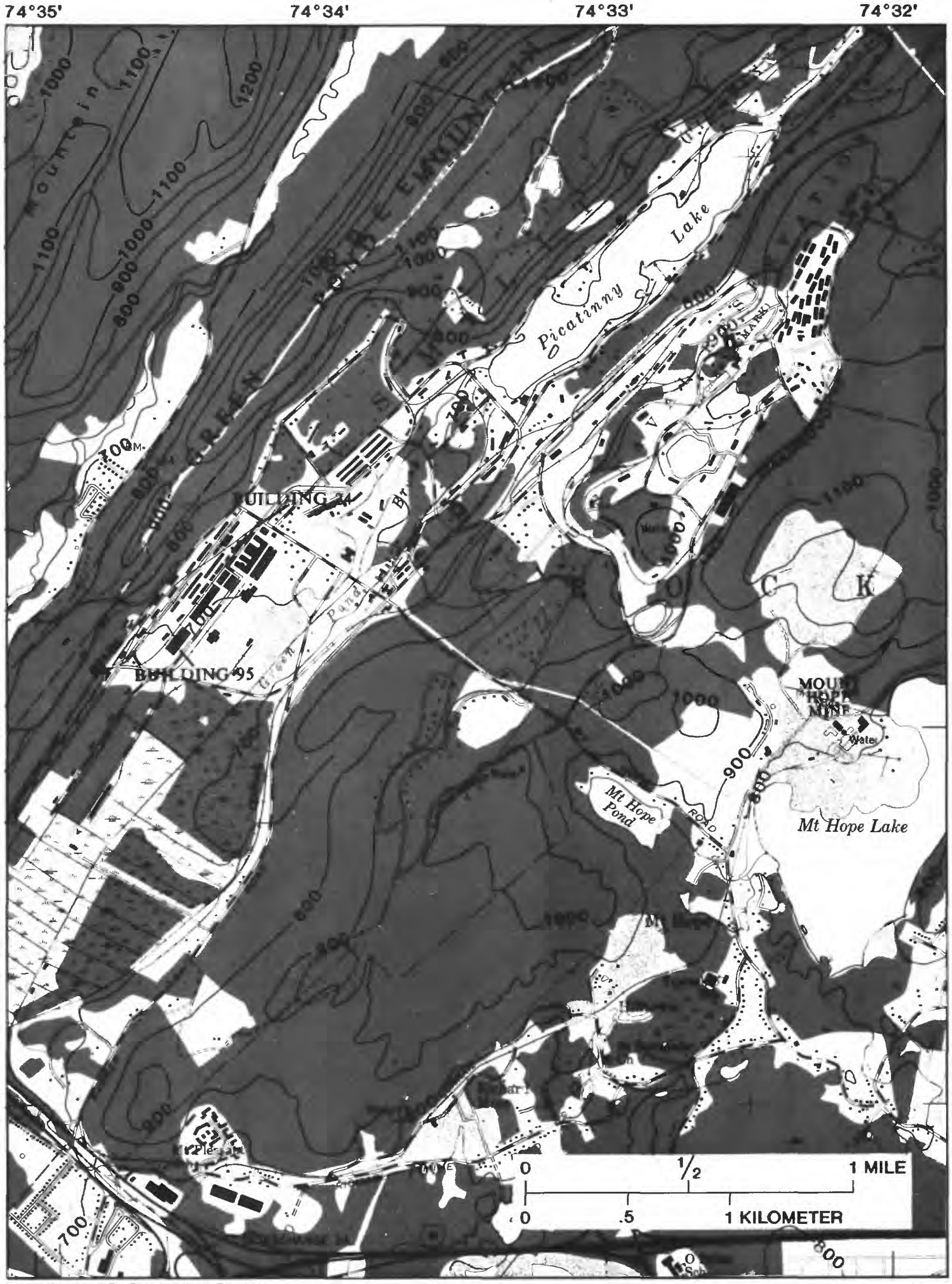
Frew and others (1989) identified sources of contamination, defined site hydrology, and compiled results of extensive chemical analyses of ground- water, surface-water, streambed, and soil samples from 33 sites at Picatinny Arsenal. Results of the well-drilling program and installation of monitoring wells from December 1987 through February 1989 were reported, and the potential for contaminant migration was assessed. Benioff and others (1991) presented site-specific information on known and (or) potential contamination sources that included site histories, a description of site geology and hydrology, documentation of the contamination present, and proposed remedial investigation plans.

Description of Study Area

The arsenal is situated in an elongated valley that trends northeast to southwest. The valley is bounded by Green Pond Mountain to the west, Copperas Mountain to the northeast, and an unnamed mountain to the east and southwest (fig. 2). Green Pond and Copperas Mountains are rugged with steep, rocky slopes and elevations exceeding 1,200 ft. The slopes on the eastern boundary are less rugged and less steep, with maximum elevations of about 1,100 ft.

The geologic setting of the study area is a composite of Pleistocene glacial and post-glacial sediments, with minor Holocene sediments. Limited but important fill deposits have been added, and dams and culverts have been constructed that alter the natural setting of Green Pond Brook and its tributaries. The surficial geology of Green Pond Valley as mapped by Stanford (1989) is shown in figure 3.

The continental glacier that covered the northern part of North America until 10,000 years ago also covered all of the terrain on which Picatinny Arsenal is now situated. The southern extent of the glacier is the site of a terminal moraine that is about 300 ft thick and more than 0.5 mi wide near the southern boundary of the arsenal. The terminal moraine is composed of unstratified and unsorted boulders, cobbles, and pebbles in a silty, fine- to medium-grained sand matrix. The topography of the terminal moraine is irregular, with numerous ridges and kettle holes. Glacial boulders and cobbles litter the forests that cover the terminal moraine today.



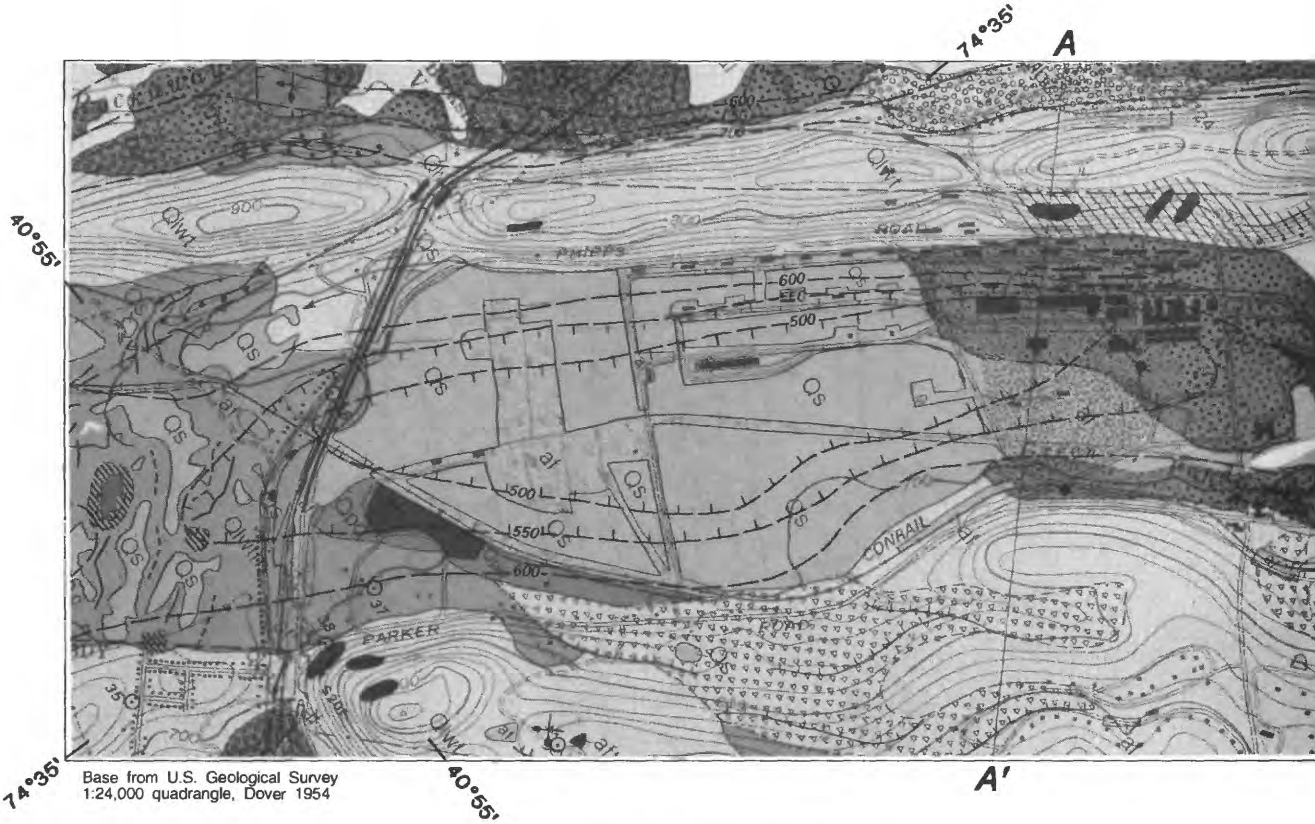
Base from U.S. Geological Survey, 1:24,000, quadrangle, Dover, 1954

EXPLANATION

——800—— TOPOGRAPHIC CONTOUR--Interval 100 feet. Datum is sea level

·—·—·— PICATINNY ARSENAL BOUNDARY

Figure 2. Physical features in the vicinity of Picatinny Arsenal, New Jersey. (Modified from Sargent and others, 1990, fig. 2)



EXPLANATION

POST-GLACIAL DEPOSITS (HOLOCENE AND LATE WISCONSINAN)

af — *Artificial Fill:* Excavated till, sand, gravel, and rock; construction debris (brick, concrete, asphalt); industrial materials (foundry sand, cinders and slag). In railroad and highway embankments, dams, and filled land. Generally less than 10 feet thick, as much as 20 feet thick. Many small areas of fill in urban areas not mapped.

afm — *Mine Tailings:* Piles and embankments of waste rock excavated from iron mines and rock quarries. Includes angular boulders, cobbles, and pebbles of bedrock; minor sand, cinders, ash, and slag. As much as 20 feet thick.

Trash Fill: Trash and construction debris mixed and covered with excavated till and weathered bedrock. As much as 25 feet thick.

Qal — *Alluvium:* Silt and fine sand; minor clay and pebble to cobble gravel. Contains variable amounts of organic matter. Includes some peat and muck along the Rockaway River north of Interstate Route 80. Maximum thickness 10 feet (estimated).

Qs — *Swamp and Marsh Deposits:* Typically gray silt and clay with minor sand overlain by brown peat, in turn overlain by dark brown to black muck and organic silt. Silt and clay may also occur interbedded with the peat. In swamps along larger streams peat may be minor or absent and sand more abundant. Generally less than 10 feet thick (Waksman and others, 1943), but may be as much as 25 feet thick (Harte and others, 1986, p. 51).

Qta — *Talus:* Angular boulders of bedrock with little or no matrix material. Forms steep aprons along base of cliffs. The only mapped deposits are on the southeast-facing slopes of Copperas and Green Pond Mountains and at the base of a small cliff on Mase Mountain. As much as 20 feet thick (estimated). Many small talus deposits are not mapped.

Qst — *Stream Terrace Deposits:* Fine sand to pebble gravel forming a small terrace approximately 10 feet above present floodplain along the Rockaway River in Rockaway Borough. Not more than 15 feet thick (estimated). Holocene age probable but not certain.

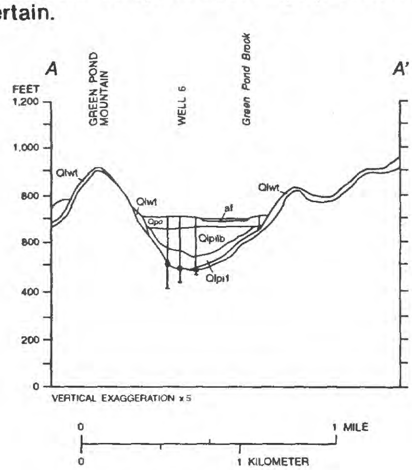
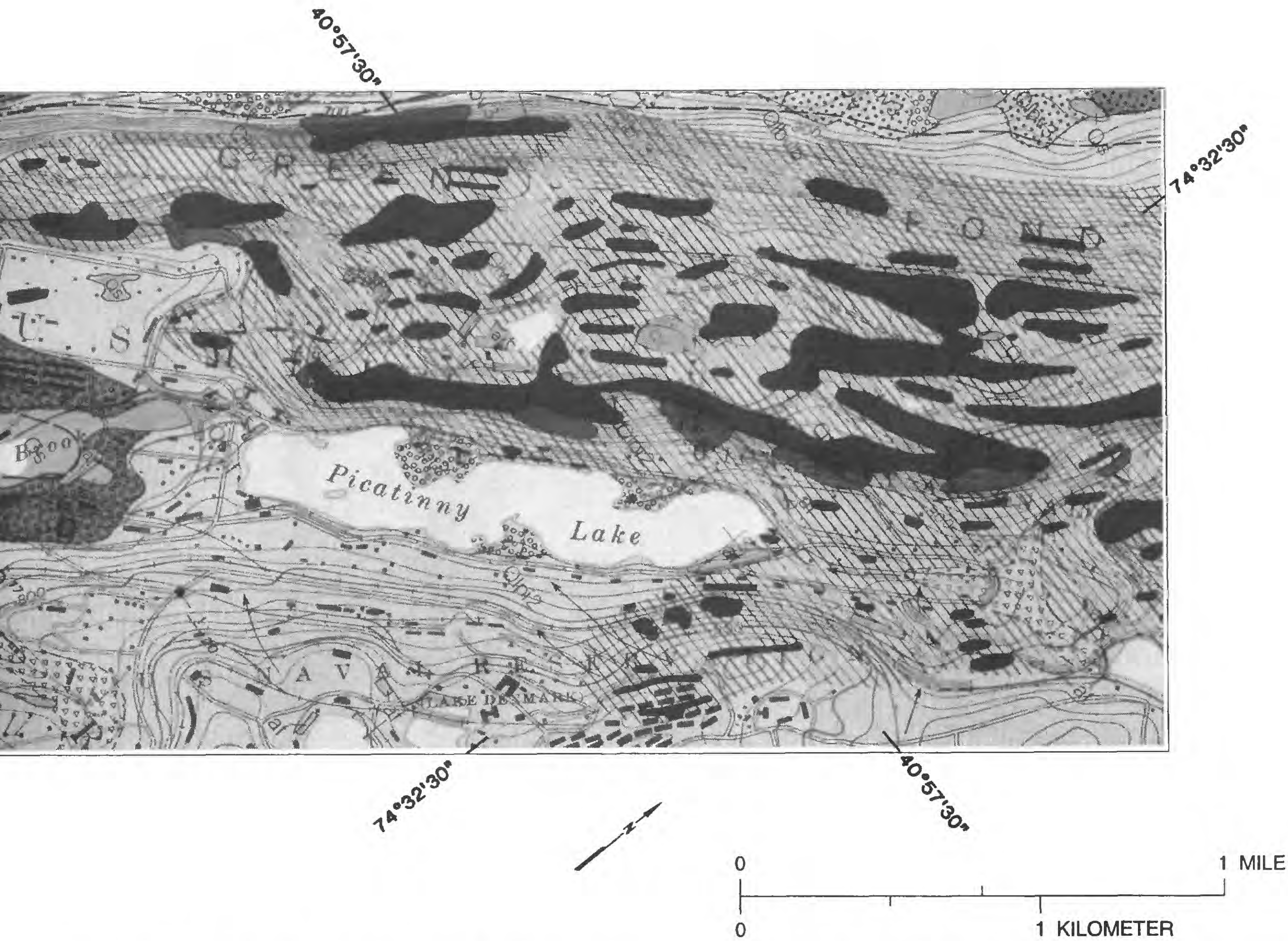


Figure 3. Surficial geology of Green Pond Valley, Picatinny Arsenal, New Jersey. (Modified from Stanford, 1989)



Qlwt

Till: Unstratified and unsorted boulders, cobbles, and pebbles in a yellowish-brown (10YR5/4-5/6) (oxidized), grayish-brown (10YR5/2) (unoxidized) silty fine sand to fine to medium sand matrix. The matrix is coarse sand at some locations and on the west slope of Green Pond Mountain near Longwood Lake consists of angular chips of red shale from the underlying High Falls Formation. Observed depths of oxidation range from about 5 to 20 feet. Outside the Terminal Moraine the till averages approximately 20 feet thick and can be as much as 50 feet thick in areas of continuous till. It is generally thicker and more continuous on the northwest-facing slopes of principal ridges and hills. In places the till is underlain by weathered bedrock.

The map unit includes colluvium (mixed till and, in places, angular pebbles, cobbles, and boulders of bedrock debris in a matrix of orange-brown to yellow-brown silty fine sand to coarse sand). Colluvium forms discontinuous aprons and fans along bases of steep slopes, especially in Berkshire Valley. It may be as much as 10 feet thick.

Qlwtm

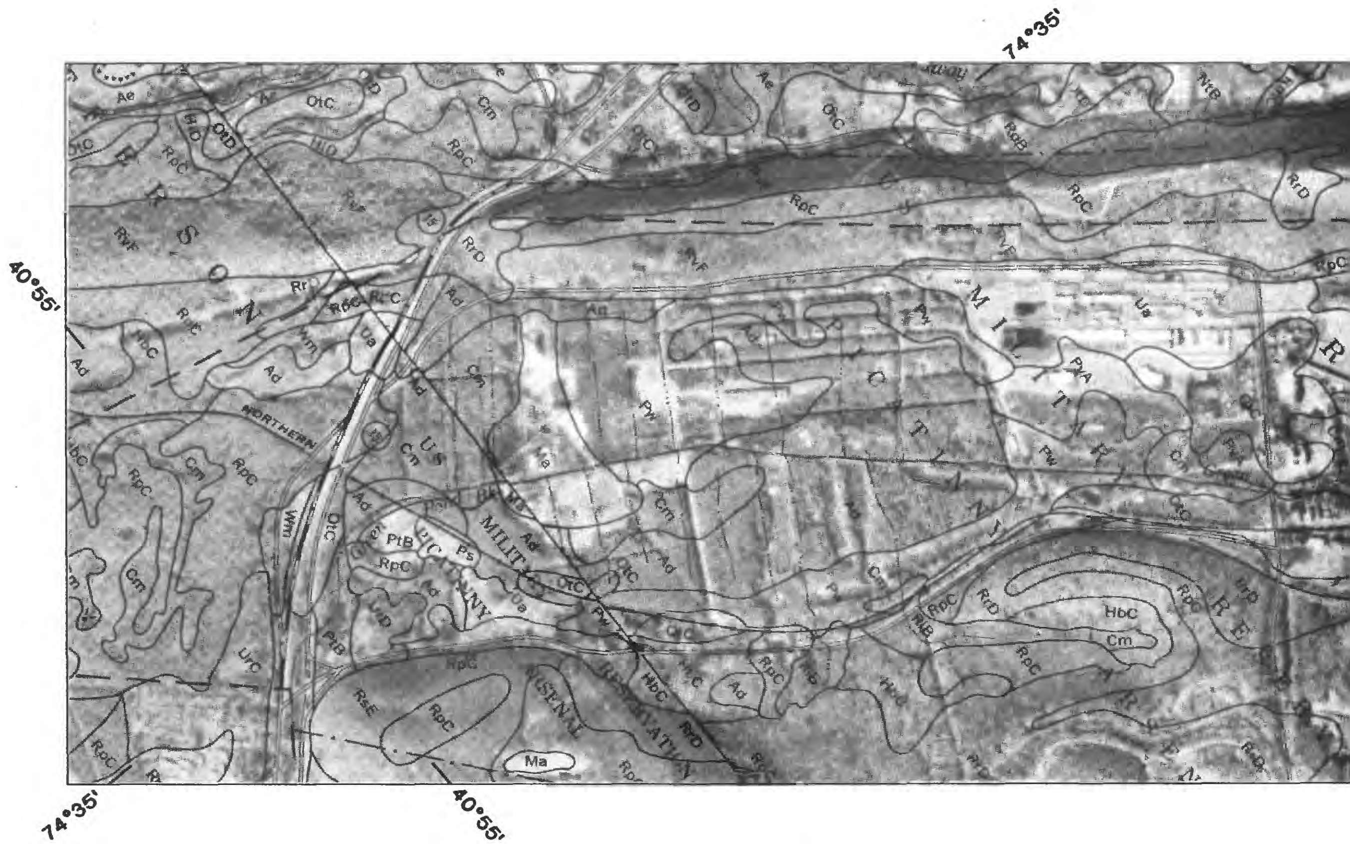
Till of the Terminal Moraine: Yellowish-brown to grayish-brown till as above forming ridge- and kettle topography of the Terminal Moraine. As much as 150 feet thick on uplands and 100 feet thick in filled valleys, where it generally overlies and is interbedded with stratified sediment deposited in glacial lakes Succasunna, Dover, and Denville.

Glacial Lake Picatinny Deposits: Vertical sequence of sublacustrine sand and gravel (Qlpi1), lake-bottom and deltaic fine sand and silt (Qlpilb), and overlying fluvial and deltaic sand and gravel (Qpo) deposited in a proglacial lake in the valley of Green Pond Brook in Picatinny Arsenal, and deltas (Qlpi2) deposited in a slightly higher proglacial lake to the north in the basin of present-day Picatinny Lake.

Qlpi2	Cobble gravel overlying probable sand and pebble gravel along both sides of Picatinny Lake. Maximum thickness 30 feet (estimated).
Qpo	Cobble gravel, fining south to pebbly sand. As much as 40 feet thick.
Qlpilb	Fine sand, silt and minor clay. As much as 150 feet thick. In subsurface only.
Qlpi1	Sand and gravel. Ranges in thickness from 0 to 60 feet. In subsurface only.
Qla	*Glacial Lake Ames Deposits:* Poorly sorted pebble to cobble gravel. Includes collapsed deltaic deposits and ice-contact diamict. As much as 20 feet thick.

A —— *A'* Line of section

Figure 3. Surficial geology of Green Pond Valley, Picatinny Arsenal, New Jersey--Continued. (Modified from Stanford, 1989)



EXPLANATION

Map symbol	Mapping unit	Map symbol	Mapping unit
Ad	Adrian muck	RlB	Ridgebury extremely stony loam
Cm	Carlisle muck	RmB	Riverhead gravelly sandy loam
Hbc	Hibernia stony loam	RoB	Rockaway gravelly sandy loam
Hld	Hibernia very stony loam	RpC	Rockaway very stony sandy loam
Ma	Made land, sanitary land fill	RrD	Rockaway extremely stony sandy loam
Ntb	Netcong gravelly sandy loam	RsD	Rockaway_Rock outcrop complex, 15 to 25 percent slopes
OtC	Otisville gravelly loamy sand, 3 to 15 percent slopes	RsE	Rockaway-Rock outcrop complex, 25 to 45 percent slopes
OtD	Otisville gravelly loamy sand, 15 to 25 percent slopes	Rt	Rock outcrop
Ps	Pits, sand and gravel	RvF	Rock outcrop-Rockaway complex
PtB	Pompton sandy loam	Ua	Urban land
PvA	Preakness sandy loam	Urd	Urban land-Rockaway complex
Pw	Preakness sandy loam, varient	Wm	Whitman very stony loam
RgA	Ridgebury very stony loam		

Figure 4. Soils in the study area, Picatinny Arsenal, New Jersey. (Modified from Eby, 1976, sheets 4, 5, 8, 9, 14)

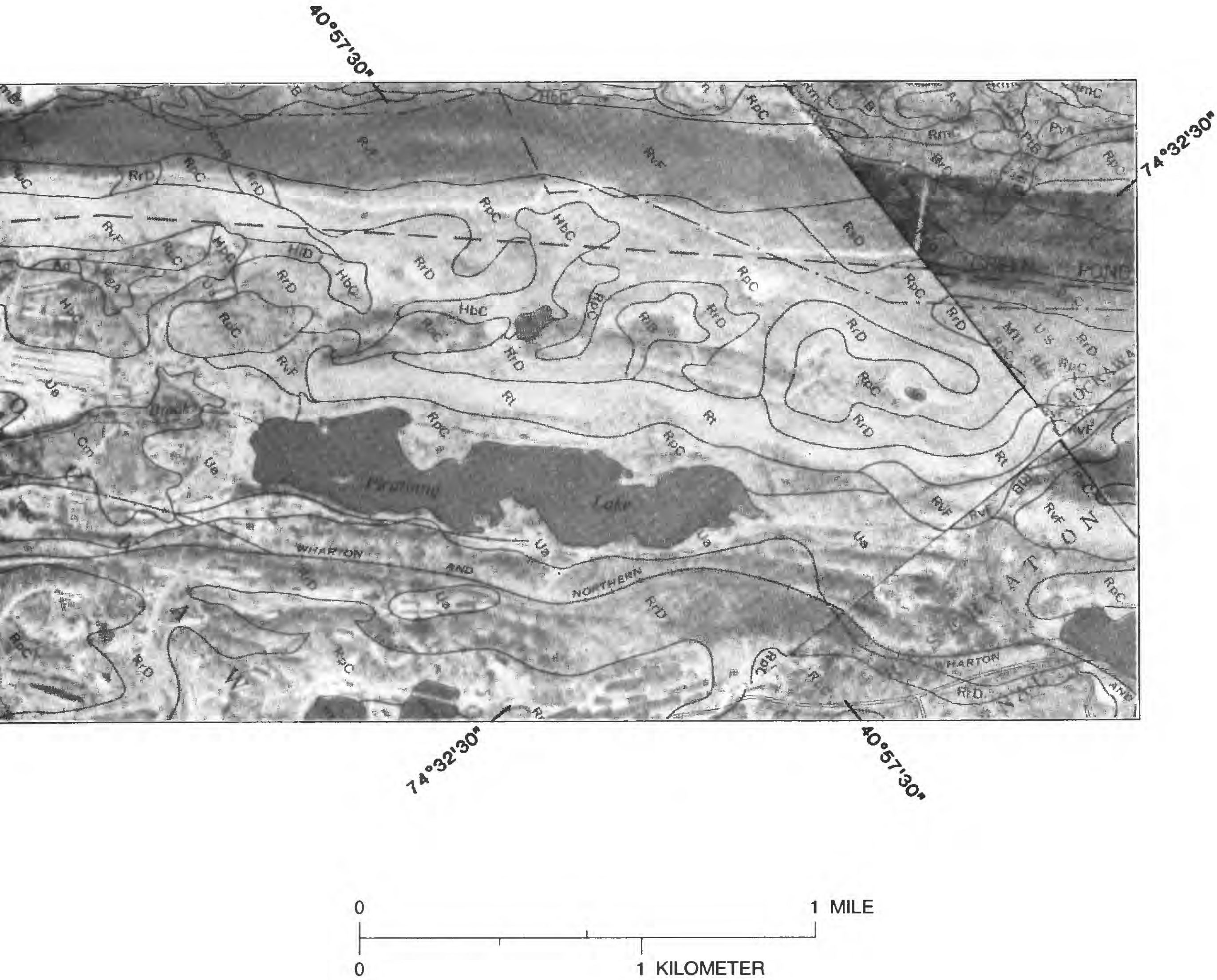


Figure 4. Soils in the study area, Picatinny Arsenal, New Jersey--Continued. (Modified from Eby, 1976, sheets 4, 5, 8, 9, 14)

During the warming that occurred near the end of the Wisconsinan glacial advance, the glacier began to ablate, depositing its load as a bottom moraine. This deposit is identical to the terminal moraine in composition, but typically is 20 to 50 ft thick. Glacial melting ceased for a short period, causing the formation of a recessional moraine that crops out between Picatinny Lake and Ninth Street (fig. 3; pl. 1). Deposits of the recessional moraine are identical to those of the terminal moraine and the bottom moraine, but are 100 to 150 ft thick.

At the time the recessional moraine was deposited, glacial Lake Picatinny was formed between the terminal moraine and the glacial front of the recessional moraine. Waterborne sediments carried from the glacial front were deposited in glacial Lake Picatinny. Initially, the sediments were predominantly gravel and coarse-grained sand that formed stratified deposits overlying the bottom moraine. Eventually, the sediments became finer grained as the glacial front ablated farther north. The fine-grained sand, silt, and clay that were deposited in glacial Lake Picatinny are as much as 150 ft thick and crop out along the banks of Green Pond Brook, south of the sewage-treatment plant (pl. 1). As glacial Lake Picatinny filled with sediments, it became swampy. The glacier to the north was still a significant source of water and, therefore, the streamflow of the ancestral Green Pond Brook was significantly larger than it is today. One oxbow or meander in ancestral Green Pond Brook is more than 150 ft wide and 15 ft deep. Today Green Pond Brook is 10 to 25 ft wide and 1 to 5 ft deep. The soil series found in the study area are shown in figure 4.

Acknowledgments

The authors thank Theodore Gabel of the Environmental Affairs Office of the U.S. Army Armament Research Development and Engineering Center for assistance in the planning and implementation of this investigation. Thanks also are extended to Ira May and Roxanne Moran of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) for assistance with this investigation.

DATA-COLLECTION AND ANALYTICAL METHODS

In August 1989, 25 samples of streambed material from Green Pond Brook and Bear Swamp Brook were collected and analyzed for trace elements, base/ neutral- and acid-extractable compounds, organochlorine and organophosphorus insecticides, and PCB's. Twenty additional streambed samples were collected in September 1990 to better define the presence and distribution of selected constituents and the extent of contamination at specific locations. A geophysical survey, including electromagnetic-conductivity and natural- gamma-ray techniques, was conducted during May 23-24 and June 6-7, 1990, to determine the characteristics of sediment present in the streambed and substreambed of Green Pond Brook.

Determination of Physical Characteristics of Streambed and Substreambed

A geologic and geophysical investigation was conducted to aid in the identification of the streambed- and substreambed-sediment types in Green Pond Brook. The geologic investigation enabled the mapping of material comprising the streambed and substreambed at points in and beneath the stream. The geophysical survey enabled the collection of a continuous set of electromagnetic-conductivity and natural-gamma-ray data in the center of the stream channel and the mapping of the sediments beneath the streambed. The map of the substreambed sediments facilitated estimation of the permeability of the sediments and their ability to sorb organic compounds. The streambed sediments were characterized by field mapping, whereas the substreambed sediments were characterized by analysis of the results of electromagnetic and gamma-ray surveys in conjunction with analysis of shallow auger samples from the streambed, data from logs of nearby boreholes, a map of the surficial geology (Stanford, 1989), and soil maps (Eby, 1976).

The surface-geophysical technique of measuring electromagnetic conductivity commonly is used to characterize subsurface-sediment types. The borehole-geophysical technique of natural-gamma-ray logging commonly is used to determine lithologies of sediments penetrated by a borehole or well. Because

Green Pond Brook is straight and shallow and its channel bottom is smooth, it was possible to conduct both a typical electromagnetic- conductivity survey in the channel with a surficial-type tool and an atypical gamma-ray survey in the channel with a borehole gamma-ray logging tool.

Electromagnetic-Conductivity Survey

Theory

The electromagnetic-conductivity technique can be used to measure the apparent conductivity of the sediments beneath a streambed. With the data resulting from the use of this method together with additional geohydrologic data from borehole logs and geologic maps, the major sediment types can be identified.

The technique involves the use of an electromagnetic transmitter and a receiver. The transmitter creates a primary electromagnetic field by passing alternating current through a loop of wire or coil. The electromagnetic field passes through the subsurface and induces a flow of electric current proportional to the conductivity of the ground water and earth materials. The current flow induces a secondary electromagnetic field with the same frequency as the primary field but with a different phase and direction. The primary and secondary electromagnetic fields are measured as a change in the potential induced in the receiver coil. The apparent conductivity of the subsurface is calculated in the receiver.

Changing the orientation of the coils alters the effective depth of measurement of apparent conductivity. Two coil orientations were used--the horizontal-dipole and vertical-dipole configurations. The horizontal- configuration method is used with the coils on edge and coplanar. This configuration is used to measure the electrical character of the shallow subsurface. The effective depth of measurement typically is 75 percent of the intercoil spacing. The vertical-configuration method is used with the coils flat on the ground and coplanar. This method is used to measure the deeper subsurface, about 1 to 1.5 times the intercoil spacing.

Values of apparent conductivity of the subsurface are used to differentiate among various types of sediment. For example, the apparent conductivity of sand is lower than that of clay. Although the absolute value of the apparent conductivity is not diagnostic of any particular sediment type, changes in apparent conductivity can be used to identify changes in grain size. Metallic objects such as service lines and bridges cause severe interference and prevent collection of meaningful data.

Field procedure

Electromagnetic conductivity was measured with a Geonics EM 31[1] transmitter and receiver system. The instrument's intercoil spacing is 12 ft and its transmission frequency is 9.8 Hertz. The instrument was strapped to a fiberglass canoe, and the canoe was paddled or towed down the channel. The channel was divided into 100-ft-long reaches, as shown on plate 1. The range of electromagnetic-conductivity values was recorded and an average was plotted for each 100-ft-long reach of the stream.

The lithology of streambed sediments; water depth; and the locations of overhead and underground service lines, service lines in the channel, and metallic debris in the channel were recorded. Two traverses of the stream were made. Data were collected in the vertical-dipole configuration on the first traverse and in the horizontal-dipole configuration on the second traverse. Apparent-conductivity values for each stream segment are shown on plate 1. The northern end of the study area is developed extensively and, therefore, many of the values recorded there represent interference rather than actual values.

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[1] The use of brand, firm, or trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Natural-Gamma-Ray Survey

Theory

The natural-gamma-ray survey can be used to measure the amount of natural-gamma radiation that is emitted from sediments. Gamma-ray data are used in conjunction with apparent-conductivity data and additional geohydrologic data from borehole logs and geologic maps to identify the major sediment types.

The gamma-emitting radioisotopes commonly found in sediments are potassium-40 and daughter products of the uranium- and thorium-decay series. In general, clay-bearing sediments contain higher concentrations of potassium-40 than do most other common sediments, although in granitic areas such as Picatinny Arsenal, potassium feldspar sand also contains high concentrations of potassium-40. The gamma rays are detected with a crystal of thallium-activated sodium iodide, which emits a flash of light when exposed to nuclear radiation such as a gamma ray. The crystal is coupled to a photomultiplier, where a pulse of electric current is produced. This pulse is displayed as a reading on a meter. The relative intensity of the gamma radiation corresponds to the intensity of the electric currents. The electric current is measured with an ammeter in inches of deflection, which describes the relative intensity of radiation. Streambed and substreambed sediments that contain clay or potassium feldspar grains produce a greater deflection than do sediments consisting of silt, sand, and gravel. The radius of investigation of a gamma-ray detector is roughly spherical; however, because the detector was dragged along the bottom of the channel, the source of variable gamma rays is hemispherical from below.

Field procedure

Natural-gamma-ray data were collected with a Mt. Sopris portable borehole logger system. The winch and recorder were placed in the bottom of a fiberglass canoe and the gamma-ray probe was dragged about 20 ft behind the canoe. The canoe was paddled or towed downstream about 25 ft per minute. The length of cable that was laid out was sufficient so that the tool was flat on the bottom of the brook. Gamma values were recorded every 15 ft (one boat length) and then averaged for each 100-ft reach of the brook. These average values are plotted on plate 1.

Collection of Streambed Samples and Analysis of Streambed and Surface-Water Samples

Streambed samples were collected from 45 locations in Green Pond Brook, Bear Swamp Brook, and their tributaries for analysis for trace elements and organic compounds. Samples were collected during two periods--August 22, 23, and 31, 1989; and September 4 and 5, 1990. The locations of these sites, along with the locations of sites at which samples were collected in December 1983 and June 1984, are shown on plate 2.

At most sites, samples were collected from the top 2 to 3 in. of undisturbed streambed with a BHM-52 piston sampler. In areas where the brook is wider than 5 ft, samples were collected from several points across the section. Composite samples were mixed in a polyurethane pan and placed into sample containers. Where the channel is narrow, as it is at most sites in Bear Swamp Brook and in other tributaries of Green Pond Brook, samples were collected and placed directly into the sample containers.

At two locations, samples were collected from several depths below the streambed surface. To collect the sample, a core barrel was driven to a depth about 2 ft below the streambed. Three subsamples from each core were taken from intervals of about 0 to 0.3 ft, 0.8 to 1.2 ft, and 1.7 to 2.0 ft below the streambed surface (sites 410A, 410B, and 410C, and sites 590A, 590B, and 590C; pl. 2). All streambed samples were collected and preserved in accordance with accepted USGS field techniques as described by Guy and Norman (1970), Brown and others (1970), and Wood (1976).

Following collection, the streambed samples were packed in ice and shipped to the USGS National Water Quality Laboratory in Denver, Colorado, for analysis for base/neutral- and acid-extractable organic compounds, organochlorine and organophosphorus insecticides, PCB's, polychlorinated naphthalenes, and trace elements.

Concentrations of inorganic constituents, including major ions and trace elements, in streambed and surface-water samples were determined with the methods of Fishman and Friedman (1989). Organic constituents, including base/neutral-, acid-extractable, and volatile organic compounds; organochlorine and organophosphorus insecticides; and PCB's were determined by using the methods described in Wershaw and others (1987). The methods used for analysis for organic compounds are equivalent to U.S. Environmental Protection Agency (USEPA) Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater 608, 624, and 625 (Longbottom and Lichtenberg, 1982). Quality-assurance checks were conducted according to the methods of Friedman and Erdmann (1982).

Analyses of water samples for 30 volatile organic compounds were performed at the USGS laboratory in Trenton, N.J. The method used was a modification of USEPA methods 601 and 602 (Longbottom and Lichtenberg, 1982). Modifications included the use of a wide-bore capillary chromatograph column; two selective detectors, a Hall electrolytic conductivity detector and a photoionization detector, connected in series; and subambient cooling.

DESCRIPTION OF THE SHALLOW FLOW SYSTEM

Water enters the study area as precipitation, flows overland or through various combinations of bedrock, till, and stratified drift, and then discharges into streams and ponds. Three aquifers have been defined in Green Pond Valley: an unconfined glacial (water-table) aquifer, a confined glacial aquifer, and a confined bedrock aquifer (Sargent and others, 1990). The unconfined glacial aquifer consists of deltaic sands and gravels and lake-bottom and deltaic fine sand and silt to a depth of about 50 to 70 ft below land surface within the study area.

The major stream in the study area is Green Pond Brook, a tributary to the Rockaway River. Green Pond Brook drains the long, narrow valley between Green Pond and Copperas Mountains to the west and north and the unnamed mountain to the east. Three large, artificial lakes are located in the Green Pond valley--Green Pond, 1.5 mi upstream from the arsenal, and Lake Denmark and Picatinny Lake, within the arsenal boundaries (fig. 1). Several other, smaller lakes and reservoirs drain into Burnt Meadow Brook and Green Pond Brook north and east of the arsenal. Burnt Meadow Brook drains Lake Denmark and discharges into Green Pond Brook approximately 0.5 mi upstream from Picatinny Lake. Bear Swamp Brook, which flows through an industrialized part of the arsenal, drains an area of 0.6 mi^2 and discharges into Green Pond Brook near First Street (pl. 1).

The streamflow and stage of Green Pond Brook can be regulated at several points within the arsenal, including a dam at the outflow of Picatinny Lake and a small flood-control dam about 800 ft downstream from the open burning area (pl. 1). Many small streams and intermittent streams discharge into Green Pond Brook throughout the arsenal. The southern part of the arsenal also is drained by a series of ditches cut perpendicular to Green Pond Brook. The reach of the stream channel that extends south of Farley Avenue (pl. 1) to the southern boundary of the arsenal has been straightened or relocated in many areas. The surface-water-drainage patterns are shown in figure 5.

The USGS maintains three streamflow-gaging stations on Green Pond Brook within the arsenal (fig. 5). Green Pond Brook at Picatinny Arsenal, site 180, is just upstream from Picatinny Lake. This station gages a drainage area of 7.65 mi^2 and has been active since October 1982. Green Pond Brook below Picatinny Lake at Picatinny Arsenal, site 310, is just downstream from the dam at Picatinny Lake. This station gages an area of 9.16 mi^2 and has been active since October 1984. Green Pond Brook at Wharton, site 920, is about 200 ft upstream from the point at which Green Pond Brook leaves the arsenal property. This station has a drainage area of 12.6 mi^2 and has been active since October 1982.

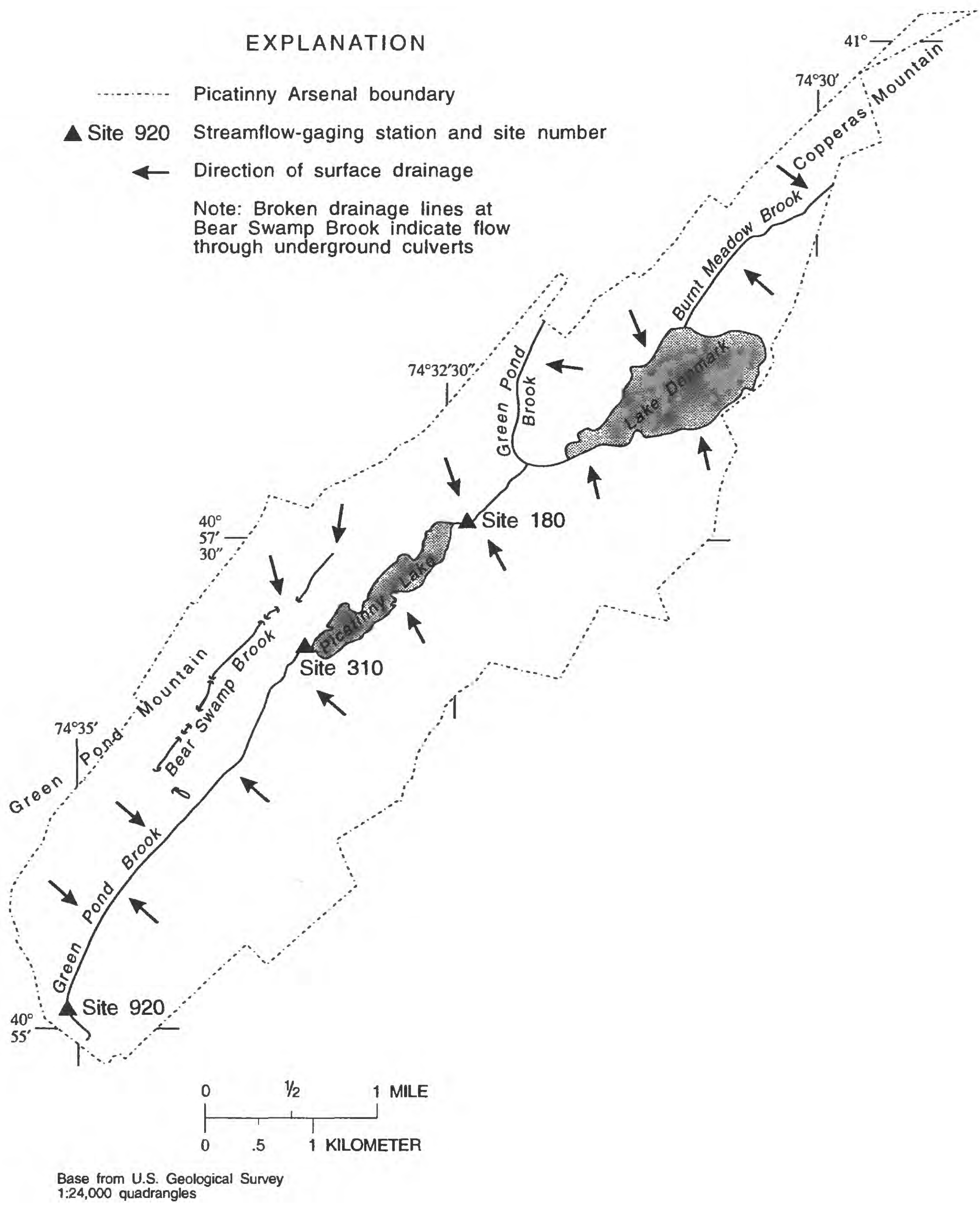

Figure 5. Surface-water drainage in the study area and locations of streamflow-gaging stations, Picatinny Arsenal, New Jersey. (Modified from Sargent and others, 1990, fig. 16.)

Hydrographs of streamflow at the three gaging stations for the period October 1, 1982, through September 30, 1990, are shown in figure 6. The hydrographs show that Green Pond Brook exhibits a large, sharp response to rainfall because of rapid runoff from the steep slopes of the valley walls. The recession segment of the streamflow hydrograph tends to be prolonged because of storage in the lakes and swamps in the basin, bank storage, and an increase in ground-water discharge. Daily mean discharges during the 1990 water year[2] were 17.8, 22.1, and 31.4 ft^3/s at sites 180, 310, and 920, respectively. Peak instantaneous discharges for 1990 of 200, 236, and 344 ft^3/s, respectively, were recorded at the three sites on May 17, 1990, and instantaneous low-flow discharges for 1990 were 3.6, 4.1, and 4.7 ft^3/s, respectively. Peak discharges for the period of record of 333 ft^3/s and 572 ft^3/s were recorded on April 5, 1984, at sites 180 and 920, respectively. Peak discharge of 243 ft^3/s at site 310 was recorded on September 13, 1987.

CHARACTERISTICS OF STREAMBED AND SUBSTREAMBED

The distribution of sediments in the streambed and substreambed of Green Pond Brook is shown on plate 1. Lithologic interpretations are based on a map of surficial geology (fig. 3), a soils map (fig. 4), results of field mapping of outcrops and streambed sediments, descriptions of samples of sediments from holes augered in the channel bottom, geologists' logs, drillers' logs, interpretations of borehole geophysical logs, interpretations of apparent-conductivity data, and natural-gamma-radiation measurements made along the stream channel.

Streambed samples were collected from 45 sites in Green Pond Brook, Bear Swamp Brook, and their tributaries (pl. 2). During August 22 - August 31, 1989, 25 samples were collected; during September 4 - 5, 1990, 20 additional samples were collected. Samples were analyzed for trace elements, base/neutral- and acid-extractable compounds, organochlorine and organophosphorus insecticides, and PCB's.

In addition, results of analyses of streambed samples collected from 15 sites on December 2, 1983, and June 5 to 6, 1984, are listed in appendix 1. Samples from most of these sites were analyzed for trace elements, extractable compounds, insecticides, and PCB's for both sampling periods.

Sediment Type and Particle Size

The streambed sediments form a veneer on the bottom of Green Pond Brook. The types of sediments found in the streambed are the result of a combination of streamflow velocity, underlying geology, and land use in the drainage basin. In areas where streamflow velocity is high and the underlying geology consists of terminal-moraine and recessional-moraine deposits, the streambed sediments consist of gravel- to boulder-size clasts. In areas where streamflow velocity is high and riprap was added to the streambanks to prevent bridge scour, the streambed consists of angular gravel deposits. In areas where the streamflow velocity is low and the underlying geology is predominantly sand and silt, the streambed sediments consist of coarse- to fine-grained sand and silt. In areas where streamflow velocity is low and the underlying geology is peat, the streambed consists almost exclusively of sticks, branches, and the coarse fraction of nearby organic muck deposits. In areas where streamflow velocity is low and the underlying geology is coarse- to fine-grained sand, silt, and clay, the streambed sediments consist of very fine-grained sand, silt, and clay.

The streambed of Green Pond Brook from station 0 to station 8 (pl. 1) is covered with boulders and gravel. Stanford (1989) mapped this area as till consisting of unstratified and unsorted boulders, cobbles, and pebbles in a silty, fine-grained sand to fine- to medium-grained sand matrix. The till of this recessional moraine is 12 ft below land surface at well 27-271 and 34 ft below land surface at well 27-278. Geophysical measurements were not made between stations 0 and 11 because the rapids were too severe to walk or canoe, and the pond upstream from the railroad bridge near building 329 was too deep to allow safe use of the gamma-ray tool.

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[2] 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.

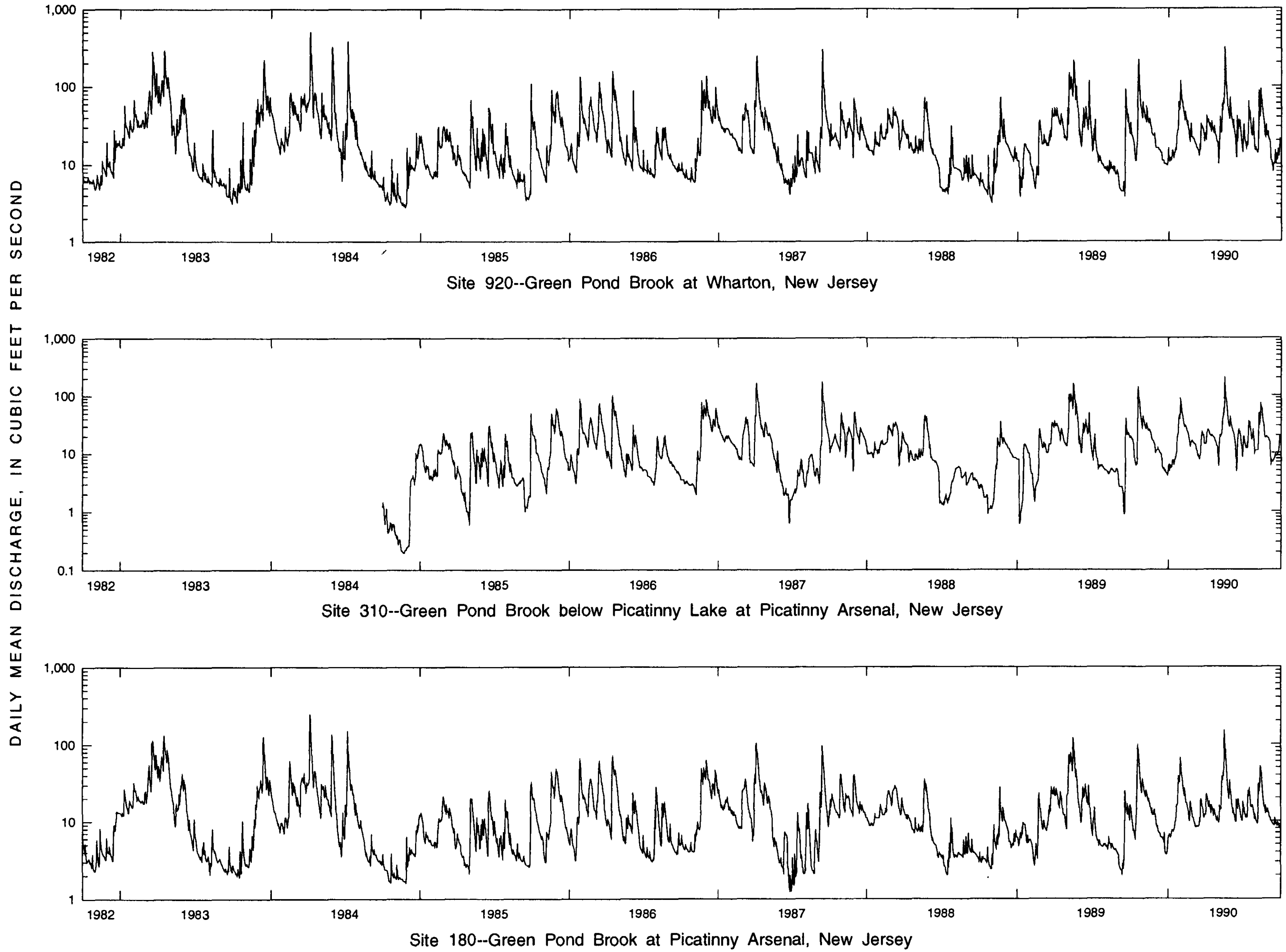

Figure 6. Hydrographs of streamflow at three gaging stations on Green Pond Brook at Picatinny Arsenal, New Jersey.

The stream from station 8 to station 18 (pl. 1) is flanked on both sides by undeveloped swampland. Stanford (1989) mapped the surficial geology as swamp and marsh deposits; Eby (1976) mapped the soil type as Carlisle muck. The decreasing gamma-ray values between stations 11 and 17 indicate that the shallow sediments contain some clay. The high gamma-ray counts at stations 17 and 18 resulted from the presence of granitic riprap added to the streambanks to protect the bridge from scour. The constant horizontal apparent-conductivity values in this area indicate the presence of homogenous shallow subsurface sediments. The variable vertical apparent- conductivity values between these two stations indicate that the matrix of the recessional moraine is highly variable. The substreambed sediments are interpreted to consist of a layer of organic muck 3 to 10 ft thick, which overlies a till deposit. Apparent-conductivity values at stations 18 and 19 show interference from the metal in the Ninth Street Bridge.

The stream from station 19 to station 42 is flanked on the east side by undeveloped swampland and forest, and on the west side by a developed industrial area. In most parts of this reach, the streambed is composed of silt, muck, and woody debris. From station 27 to 30, artificial fill has been deposited along the streambanks and in the stream as a result of the construction of buildings and parking lots. Stanford (1989) described the surficial geology as swamp and marsh deposits, and Eby (1976) mapped the soil type as Carlisle muck. Well 27-278 penetrates a 34-ft-thick layer of organic muck and peat (pl. 1). Samples of the streambanks collected at stations 28, 33, 35, and 40 indicate the presence of a layer of organic muck more than 7 ft thick. Gamma-ray values were low from station 20 to 27 and from station 33 to 39, indicating the presence of clay-poor muck in the streambed (pl. 1). The artificial fill from station 27 to 31 caused high gamma-ray values for the shallow system. An obstruction in the brook from station 31 to 33 prevented collection of meaningful data. Apparent- conductivity values measured from station 19 to station 42 in areas with no interference were subtly higher than values measured upstream and significantly higher than those measured downstream. The high values may indicate the presence of a clay-rich muck in the substreambed sediments. Rapids, the steel in the Farley Avenue Bridge, and the artificial fill of angular riprap from station 42 to 43 along Green Pond Brook precluded the collection of meaningful data.

The stream from station 43 to station 50 is flanked by a golf course. The streambed material generally is coarse sand. Stanford (1989) mapped this area as swampland muck deposits, and Eby (1976) mapped it as Carlisle muck. Gamma-ray values generally were low and apparent-conductivity values were relatively high, indicating the presence of an organic-muck substreambed deposit below the thin sand and gravel streambed sediments. Sargent and others (1990, fig. 8) show results of a ground-penetrating-radar traverse in this region that reveals the presence of a buried peat-filled ancestral stream channel that crosses under Green Pond Brook. Interpretation of the ground-penetrating-radar data indicates that peat, silt, and sand deposits about 17 ft thick fill the channel, and the lithologic log from well 27-1207 shows organic muck 25 ft thick overlying sand and silt deposits.

The stream from station 50 to station 63 is flanked by a golf course. The streambed is covered with a layer of coarse-grained sand. Stanford (1989) shows the surface geology of this area as artificial fill, and Eby (1976) shows the soil type of the area as Preakness sandy loam. Ground- penetrating-radar measurements made in 1986 show the presence of a buried stream channel on the western bank, but not on the eastern bank, of the stream. Lithologic data from wells 27-1204, 27-942, 27-1199, and 27-940 indicate the presence of gravel and sand deposits overlying muck and fine- to coarse-grained sand. All electromagnetic-conductivity values measured between stations 50 and 60 probably are affected by interference from the metal service line that runs along the length of the brook. Apparent- conductivity values were about 10 mS/m lower than those measured upstream from this reach. Gamma-ray values were about 5 units higher than those measured in the upstream areas, where streambed materials are organic-rich and are not influenced by the presence of fill deposits. The substreambed sediments are interpreted to be silt and fine-grained sand with minor lenses of organic muck or peat.

The stream from station 63 to station 66 is flanked by a golf course, and the streambed consists of coarse sand and gravel. Stanford (1989) shows that the surficial sediments are artificial fill, and Eby (1976) shows the soil type as Preakness sandy loam. From field observation, the artificial fill on both sides of the stream appears to be less than 2 ft thick. The substreambed sediments are interpreted to be a lens of muck and organic debris. Geophysical measurements made in the stream under the First Street Bridge and railroad trestle (station 66 to 68) are not reported because of interference from construction fill and the metal in the bridges.

Streamflow velocity is low from station 68 to station 120. The land on both sides of the brook from station 68 to station 115 is a golf course or undeveloped land. From station 115 to station 120, the land is used for munition burning or detonation. Stanford (1989) shows the surficial sediments as swamp and marsh deposits; Eby (1976) shows the soil as Adrian muck or Preakness sandy loam. Geologic data from boreholes near Green Pond Brook show that the muck deposits typically are less than 12 in. thick and are underlain by silt and sand. Stanford (1989) describes sediments below the surface as coarse- to fine-grained sand, silt, and minor clay. Subsurface sediments in former glacial Lake Picatinny are described in logs of wells 27-970 and 27-234 as fine-grained sand and silt. Laminated fine- grained sand and silt with minor clay crops out along the banks of Green Pond Brook in this reach of the brook. Results of a ground-penetrating-radar investigation conducted 200 ft west of the sewage-treatment plant show subsurface bedding planes that have an apparent dip of 5 degrees southwest. Gamma-ray and apparent-conductivity values were constant (except in the vicinity of fill deposits and service lines), which indicates the presence of homogenous subsurface sediments interpreted to be a laminated fine- grained sand, silt, and clay. The high horizontal apparent-conductivity anomaly from station 99 to station 105 reflects the presence of service lines and the metal in the bridge over the brook.

From station 120 to station 135, the land on both sides of the brook is undeveloped. Stanford (1989) described the area between stations 120 and 135 as covered with swampland marsh deposits, and Eby (1976) described the soil as Adrian muck and Carlisle muck. Samples from auger holes along the western bank of the stream show that the muck is less than 24 in. thick in most places. The stream has incised the muck completely. The outcrop on the streambanks and grab samples from the streambed and substreambed consist of fine-grained sand, silt, and minor clay, as described by Stanford (1989). Geologic data from well 27-250 show that sediments consist of fine- to coarse-grained sand 0 to 5 ft below land surface, and sand, gravel, and boulders 5 to 25 ft below land surface. Gamma-ray values were slightly lower and apparent-conductivity values were slightly higher between stations 120 and 135 than between stations 63 and 120. These data indicate that this area is underlain by a sequence of laminated fine-grained sand and silt about 5 to 10 ft thick that overlies bottom moraine.

Along Green Pond Brook from station 135 to station 146, the streambed, streambanks, and forest floor contain outcrops of boulders and cobbles of the terminal moraine. Stanford (1989) describes the surficial and subsurface deposits as cobbles, gravel, and till of the terminal moraine. Eby (1976) describes the soil as a Pompton sandy loam. Gamma-ray values measured in each of the 100-ft reaches of the stream fluctuated from 5 to 25 units; this is a much wider range than that measured in any of the reaches farther upstream. The wide range probably was caused by the wide range of grain sizes and types of clasts. Some boulders are potassium-feldspar granites and others are quartz conglomerates. Lithologic differences would cause gamma-ray values to vary widely within a short distance. The streambed consists of boulders, cobbles, and gravel; the subsurface consists of the same large clasts with sand, silt, and clay. The apparent-conductivity values for the reach show the presence of an anomaly between stations 137 and 138 that most likely is caused by the metal casing of well 27-1133. The above data indicate that this area is underlain by boulders and cobbles in a matrix of sand, silt, and clay of the terminal moraine.

Chemical Quality

Chemicals resulting from human activities can enter the surface-water system through various pathways. Contaminants can enter the stream as dissolved constituents in ground-water and surface-water inflow or overland flow. Contaminants also can enter the stream sorbed to natural particles carried by water, wind, or other means. Once they enter the stream, contaminants interact with natural particles in the water and in the surficial sediments. These sediments can act as a reservoir for contaminants and have the ability to take up and release contaminants in response to variations in the overlying water column. Also, naturally occurring inorganic constituents found in the sediments can be dissolved as water moves through the material. The behavior of organic compounds is determined by their physical and chemical properties under a given set of environmental conditions (Witkowski and others, 1987). The lithology of streambed material strongly affects the distribution of contaminants. Fine- grained sediments that contain a large concentration of naturally occurring organic material and are found in reaches of the channel where streamflow velocities are low have a greater capacity to store contaminants than do coarse-grained sediments that contain little organic matter and are found in reaches where streamflow velocities are high.

The solubility of a compound in water arguably is the most important property affecting the movement of compounds between the water and sediment phases (Oschwald, 1972; Pionke and Chesters, 1973). In general, organic compounds with low solubility in water tend to accumulate in the organic material found in stream sediments. Concentrations of contaminants, such as PCB's, PAH's, and phthalate esters, can be many times greater in the sediment than in water because of this affinity of the compound for the sediment. Other properties that affect the distribution of organic compounds include the degree of halogen substitution, the number of aromatic and cyclic ring substitutions, vapor pressure, polarity, ionization constant, molecular charge, molecular size, and molecular configuration (Verschueren, 1983). In general, organic compounds with low solubilities in water and high octanol-water partition coefficients are most persistent in the environment. Selected physical and chemical properties and the environmental significance of constituents detected in streambed samples from Green Pond Brook, Bear Swamp Brook, and their tributaries at Picatinny Arsenal are presented in table 1.

Trace Elements

Streambed samples from 45 locations at Picatinny Arsenal (pl. 2) were analyzed for trace elements at the USGS National Water Quality Laboratory. The results of these analyses, listed in downstream order of sampling site, are presented in table 2. No quality-assurance/quality-control samples were analyzed; however, results of analyses of samples collected at different times from the same or a nearby site were similar.

Streambed samples from three areas contained significant concentrations of trace elements resulting from human activities. Streambed material from stream reaches within these areas contained elevated concentrations of three or more constituents at three or more consecutive site locations. The areas are (1) Green Pond Brook from Ninth Street downstream to Farley Avenue (sites 330 to 420), (2) Bear Swamp Brook from the building 24 area downstream to the confluence with Green Pond Brook (sites 560-595), and (3) Green Pond Brook from the open burning area downstream to the dam near building 1178 (sites 800 to 890) (pl. 2). Although constituents derived from human activities were found at other locations as well, these locations are much less extensive in area or contained streambed material in which fewer compounds were detected than the three areas described above.

The first area, Green Pond Brook from Ninth Street downstream to Farley Avenue, covers stations 19 through 41 (pl. 1) and sampling sites 330 through 420 (pl. 2). The streambed material in the reach of the channel immediately upstream from Ninth Street, which includes site 320, consists of gravel, boulders, and coarse sand. The concentrations of most trace elements determined at site 320 were relatively low because the streambed material is coarse, although arsenic was detected at a concentration of 40 μg/kg.

At site 330, the streambed material is much finer and includes deposits of organic muck; therefore, trace elements that enter the stream tend to accumulate in this area. At sites 340 and 400, the streambed material also consists of organic muck. Concentrations of most constituents determined at these sites were higher than those found at site 330. High concentrations of arsenic, copper, zinc, and mercury were found at sites 340 and 400. Site 410A is characterized by a thin layer of coarse sand and gravel overlying deposits of organic muck. Again, because the streambed material is coarse, concentrations of trace elements would be expected to be low, although copper and lead were present in high concentrations.

Table 1. Physical and chemical properties and environmental significance of selected trace elements and organic compounds detected in streambed samples from Green Pond Brook, Picatinny Arsenal

[mg/L, milligrams per liter; µg/L, micrograms per liter; °C, degrees Celsius]

Compound or element	Physical and chemical properties, and common uses of compound
	TRACE ELEMENTS
Arsenic	Used in the manufacture of pharmaceuticals, paints, and metal finishes, in pesticides, and as an oil additive (Sittig, 1985).
Cadmium	Insoluble in water, used in metal plating and alloys, and found in some pesticides, paints, and batteries (Sittig, 1985).
Chromium	Found in valences of +3 and +6; the hexavalent form is more toxic than the trivalent form. Used in metal plating and in the production of chromium chemicals. Chromium compounds are used as pigments, as chemical oxidants, and in electroplating (Moore and Ramamoorthy, 1984).
Lead	Soft metal, low solubility in water. Lead has a wide variety of industrial uses, including as solder in plumbing, and as an additive in paints, batteries, petroleum products, and other metals (Sittig, 1985; Moore and Ramamoorthy, 1984).
	BASE/NEUTRAL AND ACID-EXTRACTABLE COMPOUNDS
Bis (2 ethylhexyl) phthalate	Liquid, used as a plasticizer and in vacuum pumps (Sittig, 1985; Hawley, 1981).
Diethyl phthalate	White, odorless liquid. Used as a solvent for cellulose esters, as a vehicle in pesticide sprays, and as a plasticizer in solid rocket propellants (Sittig, 1985).
Di-n-butyl phthalate	Colorless liquid, soluble in water (Windholz and others, 1976). Used in plasticizing vinyl acetate emulsion systems, in plasticizing cellulose esters, and as an insect repellant (Sittig, 1985; Verschueren, 1983).
2,4-Dinitrotoluene	Soluble in water (270 mg/L at 22 °C). Used in the manufacture of explosives and dyes (Sittig, 1985; Verschueren, 1983).
2,6-Dinitrotoluene	Soluble in water (270 mg/L at 22 °C). Used in the manufacture of explosives, dyes, and urethane polymers (Sittig, 1985; Verschueren, 1983).
N-Butylbenzyl phthalate	Clear liquid, slightly soluble in water. Used as a plasticizer for synthetic resins, chiefly polyvinyl chloride (Verschueren, 1983).
N-Nitrosodiphenylamine	Solid, crystals, slightly soluble in water. Used as an accelerator in vulcanizing rubber (Windholz and others, 1976).
PCN's (Polychlorinated naphthalenes)	Waxlike substances containing one to eight chlorine atoms. Wide industrial application, including electrical cable and wire insulation, and production of electrical condensers (Sittig, 1985).
	Polynuclear Aromatic Hydrocarbons
Acenaphthene	White, crystalline solid, insoluble in water; found in coal tar, asphalt, and petroleum refining, and detected in gasoline exhaust (Sittig, 1985; Verschueren, 1983). Used as dye intermediates, in manufacture of plastics, and as an insecticide and fungicide (Windholz and others, 1976).
Anthracene	Solid, insoluble in water, isomeric with phenanthrene; obtained from coal tar, forms molecular complexes with nitro compounds. Used in the manufacture of dyes (Windholz and others, 1976).
Benzo (a) anthracene	Solid, crystals, condensed ring aromatic; present in coal tar, asphalt, gasoline exhaust, and emissions from gas and electric plants. No reported commercial use (Sittig, 1985).

Table 1. Physical and chemical properties and environmental significance of selected trace elements and organic compounds detected in streambed samples from Green Pond Brook, Picatinny Arsenal--Continued

Compound or element	Physical and chemical properties, and common uses of compound
	BASE/NEUTRAL AND ACID-EXTRACTABLE COMPOUNDS--Continued
	Polynuclear Aromatic Hydrocarbons--Continued
Benzo (b) fluoranthene	From the combustion of gasoline, commonly detected in sewage sludge (Verschueren, 1983).
Benzo (k) fluoranthene	Found in oil, commonly detected in sewage sludge (Verschueren, 1983).
Benzo (a) pyrene	Solid, practically insoluble in water; found in coal tar, asphalt, and petroleum refining, and is a by-product of combustion (Windholz and others, 1976; Verschueren, 1983). Not produced commercially (Sittig, 1985).
Benzo (g,h,i) perylene	From combustion of petroleum, detected in exhaust (Verschueren, 1983).
Chrysene	Solid, insoluble in water; found in coal tar and gasoline (Verschueren, 1983; Windholz and others, 1976).
1,2,5,6-Dibenzanthracene	Solid, crystals, insoluble in water; found in coal tar and gasoline (Windholz and others, 1976; Verschueren, 1983).
Fluoranthene	Solid, slightly soluble in water (Verschueren, 1983). Produced from pyrolytic processing of coal and petroleum (Sittig, 1985).
Fluorene	Solid, found in coal tar. Forms molecular complexes with 1,3,5- trinitrobenzene, picric acid, and picryl chloride (Windholz and others, 1976).
Indeno (1,2,3-c,d) pyrene	Found in gasoline and oil (Verschueren, 1983).
Naphthalene	Solid, white crystals, insoluble in water, volatile at room temperature; the most abundant constituent of coal tar (Windholz and others, 1976). Used in the manufacture of dyes, synthetic resins, and smokeless powder. Also used as moth repellant and insecticide (Sittig, 1985).
Phenanthrene	Solid, crystal, practically insoluble in water, isomeric with anthracene (Windholz and others, 1976). Used in the manufacture of dyes and explosives (Verschueren, 1983).
Pyrene	Clear solid, insoluble in water; found in coal tar and oil. Forms molecular complexes with 1,3,5-trinitrobenzene, and other nitro compounds (Windholz and others, 1976).
	INSECTICIDES
	Organochlorine Insecticides
Chlordane	Broad-spectrum polycyclic chlorinated hydrocarbon insecticide, low solubility in water. Used for more than 30 years in termite control (National Research Council, 1977).
DDT (Dichlorodiphenyl trichloroethane)	DDT and its metabolites DDD and DDE are low-cost, broad-spectrum chlorinated hydrocarbon insecticides. DDD (also known as TDE) is also independently formulated as an insecticide. DDT and DDE have low solubility in water and high lipophilicity and tend to accumulate in body fat. DDD, DDE, and DDT exhibit long-term persistence in soil and water (Sittig, 1985; Windholz and others, 1976; Verschueren, 1983).
Dieldrin	Cyclodiene chlorinated hydrocarbon insecticide, slightly soluble in water, extremely low vapor pressure, high lipophilicity, and tends to accumulate in body fat. Manufacture of dieldrin in the United States was suspended in 1974 (Sittig, 1985; National Research Council, 1977).

Table 1. Physical and chemical properties and environmental significance of selected trace elements and organic compounds detected in streambed samples from Green Pond Brook, Picatinny Arsenal--Continued

Compound or element	Physical and chemical properties, and common uses of compound
	INSECTICIDES--Continued
	Organochlorine Insecticides--Continued
Heptachlor	Waxy solid, used as an insecticide for termite and cotton boll weevil control (Sittig, 1985; Windholz and others, 1976).
Heptachlor epoxide	Degradation product of heptachlor, and more acutely toxic than heptachlor (Sittig, 1985; Verschueren, 1983).
PCB's (Polychlorinated biphenyls)	PCB's (aroclors) are light, straw-colored liquids, formed by the chlorination of diphenyl rings. Although 209 substitutions of chlorine for hydrogen are possible, including all isomers, the industrially significant products are those containing 21, 42, 48, 54, 60 percent chlorine by weight (Sax, 1974). PCB's are nearly inert chemically (Sittig, 1985). Used as insulation for electric cable, wire, and condensers, and as a heat-transfer fluid. They are stable, nonflammable thermoplastics (Sittig, 1985). Technical PCB can contain contaminants including polychlorinated naphthalenes and dibenzofurans. The solubilities in water range from 2 to 250 mg/L, depending on the specific aroclor (Windholz and others, 1976).
	Organophosphorus Insecticides
Diazinon	Colorless liquid, solubility of 40 mg/L in water (Verschueren, 1983). Used as a pesticide for crops, domestic animals, lawns and gardens (Sittig, 1985).
Malathion	Brown to yellow liquid, slightly soluble in water. Used as an insecticide for flies, mosquitoes, lice, aphids, mites, and spiders (Sittig, 1985; Windholz and others, 1976).
Mirex	White crystal, practically insoluble in water; degrades to kepone in soil. Used as an insecticide for control of fire ants, and as a fire retardant for plastics, clothing, rubber, paint, and electrical goods (Sittig, 1985; Verschueren, 1983; Windholz and others, 1976).

Table 2. Results of analyses of streambed samples from Picatinny Arsenal for selected trace elements, 1989-90

[All constituents are recoverable from bottom material, except arsenic and selenium, which are total in bottom material; concentrations in micrograms per gram; <, less than]

Site	Date	Arsenic [1](01003)	Cadmium (01028)	Chromium (01029)	Cobalt (01038)	Copper (01043)	Lead (01052)	Manganese (01053)	Zinc (01093)	Selenium (01148)	Iron (01170)	Mercury (71921)
170	09-04-90	11	1	<10	<10	30	20	700	90	<1	4,500	0.02
310	09-04-90	6	<1	10	<10	30	110	1,100	150	<1	12,000	.81
320	09-04-90	40	<1	<10	<10	40	20	520	10	<1	19,000	.08
330	08-22-89	5	2	7	10	20	40	400	70	<1	8,100	.16
340	09-04-90	30	5	30	50	1,100	90	430	1,400	<1	25,000	9.90
360	08-31-89	9	2	60	30	70	140	170	150	<1	12,000	.32
380	08-23-89	4	1	10	<5	4	50	1,200	70	<1	9,000	.14
390	09-05-90	1	<1	<10	<10	60	50	120	50	<1	4,700	.22
400	08-31-89	13	7	20	<5	130	210	470	340	<1	27,000	.28
410A	09-05-90	3	3	<10	<10	9,400	330	290	720	<1	7,600	.11
410B	09-05-90	7	<1	10	<10	3,400	320	220	480	<1	6,900	.20
410C	09-05-90	2	<1	<10	<10	30	<10	370	20	<1	3,800	.02
420	08-22-89	7	6	90	20	270	180	740	240	<1	21,000	5.80
430	08-22-89	4	1	6	<5	30	20	920	70	<1	6,600	.33
450	08-22-89	3	1	4	<5	20	10	190	60	<1	5,000	.14
470	08-22-89	3	1	5	<5	20	20	230	60	<1	7,200	.15
490	08-22-89	2	2	7	<5	40	10	100	80	<1	6,300	.27
505	09-04-90	6	<1	<10	<10	10	30	270	70	<1	4,900	.07
520	09-04-90	5	<1	<10	10	10	10	220	80	<1	3,700	1.00
530	09-05-90	3	<1	<10	<10	520	30	230	90	<1	5,300	.12
540	08-31-89	4	<1	5	<5	10	30	310	90	<1	3,600	.08
560	09-04-90	5	18	50	10	180	120	510	240	<1	4,200	.23
580	08-23-89	7	6	50	<5	50	120	230	200	<1	8,700	.20
590A	09-04-90	3	8	210	<10	80	70	190	230	<1	6,900	.09
590B	09-04-90	2	8	240	<10	120	20	71	290	<1	5,300	.07
590C	09-04-90	2	5	170	<10	70	20	35	170	<1	3,800	.02
595	08-31-89	12	450	2,400	10	1,600	400	3,500	1,700	<1	17,000	32
600	08-22-89	3	5	80	<5	30	<10	140	60	<1	6,000	.23
610	08-22-89	3	1	8	<5	10	<10	150	40	<1	7,400	.07
620	08-22-89	5	2	10	10	30	110	540	330	<1	7,700	.04
630	08-22-89	4	<1	4	<5	1	10	40	<10	<1	<10	.06
640	09-05-90	120	7	370	40	270	240	2,100	480	<1	170,000	1.00
650	08-22-90	5	2	10	<5	20	<10	120	60	<1	5,400	.17
690	09-04-90	2	<1	<10	<10	5	<10	60	30	<1	1,300	.05
710	08-23-89	1	1	5	<5	8	<10	70	30	<1	5,100	.04
730	08-23-89	3	4	20	<5	20	<10	190	70	<1	6,600	.14
760	08-23-89	1	1	10	<5	20	10	240	40	<1	7,500	.06
800	08-23-89	6	6	30	<5	40	20	1,500	80	<1	6,200	.37
820	08-31-89	6	4	40	<5	770	50	110	3,100	<1	9,400	3.1
840	08-23-89	2	12	50	10	200	70	240	240	<1	1,200	.40
850	09-05-90	7	3	30	<10	580	50	190	180	<1	10,000	.27
890	08-23-89	4	3	20	<5	150	30	50	70	<1	6,000	.14
920	08-31-89	3	1	6	<5	40	<10	90	<10	<1	3,700	.03
930	09-05-90	2	1	10	<10	20	20	320	70	<1	43,000	.03
960	09-05-90	2	<1	<10	<10	180	170	190	50	<1	4,100	.02

[1] Constituent-analysis code used by U.S. Geological Survey National Water Quality Laboratory

Downstream from this site, the deposit of sand and gravel is absent and, at site 420, the streambed material consists only of organic muck. Elevated concentrations of chromium, copper, lead, and mercury were detected at this site. At site 430, located near Farley Avenue, the streambed material consists of gravel and cobbles, and streamflow velocity is high; consequently, trace elements would not be expected to accumulate here. At this site, concentrations of most constituents determined were similar to those found in uncontaminated reaches of the stream.

The concentrations of most constituents present in samples collected from Ninth Street to Farley Avenue were higher than those typically found in sediments in Green Pond Brook. The contaminants found in streambed samples from this area could be derived from any of a number of possible sources. Many buildings that contain laboratory and research facilities and storage areas are found in this part of the arsenal. Maximum concentrations were as follows: arsenic, 30 μg/g (site 340); chromium, 60 μg/g (site 360); cobalt, 50 μg/g (site 340); copper, 9,400 μg/g (site 410A); lead, 330 μg/g (site 410A); zinc, 1,400 μg/g (site 340); and mercury, 9.90 μg/g (site 340).

Streambed material in the second area, Bear Swamp Brook from the building 24 area downstream to Green Pond Brook, consists of gravel, sand, and silt. The surrounding area is classified as urban land and artificial fill (Eby, 1976; Stanford, 1989). This area includes sample sites 560 through 595. The channel downstream from Farley Avenue has been straightened and relocated. Concentrations of most trace elements determined in streambed samples from site 540, about 800 ft upstream from Farley Avenue, were near or less than the reporting limit for the chemical- analysis method used. Concentrations of 10 of the 11 constituents determined in samples from site 560, 100 ft downstream from building 24, were greater than those in samples from site 540 (table 2). Concentrations of many of the trace elements in samples from sites 580 and 590A were lower than concentrations at site 560 but, nevertheless, were greater than those detected in samples collected from the streambed in uncontaminated reaches.

At the site farthest downstream on Bear Swamp Brook (site 595), a streambed sample was collected from a small pool near building 41. This pool and a catch basin immediately downstream from it were constructed to reduce the velocity of the brook and allow sediments to settle out of the water column. Therefore, accumulation of contaminants sorbed to the sediment particles would be expected at this site. Concentrations of many of the trace elements found at the arsenal, including cadmium, chromium, lead, and mercury, were highest at site 595.

Concentrations of many constituents determined in samples from the building 24 area downstream to Green Pond Brook were higher than in samples collected from the uppermost reach of Bear Swamp Brook. This section of the arsenal is developed extensively and includes many industrial facilities, such as machine shops, metal-etching and plating facilities, and research laboratories. Maximum concentrations in this area were as follows: cadmium, 450 μg/g; chromium, 2,400 μg/g; copper, 1,600 μg/g; lead, 400 μg/g; zinc, 1,700 μg/g; and mercury, 32 μg/g; all at site 595.

The third area, Green Pond Brook from the open burning area downstream to the dam near building 1178, covers stations 114 through 133 (pl. 1) and sampling sites 800 through 890 (pl. 2). The streambed in much of this reach consists of laminated very fine-grained sand, silt, and clay. Streambed material in the reach extending from station 130 through station 133, which includes site 890, consists of coarse sand and gravel. The channel has been straightened throughout this reach. Concentrations of several constituents appeared to be higher than those typically found in Green Pond Brook. At site 800, adjacent to the northwestern corner of the open burning area, concentrations of most trace elements determined, although relatively low, were greater than those at site 760 (table 2). At site 820, concentrations of most trace elements determined were greater than those measured in samples from site 800; concentrations of copper, zinc, lead, and mercury were high. At sites 840 and 850, concentrations of most trace elements determined were lower than those detected at sites 800 and 820 at the open burning area. The farthest downstream sampling site in this area (site 890) is just downstream from a small dam near building 1178. Concentrations of trace elements at this site were lower than those at the adjacent upstream site, as expected, because of the presence of coarse streambed material and the increase in streamflow velocity downstream from the dam.

Concentrations of many constituents present in samples from the open burning area downstream to the dam near building 1178 were higher than those typically found in sediments in Green Pond Brook. This part of the arsenal contains several inactive landfills; the open burning area, where soils are known to be contaminated with heavy metals (Benioff and others, 1991; Frew and others, 1989); and a pyrotechnic test area west of Green Pond Brook. Maximum concentrations in samples from the area described above were as follows: chromium, 50 μg/g and lead, 70 μg/g (site 840); and copper, 770 μg/g, mercury, 3.1 μg/g, and zinc, 3,100 μg/g (site 820).

In order to determine the vertical extent of contamination, two locations were selected at which samples were collected from different depths below the streambed surface. At each site, three subsamples were collected from depths of about 0, 1, and 2 ft below the streambed (sites 410A, 410B, and 410C, respectively, and sites 590A, 590B, and 590C, respectively). Results of analyses for trace elements indicate a decrease in concentration with depth at both locations. For example, the concentrations of copper were 9,400, 3,400, and 30 μg/g and the concentrations of zinc were 720, 480, and 20 μg/g at sites 410A, 410B, and 410C, respectively (table 2). At sites 590A, 590B, and 590C, concentrations of iron were 6,900, 5,300, and 3,800 μg/g, respectively. At both locations, the maximum concentrations of five of the nine constituents detected in concentrations greater than the method reporting limit were measured in the sample from the shallowest site. Three of nine constituents were found in the highest concentrations at the intermediate depth, and only one constituent was found in the highest concentration at the 2-ft depth.

At both locations, the concentrations of most constituents in the deepest sample (2 ft) were comparable to those measured in streambed samples collected from relatively uncontaminated areas. At site 590C, concentrations of chromium (170 μg/g) and zinc (170 μg/g) were not significantly lower than those measured in samples from shallower depths. At site 410C, the concentrations of all constituents determined were at or near the reporting limits.

The zone in which concentrations of trace elements were elevated at both locations was confined to relatively shallow sediments, indicating that migration of constituents to more than 2 ft below the streambed surface has been minimal. Even at site 590, located in a reach where the stream is losing under normal flow conditions (Sargent and others, 1990), few constituents were found in concentrations greater than the reporting limit at a depth of 2 ft beneath the streambed.

Organic Compounds

Streambed samples from 45 locations were analyzed at the USGS National Water Quality Laboratory for base/neutral- and acid-extractable compounds, organochlorine and organophosphorus insecticides, and PCB's. The results of these analyses, listed in downstream order of sampling site, are presented in appendix 2.

As with the trace elements, three areas were identified in which streambed samples contained significant concentrations of organic compounds. These areas do not coincide exactly with those in which high concentrations of trace elements were found, although they overlap. The areas are (1) Green Pond Brook from the area near the outflow of Picatinny Lake downstream to Farley Avenue (site 310 to site 420), (2) Bear Swamp Brook from the area near building 241 downstream to the confluence with Green Pond Brook (site 540 to site 595), and (3) Green Pond Brook from the open burning area downstream to the dam near building 1178 (site 800 to site 890) (pl. 2).

The streambed material in the first area, Green Pond Brook from below Picatinny Lake downstream to Farley Avenue, consists of boulders and gravel between stations 0 and 9 and organic muck overlying till deposits from station 9 to station 18 (Stanford, 1989). No geophysical survey was conducted from station 0 to station 11 because access to the brook was limited. The rest of this area, stations 18 to 41, is described in the previous section. Most of the organic compounds detected in this area were PAH's. At site 310, just downstream from the outflow of Picatinny Lake, concentrations of PAH's and polychlorinated naphthalenes were elevated even though the streambed material is coarse and contaminants theoretically would not be likely to accumulate. Streambed samples from site 320 contain relatively little organic contamination, although three constituents were detected at low concentrations. Streambed samples from site 330, the first site downstream from Picatinny Lake at which the streambed consists of organic muck, contained many of the same PAH's found at site 310 in addition to high concentrations of mirex and PCB's. Samples from the remaining sites in this area, including sites 340 to 420, also contained detectable concentrations of PAH's, PCB's, polychlorinated naphthalenes, and several insecticides; however, the concentrations and the frequency of detection were consistently lower at these sites than at sites 310 and 330. Maximum concentrations of selected constituents detected were benzo (b) fluoranthene, 1,200 µg/kg, and benzo (a) pyrene, 1,400 µg/kg (site 310); and flouranthene, 3,400 µg/kg, phenanthrene, 2,000 µg/kg, pyrene, 2,500 µg/kg, and chrysene, 1,700 µg/kg (site 330) (app. 2). One explosive compound, 2,4-dinitrotoluene (240 µg/kg), was detected at site 340.

Several insecticides, including chlordane, DDD, DDE, and DDT, were detected frequently at low concentrations (from 0.2 to 96 µg/kg) in the streambed samples. Mirex was detected at a concentration of 6,500 µg/kg at site 330. PCB's and polychlorinated naphthalenes also were detected, at maximum concentrations of 870 µg/kg (at site 420) and 320 µg/kg (at site 340), respectively (app. 2).

Streambed samples from the second area, Bear Swamp Brook from the area near building 241 downstream to Green Pond Brook, generally contained the same constituents (mostly PAH's) that were found in the first area, and at similar concentrations. Unlike the trace elements in this area, organic compounds were detected in the highest concentrations at site 540, located upstream from building 24 near building 241, and downstream at site 595. At site 540, 10 PAH's were detected at concentrations greater than 1,000 µg/kg. Maximum concentrations of organic constituents found in streambed samples from Bear Swamp Brook were benzo (b) fluoranthene, 1,200 µg/kg, benzo (a) pyrene, 1,400 µg/kg, chrysene, 2,700 µg/kg, fluoranthene, 1,800 µg/kg, phenanthrene, 3,500 µg/kg, pyrene, 1,200 µg/kg, and benzo (a) anthracene, 2,100 µg/kg (site 540); and bis (2-ethylhexyl) phthalate, 4,500 µg/kg (site 595). Two insecticides, chlordane and DDD, and PCB's were detected at high concentrations in this reach of the channel, with maximum concentrations of 71, 130, and 4,400 µg/kg, respectively (app. 2).

The constituents found in the third area, Green Pond Brook at the open burning area downstream to the dam near building 1178 (stations 114 to 133, pl. 1), are the same as those found in the first and second areas, with a few exceptions. Two explosive compounds, 2,4- and 2,6-dinitrotoluene, were detected in streambed samples from site 820 at concentrations of 2,700 and 270 µg/kg, respectively (app. 2). At site 800, no base/neutral- or acid- extractable compounds were detected, although several insecticides, including chlordane and mirex, were detected at low concentrations. At sites 820 and 850, located adjacent to and downstream from the open burning area, high concentrations of base/neutral- and acid-extractable compounds, including many PAH's, naphthalenes, and phthalate compounds, and PCB's, were detected. The streambed sample from site 890 contained no organic compounds at concentrations greater than the method reporting limit, except for the presence of low concentrations of several insecticides and PCB's.

As described earlier for trace elements, samples were collected from different depths below the streambed surface at two locations and analyzed for organic compounds. At each location, three subsamples were collected from depths of 0, 1, and 2 ft below the streambed surface to determine the vertical extent of contamination. Results of analyses for organic compounds indicated a decrease in concentration with depth at both sites for all constituents but one that were detected in concentrations greater than the method reporting limit. At sites 410A, 410B, and 410C, mirex was detected at concentrations of 60, 88, and <1 µg/kg, respectively. Of the nine compounds detected in the shallowest samples at both sites, only one (PCB's) also was detected in the deepest samples. PCB's were detected at concentrations of 260, 50, and 28 µg/kg at sites 590A, 590B, and 590C, respectively.

Like trace elements, organic compounds found at both locations were confined to relatively shallow sediments. The physical and chemical properties of the constituents determined, such as their low solubilities in water, have prevented them from migrating more than about 1 ft below the streambed.

Areas of less significant contamination than the three areas discussed above, in which only a few compounds were detected in high concentrations or in which constituents were confined to small areas, include site 640, a drainage ditch near buildings 70 and 71; site 650, downstream from the sewage-treatment plant; site 170, about 1,400 ft upstream from Picatinny Lake; and site 710, a drainage ditch near Parker Road.

Streambed material at site 640 consists of fine-grained sand to silt and organic muck (including naturally occurring organic material, such as fluvic and humic compounds). Contaminants entering the drainage ditch from surface runoff would be expected to accumulate in this area because of the composition of the streambed material. High concentrations of several trace elements were detected here, including arsenic (120 μg/g), chromium (370 μg/g), lead (240 μg/g), and mercury (1.0 μg/g) (table 2). A possible source of contamination at this site is the building 95 area, where the presence of elevated concentrations of metals and volatile organic compounds has been documented (Sargent and others, 1994).

At site 650, streambed material consists of medium to coarse sand that contains elevated concentrations of several PAH's, including chrysene (1,200 μg/kg), pyrene (280 μg/kg), and benzo (a) anthracene (880 μg/kg). Contaminants at this site may be the result of past activities at the sewage-treatment plant, inasmuch as PAH's commonly are found in sewage sludge (Verschueren, 1983).

Streambed samples from site 170 contained elevated concentrations of arsenic (11 μg/g), polychlorinated naphthalenes (670 μg/kg), two plasticizers, (bis (2 ethylhexyl) phthalate (2,500 μg/kg) and di-n-butyl phthalate (440 μg/kg)), and 2,4-dinitrotoluene (520 μg/kg). Streambed samples from site 710 contained elevated concentrations of PAH's, including chrysene (2,600 μg/kg), fluoranthene (1,000 μg/kg), and DDT (56 μg/kg). No possible sources of these compounds at these sites have been identified.

SURFACE-WATER QUALITY

Surface-water samples were collected at 15 sites on Green Pond Brook and its tributaries (pl. 2) from December 2, 1983, to August 6, 1990. Samples were analyzed for physical and chemical properties, major ions, nutrients and organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and PCB's. A large proportion of the available surface-water-quality data consists of results of analyses for volatile organic compounds of surface-water samples from three sites studied during the investigation of surface-water contamination in the area of building 24 (Sargent and others, 1990). Fifteen surface-water samples were collected during this period at two sites--Green Pond Brook at Farley Avenue (site 430) and Green Pond Brook at First Street (site 600); 14 surface-water samples were collected at the third site, Green Pond Brook at Wharton (site 920). One to four surface-water samples were collected at each of the remaining 12 sites during 1983-90.

Results of analyses of surface-water samples for inorganic and organic constituents are shown in appendix 3. Concentrations of two inorganic constituents, iron and manganese, exceeded USEPA secondary maximum contaminant levels[3] (U.S. Environmental Protection Agency, 1988c). The maximum concentrations of iron and manganese were 970 and 230 μg/L, respectively. High concentrations of iron and manganese have been found in both ground water and surface water at the arsenal and are considered to be typical of this area (Sargent and others, 1986). Aquifer and streambed material may be coated with

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[3] Secondary Maximum Contaminant Level: Contaminants that affect the aesthetic quality of drinking water. At high concentrations or values, health implications as well as aesthetic degradation may also exist. Secondary Maximum Contaminant Levels are not Federally enforceable but are intended as guidelines for the States. (U.S. Environmental Protection Agency, 1988c)

hydrous iron and manganese oxides, which can contribute iron under the reducing conditions that exist at the arsenal. USEPA secondary maximum contaminant levels for iron and manganese are 0.3 and 0.05 mg/L, respectively.

Results of analyses of surface-water samples for organic compounds indicate that no constituents exceeded USEPA primary or secondary maximum contaminant levels[4] (U.S. Environmental Protection Agency, 1988a; U.S. Environmental Protection Agency, 1988c). Maximum detected concentrations of selected organic compounds are as follows: trichloroethylene, 3.8 μg/L; cis- and trans-1,2-dichloroethylene, 11 μg/L; tetrachloroethylene, 4.6 μg/L; mirex, 2.0 μg/L; chloroform, 1.9 μg/L; and bromodichloromethane, 0.3 μg/L.

Results of analyses indicate that the concentrations of four of these compounds--trichloroethylene, chloroform, and cis- and trans-1,2- dichloroethylene--increased slightly from Farley Avenue (site 430) to First Street (site 600) (pl. 2), probably as a result of the inflow of ground water from the contaminant plume near building 24 (Sargent and others, 1990). At site 600, trichloroethylene was detected in 8 of 14 samples at concentrations ranging from 1.0 to 3.8 μg/L, and cis- and trans-1,2- dichloroethylene were detected in 8 of 14 samples at concentrations ranging from 2.0 to 11 μg/L. Three organic compounds, trichloroethylene, tetrachloroethylene, and mirex, were detected at or upstream from Farley Avenue (sites 310 and 430).

The concentration of volatile constituents is reduced in the fast- flowing reaches of the brook in the southern end of the arsenal by volatilization and dilution by surface-water and ground-water inflow. At Green Pond Brook at Wharton (site 920), about 200 ft upstream from the location where the brook exits the arsenal, only cis- and trans-1,2- dichloroethylene were detected at concentrations greater than 3 μg/L. Dichloroethylene was detected in 6 of 13 samples at concentrations ranging from 1.0 to 4.2 μg/L.

SUMMARY AND CONCLUSIONS

In order to document the quality of water in Green Pond Brook and its tributaries, and to determine the distribution of inorganic and organic contaminants in streambed materials, 45 streambed samples were collected during 1989-90. Samples were analyzed for trace elements, base/neutral- and acid-extractable compounds, organochlorine and organophosphorus insecticides, PCB's, and polychlorinated naphthalenes. Results of analyses of surface-water and streambed samples collected by the U.S. Geological Survey as part of other studies during 1983-90 also are presented.

A geologic and geophysical survey, including field mapping and electromagnetic-conductivity and natural-gamma-ray studies, was conducted to determine the distribution of streambed and substreambed sediment types and particle sizes. Results indicate that the substreambed deposits consist of the following: gravel and boulders, stations 0 to 8; organic muck, stations 9 to 25; 0 to 5 in. of debris over organic muck, stations 25 to 34; organic muck, stations 34 to 41; medium sand and silt, stations 41 to 44; organic muck, stations 44 to 50; laminated medium sand, silt, and clay, stations 50 to 54; organic muck, stations 54 to 56; laminated medium sand, silt, and clay, stations 56 to 63; organic muck, stations 63 to 67; laminated very fine sand, silt, and clay, stations 67 to 130; coarse sand and gravel, stations 130 to 135; and boulders and cobbles, stations 135 to 145. The particle size of streambed material determines, in part, where contaminants accumulate. Sediments that consist of fine-grained material, contain large concentrations of natural organic material, and are located in reaches of the channel where streamflow velocities are low have a greater capacity to store contaminants than do coarse-grained sediments that contain little organic material and are located in reaches where streamflow velocities are high.

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[4] Maximum Contaminant Level: Enforceable, health-based regulation that is to be set as close to the Maximum Contaminant Level Goal as is feasible. The definition of feasible means the use of best technology, treatment techniques, and other means that the Administrator of USEPA finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are generally available (taking cost into consideration). (U.S. Environmental Protection Agency, 1988a)

Samples of streambed material from two areas in Green Pond Brook and one area in Bear Swamp Brook contained concentrations of organic and (or) inorganic constituents greater than those typically found at the arsenal: (1) Green Pond Brook from the area near the outflow of Picatinny Lake downstream to Farley Avenue, (2) Bear Swamp Brook from the area near building 241 downstream to the confluence with Green Pond Brook, and (3) Green Pond Brook from the open burning area downstream to the dam near building 1178. Trace elements detected and maximum concentrations determined include arsenic (120 µg/g), chromium (2,400 µg/g), lead (400 µg/g), copper (9,400 µg/g), mercury (32 µg/g), and zinc (3,100 µg/g). Base/neutral- and acid-extractable compounds detected include benzo (b) fluoranthene (1,200 µg/kg), benzo (a) pyrene (1,400 µg/kg), flouranthene (3,400 µg/kg), phenanthrene (3,500 µg/kg), pyrene (2,500 µg/kg), and chrysene (2,700 µg/kg).

Results of chemical analyses of sediments at and beneath the streambed surface at two locations indicate that concentrations of organic and inorganic constituents decreased with depth. PCB's were the only organic compounds detected at a depth of 2 ft below the streambed, and most inorganic constituents detected at this depth were present at concentrations at or near the reporting limit.

Results of analyses of surface-water samples collected at 15 sites in Green Pond Brook and its tributaries during 1983-90 indicate that several volatile organic compounds enter the brook as a result of the inflow of ground water from the contaminant plume at building 24. Constituents detected and maximum concentrations determined include trichloroethylene, 3.8 µg/L; tetrachloroethylene, 4.6 µg/L; and cis- and trans-1,2- dichloroethylene, 11 µg/L. Volatilization probably removes volatile organic compounds in the steep, fast-flowing reaches of the brook before the water leaves the arsenal property. No constituents determined in surface-water samples were detected in concentrations greater than U.S. Environmental Protection Agency primary drinking-water regulations. Iron and manganese were detected in concentrations greater than U.S. Environmental Protection Agency secondary drinking-water regulations.

REFERENCES CITED

Benioff, P.A., Bhattacharyya, M.A., Biang, C., Chiu, S.Y., Miller, S., Patton, T., Pearl, D., Yonk, A., and Yuen, C.R., 1991, Remedial investigation concept plan for Picatinny Arsenal: Argonne, Ill., Argonne National Laboratory, Environmental Assessment and Information Sciences Division, Final report, March 1991, 2 v., 552 p.

Brown, E., Skougstad, M.W., and Fishman, M.J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 160 p.

Eby, C.F., 1976, Soil survey of Morris County, New Jersey: U.S. Department of Agriculture, Soil Conservation Service, 111 p.

Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Frew, R.L., Lemont, S., Osgood, J., McBride, M.S., Prasad, S.S., and Tucker, R.C., 1989, Site investigation of Picatinny Arsenal: Bethesda, Md., Dames and Moore, Inc., Final report, July 1989, 2 v., 1,251 p.

Friedman, L.C., and Erdman, D.E., 1982, Quality assurance practices for the chemical and biological analysis of water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A6, 181 p.

Gill, H.E., and Vecchioli, John, 1965, Availability of ground water in Morris County, New Jersey: New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply, Special Report 25, 56 p.

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

Harte, P.T., Sargent, B.P., and Vowinkel, E.F., 1986, Description and results of test drilling program at Picatinny Arsenal, New Jersey, 1982-84: U.S. Geological Survey Open-File Report 86-316, 54 p.

Hawley, G.G., 1981, The condensed chemical dictionary: New York, Van Nostrand Reinhold Co., 1,135 p.

Imbrigiotta, T.E., Gibs, Jacob, Fusillo, T.V., Kish, G.R., and Hochreiter, J.J., Jr., 1988, Field evaluation of seven sampling devices for purgeable organic compounds in ground water, *in* Collins, A.G., and Johnson, A.I., eds., Ground-water contamination field methods: American Society for Testing and Materials, Special Technical Publication no. 963, p. 258-273.

Lacombe, P.J., Sargent, B.P., Harte, P.T., and Vowinkel, E.F., 1986, Determination of geohydrologic framework and extent of ground-water contamination using surface geophysical techniques at Picatinny Arsenal, New Jersey: U.S. Geological Survey Water-Resources Investigations Report 86-4051, 31 p.

Longbottom, J.E., and Lichtenberg, J.J., eds., 1982, Methods for organic chemical analysis of municipal and industrial wastewater: EPA-600/4- 82-057, U.S. Environmental Protection Agency, Cincinnati, Ohio, July 1982, 147 p.

Moore, J.W., and Ramamoorthy, S., 1984, Heavy metals in natural waters: Applied monitoring and impact assessment: New York, Springer-Verlag, 268 p.

National Research Council, 1977, Drinking water and health: Washington, D.C., National Academy of Sciences, 939 p.

Oschwald, W.R., 1972, Sediment-water interactions: Journal of Environmental Quality, v. 1, no. 4, p. 360-366.

Owens, J.P., and Sohl, Norman, 1969, Shelf and deltaic paleoenvironments in the Cretaceous-Tertiary formations of the New Jersey Coastal Plain, *in* Subitsky, Seymour, ed., Geology of selected areas in New Jersey and eastern Pennsylvania, and guidebook of excursions: New Brunswick, New Jersey, Rutgers University Press, 382 p.

Pionke, H.B., and Chesters, G., 1973, Pesticide-sediment-water interactions: Journal of Environmental Quality, v. 2, no. 1, p. 29-45.

Sargent, B.P., Green, J.W., Harte, P.T., and Vowinkel, E.F., 1986, Ground-water quality data for Picatinny Arsenal, New Jersey, 1958-85: U.S. Geological Survey Open-File Report 86-58, 66 p.

Sargent, B.P., Fusillo, T.V., Storck, D.A., and Smith, J.A., 1990, Assessment of contamination of ground water and surface water in the area of building 24, Picatinny Arsenal, New Jersey, 1986-87: U.S. Geological Survey Water-Resources Investigations Report 90-4057, 120 p.

Sargent, B.P., and Storck, D.A., 1994, Contamination of shallow ground water in the area of building 95, Picatinny Arsenal, New Jersey, 1985-90: U.S. Geological Survey Water-Resources Investigation Report 92-4122, 72 p.

Sax, N.I., ed., 1974, Industrial pollution: New York, Van Nostrand Reinhold Co., 702 p.

Sittig, Marshall, 1985, Handbook of toxic and hazardous chemicals and carcinogens, (2d ed.): Park Ridge, New Jersey, Noyes Publications, 950 p.

Stanford, Scott, 1989, Surficial geologic map of the Dover Quadrangle, Morris and Sussex Counties, New Jersey: New Jersey Geological Survey, Geological Survey Map 89-2, scale 1:24,000.

U.S. Environmental Protection Agency, 1988a, Maximum contaminant levels (subpart B of 141, National interim primary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised as of July 1, 1988, p. 530-533.

_____ 1988b, National revised primary drinking-water regulations: Maximum contaminant levels (subpart G of part 141, National interim primary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised as of July 1, 1988, p. 586-587.

_____ 1988c, Secondary maximum contaminant levels (section 143.3 of part 143, National secondary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised as of July 1, 1988, p. 608.

Verschueren, Karel, 1983, Handbook of environmental data on organic chemicals, (2d ed.): New York, Van Nostrand Reinhold Co., 1,310 p.

Waksman, S.A., Schulhoff, H., Hickman, C.A., Cordon, T.C., and Stevens, S.C., 1943, The peats of New Jersey and their utilization: New Jersey Department of Conservation and Development Geologic Series, Bulletin 55, Part B, 278 p.

REFERENCES CITED--Continued

Wershaw, R.L., Fishman, M.J., Grabbe, R.R., and Lowe, L.E., eds., 1987, Methods for the determination of organic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A3, 80 p.

Windholz, Martha, Budavari, Susan, Stroumtsos, L.Y., and Fertig, M.N., eds., 1976, The Merck index, (9th ed.): Rahway, New Jersey, Merck and Co., 1,937 p.

Witkowski, P.J., Smith, J.A., Fusillo, T.V., and Chiou, C.T., 1987, A review of surface-water sediment fractions and their interactions with persistent manmade organic compounds: U.S. Geological Survey Circular 993, 39 p.

Wood, Warren, 1976, Guidelines for collection and field analysis of ground- water samples for selected unstable constituents: U.S. Geological Survey Techniques of Water-Resources Investigations, book 1, chap. D2, 24 p.

Appendix 1. Results of analyses of streambed samples for selected trace elements, base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1983-84

[All constituents are recoverable from bottom material, except arsenic and selenium, which are total in bottom material; concentrations in micrograms per kilogram, except as noted; --, constituent not determined; <, less than; µg/g, micrograms per gram; PCN's, polychlorinated naphthalenes]

Site	Date	Arsenic (µg/g) [1](01003)	Boron (µg/g) (01023)	Cadmium (µg/g) (01028)	Chromium (µg/g) (01029)	Cobalt (µg/g) (01038)	Copper (µg/g) (01043)	Lead (µg/g) (01052)	Manganese (µg/g) (01053)	Strontium (µg/g) (01083)
60	06-05-84	1	<10	2	7	20	100	30	510	20
120	12-02-83	<1	<10	<1	4	10	4	20	87	1
	06-05-84	1	<10	<1	5	20	4	30	830	3
180	12-02-83	<1	50	9	20	30	280	180	120	20
	06-05-84	2	<10	3	4	20	100	<10	300	5
330	06-05-84	1	<10	<1	4	10	8	20	200	8
410	12-02-83	<1	10	35	30	10	16,000	2,900	340	30
	06-06-84	1	<10	4	10	20	3,800	340	480	20
430	06-06-84	<1	<10	<1	9	10	240	60	140	10
450	12-02-83	<1	10	1	10	10	40	30	360	6
	06-05-84	1	<10	<1	3	10	20	10	110	3
510	12-02-83	<1	10	<1	5	20	20	30	200	10
	06-05-84	<1	<10	<1	5	20	20	30	160	30
550	12-02-83	1	10	20	70	10	170	210	120	6
	06-05-84	2	<10	10	90	20	110	20	120	4
580	12-02-83	<1	10	10	50	<10	50	30	29	3
	06-05-84	2	<10	200	610	40	490	340	110	10
595	12-02-83	<1	10	29	240	10	170	60	300	9
	06-05-84	1	<10	11	160	10	80	60	170	8
600	12-02-83	<1	<10	3	40	<10	20	20	84	2
	06-06-84	1	<10	<1	20	10	10	10	50	2
630	12-02-83	<1	10	1	10	10	20	20	100	4
	06-06-84	1	<10	<1	8	10	8	<10	71	2
870	12-02-83	<1	<10	1	10	10	30	20	68	4
	06-06-84	<1	<10	2	20	20	1,500	120	110	7
920	12-02-83	<1	<10	1	9	<10	20	10	48	1
	06-06-84	1	<10	<1	7	10	10	10	80	2

Site	Date	Zinc (µg/g) (01093)	Aluminum (µg/g) (01108)	Selenium (µg/g) (01148)	Iron (µg/g) (01170)	Acenaphthylene (34203)	Acenaphthene (34208)	Anthracene (34223)	Benzo (b) fluoranthene (34233)	Benzo (k) fluoranthene (34245)
60	06-05-84	130	3,500	<1	7,700	<200	<200	<200	<400	<400
120	12-02-83	40	1,700	<1	6,300	--	--	--	--	--
	06-05-84	100	1,300	<1	12,000	<200	<200	<200	<400	<400
180	12-02-83	380	11,000	<1	13,000	--	--	--	--	--
	06-05-84	120	50	5	1,400	<200	<200	<200	<400	<400
330	06-05-84	60	2,200	<1	12,000	<200	<200	<200	<400	<400
410	12-02-83	7,100	2,500	<1	13,000	--	--	--	--	--
	06-06-84	1,100	3,800	2	15,000	<200	<200	510	590	<400
430	06-06-84	120	2,400	<1	8,000	<200	<200	430	690	<400
450	12-02-83	70	3,400	<1	8,300	--	--	--	--	--
	06-05-84	40	940	1	3,200	<200	<200	<200	<400	<400
510	12-02-83	50	2,900	<1	6,400	--	--	--	--	--
	06-05-84	30	--	<1	4,700	<200	<200	<200	<400	<400
550	12-02-83	130	2,400	<1	3,700	--	--	--	--	--
	06-05-84	120	240	3	460	<200	200	380	580	<400
580	12-02-83	110	2,100	<1	2,100	--	--	--	--	--
	06-05-84	990	4,200	6	11,000	<200	<200	290	640	<400
595	12-02-83	390	3,400	<1	7,400	--	--	--	--	--
	06-05-84	230	2,100	1	6,600	<200	<200	<200	<400	<400
600	12-02-83	40	1,500	<1	.6,500	--	--	--	--	--
	06-06-84	40	1,700	<1	5,800	<200	<200	<200	<400	<400
630	12-02-83	50	3,300	<1	8,600	--	--	--	--	--
	06-06-84	30	2,100	<1	6,500	<200	<200	<200	<400	<400
870	12-02-83	40	2,700	<1	5,800	--	--	--	--	--
	06-06-84	590	2,500	<1	8,700	<200	<200	<200	<400	<400
920	12-02-83	30	2,000	<1	5,100	--	--	--	--	--
	06-06-84	30	2,100	<1	5,400	<200	<200	<200	<400	<400

Appendix 1. Results of analyses of streambed samples for selected trace elements, base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1983-84--Continued

Site	Date	Benzo (a) pyrene (34250)	Bis (2-chloro-ethyl) ether (34276)	Bis (2-chloro-ethoxy) methane (34281)	Bis (2-chloro-iso-propyl) ether (34286)	N-Butyl benzyl phthal-ate (34295)	Chrysene (34323)	Diethyl phthal-ate (34339)	Dimethy phthal-ate (34344)	Fluor-anthene (34379)	Fluorene (34384)
60	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
120	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
180	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
330	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	360	<200
410	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	880	<200	<200	<200	<200	400	200	<200	860	350
430	06-06-84	700	<200	<200	<200	<200	400	<200	<200	1,600	<200
450	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
510	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
550	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	320	<200	<200	<200	<200	280	<200	<200	1,300	190
580	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	480	<200	<200	<200	<200	<200	<200	<200	1,300	<200
595	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<400	<200	<200	<200	<200	<200	<200	<200	310	<200
600	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<400	<200	<200	<200	<200	<200	<200	<200	440	<200
630	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
870	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200
920	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<400	<200	<200	<200	<200	<200	<200	<200	<200	<200

Site	Date	Hexa-chloro-cyclo-penta-diene (34389)	Hexa-chloro-ethane (34399)	Indeno (1,2,3-cd) pyrene (34406)	Iso-phorone (34411)	N-Nitro-sodi-N-propyl-amine (34431)	N-Nitro -sodi-phenyl-amine (34436)	N-Nitro -sodi-methyl-amine (34441)	Naph-thalene (34445)	Nitro-benzene (34450)	Para-chloro-meta-cresol (34455)
60	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
120	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
180	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
330	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
410	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	1,800	<200	<200	460	<200	390	<200	<600
430	06-06-84	<200	<200	870	<200	<200	210	<200	<200	<200	<600
450	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
510	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
550	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	1,200	<200	<200	<200	<200	<200	<200	<600
580	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	520	<200	<200	<200	<200	<200	<200	<600
595	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
600	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
630	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
870	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600
920	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<200	<200	<200	<600

Appendix 1. Results of analyses of streambed samples for selected trace elements, base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1983-84--Continued

Site	Date	Phenan-threne (34464)	Pyrene (34472)	Benzo (g,h,i) perylene (34524)	Benzo (a) an-thracene (34529)	1,2-Di-chloro-benzene (34539)	1,2,4-Tri-chloro-benzene (34554)	1,2,5,6-Dibenz-anthra-cene (34559)	1,3-Di-chloro-benzene (34569)	1,4-Di-chloro-benzene (34574)	2-Chloro-naph-thalene (34584)
60	06-05-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
120	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
180	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
330	06-05-84	410	250	<400	<200	<200	<200	<400	<200	<200	<200
410	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	2,000	650	1,700	370	<200	<200	610	<200	<200	<200
430	06-06-84	1,400	1,200	1,900	320	<200	<200	<400	<200	<200	<200
450	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
510	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
550	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	1,500	920	660	200	<200	<200	<400	<200	<200	<200
580	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	1,100	870	<400	<200	<200	<200	<400	<200	<200	<200
595	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	260	290	<400	<200	<200	<200	<400	<200	<200	<200
600	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	620	270	<400	<200	<200	<200	<400	<200	<200	<200
630	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
870	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200
920	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<400	<200	<200	<200	<400	<200	<200	<200

Site	Date	2-Chloro-phenol (34589)	2-Nitro-phenol (34594)	Di-N-octyl phthal-ate (345990)	2,4-Di-chloro-phenol (34604)	2,4-Di-methyl-phenol (34609)	2,4-Di-nitro-toluene (34614)	2,4-Di-nitro-phenol (34619)	2,4,6-Tri-chloro-phenol (34624)	2,6-Di-nitro-toluene (34629)	3,3'-Di-chloro-benzi-dine (34634)
60	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
120	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
180	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
330	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
410	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
430	06-06-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
450	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
510	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
550	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
580	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
595	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
600	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
630	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
870	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200
920	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<200	<200	<200	<200	<600	<600	<200	<200

Appendix 1. Results of analyses of streambed samples for selected trace elements, base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1983-84--Continued

Site	Date	4-Bromo-phenyl phenyl ether (34639)	4-Chloro-phenyl phenyl ether (34641)	4-Nitro-Phenol (34649)	4,6-Dinitro-ortho-cresol (34660)	2,3,7,8 Tetra-chlorodi-benzo-p-dioxin (34678)	Phenol (34695)	Penta-chloro-phenol (39061)	Bis (2-ethyl-hexyl) phthal-ate (39102)	Di-N-butyl phthal-ate (39112)	Benzi-dine (39121)
60	06-05-84	<200	<200	<600	<600	<200	<600	<600	<200	340	<200
120	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	<200	450	<200
180	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	420	360	<200
330	06-05-84	<200	<200	<600	<600	<200	<600	<600	200	220	<200
410	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<600	<600	<200	<600	<600	<200	640	<200
430	06-06-84	<200	<200	<600	<600	<200	<600	<600	<200	570	<200
450	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	220	290	<200
510	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	<200	610	<200
550	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	<200	330	<200
580	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	220	370	<200
595	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<200	<200	<600	<600	<200	<600	<600	<200	370	<200
600	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<600	<600	<200	<600	<600	<200	320	<200
630	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<600	<600	<200	<600	<600	<200	340	<200
870	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<600	<600	<200	<600	<600	<200	500	<200
920	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<200	<200	<600	<600	<200	<600	<600	<200	440	<200

Site	Date	PCN's (39251)	Aldrin (39333)	Lindane (39343)	Chlordane (39351)	DDD (39363)	DDE (39368)	DDT (39373)	Dieldrin (39383)	Endo-sulfan (39389)	Endrin (39393)
60	06-05-84	570	<0.1	<0.1	<1.0	0.9	0.3	14	<0.1	<0.1	<0.1
120	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<1.0	<.1	<.1	<1.0	6.5	13	4.4	<.1	<.1	<.1
180	12-02-83	<1.0	<.1	<.1	14	98	54	30	<.1	<.1	<.1
	06-05-84	<1.0	<.1	<.1	16	28	<.1	7.4	<.1	<.1	<.1
330	06-05-84	<1.0	<.1	<.1	<1.0	1.5	.7	46	<.1	<.1	<.1
410	12-02-83	<1.0	<.1	<.1	74	12	17	<0.1	<.1	<.1	<.1
	06-06-84	<1.0	<.1	<.1	<1.0	32	<.1	11	<.1	<.1	<.1
430	06-06-84	<1.0	<.1	<.1	9.0	3.1	6.2	<.1	<.1	<.1	<.1
450	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<9.0	<.1	<.1	3.0	9.4	<.1	2.7	<.1	<.1	<.1
510	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<1.0	<.1	<.1	<1.0	<.1	<.1	2.4	<.1	<.1	<.1
550	12-02-83	<1.0	<.1	<.1	6.0	69	18	11	<.1	<.1	<.1
	06-05-84	<1.0	<.1	<.1	<1.0	140	27	7.3	<.1	<.1	<.1
580	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-05-84	<1.0	<.1	<.1	<1.0	30	<.1	3.5	<.1	<.1	<.1
595	12-02-83	<1.0	<.1	<.1	22	37	<.1	<.1	<.1	<.1	<.1
	06-05-84	<1.0	<.1	<.1	6.0	8.9	<.1	5.3	<.1	<.1	<.1
600	12-02-83	<1.0	<.1	<.1	1.0	1.2	.3	.5	<.1	<.1	<.1
	06-06-84	<1.0	<.1	<.1	4.0	17	<.1	6.3	<.1	<.1	<.1
630	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<1.0	<.1	<.1	<1.0	.5	<.1	.8	<.1	<.1	<.1
870	12-02-83	--	--	--	--	--	--	--	--	--	--
	06-06-84	<1.0	<.1	<.1	3.0	12	2.1	2.0	<.1	<.1	<.1
920	12-02-83	<1.0	<.1	<.1	<1.0	12	3.6	2.6	<.1	<.1	<.1
	06-06-84	<1.0	<.1	<.1	<1.0	4.3	<.1	2.3	<.1	<.1	<.1

Appendix 1. Results of analyses of streambed samples for selected trace elements, base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1983-84--Continued

Site	Date	Ethion (39399)	Toxaphene (39403)	Hepta-chlor (39413)	Hepta-chlor-epoxide (39423)	Methoxy-chlor (39481)	PCB's (39519)	Malathion (39531)	Para-thion (39541)	Diazinon (39571)
60	06-05-84	--	<10	<0.1	<0.1	<0.1	<1	--	--	--
120	12-02-83	--	--	--	--	--	--	--	--	--
	06-05-84	--	<10	<.1	<.1	<.1	40	--	--	--
180	12-02-83	<.1	<10	<.1	<.1	<.1	440	<.1	<.1	<.1
	06-05-84	--	<10	<.1	<.1	<.1	220	--	--	--
330	06-05-84	--	<10	<.1	<.1	<.1	32	--	--	--
410	12-02-83	<.1	<10	<.1	<.1	<.1	4,100	<.1	<.1	<.1
	06-06-84	--	<10	.3	<.1	<.1	2,000	--	--	--
430	06-06-84	--	<10	<.1	<.1	<.1	690	--	--	--
450	12-02-83	--	--	--	--	--	--	--	--	--
	06-05-84	--	<10	.1	<.1	<.1	12	--	--	--
510	12-02-83	--	--	--	--	--	--	--	--	--
	06-05-84	--	<10	<.1	<.1	<.1	230	--	--	--
550	12-02-83	<.1	<10	<.1	<.1	<.1	82	<.1	<.1	<.1
	06-05-84	--	<10	<.1	<.1	<.1	810	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--
	06-05-84	--	<10	<.1	<.1	<.1	2,100	--	--	--
595	12-02-83	<.1	<10	<.1	<.1	<.1	1,200	<.1	<.1	<.1
	06-05-84	--	<10	.2	<.1	<.1	190	--	--	--
600	12-02-83	<.1	<10	<.1	<.1	<.1	10	<.1	<.1	<.1
	06-06-84	--	<10	<.1	<.1	<.1	17	--	--	--
630	12-02-83	--	--	--	--	--	--	--	--	--
	06-06-84	--	<10	<.1	<.1	<.1	<1	--	--	--
870	12-02-83	--	--	--	--	--	--	--	--	--
	06-06-84	--	<10	<.1	<.1	<.1	140	--	--	--
920	12-02-83	<.1	<10	<.1	<.1	<.1	20	<.1	<.1	<.1
	06-06-84	--	<10	<.1	<.1	<.1	35	--	--	--

Site	Date	Methyl para-thion (39601)	Hexa-chloro-benzene (39701)	Hexa-chloro butadiene (39705)	Mirex (39758)	Trithion (39787)	Methyl trithion (39791)	Mercury (µg/g) (71921)	Perthane (81886)
60	06-05-84	--	<200	<200	<0.1	--	--	0.12	<1.0
120	12-02-83	--	--	--	--	--	--	<.01	--
	06-05-84	--	<200	<200	<.1	--	--	.12	<1.0
180	12-02-83	<.1	--	--	78	<.1	<.1	.62	<1.0
	06-05-84	--	<200	<200	130	--	--	.64	<1.0
330	06-05-84	--	<200	<200	7,100	--	--	.38	<1.0
410	12-02-83	<.1	--	--	390	<.1	<.1	.83	<1.0
	06-06-84	--	<200	<200	870	--	--	--	<1.0
430	06-06-84	--	<200	<200	350	--	--	.68	<1.0
450	12-02-83	--	--	--	--	--	--	<.01	--
	06-05-84	--	<200	<200	58	--	--	.20	<1.0
510	12-02-83	--	--	--	--	--	--	.21	--
	06-05-84	--	<200	<200	9.4	--	--	.24	<1.0
550	12-02-83	<.1	--	--	<.1	<.1	<.1	1.7	<1.0
	06-05-84	--	<200	<200	<.1	--	--	1.1	<1.0
580	12-02-83	--	--	--	--	--	--	.10	--
	06-05-84	--	<200	<200	<.1	--	--	9.6	<1.0
595	12-02-83	<.1	--	--	<.1	<.1	<.1	.48	<1.0
	06-05-84	--	<200	<200	<.1	--	--	.51	<1.0
600	12-02-83	<.1	--	--	25	<.1	<.1	.33	<1.0
	06-06-84	--	<200	<200	120	--	--	.25	<1.0
630	12-02-83	--	--	--	--	--	--	.07	--
	06-06-84	--	<200	<200	81	--	--	.12	<1.0
870	12-02-83	--	--	--	--	--	--	.14	--
	06-06-84	--	<200	<200	130	--	--	.50	<1.0
920	12-02-83	<.1	--	--	27	<.1	<.1	.04	<1.0
	06-06-84	--	<200	<200	26	--	--	.13	<1.0

[1] Constituent-analysis code used by U.S. Geological Survey National Water Quality Laboratory

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90

[All constituents are recoverable from bottom material; concentrations in micrograms per kilogram; <, less than]

Site	Date	Acenaph-thylene [1](34203)	Acenaph-thene (34208)	Anthra-cene (34223)	Benzo (b) fluoran-thene (34233)	Benzo (k) fluoran-thene (34245)	Benzo (a) Pyrene (34250)	Bis (2-chloro-ethyl) ether (34276)	Bis (2-chloro-ethoxy) methane (34281)	Bis (2-chloro-iso-propyl) ether (34286)
170	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
310	09-04-90	<200	<200	260	1,200	1,100	1,400	<200	<200	<200
320	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
330	08-22-89	<200	<200	500	960	1,200	1,100	<200	<200	<200
340	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
360	08-31-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
380	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
390	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
400	08-31-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
410A	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
410B	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
410C	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
420	08-22-89	<200	<200	<200	<400	<400	470	<200	<200	<200
430	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
450	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
470	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
490	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
505	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
520	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
530	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
540	08-31-89	<200	520	1,000	1,200	1,100	1,400	<200	<200	<200
560	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
580	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
590A	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
590B	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
590C	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
595	08-31-89	<200	<200	<200	<400	410	470	<200	<200	<200
600	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
610	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
620	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
630	08-22-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
640	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
650	08-22-89	<200	<200	<200	1,100	740	660	<200	<200	<200
690	09-04-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
710	08-23-89	<200	280	410	910	1,000	1,400	<200	<200	<200
730	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
760	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
800	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
820	08-31-89	<200	310	430	470	570	760	<200	<200	<200
840	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
850	09-05-90	<200	<200	<200	400	<400	530	<200	<200	<200
890	08-23-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
920	08-31-89	<200	<200	<200	<400	<400	<400	<200	<200	<200
930	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200
960	09-05-90	<200	<200	<200	<400	<400	<400	<200	<200	<200

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	N-Butyl benzyl phthal-ate (34295)	Chrysene (34323)	Diethyl phthal-ate (34339)	Dimethyl phthal-ate (34344)	Fluor-anthene (34379)	Fluorene (34384)	Hexa-chloro-cyclo-penta-diene (34389)	Hexa-chloro-ethane (34399)	Indeno (1,2,3-CD) pyrene (34406)	Iso-phorone (34411)
170	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
310	09-04-90	<200	960	<200	<200	1,300	<200	<200	<200	710	<200
320	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
330	08-22-89	<200	1,700	<200	<200	3,400	290	<200	<200	1,600	<200
340	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
360	08-31-89	<200	<400	<200	<200	270	<200	<200	<200	<400	<200
380	08-23-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
390	09-05-90	<200	<400	<200	<200	370	<200	<200	<200	<400	<200
400	08-31-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
410A	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
410B	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
410C	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
420	08-22-89	<200	910	<200	<200	540	<200	<200	<200	490	<200
430	08-22-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
450	08-22-89	<200	<400	<200	<200	260	<200	<200	<200	<400	<200
470	08-22-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
490	08-22-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
505	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
520	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
530	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
540	08-31-89	<200	2,700	<200	<200	1,800	390	<200	<200	1,200	<200
560	09-04-90	<200	500	<200	<200	540	<200	<200	<200	<400	<200
580	08-23-89	<200	510	<200	<200	<200	<200	<200	<200	<400	<200
590A	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
590B	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
590C	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
595	08-31-89	<200	1,300	<200	<200	910	<200	<200	<20C	<400	<200
600	08-22-89	<200	<400	<200	<200	290	<200	<200	<200	<400	<200
610	08-22-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
620	08-22-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
630	08-22-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
640	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
650	08-22-89	<200	1,200	<200	<200	<200	<200	<200	<200	<400	<200
690	09-04-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
710	08-23-89	<200	2,600	<200	<200	1,000	<200	<200	<200	1,200	<200
730	08-23-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
760	08-23-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
800	08-23-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
820	08-31-89	370	1,600	910	<200	1,400	250	<200	<200	730	<200
840	08-23-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
850	09-05-90	<200	640	<200	<200	530	<200	<200	<200	<400	<200
890	08-23-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
920	08-31-89	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
930	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200
960	09-05-90	<200	<400	<200	<200	<200	<200	<200	<200	<400	<200

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	N-Nitro-sodi-N-propyl-amine (34431)	N-Nitro-sodi-phenyl-amine (34436)	N-Nitro-sodi-methyl-amine (34441)	Naphth-alene (34445)	Nitro-benzene (34450)	Para-chloro-meta cresol (34455)	Phenan-threne (34464)	Pyrene (34472)	Benzo (g,h,i) perylene (34524)	Benzo (a) an-thracene (34529)
170	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
310	09-04-90	<200	<200	<200	<200	<200	<600	1,100	970	440	1,000
320	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
330	08-22-89	<200	<200	<200	200	<200	<600	2,000	2,500	1,700	1,700
340	09-04-90	<200	210	<200	<200	<200	<600	<200	<200	<400	<400
360	08-31-89	<200	<200	<200	<200	<200	<600	230	250	<400	<400
380	08-23-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
390	09-05-90	<200	<200	<200	<200	<200	<600	350	260	<400	<400
400	08-31-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
410A	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
410B	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
410C	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
420	08-22-89	<200	280	<200	<200	<200	<600	730	400	<400	460
430	08-22-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
450	08-22-89	<200	<200	<200	<200	<200	<600	<200	210	<400	<400
470	08-22-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
490	08-22-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
505	09-04-90	<200	200	<200	<200	<200	<600	<200	<200	<400	<400
520	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
530	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
540	08-31-89	<200	<200	<200	<200	<200	<600	3,500	1,200	1,200	2,100
560	09-04-90	<200	<200	<200	<200	<200	<600	240	430	<400	<400
580	08-23-89	<200	<200	<200	<200	<200	<600	240	<200	<400	<400
590A	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
590B	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
590C	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
595	08-31-89	<200	<200	<200	<200	<200	<600	660	880	480	590
600	08-22-89	<200	<200	<200	<200	<200	<600	430	<200	<400	<400
610	08-22-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
620	08-22-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
630	08-22-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
640	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
650	08-22-89	<200	<200	<200	<200	<200	<600	<200	280	<400	880
690	09-04-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
710	08-23-89	<200	<200	<200	<200	<200	<600	2,000	820	970	1,400
730	08-23-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
760	08-23-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
800	08-23-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
820	08-31-89	<200	1,000	<200	250	<200	<600	2,300	1,400	660	1,100
840	08-23-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
850	09-05-90	<200	<200	<200	<200	<200	<600	320	410	<400	440
890	08-23-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
920	08-31-89	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
930	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400
960	09-05-90	<200	<200	<200	<200	<200	<600	<200	<200	<400	<400

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	1,2-Dichlorobenzene (34539)	1,2,4-Trichlorobenzene (34554)	1,2,5,6-Dibenzanthracene (34559)	1,3-Dichlorobenzene (34569)	1,4-Dichlorobenzene (34574)	2-Chloronaphthalene (34584)	2-Chlorophenol (34589)	2-Nitrophenol (34594)	Di-N-octyl phthalate (34599)	2,4-Dichlorophenol (34604)
170	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
310	09-04-90	<200	<200	580	<200	<200	<200	<200	<200	<400	<200
320	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
330	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
340	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
360	08-31-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
380	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
390	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
400	08-31-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
410A	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
410B	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
410C	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
420	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
430	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
450	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
470	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
490	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
505	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
520	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
530	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
540	08-31-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
560	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
580	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
590A	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
590B	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
590C	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
595	08-31-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
600	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
610	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
620	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
630	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
640	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
650	08-22-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
690	09-04-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
710	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
730	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
760	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
800	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
820	08-31-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
840	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
850	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
890	08-23-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
920	08-31-89	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
930	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200
960	09-05-90	<200	<200	<400	<200	<200	<200	<200	<200	<400	<200

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	2,4-Di-methyl-phenol (34609)	2,4-Di-nitro-toluene (34614)	2,4-Di-nitro-phenol (34619)	2,4,6-Tri-chloro-phenol (34624)	2,6-Di-nitro-toluene (34629)	4-Bromo-phenyl phenyl ether (34639)	4-Chloro-phenyl phenyl ether (34641)	4-Nitro-phenol (34649)	4,6-Dinitro-ortho-cresol (34660)
170	09-04-90	<200	520	<600	<600	<200	<200	<200	<600	<600
310	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
320	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
330	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
340	09-04-90	<200	240	<600	<600	<200	<200	<200	<600	<600
360	08-31-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
380	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
390	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
400	08-31-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
410A	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
410B	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
410C	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
420	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
430	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
450	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
470	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
490	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
505	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
520	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
530	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
540	08-31-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
560	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
580	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
590A	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
590B	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
590C	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
595	08-31-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
600	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
610	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
620	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
630	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
640	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
650	08-22-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
690	09-04-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
710	08-23-89	<200	<600	<600	<600	<200	<200	<200	<600	<600
730	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
760	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
800	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
820	08-31-89	<200	2,700	<600	<600	270	<200	<200	<600	<600
840	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
850	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
890	08-23-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
920	08-31-89	<200	<200	<600	<600	<200	<200	<200	<600	<600
930	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600
960	09-05-90	<200	<200	<600	<600	<200	<200	<200	<600	<600

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	Phenol (34695)	Penta-chloro-phenol (39061)	Bis(2-ethyl-hexyl) phthal-ate (39102)	Di-N-butyl phthal-ate (39112)	PCN's (39251)	Aldrin (39333)	Lindane (39343)	Chlordane (39351)	DDD (39363)	DDE (39368)
170	09-04-90	<200	<600	2,500	440	670	<1.0	<0.1	<1.0	1.8	<1.0
310	09-04-90	<200	<600	<200	<200	40	<1.0	<1.0	<10	<10	<1.0
320	09-04-90	<200	<600	<200	<200	16	<.1	<.1	<1.0	<.1	<0.1
330	08-22-89	<200	<600	<200	<200	<1.0	<.3	<.1	<1.0	.2	2.0
340	09-04-90	<200	<600	<200	200	320	<.1	<.1	2.0	<.1	<1.0
360	08-31-89	<200	<600	<200	<200	<1.0	<.1	<.1	27	21	12
380	08-23-89	<200	<600	<200	<200	<1.0	<.1	<.1	<1.0	.7	1.2
390	09-05-90	<200	<600	<200	<200	25	<1.0	<1.0	<10	<10	<2.0
400	08-31-89	<200	<600	<200	<200	<1.0	<1.0	<.1	<1.0	12	<1.0
410A	09-05-90	<200	<600	<200	<200	40	<1.0	<.1	1.0	2.0	<1.0
410B	09-05-90	<200	<600	<200	<200	10	<1.0	<.1	<1.0	.3	<1.0
410C	09-05-90	<200	<600	<200	<200	<10	<1.0	<.1	<1.0	<.1	<1.0
420	08-22-89	<200	<600	<200	760	<1.0	<.1	<.1	7.0	96	55
430	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	9.0	2.7	3.9
450	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	2.0	.2	1.0
470	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	3.0	3.3	2.1
490	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	5.0	5.2	2.3
505	09-04-90	<200	<600	<200	<200	520	<1.0	<1.0	<10	<10	<10
520	09-04-90	<200	<600	<200	<200	30	<1.0	<.1	2.0	5.0	6.0
530	09-05-90	<200	<600	<200	<200	30	<1.0	<.1	1.0	4.6	<1.0
540	08-31-89	<200	<600	690	<200	<1.0	<1.0	<.1	71	130	3.5
560	09-04-90	<200	<600	1,300	<200	30	<1.0	<1.0	<10	<10	17
580	08-23-89	<200	<600	910	<200	<1.0	<.1	<.1	4.0	5.7	3.9
590A	09-04-90	<200	<600	340	<200	43	<1.0	<.1	4.0	<.1	<1.0
590B	09-04-90	<200	<600	<200	<200	<20	<1.0	<1.0	<10	<10	<10
590C	09-04-90	<200	<600	<200	<200	<1.0	<.1	<.1	<1.0	<.1	<.1
595	08-31-89	<200	<600	4,500	<200	<1.0	<10	<.1	30	12	<10
600	08-22-89	<200	<600	290	<200	<1.0	<.1	<.1	2.0	2.1	1.8
610	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	<1.0	.5	.6
620	08-22-89	<200	<600	550	<200	<1.0	<.1	<.1	1.0	1.2	1.3
630	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	1.0	3.8	<3.0
640	09-05-90	<200	<600	<200	<200	<100	<10	<1.0	30	80	40
650	08-22-89	<200	<600	<200	<200	<1.0	<.1	<.1	3.0	5.6	4.8
690	09-04-90	<200	<600	<200	<200	<10	<1.0	<.1	5.0	2.5	3.0
710	08-23-89	<200	<600	230	<200	<1.0	<.1	<.1	10	3.4	18
730	08-23-89	<200	<600	700	<200	<1.0	<.1	<.1	3.0	5.3	5.5
760	08-23-89	<200	<600	<200	<200	<1.0	<.1	<.1	1.0	6.8	2.4
800	08-23-89	<200	<600	<200	<200	<1.0	<.1	<.1	3.0	20	<30
820	08-31-89	<200	<600	1,100	3,400	<1.0	<.1	<.1	8.0	14	44
840	08-23-89	<200	<600	270	<200	<1.0	<.1	<.1	7.0	120	23
850	09-05-90	<200	<600	710	270	470	<10	<1.0	12	52	<10
890	08-23-89	<200	<600	<200	<200	<1.0	<.1	<.1	2.0	6.0	4.0
920	08-31-89	<200	<600	9,500	<200	<1.0	<.1	<.1	<1.0	.9	.2
930	09-05-90	<200	<600	<200	<200	<10	<1.0	<1.0	<10	<10	<1.0
960	09-05-90	<200	<600	<200	<200	<10	<1.0	<1.0	<10	<10	<1.0

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	DDT (39373)	Dieldrin (39383)	Endo-sulfan (39389)	Endrin (39393)	Ethion (39399)	Toxaphene (39403)	Hepta-chlor (39413)	Hepta-chlor-epoxide (39423)	Methoxy-chlor (39481)	PCB's (39519)
170	09-04-90	<1.0	<0.1	<0.1	<0.1	<0.1	<10	<0.1	<0.1	<0.1	<10
310	09-04-90	<10	<.1	<.1	<.1	<.1	<10	<1.0	<1.0	<10	<10
320	09-04-90	<.1	.1	<.1	<.1	<.1	<10	<2.0	<.1	<1.0	<1.0
330	08-22-89	.5	<.1	<.1	<.1	<1.0	<10	<4.0	<.1	<.1	50
340	09-04-90	<1.0	.5	<.1	<.1	<.1	<10	<50	<.1	<1.0	110
360	08-31-89	27	<.1	<.1	<.1	<1.0	<10	<.1	<.1	<.1	280
380	08-23-89	<.1	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	4
390	09-05-90	<10	<.1	<.1	<.1	<.1	<10	<1.0	<1.0	<10	<10
400	08-31-89	<1.0	<.1	<.1	<.1	<.1	<10	<1.0	<.1	<.1	280
410A	09-05-90	<1.0	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<10
410B	09-05-90	<1.0	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<10
410C	09-05-90	<1.0	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<10
420	08-22-89	19	<.1	<.1	<.1	<.1	<10	<.1	<.1	<1.0	870
430	08-22-89	.1	<.1	<.1	<.1	<.1	<10	<1.0	<.1	<.1	40
450	08-22-89	.2	<.1	<.1	<.1	<.1	<10	<2.0	<.1	<.1	14
470	08-22-89	1.5	<.1	<.1	<.1	<.1	<10	<5	<.1	<.1	21
490	08-22-89	.6	<.1	<.1	<.1	<.1	<10	<2.0	<.1	<.1	30
505	09-04-90	<10	<1.0	<.1	<.1	<.1	<10	<1.0	<1.0	<10	20
520	09-04-90	<1.0	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<10
530	09-05-90	<1.0	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<10
540	08-31-89	5.6	.1	<.1	<.1	<.9	<10	<1.0	<.1	<.1	44
560	09-04-90	<10	<1.0	<1.0	<1.0	<.1	<10	<.1	<1.0	<10	200
580	08-23-89	1.4	.2	<.1	<.1	<.1	<10	<2.2	.1	<.1	480
590A	09-04-90	<.1	<.1	<.1	<.1	<.1	<10	<1.0	<.1	<1.0	260
590B	09-04-90	<10	<.1	<.1	<.1	<.1	<10	<1.0	<1.0	<10	50
590C	09-04-90	<.1	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	28
595	08-31-89	<10	<.1	<.1	<.1	<1.0	<10	<10	<.1	<.1	4,400
600	08-22-89	4.0	<.1	<.1	<.1	<.1	<10	<.7	<.1	<.1	18
610	08-22-89	.9	<.1	<.1	<.1	<.1	<10	<.3	<.1	<.1	9
620	08-22-89	.5	.1	<.1	<.1	<.1	<10	<.4	<.1	<.1	8
630	08-22-89	<.4	<.1	<.1	<.1	<.1	<10	<.7	<.1	<.1	16
640	09-05-90	<10	3.0	<1.0	<1.0	<1.0	<100	<1.0	<1.0	<1.0	<100
650	08-22-89	2.3	<.1	<.1	<.1	<.1	<10	<1.0	<.1	<.1	23
690	09-04-90	<1.0	.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<10
710	08-23-89	56	.3	<.1	<.1	<.1	<10	<1.1	<.1	<1.0	160
730	08-23-89	1.6	<.1	<.1	<.1	<.1	<10	<1.7	<.1	<.1	20
760	08-23-89	10	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	12
800	08-23-89	<100	<.1	<.1	<.1	<.1	<10	<3.0	<.1	<.1	97
820	08-31-89	<.1	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	1,800
840	08-23-89	5.4	<.1	<.1	<.1	<.1	<10	<11	<.1	<.1	190
850	09-05-90	<10	.3	<.1	<.1	<.1	<10	<1.0	<1.0	<10	100
890	08-23-89	3.5	<.1	<.1	<.1	<.1	<10	<.9	<.1	<.1	47
920	08-31-89	.8	<.1	<.1	<.1	<.1	<10	<.1	<.1	<.1	<1.0
930	09-05-90	<10	<.1	<.1	<.1	<.1	<10	<1.0	<1.0	<10	<10
960	09-05-90	<10	<.1	<.1	<.1	<.1	<10	<1.0	<1.0	<10	<10

Appendix 2. Results of analyses of streambed samples for selected base/neutral- and acid extractable compounds, organochlorine and organophosphorus insecticides, and other organic compounds, 1989-90--Continued

Site	Date	Malathion (39531)	Para-thion (39541)	Diazinon (39571)	Methyl para-thion (39601)	Hexa-chloro-benzene (39701)	Hexa-chloro butadiene (39705)	Mirex (39758)	Trithion (39787)	Methyl trithion (39791)	Perthane (81886)
170	09-04-90	<0.1	<0.1	<0.1	<0.1	<200	<200	6.0	<0.1	<0.1	<1.0
310	09-04-90	<.1	<.1	<.1	<.1	<200	<200	2.0	<.1	<.1	<10
320	09-04-90	<.1	<.1	<.1	<.1	<200	<200	96	<.1	<.1	<1.0
330	08-22-89	<1.0	<1.0	<1.0	<1.0	<200	<200	6,500	<1.0	<1.0	<1.0
340	09-04-90	<.1	<.1	<.1	<.1	<200	<200	2,200	<.1	<.1	<1.0
360	08-31-89	.7	<.1	.6	<.1	<200	<200	690	<.1	<.1	<1.0
380	08-23-89	<.1	<.1	<.1	<.1	<200	<200	<0.1	<.1	<.1	<1.0
390	09-05-90	<.1	<.1	<.1	<.1	<200	<200	120	<.1	<.1	<10
400	08-31-89	<.1	<.1	<.1	<.1	<200	<200	690	<.1	<.1	<1.0
410A	09-05-90	<.1	<.1	.2	<.1	<200	<200	60	<.1	<.1	<1.0
410B	09-05-90	<.1	<.1	<.1	<.1	<200	<200	88	<.1	<.1	<1.0
410C	09-05-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<1.0
420	08-22-89	<.1	<.1	<.1	<.1	<200	<200	1,500	<.1	<.1	<1.0
430	08-22-89	<.1	<.1	<.1	<.1	<200	<200	17	<.1	<.1	<1.0
450	08-22-89	<.1	<.1	<.1	<.1	<200	<200	17	<.1	<.1	<1.0
470	08-22-89	<.1	<.1	<.1	<.1	<200	<200	44	<.1	<.1	<1.0
490	08-22-89	<.1	<.1	<.1	<.1	<200	<200	130	<.1	<.1	<1.0
505	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<10
520	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<1.0
530	09-05-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<1.0
540	08-31-89	<.1	<.1	<.1	<.1	<200	<200	.5	<.1	<.1	<1.0
560	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<10
580	08-23-89	<.1	<.1	<.1	<.1	<200	<200	.4	<.1	<.1	<1.0
590A	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<1.0
590B	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<10
590C	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<.1	<.1	<.1	<1.0
595	08-31-89	<1.0	<1.0	<1.0	<1.0	<200	<200	2.4	<1.0	<1.0	<1.0
600	08-22-89	<.1	<.1	<.1	<.1	<200	<200	12	<.1	<.1	<1.0
610	08-22-89	<.1	<.1	<.1	<.1	<200	<200	18	<.1	<.1	<1.0
620	08-22-89	<.1	<.1	<.1	<.1	<200	<200	4.9	<.1	<.1	<1.0
630	08-22-89	<.1	<.1	<.1	<.1	<200	<200	2.9	<.1	<.1	<1.0
640	09-05-90	<1.0	<1.0	<1.0	<1.0	<200	<200	<10	<1.0	<1.0	<10
650	08-22-89	<.1	<.1	<.1	<.1	<200	<200	42	<.1	<.1	<1.0
690	09-04-90	<.1	<.1	<.1	<.1	<200	<200	<1.0	<.1	<.1	<1.0
710	08-23-89	<.1	<.1	.2	<.1	<200	<200	1.3	<.1	<.1	<10
730	08-23-89	<.1	<.1	<.1	<.1	<200	<200	23	<.1	<.1	<1.0
760	08-23-89	<.1	<.1	<.1	<.1	<200	<200	13	<.1	<.1	<1.0
800	08-23-89	<.1	<.1	<.1	<.1	<200	<200	48	<.1	<.1	<1.0
820	08-31-89	<.1	<.1	<.1	<.1	<200	<200	450	<.1	<.1	<1.0
840	08-23-89	<.1	<.1	<.1	<.1	<200	<200	110	<.1	<.1	<1.0
850	09-05-90	<.1	<.1	<.1	<.1	<200	<200	500	<.1	<.1	<10
890	08-23-89	<.1	<.1	<.1	<.1	<200	<200	28	<.1	<.1	<1.0
920	08-31-89	<.1	<.1	<.1	<.1	<200	<200	1.0	<.1	<.1	<1.0
930	09-05-90	<.1	<.1	<.1	<.1	<200	<200	7.0	<.1	<.1	<10
960	09-05-90	<.1	<.1	<.1	<.1	<200	<200	6.0	<.1	<.1	<10

[1] Constituent-analysis code used by U.S. Geological Survey National Water Quality Laboratory

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90

[Constituents are total, except as noted; concentrations in micrograms per liter, except as noted; --, constituent not determined; <, less than; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; all samples collected in 1990 were analyzed at the U.S. Geological Survey laboratory in Trenton, New Jersey]

Site	Date	Temperature (°C) [1](00010)	Field specific conductance (µS/cm) (00095)	Lab specific conductance (µS/cm) (90095)	Dissolved solids (mg/L) (70300)	Lab alkalinity (mg/L as $CaCO_3$) (90410)	Dissolved oxygen (mg/L) (00300)	Field pH (units) (00400)	Lab pH (units) (00403)	Organic carbon (mg/L as C) (00680)	Organic carbon, dissolved (mg/L as C) (00681)
60	04-05-84	--	--	--	--	--	--	--	--	--	--
120	04-05-84	--	--	--	--	--	--	--	--	--	--
180	04-05-84	7.0	--	--	--	--	--	--	--	--	--
	09-11-84	16.0	62	61	48	10	10.0	7.00	7.00	4.0	4.0
310	04-05-84	8.5	--	--	--	--	--	--	--	--	--
	09-11-84	19.0	74	77	46	12	8.3	7.00	7.20	6.4	4.4
	07-16-86	22.0	246	--	--	--	9.2	6.90	--	--	--
375	09-11-84	18.0	348	363	223	57	9.1	7.80	8.10	1.6	1.6
430	04-05-84	8.5	--	--	--	--	--	--	--	--	--
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	120	--	--	--	--	6.90	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
450	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
550	09-11-84	20.0	192	193	117	42	7.8	7.60	7.30	2.5	3.0
570	11-09-87	--	150	--	--	--	--	7.20	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--	--
595	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	24.0	135	138	86	27	8.3	7.90	7.20	3.3	3.2
600	09-11-84	20.0	240	240	163	47	9.0	7.60	7.60	2.5	2.7
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	118	--	--	--	--	7.20	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
630	09-11-84	20.0	260	262	156	46	7.7	7.30	7.00	3.5	3.5
890	04-05-84	--	--	--	--	--	--	--	--	--	--
920	09-11-84	19.0	230	242	153	38	4.2	7.10	6.70	3.8	4.0
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	140	--	--	--	--	7.30	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90--Continued

Site	Date	Ammonia, dissolved (mg/L as N) (00608)	Ammonia (mg/L as N) (00610)	Nitrite, dissolved (mg/L as N) (00613)	Nitrite (mg/L as N) (00615)	Ammonia + organic N dissolved (mg/L as N) (00623)	Ammonia + organic N (mg/L as N) (00625)	Nitrite + nitrate, (mg/L as N) (00630)	Nitrite + nitrate, dissolved (mg/L as N) (00631)	Phos-phorus (mg/L as P) (00665)	Phos-phorus, dissolved (mg/L as P) (00666)
60	04-05-84	--	--	--	--	--	--	--	--	--	--
120	04-05-84	--	--	--	--	--	--	--	--	--	--
180	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	.020	.030	<.010	<.010	.30	.50	<.100	<.100	<.010	.010
310	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	.040	.130	<.010	<.010	.30	.80	<.100	<.100	.020	.020
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	--	--	--	--	--	--	--	--	--	--
430	04-05-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
450	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
550	09-11-84	.080	.090	<.010	<.010	.30	.30	<.100	<.100	<.010	.010
570	11-09-87	--	--	--	--	--	--	--	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--	--
595	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	.020	.030	<.010	.010	.50	.60	<.100	<.100	.040	.040
600	09-11-84	.120	.140	<.010	.010	.10	.30	.200	.210	.020	.010
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
630	09-11-84	.360	.340	.040	.030	1.0	1.0	1.00	.960	.180	.160
890	04-05-84	--	--	--	--	--	--	--	--	--	--
920	09-11-84	.600	.610	.140	.140	.90	1.2	1.10	1.00	.170	.090
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90--Continued

Site	Date	Calcium, dissolved (mg/L) (00915)	Magnesium, dissolved (mg/L) (00925)	Sodium, dissolved (mg/L) (00930)	Potassium, dissolved (mg/L) (00935)	Chloride, dissolved (mg/L) (00940)	Sulfate, dissolved (mg/L as SO_4) (00945)	Fluoride, dissolved (mg/L) (00950)	Silica, dissolved (mg/L as SiO_2) (00955)	Mercury, dissolved (71890)	Mercury, total recov-erable (71900)
60	04-05-84	--	--	--	--	--	--	--	--	--	<0.10
120	04-05-84	--	--	--	--	--	--	--	--	--	<.10
180	04-05-84	--	--	--	--	--	--	--	--	--	.10
	09-11-84	4.2	1.6	3.7	.30	7.2	7.4	<.10	3.1	.2	.30
310	04-05-84	--	--	--	--	--	--	--	--	--	<.10
	09-11-84	4.8	1.7	5.7	.50	--	7.5	<.10	.29	.2	.30
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	27	8.3	26	1.1	62	20	.10	16	.1	.10
430	04-05-84	--	--	--	--	--	--	--	--	--	<.10
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
450	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
550	09-11-84	13	4.1	17	1.0	26	12	.10	7.5	.1	.10
570	11-09-87	--	--	--	--	--	--	--	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--	--
595	04-05-84	--	--	--	--	--	--	--	--	--	.20
	09-11-84	8.4	2.5	13	.70	16	13	<.10	3.3	.1	.10
600	09-11-84	16	6.2	19	2.1	35	18	.10	5.8	.2	.10
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
630	09-11-84	17	6.3	20	1.4	37	18	.10	5.7	.2	.20
890	04-05-84	--	--	--	--	--	--	--	--	--	.20
920	09-11-84	15	5.4	20	1.5	33	16	<.10	4.8	.1	.10
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--

Site	Date	Arsenic, dis-solved (01000)	Arsenic (01002)	Berylium, total recov-erable (01012)	Cadmium, dis-solved (01025)	Cadmium, total recov-erable (01027)	Chromium, dis-solved (01030)	Chromium, total recov-erable (01034)	Cobalt, dis-solved (01035)	Cobalt, total recov-erable (01037)	Copper, dis-solved (01040)
60	04-05-84	--	1	--	--	<1	--	--	--	--	--
120	04-05-84	--	1	--	--	<1	--	10	--	--	--
180	04-05-84	--	1	--	--	<1	--	--	--	--	--
	09-11-84	<1	1	--	<1	<1	<10	20	<1	<1	4
310	04-05-84	--	1	<10	--	<1	--	20	--	--	--
	09-11-84	<1	1	--	<1	<1	<10	10	<1	<1	3
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	<1	1	--	<1	<1	<10	10	1	1	1
430	04-05-84	--	1	<10	--	<1	--	10	--	--	--
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
450	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
550	09-11-84	<1	1	--	1	<1	<10	10	<1	<1	1
570	11-09-87	--	--	--	--	--	--	--	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--	--
595	04-05-84	--	1	--	--	1	--	--	--	--	--
	09-11-84	<1	1	--	<1	<1	10	20	1	1	16
600	09-11-84	<1	1	--	<1	<1	<10	40	3	<1	6
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
630	09-11-84	<1	1	--	<1	<1	<10	20	2	1	6
890	04-05-84	--	1	--	--	1	--	40	--	--	--
920	09-11-84	<1	1	--	<1	<1	<10	10	1	<1	6
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90—Continued

Site	Date	Copper, total recov-erable (01042)	Iron, total recov-erable (01045)	Iron, dis-solved (01046)	Lead, dis-solved (01049)	Lead, total recov-erable (01051)	Manganese, total recov-erable (01055)	Manganese, dis-solved (01056)	Molybdenum, total recov-erable (01062)	Nickel, total recov-erable (01067)	Zinc, dis-solved (01090)
60	04-05-84	24	--	--	--	17	230	--	<1	3	--
120	04-05-84	2	--	--	--	10	30	--	<1	2	--
180	04-05-84	19	--	--	--	18	140	--	<1	3	--
	09-11-84	4	320	120	<1	8	30	17	--	--	11
310	04-05-84	7	--	--	--	12	20	--	<1	2	--
	09-11-84	5	440	150	2	21	40	15	--	--	6
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	2	460	9	<1	8	50	4	--	--	6
430	04-05-84	15	--	--	--	3	60	--	<1	1	--
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
450	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
550	09-11-84	1	230	70	<1	9	20	14	--	--	9
570	11-09-87	--	--	--	--	--	--	--	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--	--
595	04-05-84	15	--	--	--	11	70	--	<1	4	--
	09-11-84	18	330	89	1	6	20	7	--	--	63
600	09-11-84	6	270	150	1	10	80	70	--	--	11
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
630	09-11-84	7	610	210	<1	9	140	130	--	--	21
890	04-05-84	35	--	--	--	21	150	--	1	7	--
920	09-11-84	7	970	150	<1	9	70	68	--	--	14
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90--Continued

Site	Date	Zinc, total recov-erable (01092)	Aluminum, total recov-erable (01105)	Aluminum, dis-solved (01106)	Lithium, total recov-erable (01132)	Selenium, dis-solved (01145)	Selenium (01147)	Bromo-di-chloro-methane (32101)	Carbon-tetra-chloride (32102)	1,2-Di-chloro-ethane (32103)	Bromo-form (32104)
60	04-05-84	110	950	--	<10	--	<1	--	--	--	--
120	04-05-84	50	170	--	<10	--	11	--	--	--	--
180	04-05-84	60	540	--	<10	--	<1	--	--	--	--
	09-11-84	20	50	20	--	<1	<1	--	--	--	--
310	04-05-84	90	90	--	<10	--	<1	--	--	--	--
	09-11-84	20	30	<10	--	<1	<1	--	--	--	--
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	10	140	10	--	<1	<1	--	--	--	--
430	04-05-84	40	--	--	<10	--	<1	--	--	--	--
	08-07-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	09-10-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	10-29-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	03-12-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	04-30-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	05-20-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	06-04-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	08-25-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	09-29-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	11-09-87	--	--	--	--	--	--	<.20	<.20	<.20	<.20
	04-18-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	06-08-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	07-11-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	08-06-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
450	04-18-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	06-08-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	07-11-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	08-06-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
550	09-11-84	20	40	<10	--	<1	<1	--	--	--	--
570	11-09-87	--	--	--	--	--	--	.30	<.20	<.20	<.20
580	12-02-83	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
595	04-05-84	190	510	--	<10	--	<1	--	--	--	--
	09-11-84	70	50	30	--	<1	<1	--	--	--	--
600	09-11-84	20	20	<10	--	<1	<1	--	--	--	--
	08-07-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	09-10-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	10-29-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	03-12-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	04-30-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	05-20-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	06-04-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	08-25-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	09-29-87	--	--	--	--	--	--	<2.9	<3.0	<3.0	<3.0
	11-09-87	--	--	--	--	--	--	<.20	<.20	<.20	<.20
	04-18-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	06-08-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	07-11-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	08-06-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
630	09-11-84	20	40	10	--	<1	<1	--	--	--	--
890	04-05-84	60	630	--	<10	--	<1	--	--	--	--
920	09-11-84	10	60	<10	--	<1	<1	--	--	--	--
	08-07-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	09-10-86	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	03-12-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	04-30-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	05-20-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	06-04-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	08-25-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	09-29-87	--	--	--	--	--	--	<3.0	<3.0	<3.0	<3.0
	11-09-87	--	--	--	--	--	--	<.20	<.20	<.20	<.20
	04-18-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	06-08-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	07-11-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0
	08-06-90	--	--	--	--	--	--	<1.0	<1.0	<1.0	<1.0

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90—Continued

Site	Date	Dibromo-chloro-methane (32105)	Chloro-form (32106)	Phenol (32730)	Toluene (34010)	Benzene (34030)	Chloro-benzene (34301)	Chloro-ethane (34311)	Ethyl-benzene (34371)	Methyl-bromide (34413)	Methyl-chloride (34418)
60	04-05-84	--	--	--	--	--	--	--	--	--	--
120	04-05-84	--	--	--	--	--	--	--	--	--	--
180	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	--	--	<1	--	--	--	--	--	--	--
310	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	--	--	<1	--	--	--	--	--	--	--
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	--	--	<1	--	--	--	--	--	--	--
430	04-05-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-10-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	10-29-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	03-12-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	04-30-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	05-20-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	06-04-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08-25-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-29-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	11-09-87	<.20	<.20	--	<.20	<.20	<.20	<.20	<.20	<.20	<.20
	04-18-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	06-08-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	07-11-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	08-06-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
450	04-18-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	06-08-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	07-11-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	08-06-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
550	09-11-84	--	--	<1	--	--	--	--	--	--	--
570	11-09-87	<.20	1.9	--	<.20	<.20	<.20	<.20	<.20	<.20	<.20
580	12-02-83	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--
595	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	--	--	<1	--	--	--	--	--	--	--
600	09-11-84	--	--	<1	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-10-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	10-29-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	03-12-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	04-30-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	05-20-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	06-04-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08-25-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-29-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	11-09-87	<.20	.20	--	<.20	<.20	<.20	<.20	<.20	<.20	<.20
	04-18-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	06-08-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	07-11-90	<1.0	1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	08-06-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
630	09-11-84	--	--	<1	--	--	--	--	--	--	--
890	04-05-84	--	--	--	--	--	--	--	--	--	--
920	09-11-84	--	--	<1	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-10-86	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	03-12-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	04-30-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	05-20-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	06-04-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08-25-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-29-87	<3.0	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	11-09-87	<.20	.50	--	<.20	<.20	<.20	<.20	<.20	<.20	<.20
	04-18-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	06-08-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	07-11-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
	08-06-90	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90--Continued

Site	Date	Methylene chloride (34423)	Tetra-chloro-ethylene (34475)	Tri-chloro-fluoro-methane (34488)	1,1-Di-chloro-ethane (34496)	1,1-Di-chloro-ethylene (34501)	1,1,1-Tri-chloro-ethane (34506)	1,1,2-Tri-chloro-ethane (34511)	1,1,2,2 Tetra-chloro-ethane (34516)	1,2-Di-chloro-benzene (34536)	1,2-Di-chloro-propane (34541)
60	04-05-84	--	--	--	--	--	--	--	--	--	--
120	04-05-84	--	--	--	--	--	--	--	--	--	--
180	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	--	--	--	--	--	--	--	--	--	--
310	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	--	--	--	--	--	--	--	--	--	--
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	--	--	--	--	--	--	--	--	--	--
430	04-05-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	10-29-86	<3.0	4.6	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	03-12-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	04-30-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	05-20-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	06-04-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08-25-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-29-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	11-09-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
	04-18-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	06-08-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
450	04-18-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	06-08-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
550	09-11-84	--	--	--	--	--	--	--	--	--	--
570	11-09-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
580	12-02-83	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
595	04-05-84	--	--	--	--	--	--	--	--	--	--
	09-11-84	--	--	--	--	--	--	--	--	--	--
600	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	10-29-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	03-12-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	04-30-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	05-20-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	06-04-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08-25-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-29-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	11-09-87	<.20	.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
	04-18-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	06-08-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
630	09-11-84	--	--	--	--	--	--	--	--	--	--
890	04-05-84	--	--	--	--	--	--	--	--	--	--
920	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	03-12-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	04-30-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	05-20-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	06-04-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08-25-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	09-29-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	11-09-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
	04-18-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	06-08-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90--Continued

Site	Date	Trans-1,2-Di-chloro-ethylene[2] (34546)	Cis-1,2-Di-chloro-ethylene[2] (77093)	1,3-Di-chloro-benzene (34566)	1,4-Di-chloro-benzene (34571)	2-Chloro-ethyl-vinyl-ether (34576)	Dichloro-difluoro-methane (34668)	Trans-1,3-Di-chloro-propene (34699)	Cis-1,3-Di-chloro-propene (34704)	Perthane (39034)	1,2-Dibromo-ethlyene (39082)
60	04-05-84	--	--	--	--	--	--	--	--	<0.1	--
120	04-05-84	--	--	--	--	--	--	--	--	<.1	--
180	04-05-84	--	--	--	--	--	--	--	--	<.1	--
	09-11-84	--	--	--	--	--	--	--	--	--	--
310	04-05-84	--	--	--	--	--	--	--	--	<.1	--
	09-11-84	--	--	--	--	--	--	--	--	--	--
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	--	--	--	--	--	--	--	--	--	--
430	04-05-84	--	--	--	--	--	--	--	--	<.1	--
	08-07-86	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	09-10-86	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	10-29-86	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	03-12-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	04-30-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	05-20-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	06-04-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	08-25-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	09-29-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	11-09-87	<.20	--	<.20	<.20	<.20	<.20	<.20	<.20	--	<.20
	04-18-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	06-08-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
450	04-18-90	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	06-08-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
550	09-11-84	--	--	--	--	--	--	--	--	--	--
570	11-09-87	<.20	--	<.20	<.20	<.20	<.20	<.20	<.20	--	<.20
580	12-02-83	<3.0	--	--	--	<3.0	<3.0	--	--	--	--
595	04-05-84	--	--	--	--	--	--	--	--	<.1	--
	09-11-84	--	--	--	--	--	--	--	--	--	--
600	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	09-10-86	5.7	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	10-29-86	11	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	03-12-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	04-30-87	5.4	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	05-20-87	4.8	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	06-04-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	08-25-87	5.8	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	09-29-87	<4.7	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	11-09-87	2.3	--	<.20	<.20	<.20	<.20	<.20	<.20	--	<.20
	04-18-90	<1.0	3.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	06-08-90	<1.0	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	07-11-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
630	09-11-84	--	--	--	--	--	--	--	--	--	--
890	04-05-84	--	--	--	--	--	--	--	--	<.1	--
920	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	09-10-86	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	03-12-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	04-30-87	<6.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	05-20-87	4.2	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	06-04-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	08-25-87	3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	09-29-87	<3.0	--	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0
	11-09-87	1.9	--	<.20	<.20	<.20	<.20	<.20	<.20	--	<.20
	04-18-90	<1.0	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	06-08-90	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	07-11-90	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0
	08-06-90	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	<1.0

Appendix 3. Results of analyses of surface-water samples for selected physical and chemical properties, major ions, nutrients, organic carbon, trace elements, volatile organic compounds, organochlorine insecticides, and other organic compounds, 1983-90--Continued

Site	Date	Vinyl chloride (39175)	Tri-chloro-ethylene (39180)	Styrene (77128)	Xylene (81551)	PCN's (39250)	Aldrin (39330)	Lindane (39340)	Chlordane (39350)	DDD (39360)	DDE (39365)
60	04-05-84	--	--	--	--	<0.10	<0.010	<0.010	<0.1	<0.010	<0.010
120	04-05-84	--	--	--	--	<.10	<.010	<.010	<.1	<.010	<.010
180	04-05-84	--	--	--	--	<.10	<.010	<.010	<.1	<.010	<.010
	09-11-84	--	--	--	--	--	--	--	--	--	--
310	04-05-84	--	--	--	--	<.10	<.010	<.010	<.1	<.010	<.010
	09-11-84	--	--	--	--	--	--	--	--	--	--
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	--	--	--	--	--	--	--	--	--	--
430	04-05-84	--	--	--	--	<.10	<.010	<.010	<.1	<.010	<.010
	08-07-86	<3.0	<3.0	<3.0	--	--	--	--	--	--	--
	09-10-86	<3.0	<3.0	<3.0	--	--	--	--	--	--	--
	10-29-86	<3.0	<3.0	<3.0	--	--	--	--	--	--	--
	03-12-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	04-30-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	05-20-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	06-04-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	08-25-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	09-29-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	11-09-87	<.20	.3	<2	<.2	--	--	--	--	--	--
	04-18-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	06-08-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	07-11-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	08-06-90	<1.0	<1.0	--	--	--	--	--	--	--	--
450	04-18-90	<1.0	1.0	--	--	--	--	--	--	--	--
	06-08-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	07-11-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	08-06-90	<1.0	<1.0	--	--	--	--	--	--	--	--
550	09-11-84	--	--	--	--	--	--	--	--	--	--
570	11-09-87	<.20	<.20	<.20	<.20	--	--	--	--	--	--
580	12-02-83	<3.0	<3.0	--	--	--	--	--	--	--	--
595	04-05-84	--	--	--	--	<.10	<.010	<.010	<.1	<.010	<.010
	09-11-84	--	--	--	--	--	--	--	--	--	--
600	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	<3.0	--	--	--	--	--	--	--
	09-10-86	<3.0	3.5	<3.0	--	--	--	--	--	--	--
	10-29-86	<3.0	3.6	<3.0	--	--	--	--	--	--	--
	03-12-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	04-30-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	05-20-87	<3.0	3.8	<3.0	<3.0	--	--	--	--	--	--
	06-04-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	08-25-87	<3.0	3.6	<3.0	<3.0	--	--	--	--	--	--
	09-29-87	<3.0	<3.3	<3.0	<3.0	--	--	--	--	--	--
	11-09-87	<.20	2.5	<.2	<.2	--	--	--	--	--	--
	04-18-90	<1.0	2.0	--	--	--	--	--	--	--	--
	06-08-90	<1.0	2.0	--	--	--	--	--	--	--	--
	07-11-90	<1.0	1.0	--	--	--	--	--	--	--	--
	08-06-90	<1.0	<1.0	--	--	--	--	--	--	--	--
630	09-11-84	--	--	--	--	--	--	--	--	--	--
890	04-05-84	--	--	--	--	<.10	<.010	<.010	<.1	<.010	<.010
920	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	<3.0	<3.0	<3.0	--	--	--	--	--	--	--
	09-10-86	<3.0	<3.0	<3.0	--	--	--	--	--	--	--
	03-12-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	04-30-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	05-20-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	06-04-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	08-25-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	09-29-87	<3.0	<3.0	<3.0	<3.0	--	--	--	--	--	--
	11-09-87	<.20	1.8	<.2	<.2	--	--	--	--	--	--
	04-18-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	06-08-90	<1.0	<1.0	--	--	--	--	--	--	--	--
	07-11-90	<1.0	1.0	--	--	--	--	--	--	--	--
	08-06-90	<1.0	<1.0	--	--	--	--	--	--	--	--

Site	Date	DDT (39370)	Dieldrin (39380)	Endo-sulfan (39388)	Endrin (39390)	Toxaphene (39400)	Hepta-chlor (39410)	Hepta-chlor epoxide (39420)	Methoxy-chlor (39480)	PCB's (39516)	Mirex (39755)
60	04-05-84	<0.010	<0.010	<0.010	<0.010	<1	<0.010	<0.010	<0.01	<0.1	<0.01
120	04-05-84	<.010	<.010	<.010	<.010	<1	<.010	<.010	<.01	<.1	<.01
180	04-05-84	<.010	<.010	<.010	<.010	<1	<.010	<.010	<.01	<.1	<.01
	09-11-84	--	--	--	--	--	--	--	--	--	--
310	04-05-84	<.010	<.010	<.010	<.010	<1	<.010	<.010	<.01	<.1	.02
	09-11-84	--	--	--	--	--	--	--	--	--	--
	07-16-86	--	--	--	--	--	--	--	--	--	--
375	09-11-84	--	--	--	--	--	--	--	--	--	--
430	04-05-84	<.010	<.010	<.010	<.010	<1	<.010	<.010	<.01	<.1	2.0
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
450	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
550	09-11-84	--	--	--	--	--	--	--	--	--	--
570	11-09-87	--	--	--	--	--	--	--	--	--	--
580	12-02-83	--	--	--	--	--	--	--	--	--	--
595	04-05-84	<.010	<.010	<.010	<.010	<1	<.010	<.010	<.01	<.1	<.01
	09-11-84	--	--	--	--	--	--	--	--	--	--
600	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	10-29-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--
630	09-11-84	--	--	--	--	--	--	--	--	--	--
890	04-05-84	<.010	<.010	<.010	<.010	<1	<.010	<.010	<.01	<.1	.04
920	09-11-84	--	--	--	--	--	--	--	--	--	--
	08-07-86	--	--	--	--	--	--	--	--	--	--
	09-10-86	--	--	--	--	--	--	--	--	--	--
	03-12-87	--	--	--	--	--	--	--	--	--	--
	04-30-87	--	--	--	--	--	--	--	--	--	--
	05-20-87	--	--	--	--	--	--	--	--	--	--
	06-04-87	--	--	--	--	--	--	--	--	--	--
	08-25-87	--	--	--	--	--	--	--	--	--	--
	09-29-87	--	--	--	--	--	--	--	--	--	--
	11-09-87	--	--	--	--	--	--	--	--	--	--
	04-18-90	--	--	--	--	--	--	--	--	--	--
	06-08-90	--	--	--	--	--	--	--	--	--	--
	07-11-90	--	--	--	--	--	--	--	--	--	--
	08-06-90	--	--	--	--	--	--	--	--	--	--

[1] Constituent-analysis code used by U.S. Geological Survey National Water Quality Laboratory

[2] The U.S. Geological Survey National Water Quality Laboratory in Denver, Colorado, reports both trans- and cis-1,2-dichloroethylene as trans-1,2-dichloroethylene