CONTAMINATION OF SHALLOW GROUND WATER IN THE AREA OF BUILDING 95, PICATINNY ARSENAL, NEW JERSEY, 1985-90

By B. Pierre Sargent and Donald A. Storck

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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
foot per day (ft/d)	0.3048	meter per day
	Mass	
pound (lb)	0.4536	kilogram
	Temperature	
degree Fahrenheit (°F)	$°C = 5/9 \times (°F - 32)$	degree Celsius

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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/kg, micrograms per kilogram
µg/L, micrograms per liter
mg/L, milligrams per liter
mL, milliliters
mL/min, milliliters per minute
min, minute
PCB's, polychlorinated biphenyls
PVC, polyvinyl chloride
TCE, trichloroethylene
VOC's, volatile organic compounds

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ABSTRACT

A zone of contaminated ground water at Picatinny Arsenal has resulted from the operation of a metal-plating facility in building 95 during 1960-81 and the wastewater-treatment system that is in and adjacent to the building. A drive-point reconnaissance survey was conducted in 1986 and 1988 to determine the optimum locations for wells. Thirty-two monitoring wells were installed in 1989 to supplement 12 previously installed wells. Water samples were collected in 1989 and 1990 for analysis for inorganic constituents, trace elements, volatile organic compounds, and nutrients. Ground water from four wells also was analyzed for base/neutral- and acid-extractable compounds and pesticides, and soil gas from the unsaturated zone at eight sites was analyzed for volatile organic compounds.

Concentrations of dissolved solids and sulfate in the study area consistently exceeded U.S. Environmental Protection Agency secondary maximum contaminant levels. The areal distribution of sulfate differed from that of the volatile organic compounds derived from the wastewater-treatment system. Concentrations of trace elements were not elevated downgradient from the source. If contaminants are assumed to move with ground water by advection, the estimated average velocity of contaminant movement is 0.1 to 1.1 feet per day.

The major organic contaminants in the study area are trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane. Trichloroethylene was detected in wells upgradient from the wastewater-treatment site. Tetrachloroethylene and 1,1,1-trichloroethane might originate at three possible sources: (1) leaky tanks in building 95, (2) the site of the former lagoons, and (3) leakage from sewage lines to the sewage-treatment plant.

The predominant gas-phase contaminant, 1,1,1-trichloroethane, was detected at a maximum concentration of 15.7 micrograms per liter. Both trichloroethylene and tetrachloroethylene were detected in concentrations greater than 0.10 micrograms per liter in five of the eight soil-gas samples, indicating that volatilization and diffusion through the unsaturated zone might be a significant mechanism of contaminant loss from the aquifer.

INTRODUCTION

Picatinny Arsenal, officially known since 1986 as the U.S. Army Armament Research Development and Engineering Center, encompasses more than 1,500 buildings on 6,491 acres (fig. 1) of an elongated valley just north of the Wisconsinan terminal moraine in north-central New Jersey (fig. 1 inset).

The arsenal site has a long history of industrial activity. 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, the arsenal produced many types of ammunition and, during World War II, expanded production to include bombs, high explosives, pyrotechnics, and other ordnance items. In recent years, the arsenal's mission has shifted to research and development of large-caliber munitions.

History of Ground-Water Contamination

The detection in March 1981 of several volatile organic compounds (VOC's)--specifically, chlorinated solvents (Foster Wheeler USA Corporation, 1987)--in two of the arsenal's water-supply wells in the area 1 mi southwest of Picatinny Lake (fig. 2) prompted a study by the U.S. Army Environmental Hygiene Agency (USAEHA) to identify the sources of contamination. Study findings indicated buildings 24 and 95 (fig. 2), where trichloroethylene (TCE) and similar solvents had been used in metal-degreasing operations for several decades, to be possible sources. The primary wastewater-generating operations in building 95 included the plating of copper, tin, and lead; electroless plating; photodeveloping; chrome etching; photochemical resistant stripping; and hexavalent chromium reduction with sulfur dioxide. Contaminants in the wastewater included fine metal particles, TCE, tetrachloroethylene, 1,1,1-trichloroethane, hydrogen sulfate, sulfuric acid, hydrochloric acid, phosphoric acid, sodium phosphate, and ammonium phosphate.

In 1960, industrial wastewater-treatment systems were built in and adjacent to buildings 24 and 95 (fig. 2) to treat wastewater from the etching and plating operations (Foster Wheeler USA Corporation, 1987). The building 95 system discharged treated wastewater into a 1,500-ft^2 sludge-drying bed and from there to two 12,500-gallon filter-bed lagoons. The drying bed and lagoons had earthen bottoms that allowed wastewater to infiltrate into the ground. Local topography and drainage patterns at the site indicate that contaminants probably could migrate about 1,500 ft southward toward Green Pond Brook, a tributary to the Rockaway River.

In March 1981, the U.S. Army installed four ground-water monitoring wells near building 95 and the waste-disposal area and excavated the drying beds and replaced the soil with fill. During installation of one of the monitoring wells, a broken pipe was found that apparently had directed wastewater from the lagoons to a drainage ditch. Sediments near the broken pipe contained cyanide in concentrations of 150,000 μg/kg and copper in concentrations of 1,460,000 μg/kg (D.C. Bayha, U.S. Army Environmental Hygiene Agency, written commun., 1981).

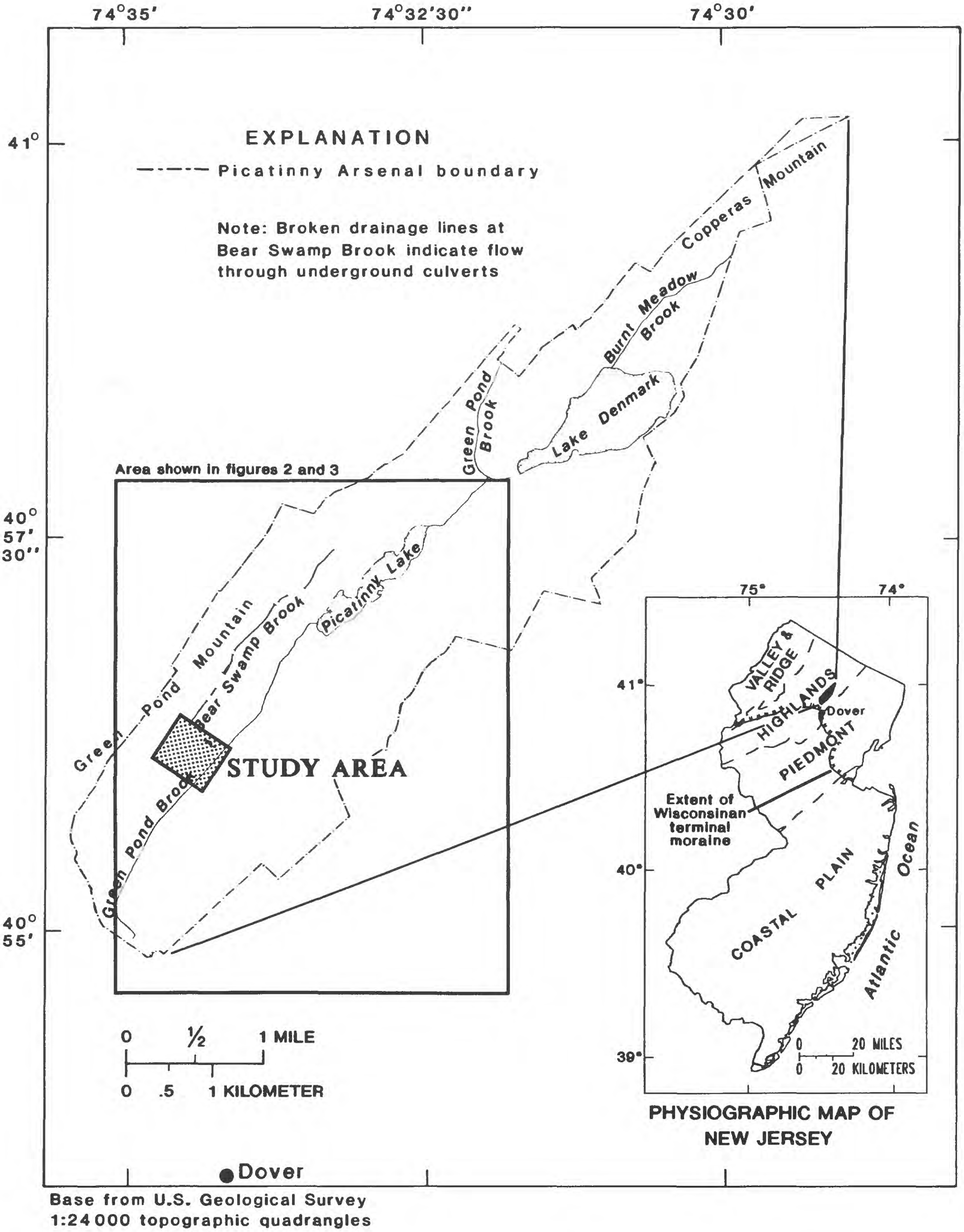
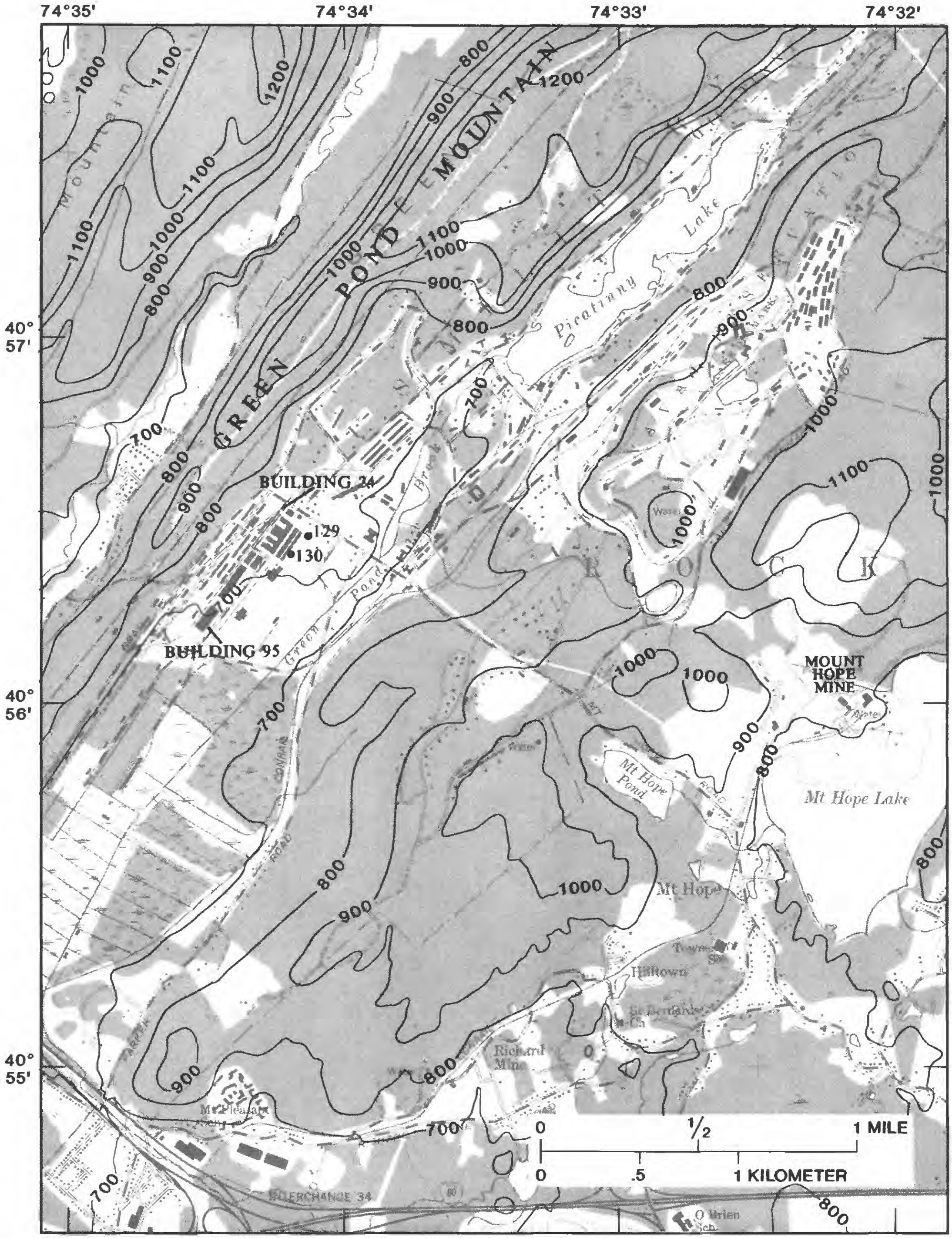


Figure 1.--Location of the study area and principal geographic features of Picatinny Arsenal, Morris County, New Jersey. (Modified from Sargent and others, 1986)



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
•130	LOCATION OF WATER-SUPPLY WELLS--Number is local identifier

Figure 2.--Physical features in the vicinity of Picatinny Arsenal. (Modified from Sargent and others, 1990) (Location is shown in fig. 1.)

In 1982, the U.S. Geological Survey (USGS), in cooperation with the U.S. Army, began an assessment of the water resources of the arsenal. Initial USGS efforts included (1) surface geophysical surveys, (2) supervision of test drilling and installation of monitoring wells by the U.S. Army Corps of Engineers, (3) collection of water-level data, (4) aquifer tests, (5) establishment of streamflow-gaging stations, (6) measurement of base flow in Green Pond and Bear Swamp Brooks, (7) sampling and analysis of surface water and ground water, and (8) development of a computerized data base for surface-water and hydrogeologic data. Results of that assessment are summarized in reports by Sargent and others (1986), Lacombe and others (1986), and Harte and others (1986).

In March 1986, the USGS, in cooperation with the U.S. Army, began a detailed assessment of ground-water quality at the arsenal as required under the Resource Conservation and Recovery Act (RCRA--Public Law 94-580, October 21, 1976), which regulates operations at hazardous-waste-treatment facilities. On the basis of results of preliminary assessments of contamination from the metal-plating operations at buildings 24 and 95, a decision was made to investigate these areas (Foster Wheeler USA Corp., 1987).

Objective of Study

In 1985 the USGS, in cooperation with the U.S. Army Armament Research Development and Engineering Center, began a 4-year investigation to delineate the extent of ground-water contamination in the vicinity of the former wastewater lagoons at building 95 and to estimate the rate of contaminant movement. The study also addressed the presence of contamination in the unsaturated zone. As a part of this study, 32 monitoring wells were installed in 1989 to supplement the 12 previously installed wells, and drive-point reconnaissance surveys were made in 1986 and 1988 at 13 sites near building 95 and the former lagoons to provide additional data on the distribution of contaminants in the shallow ground-water system.

Purpose and Scope

This report summarizes the results of sampling and analysis of shallow ground water from 1985 through 1990 in the vicinity of the building 95 wastewater-treatment system, sludge-drying bed, and filter-bed lagoons. It discusses the results of chemical analyses of water samples from all wells and drive points and includes maps showing the concentrations of selected contaminants at specified depths. The report also includes tables of results of chemical analyses of ground-water samples and presents data on soil gases collected at eight sites to detect the volatilization of ground-water contaminants.

Acknowledgments

The authors thank the personnel of the Environmental Engineering Section of the U.S. Army Armament Research Development and Engineering Center for assistance in the planning and implementation of this investigation, and Wayne A. Fox of the U.S. Army Environmental Hygiene Agency for providing technical guidance during the initial planning stages. Thanks also are

extended to Ira May and Roxanne Moran of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) for assistance in the later stages of the investigation. Richard Walker, formerly of the USGS, designed the drive-point sampler used in the investigation.

STUDY AREA

Picatinny Arsenal lies within an elongated valley 7 mi long and 1.5 mi wide that extends northeast-southwest in Morris County, New Jersey (fig. 1). 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. Green Pond and Copperas Mountains have rugged, steep, rocky slopes and exceed 1,200 ft in elevation. The slopes on the east are less rugged and less steep and reach elevations of about 1,100 ft.

Location and Physical Setting

The area around building 95 (fig. 1) consists of about 50 acres of flat, swampy, and wooded land that is crossed by roads, fire breaks, and drainage channels. The area includes the sites of the former seepage lagoons and drying bed, and the area between them and Green Pond Brook. Land-surface elevation ranges from 687 to 695 ft above sea level. Surface drainage is toward Green Pond Brook or toward drainage channels that discharge into Green Pond Brook.

Geologic Setting

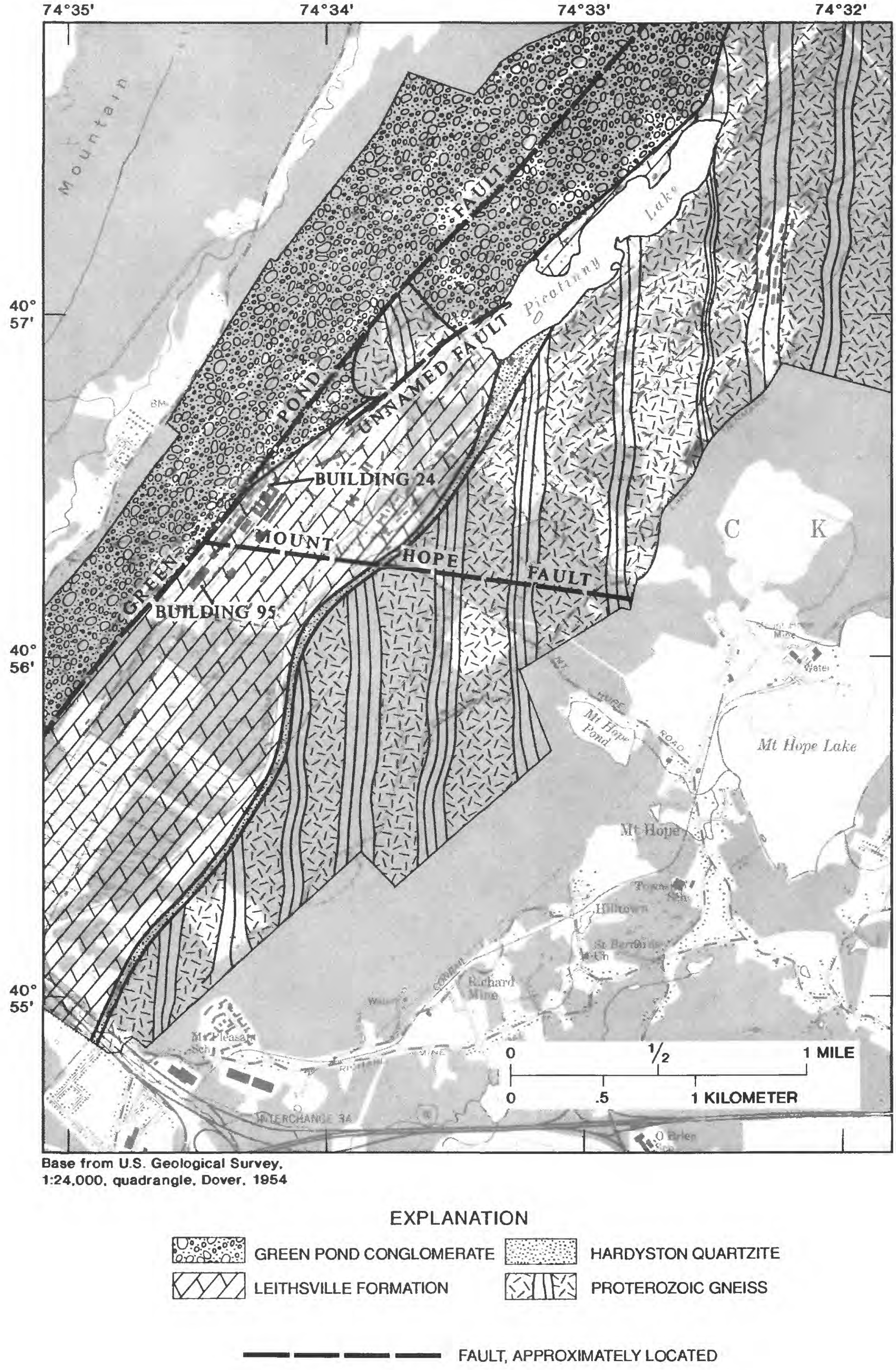
Picatinny Arsenal is within the Green Pond Syncline, a structural region of the New Jersey Highlands physiographic province (fig. 1, inset). The New Jersey Highlands comprises a northeast-southwest-trending system of folded and faulted rocks of Proterozoic to Devonian age that form a sequence of valleys and ridges. The ridges typically are broad, rounded, or flat-topped; the valleys typically are deep and narrow. Ridge crests rise about 400 to 600 ft above the valley floor (Wolf, 1977, p. 226).

The study area is underlain by unconsolidated deposits of sand, silt, clay, and peat, which in turn are underlain by bedrock, as described below.

Bedrock

The Green Pond Syncline is a narrow, northeast-southwest-trending, faulted syncline containing narrow outliers of Paleozoic rocks. The Paleozoic rocks typically lie unconformably on the Proterozoic rocks, which are exposed on the eastern side of the syncline (fig. 3). Thrust faults and folds in the Paleozoic rocks have obscured the contact between the basement and cover rocks (Lyttle and Epstein, 1987).

The oldest bedrock unit, a hornblende granite and associated alaskite of Middle Proterozoic age, is exposed at the southeastern entrance to the arsenal (Puffer, 1980, p. 50). The granite is pinkish buff to greenish buff and has a distinct gneissoid structure. The granite is mapped as an alaskite of which mafic minerals constitute less than 5 percent by volume (table 1). The alaskite facies is closely associated with magnetite-ore deposits that were mined west of the arsenal.



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

Figure 3.--Generalized bedrock geology in the study area. (Modified from Lyttle and Epstein, 1987; Gregory Herman, New Jersey Geological Survey, written commun., 1988) (Location is shown in figure 1.)

Table 1.--Stratigraphic and geohydrologic characteristics of geologic units at Picatinny Arsenal

[Modified from Drake, 1969, table 20; Sims, 1958, pl. 1; Gill and Vecchioli, 1965, table 3]

Time-stratigraphic unit			Geologic unit	Maximum thickness (in feet)		
Era	System	Series	Formation or lithologic unit		Lithology	Geohydrologic characteristics
Cenozoic	Quaternary	Holocene	Alluvium	10	Ranges from a sandy loam in the valley to a stony gravel on hillsides	Too thin to be tapped
			Swamp deposits (muck)	30	Black, brown, and gray organic material	High permeability along organic layers
		Pleistocene	Stratified drift	200+	Present in the form of glaciofluvial and glaciolacustrine deposits, mostly sand- to clay-size sediments; exhibits stratification and some rhythmic laminations (varves)	Yield depends on degree of sorting and grain size; the well-sorted and coarse-grained deposits are good aquifers with yields up to 2,200 gallons per minute; clay and silt deposits generally are unsuitable as aquifers
			Unstratified drift	100+	Present in the form of ground, terminal, and recessional moraine. Deposits generally are tightly packed and poorly sorted; grain sizes range from boulders to clay Unconformity	Yield depends on degree of sorting and packing; generally low yields
Paleozoic	Silurian	Middle and Lower	Green Pond Conglomerate	1500+	Coarse quartz conglomerate interbedded with and grading upward into quartzite and sandstone, generally massive and red but may contain white and green beds Unconformity	Generally yields small amount of water from fracture and joints
	Cambrian	Middle and Lower	Leithsville Formation	1000+	Predominantly a light- to medium-gray, microcrystalline, locally stylolitic rock to a fissile, siliceous to dolomitic micrite texture rock; commonly highly weathered to a medium-yellow, silty clay Gradational	Contains water-bearing fractures and solution cavities that generally have moderate yields of up to 380 gallons per minute
		Lower	Hardyston Quartzite	200	Orthoquartzite to conglomeratic; generally well indurated Unconformity	Generally few fractures; yields small amounts of water
Proterozoic			Alaskite		Medium- to coarse-grained, predominantly granitoid gneiss composed principally of microperthite, quartz, and oligoclase; includes local bodies of microantiperthite granite and granite pegmatite; amphibolite inclusions are common	All three lithologic units have similar hydrologic characteristics; ground water occurs in fractures and joints; yields generally are low, and range from 26 to 75 gallons per minute
			Hornblende granite		Medium- to coarse-grained, predominantly granitoid gneiss composed principally of microperthite, quartz oligoclase, and hornblende; includes local bodies of biotite granite, horneblende granite gneiss, granodiroite, and granite pegmatite; amphibolite inclusions are common	
			Biotite-quartz-feldspar gneiss		Medium-to coarse-grained gneiss of widely varying composition; the predominant facies consists of biotite, quartz, and oligoclase; minor facies are characterized by abundant garnet and microperthite, and locally by sillimanite and graphite	

The Hardyston Quartzite is fine- to medium-grained, white to dark-gray, thin- to medium-bedded, feldspathic quartzite of Lower Cambrian age, interbedded with arkose, quartz-pebble conglomerate, and silty shale or phyllite. The contact with the underlying Proterozoic granite is unconformable and abrupt. Thickness of the unit ranges from 0 to 100 ft in New Jersey (Lyttle and Epstein, 1987).

The Leithsville Formation is interbedded, light- to medium-gray, coarse-grained dolomite and calcitic dolomite of Middle and Lower Cambrian age, with thin layers of quartz and dolomitic sandstone (Wolf, 1977, p. 46). The lower contact typically is gradational with the underlying Hardyston Quartzite. The Leithsville Formation is about 800 ft thick and contains mud cracks, ripple marks, and graded beds (Wolf, 1977, p. 46).

The Green Pond Conglomerate is gray to reddish gray sandstone and conglomerate of Middle and Lower Silurian age, with predominantly white quartz and minor gray, green, red, and yellow chert, red shale, and red sandstone cobbles (Lyttle and Epstein, 1987). The lower contact is separated from the Leithsville Formation by the Green Pond fault. Thickness ranges from 984 to 1,394 ft (Lyttle and Epstein, 1987).

Glacial Deposits

Continental ice sheets advanced across northern New Jersey at least twice during the Quaternary Period (Stanford, 1989). As a result, the bedrock surface is covered by a mantle of unconsolidated glacial deposits, predominantly till in the upland areas and stratified drift in the valleys. The distribution and characteristics of the stratified drift reflect the manner in which the area was deglaciated. Deglaciation began about 18,000 years ago and progressed in stages. The southernmost extent of glaciation is delineated by a terminal moraine at the southwestern boundary of the arsenal (fig. 1). The initial melting of ice north of the terminal moraine caused the formation of a temporary proglacial lake, Lake Picatinny, in the Green Pond Brook valley. The southern end of Glacial Lake Picatinny was dammed by the moraine, and northward drainage was blocked by the glacier. The glacier receded to the southern end of the present-day Picatinny Lake, where it deposited a ridge of till (fig. 1). The lake drained southeastward through a gap in a bedrock ridge at an elevation of about 700 ft above sea level and subsequently became filled with a sequence of sediments--sublacustrine sand and gravel overlain by lake-bottom and deltaic fine-grained sand and silt and capped by deltaic sand and gravel. After deglaciation, silt and clay and, finally, peat were deposited on floodplains and in large ice-blocked depressions along Green Pond Brook.

DATA-COLLECTION AND ANALYTICAL METHODS

Data collection began in 1985 with the sampling of previously installed monitoring wells in the study area. Additional water-quality information was obtained through a drive-point reconnaissance survey conducted in 1986 and 1988. Thirty-two additional monitoring wells were subsequently installed in 1989 in areas of suspected contamination, and water samples were then collected from all monitoring wells in the study area.

Drive-Point Installation and Sampling

Ground-water-quality data collected in the vicinity of building 95 before 1989 were obtained from wells with 10-ft-long screens, most of which were placed 10 to 20 ft below land surface. The presence of contaminants at depths greater than 20 ft below land surface could not be verified, and the vertical stratification of contaminants in the ground-water system could not be determined. In order to determine the vertical distribution of contaminant concentrations, a temporary drive-point sampling device was used to collect discrete ground-water samples from various depths. Drive-point sampling allowed three-dimensional delineation of the contaminant distribution and efficient selection of observation-well locations and screened intervals.

The drive-point sampler was constructed from a 2-ft length of steel AW drill rod in which rows of 1/2-in.-diameter holes were drilled. A stainless-steel screen made of 100-mesh wire cloth on an expanded steel support was inserted inside the drill rod to prevent sediment from entering the sampler. A hardened-steel drive point was screwed to the bottom of the sampler to facilitate driving the device into the subsurface. At the top of the sampler, a 0.25-in.-O.D. (outside diameter) tubing connector was threaded into the top of the coupling to attach the tubing used to collect water samples. Five-foot sections of AW drill rod were added to the drive-point sampler, and a drive plate with a 240-lb drive hammer was secured for driving. A truck-mounted or tripod-mounted cathead was used to drive the sampler into the ground. Samples were collected, typically at 5-ft depth intervals, from the water table, about 10 ft below land surface, to 50 or 55 ft below land surface.

Continuous lengths of polyethylene tubing were used to collect the water samples. The polyethylene tubing was sufficiently durable to withstand the force of driving and probably did not have a major effect on the concentrations of volatile organic constituents in the sampled water. Barcelona and others (1985) estimated that pumping contaminated water through a 15-m (49.21-ft) length of polyethylene tubing at a rate of 100 mL/min would result in a 10-percent loss of chlorinated hydrocarbons from a 40-μg/L mixture of chloroform, TCE, tetrachloroethane, and tetrachloroethylene. Sorption onto the tubing probably was minimal because the contact time between the ground water and the tubing was generally less than 5 min.

A peristaltic pump was used to collect the water samples. In field tests, the peristaltic pump resulted in a loss of 0 to 40 percent of VOC's (Imbrigiotta and others, 1988). Other sampling devices, such as bladder pumps or submersible pumps, result in less loss; but the peristaltic pump was the only device that could be used in conjunction with the drive-point sampler as a result of the sampler's construction. The recoveries and results obtained with this system were considered to be satisfactory because the drive-point sampler was intended only as a reconnaissance tool. More rigorous sampling was done near drive-point sites after installation of monitoring wells.

At each sampling depth, the sampler tubing was attached to the peristaltic pump, and water was pumped for at least 20 min before sample collection. In order to reduce the potential for vertical cross-contamination between sampling depths at a site, the sampler was flushed continuously with ground water. This method was more practical than removing the sampler from the borehole between sample collections. Minor cross-contamination between samples was not considered to be a problem because the drive-point survey was designed only as a reconnaissance to determine the general extent of contamination. Usually, 5 to 10 volumes of the sampler and discharge tubing were purged before sample collection. Temperature, pH, specific conductance, and dissolved-oxygen concentration were measured continuously until stability was reached to ensure collection of a representative sample. After sample collection at a specific depth, a 5-ft section of drill rod was attached, and the sampler was driven an additional 5 ft to the depth from which the next sample was collected.

The drive-point sampler and discharge tubing were decontaminated with methanol and deionized water between sampling sites. Analysis of field wash blanks collected after decontamination showed that concentrations of VOC's typically did not exceed the reporting limit of 1 μg/L.

Well Drilling

After drive-point sampling was completed, 32 monitoring wells of 2-in. I.D. (inside diameter) were installed in clusters in the study area (fig. 4). Well depths range from 9 to 68 ft below land surface. The wells were installed by use of a hollow-stem auger and were constructed with 5-ft PVC screens and PVC casings. Well-construction details for these wells and the previously installed wells that were sampled from June through July 1989 are given in table 2.

In order to reduce the possibility of cross-contamination of wells, all drilling equipment, well casings, and screens were steam-cleaned before installation in the borehole. The wells were completed by inserting the well screen and casing into the hollow auger stem. A sand pack was placed at least 5 ft above the top of the screen. The auger flights then were removed, and the remainder of the borehole was filled with a 100-percent bentonite grout. All of the wells were completed near land surface in flush-mounted locking roadway boxes or above-ground locking protective casings that were cemented at the top of the borehole to protect the well. The wells were developed to remove particles from the screen and sand pack by pumping until clear water was produced.

Soil-Gas Sampling

Soil-gas samples were collected and analyzed according to the methods described by Kammer and Smith (1988) and Smith and others (1990). Soil-gas samples were collected from the unsaturated zone by using probes constructed of 0.25-in.-I.D. stainless-steel tubes cut to the desired probe depth. The bottom 3 in. of each probe was slotted and covered with a fine-mesh stainless-steel screen. Probes were installed in an augered borehole at two or three depths ranging from 1 to 6 ft below land surface, at each of eight locations in the study area. (Locations are shown in fig. 22, farther on.) The screened intervals of the probes were separated by bentonite to minimize vertical transport of vapor during sampling.

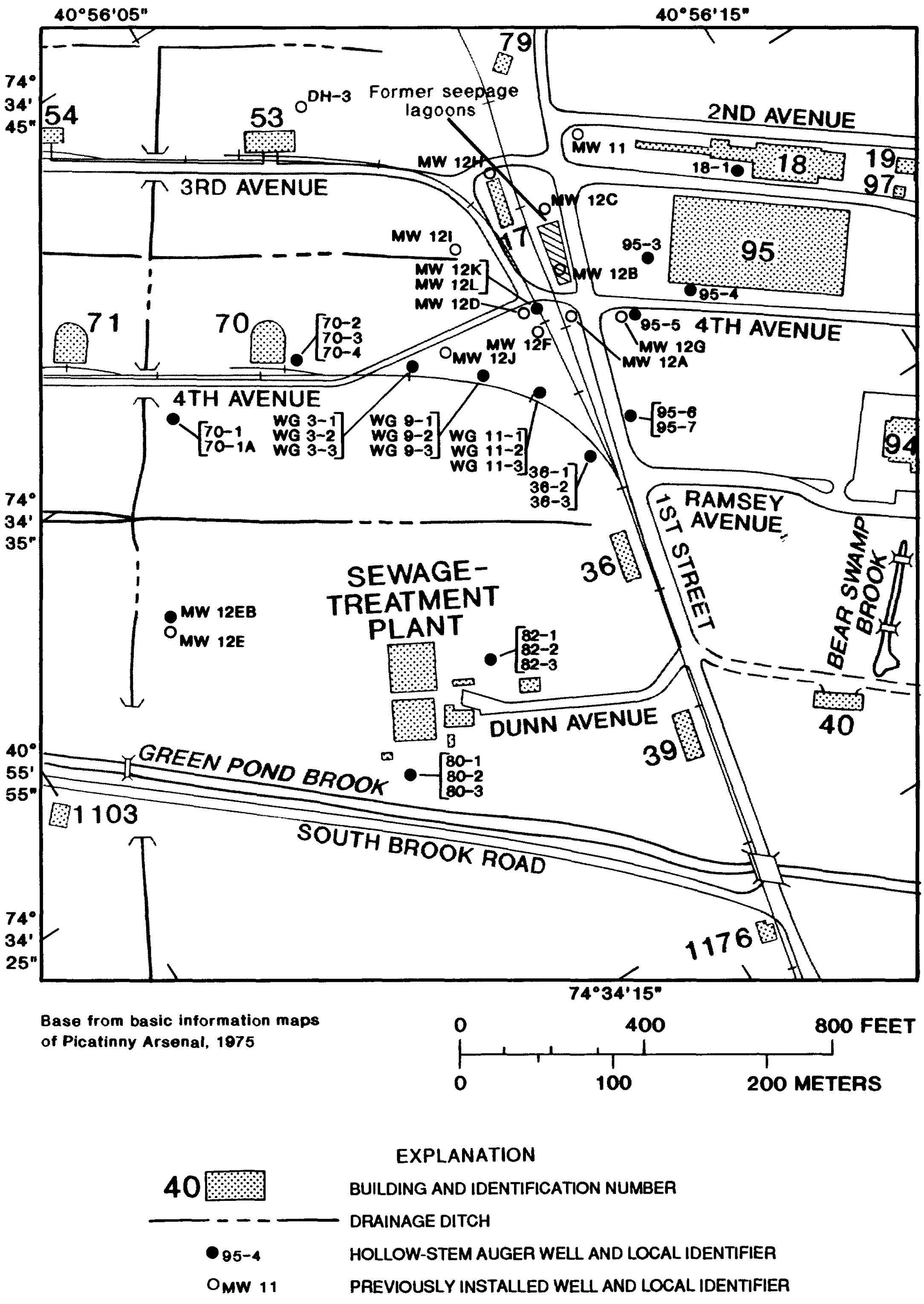


Figure 4.--Locations of wells sampled, 1985-90.

Table 2.--Well-construction and specific-capacity data for selected wells in the study area

[ft, feet; LSD, land-surface datum; gal/min, gallons per minute; (gal/min)/ft, gallons per minute per foot; all wells are screened in stratified drift (geologic unit code 112SFDF); - , data not available]

Well number	Local well identifier	Date completed	Elevation of land surface (ft above sea level)	Depth of screened interval (ft below LSD)	Screen diameter (inches)	Static water level (ft below LSD)	Date water level measured	Pumping water level (ft below LSD)	Pumping period (hours)	Yield (gal/min)	Specific capacity ((gal/min)/ft)
271271	18-1	05-09-89	697.61	10.6- 20.6	2	5.8	06-09-89	10.3	0.6	22	4.89
271297	95-3	05-17-89	696.75	10.5- 20.5	2	6.0	06-09-89	10.7	.42	25	5.32
271298	95-4	05-18-89	697.08	10.3- 20.3	2	6.0	06-09-89	8.2	.33	27.5	12.5
271299	95-5	08-01-89	695.33	16.2- 21.2	2	4.5	09-25-89	10.5	.25	12.5	2.08
271300	95-6	09-27-89	694.58	10.1- 15.1	2	3.44	09-27-89	-	-	-	-
271301	95-7	08-01-89	694.50	20.6- 25.6	2	4.54	09-27-89	-	-	-	-
270307	DH-3	10-12-84	694.47	46.0- 51.0	2	1.89	10-12-84	-	-	-	-
270097	MW 11	03-09-81	696.10	10.0- 21.3	4	5.30	08-01-83	6.80	.3	9.0	6.00
270098	MW 12A	03-09-81	694.28	8.2- 18.2	4	4.05	08-08-83	7.68	.2	9.0	2.48
270099	MW 12B	03-09-81	693.62	8.9- 19.3	4	3.47	08-08-83	9.90	.3	9.0	1.40
270100	MW 12C	03-09-81	694.0	3.4- 13.4	4	3.53	08-01-83	5.22	.3	9.0	5.33
270269	MW 12D	12-03-83	693.98	25.0- 30.0	4	4.00	01-21-84	28.0	2.0	42.8	1.78
270270	MW 12E	12-06-83	690.05	15.0- 20.0	4	4.00	12-08-83	16.70	4.0	2.8	.19
271270	MW 12EB	08-09-89	689.7	60.0- 65.0	2	-	-	-	-	-	-
270341	MW 12F	05-20-85	692.03	9.0- 14.0	2	2.40	05-09-85	9.90	2.0	4.0	.53
270342	MW 12G	05-20-85	695.19	13.5- 18.5	2	4.90	05-29-85	11.74	.5	5.0	.73
270340	MW 12H	05-20-85	693.22	9.0- 14.0	2	3.10	05-29-85	8.60	.5	55.0	10.0
270339	MW 12I	05-20-85	691.02	8.2- 13.2	2	1.50	05-29-85	3.25	1.0	8.0	1.13
270338	MW 12J	05-20-85	690.67	3.8- 8.8	2	.92	09-25-89	-	-	-	-
271295	MW 12K	05-17-89	694.09	33.1- 38.1	2	-	06-13-89	19.85	.75	6	-
271296	MW 12L	05-17-89	694.11	18.6- 23.6	2	4.12	06-13-89	19.28	.75	4	.26
271283	WG 3-1	05-18-89	690.75	31.8- 36.8	2	1.69	06-06-89	2.87	.33	12	10.2
271284	WG 3-2	05-18-89	690.95	20.3- 25.3	2	1.58	06-06-89	-	-	-	-
271285	WG 3-3	05-18-89	690.71	9.8- 14.8	2	1.57	06-05-89	3.37	.6	19	10.6
271286	WG 9-1	05-05-89	691.40	26.0- 31.0	2	.21	06-06-89	21.07	.33	6	.29
271287	WG 9-2	05-17-89	691.37	23.2- 28.2	2	1.75	06-06-89	4.48	.33	17	6.23
271288	WG 9-3	05-25-89	691.35	9.5- 14.5	2	1.74	06-06-89	11.89	.5	14	1.38
271292	WG 11-1	05-08-89	691.89	20.1- 25.1	2	3.12	06-06-89	16.82	.5	7	.51
271293	WG 11-2	05-09-89	692.47	9.8- 14.8	2	2.34	06-09-89	-	-	-	-
271294	WG 11-3	05-19-89	692.34	29.1- 34.1	2	1.04	06-06-89	20.14	.5	12	.63
271289	36-1	05-23-89	692.37	35.1- 45.1	2	1.14	06-06-89	23.55	.75	3.5	.16
271290	36-2	05-24-89	692.26	19.6- 24.6	2	2.38	06-06-89	4.83	.5	17	6.94
271291	36-3	05-24-89	692.21	10.9- 15.9	2	2.65	06-06-89	7.35	.5	21	4.47
271275	70-1	05-03-89	690.06	58.0- 68.0	2	.27	05-16-89	-	-	-	-
271276	70-1A	05-15-89	690.12	10.1- 15.1	2	1.03	05-16-89	9.80	.33	13	1.48
271280	70-2	05-04-89	691.30	34.6- 39.6	2	2.33	06-05-89	26.45	1.6	3.3	.14
271281	70-3	05-04-89	691.50	10.0- 15.0	2	2.80	06-05-89	10.32	.6	12	1.60
271282	70-4	05-04-89	691.97	21.3- 26.3	2	3.17	06-05-89	17.84	1.0	13.5	.92
271272	80-1	05-09-89	690.57	24.8- 29.8	2	4.18	09-25-89	24.81	1.0	6.5	.32
271273	80-2	05-09-89	690.63	9.4- 14.4	2	4.70	09-25-89	8.49	.67	22	5.81
271274	80-3	05-11-89	690.77	37.8- 47.8	2	4.31	06-13-89	18.29	1.0	8.5	.61
271277	82-1	05-10-89	690.03	12.8- 17.8	2	1.71	06-22-89	11.81	1.0	7	.69
271278	82-2	05-10-89	690.20	22.9- 27.9	2	1.94	06-22-89	23.01	1.0	6	.28
271279	82-3	05-11-89	690.87	37.8- 42.8	2	1.93	06-22-89	25.98	2.8	.5	.02

Samples were collected by drawing soil gas through the probes and into two 125-mL glass sampling bulbs with Teflon[1] stopcocks at both ends. The sampling bulbs were connected in parallel to the vapor probe by a glass "Y" joint. A peristaltic pump was used to induce gas flow through the bulbs at a rate of about 120 mL/min per bulb. After 1,000 mL of gas was removed from the soil, the stopcocks on the sampling bulbs were closed. The bulbs were spiked with bromochloromethane (a field vapor surrogate), and transported to the USGS laboratory in Trenton, New Jersey, for same-day analysis.

Each gas sample was analyzed by purging the organic vapors from the sampling bulb onto an adsorbent trap with 550 mL of helium. The compounds subsequently were desorbed from the trap onto a capillary gas-chromatography column. The concentrations of the organic vapors were quantified by a calibrated Hall electrolytic-conductivity detector. Vapor-calibration standards were prepared by injection of the neat compounds into a 2-L (0.5-gal) static dilution bottle. The large sample size (125 mL) discharged to the adsorbent trap, in combination with the sensitivity of the detector for halogenated organic compounds, yielded a method quantitation limit of 0.10 μg/L.

Ground-Water Sample Collection and Laboratory Methods

Ground-water samples for analysis for inorganic constituents, trace elements, nutrients, and VOC's were collected during June 1989-March 1990 at all 44 wells in the study area. Samples were collected, filtered, and preserved in accordance with accepted USGS field techniques (Brown and others, 1970; Wood, 1976). Field measurements included temperature, specific conductance, pH, dissolved-oxygen concentration, and alkalinity. Water from 2-in.-I.D. wells was purged by using a small-diameter, stainless-steel and Teflon submersible pump. All samples for analysis for inorganic constituents and nutrients were collected with the same pump; samples for analysis for VOC's and other organic constituents were collected by using a Teflon point-source bailer with Teflon-coated support wire.

Sampling progressed from wells that were expected to contain the lowest contaminant concentrations to those that were expected to contain the highest contaminant concentrations. In order to reduce the potential for cross-contamination among wells, sampling equipment was rinsed with deionized water between wells and was flushed several times with well water before sample collection. Samples were collected after removal of at least three casing volumes of water and after the measurements of temperature, pH, dissolved oxygen, and specific conductance had stabilized. Immediately after collection, samples were preserved and prepared for shipment to the laboratory.

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

Concentrations of inorganic constituents in drive-point and well samples were determined through the methods of Fishman and Friedman (1989) at the USGS National Water-Quality Laboratory (NWQL) in Denver, Colorado. Organic constituents, including organic carbon, organic nitrogen, and purgeable organic compounds, were determined by means of the methods described in Wershaw and others (1983). The method for organic analysis is equivalent to that used by the U.S. Environmental Protection Agency (USEPA) (Longbottom and Lichtenberg, 1982). Quality-assurance checks were conducted in accordance with the methods of Friedman and Erdmann (1982).

Analyses of drive-point and well samples for methane and VOC's were performed at the USGS laboratory in Trenton, New Jersey. The method used for determination of VOC's was a modification of USEPA methods 601 and 602 (Longbottom and Lichtenberg, 1982). Modifications included the use of a wide-bore capillary chromatography column; two selective detectors, a Hall electrolytic conductivity detector, and a photoionization detector connected in series; and subambient cooling. The method used for analysis of samples for methane is described by Kampbell and others (1989).

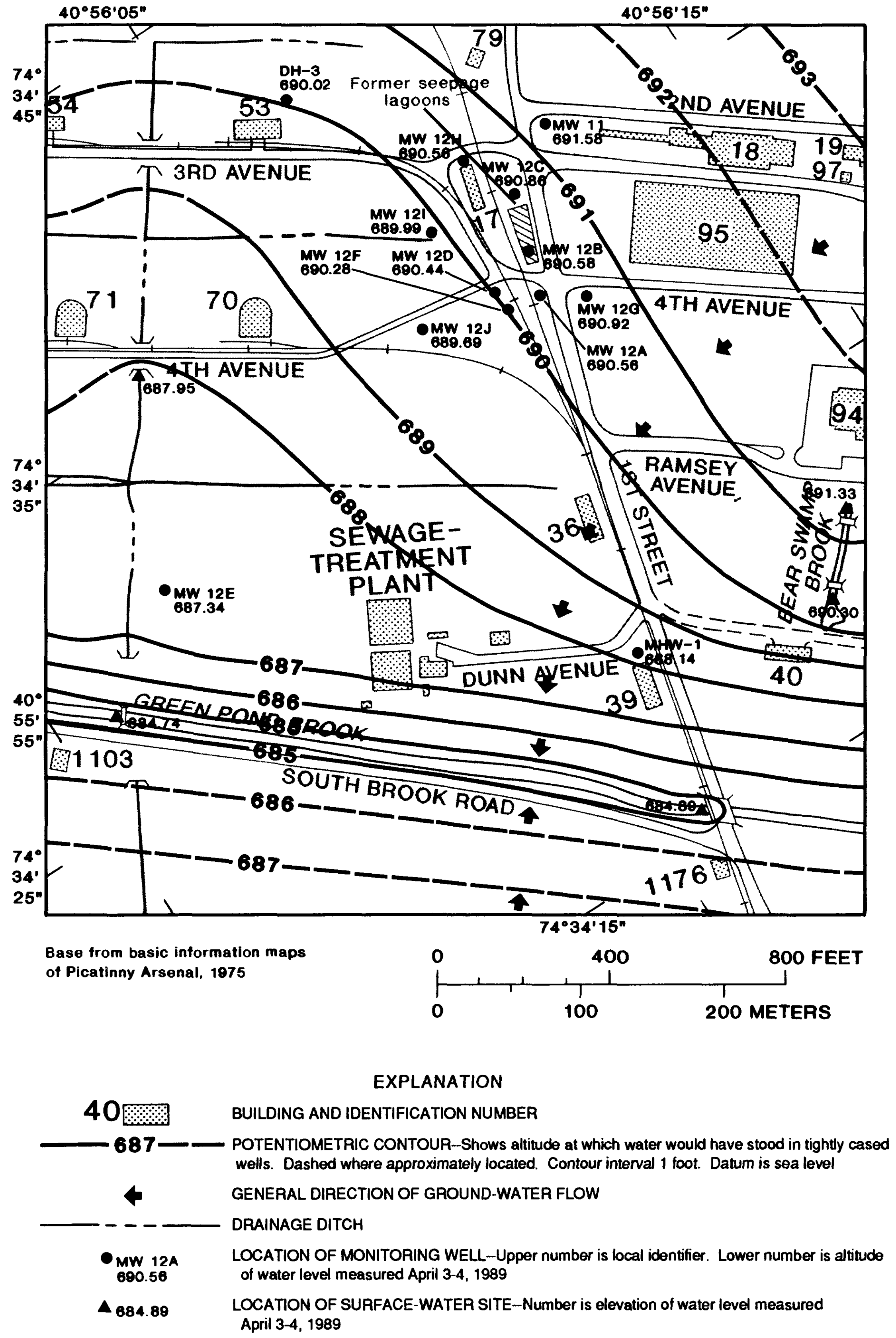
SHALLOW GROUND-WATER-FLOW SYSTEM

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 beneath the building 95 area consists of deltaic sand and gravel, and lake-bottom and deltaic fine-grained sand and silt to a depth of about 50 ft below land surface.

Water Levels

Maps showing the altitude of the water table were constructed from water levels measured in April and September 1989 to determine the direction of ground-water flow (fig. 5 and 6). April water levels are generally higher than September water levels in response to seasonal variations in precipitation and evapotranspiration. The water-table configuration is similar in both maps, however, because precipitation during the fall of 1989 was greater than normal. The water-table maps indicate that the direction of shallow ground-water flow was southward and toward Green Pond Brook during these periods. Swampy areas and drainage ditches southwest of building 95 tend to store water that backs up from Green Pond Brook, which is regulated by a weir 1 mi downstream. The control of Green Pond Brook's elevation can affect ground-water levels in the study area.

Water-level fluctuations in monitoring wells MW 11, MW 12A, and MW 12E from 1983 to 1984 are plotted in figure 7 with a graph of monthly precipitation (National Oceanic and Atmospheric Administration, 1983 and 1984). The seasonal fluctuation from April to October 1983 was about 3 ft. The water table at monitoring well MW 11 is consistently higher than at well MW 12A and, in 1984, water levels in both wells were consistently higher than that in well MW 12E. Because the land surface across this area slopes about 8 ft southward, the water-table gradient also slopes, despite the effect of the downstream weir on the stage of Green Pond Brook.



EXPLANATION

40 ▨ BUILDING AND IDENTIFICATION NUMBER

—— 687 —— POTENTIOMETRIC CONTOUR--Shows altitude at which water would have stood in tightly cased wells. Dashed where approximately located. Contour interval 1 foot. Datum is sea level

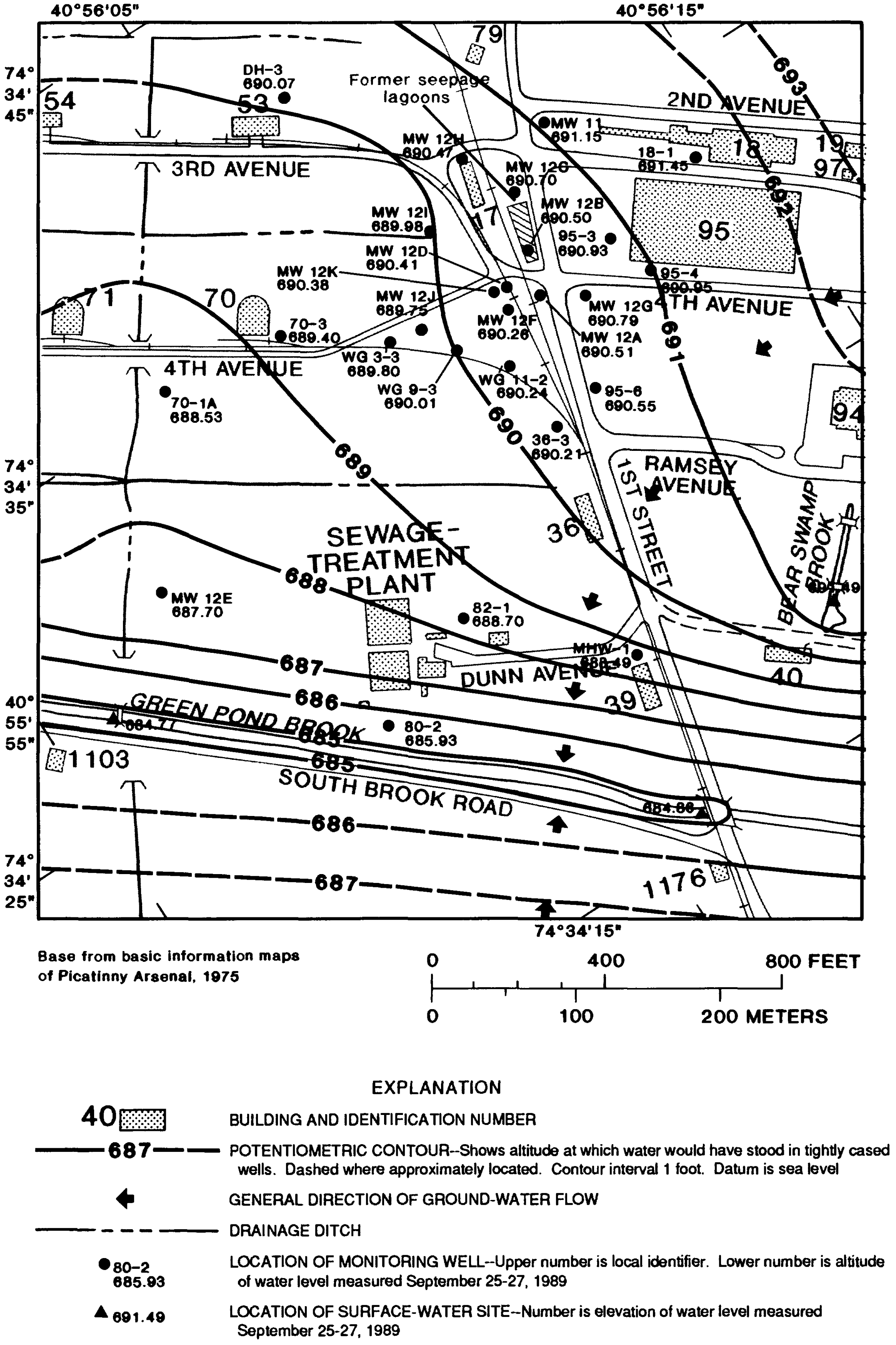
⬅ GENERAL DIRECTION OF GROUND-WATER FLOW

—— — — — —— DRAINAGE DITCH

● MW 12A 690.56 LOCATION OF MONITORING WELL--Upper number is local identifier. Lower number is altitude of water level measured April 3-4, 1989

▲ 684.89 LOCATION OF SURFACE-WATER SITE--Number is elevation of water level measured April 3-4, 1989

Figure 5.--Altitude of the water table and direction of ground-water flow in the vicinity of building 95, April 3-4, 1989.



EXPLANATION

40 ▨	BUILDING AND IDENTIFICATION NUMBER
——687——	POTENTIOMETRIC CONTOUR--Shows altitude at which water would have stood in tightly cased wells. Dashed where approximately located. Contour interval 1 foot. Datum is sea level
⬅	GENERAL DIRECTION OF GROUND-WATER FLOW
——— – – – ———	DRAINAGE DITCH
● 80-2 685.93	LOCATION OF MONITORING WELL--Upper number is local identifier. Lower number is altitude of water level measured September 25-27, 1989
▲ 691.49	LOCATION OF SURFACE-WATER SITE--Number is elevation of water level measured September 25-27, 1989

Figure 6.--Altitude of the water table and direction of ground-water flow in the vicinity of building 95, September 25-27, 1989.

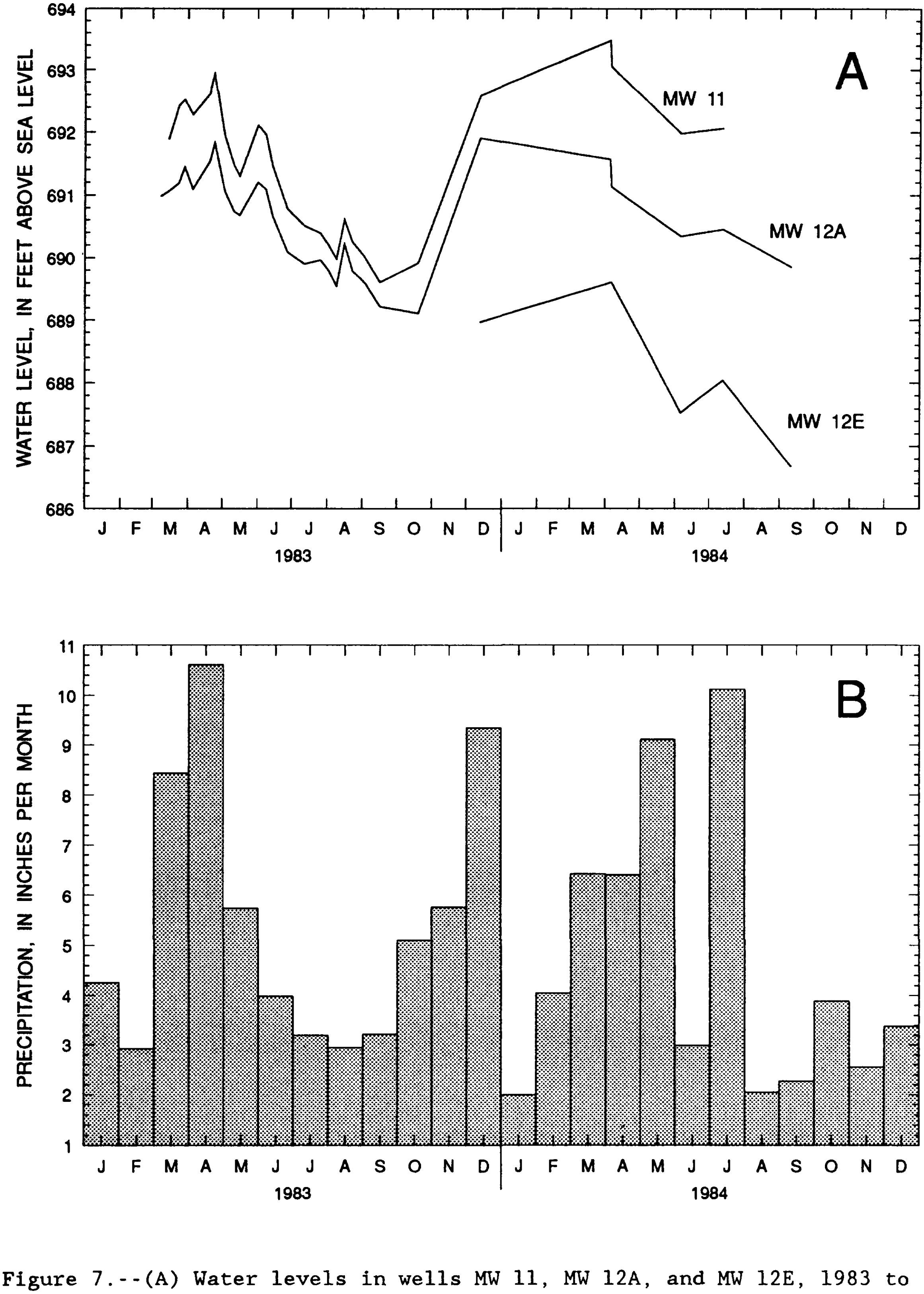


Figure 7.--(A) Water levels in wells MW 11, MW 12A, and MW 12E, 1983 to 1984, and (B) monthly precipitation at Split Rock Pond, New Jersey, January 1983 through December 1984. (Well locations shown in fig. 5.)

Rate of Ground-Water Flow

Accurate estimates of the rate of contaminant movement in the ground can be made only if the processes that control transport are accurately represented. The transport of contaminants involves chemical and biological processes as well as physical processes. Chemical processes that result in the transfer of contaminants among gas, liquid, and solid phases include adsorption, partitioning, volatilization, dissolution, precipitation, oxidation, and reduction. The mobilization or attenuation of the contaminants can be affected by the hydrogeochemical conditions in the saturated zone, such as the pH, oxidation-reduction potential, and ionic strength of the ground water, and the mineralogy of the aquifer material. Microbial processes can alter and degrade some organic contaminants.

The physical processes of primary importance for controlling contaminant movement in ground water are advection and dispersion. Advection, the movement of contaminants at the same speed as the average linear velocity of ground water, can be estimated from the velocity of ground water. Dispersion, the dilution of contaminants caused by the mechanical mixing of water during advection, can be significant; however, quantification of its effect on contaminant movement is beyond the scope of this study.

If the unconfined aquifer is assumed to be homogeneous and isotropic, the average linear velocity of ground water (V) can be estimated from the following equation:

$$V = KI/n,$$

where K is horizontal hydraulic conductivity,
I is the hydraulic head gradient, and
n is the effective porosity.

The head gradient can be calculated as the difference between water levels in two wells. Effective porosity and horizontal hydraulic conductivity were estimated from tables in Fetter (1980, p. 64) and Lohman (1972, p. 53), respectively, on the basis of lithologic and borehole geophysical logs and particle-size analyses of sediments from selected wells (Lohman, 1972). Horizontal hydraulic conductivity of glacial sediments ranges from 10^{-4} to 1 ft/d for clay, and can be as high as 13,000 ft/d for well-sorted gravel (Lyford and others, 1984, p. 12). The average horizontal hydraulic conductivity of sediments in the unconfined aquifer in the study area is estimated to be 20 to 60 ft/d (L.M. Voronin, U.S. Geological Survey, oral commun., 1990). A porosity of 0.25 to 0.35 is assumed. These values are typical for sand (Heath, 1983), the principal component of this aquifer. Head gradients calculated from the water-level data range from 0.002 to 0.0045. From these values, the average linear velocity of ground water is estimated to range from 0.1 to 1.1 ft/d.

CONTAMINATION OF SHALLOW GROUND WATER

As mentioned previously, the first hydrologic studies at Picatinny Arsenal were prompted by the detection of contaminants in two of the arsenal's supply wells in 1981. This section summarizes the expansion of the well network and results of ground-water sampling through 1990.

Well-Network Installation

Four monitoring wells (MW 11, MW 12A, MW 12B, and MW 12C) were installed by the U.S. Army as part of site cleanup in 1981. (A general summary of water-quality data from these wells is given farther on.) Well MW 11 was installed in an area presumed to be upgradient from the lagoon site, and the chemical quality of samples from this well is assumed to be representative of uncontaminated ground water. Wells MW 12A, MW 12B, and MW 12C were installed on or adjacent to the location of the former wastewater lagoons and the sludge-drying bed (fig. 4). The 4-well network was expanded to 12 wells during 1983-85. Monitoring wells MW 12D and MW 12E were installed in 1983. Well MW 12D, about 100 ft downgradient from the former wastewater lagoons, was screened 25 to 30 ft below land surface to obtain information on contamination below the 13- to 20-ft depth of the previously installed wells. Well MW 12E was installed about 1,000 ft downgradient from the contamination site to expand the areal coverage of the well network. The network was further expanded by the addition of well DH-3 in 1984 and wells MW 12F, MW 12G, MW 12H, MW 12I, and MW 12J in 1985.

From March 1985 through March 1990, the areal and vertical coverage of the study area was enhanced by well and drive-point installation and sampling. The initial monitoring network of 4 wells was expanded to 44 wells by August 1989. Drive-point sampling at six sites in 1986 and seven sites in 1988 provided information on the vertical distribution of contaminants. Laboratory analyses of ground-water samples collected in 1989 and 1990 typically determined concentrations of inorganic constituents, nutrients, trace elements, and VOC's. Analyses of water samples from four wells were expanded to include base/neutral- and acid-extractable compounds, organochlorine and organophosphorus pesticides, and PCB's.

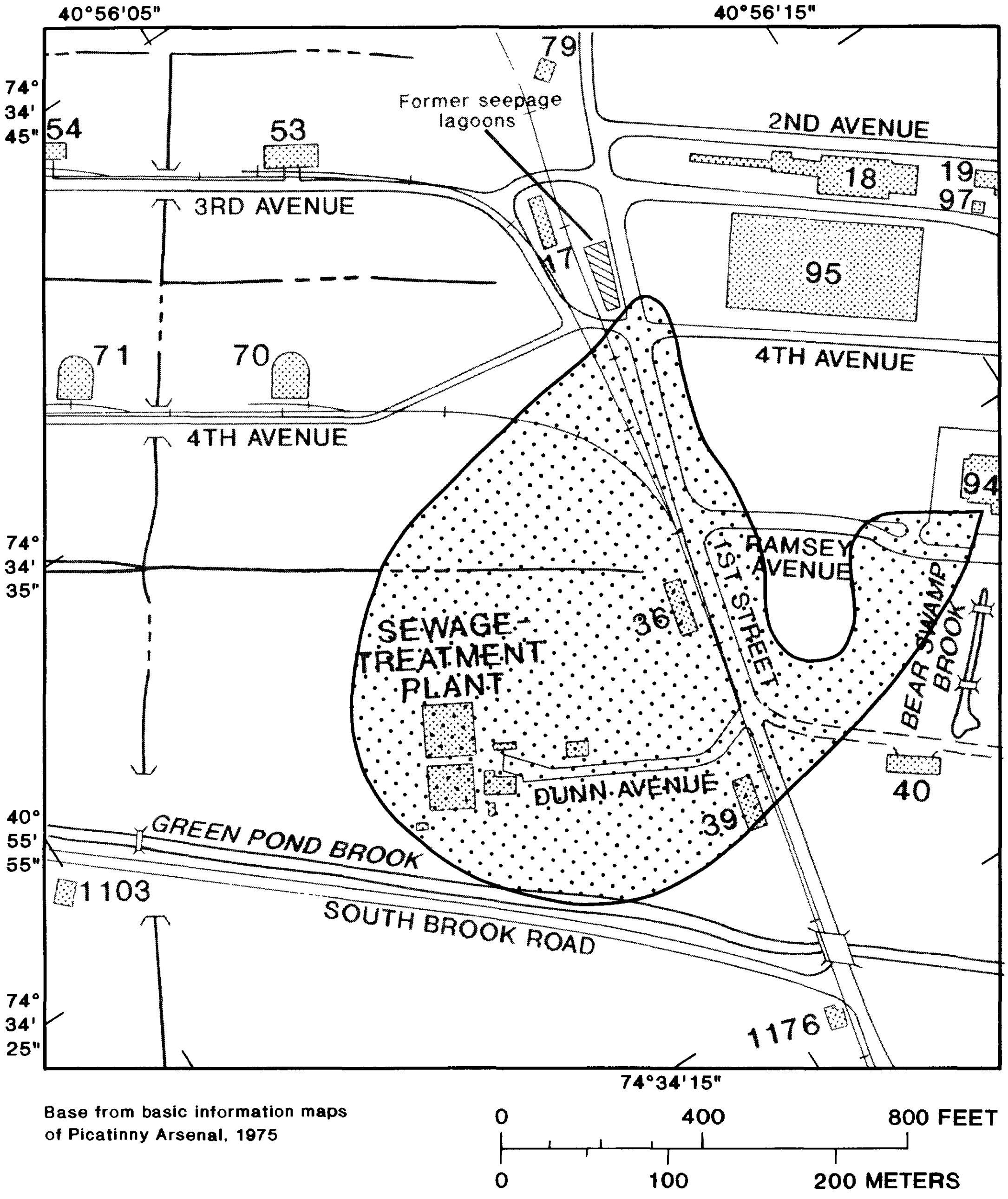
Previous Investigations

Several studies provided information that was useful in the present investigation. Results of previously completed field work and published reports served as a background for this report.

Electromagnetic Conductivity

Lacombe and others (1986) used surface geophysical methods to investigate ground-water contamination at the arsenal, including the vicinity of building 95, in 1983. They used electromagnetic-conductivity techniques with transmitting and receiving coils separated by either 32.8-ft or 12-ft intervals to delineate areas of high apparent conductivity that could indicate ground-water contamination. Because the presence of metallic objects, buildings, above-ground and underground service lines, and debris can mask variations in apparent conductivity that indicate ground-water contamination, the area surveyed was limited to the undeveloped parts of the arsenal.

Most of a region of anomalously high apparent conductivity (fig. 8) correlates with a contaminant plume originating from the site of the former building 95 lagoons. A high water table, fine-grained sediments, or dissolved constituents from the sewage-treatment plant could affect the



Base from basic information maps of Picatinny Arsenal, 1975

EXPLANATION

⁘ AREA WITH APPARENT CONDUCTIVITY EXCEEDING 15 MILLISIEMENS PER METER

40 ▨ BUILDING AND IDENTIFICATION NUMBER

— — — — DRAINAGE DITCH

Figure 8.--Area in which apparent conductivity exceeded 15 millisiemens per meter during 1983 surface geophysical survey. (Modified from Lacombe and others, 1986, fig. 11) (Location is shown in figure 1.)

results of the survey, however. The findings of the survey indicated that additional monitoring wells were needed in the building 95 area to identify the source of the electromagnetic anomaly and to determine whether the ground water is contaminated.

Trace Elements and Organic Compounds

Sargent and others (1986) compiled ground-water-quality data collected from 56 wells at the arsenal during 1958-85. Their report contains water-quality data from four wells in the building 95 study area: MW 11, MW 12A, MW 12B, and MW 12C (locations shown in fig. 4). These wells were resampled by the USGS in 1985; concentrations of trace elements and VOC's are summarized in table 3. Iron and manganese were found in relatively high concentrations in ground water throughout the arsenal but are probably the result of reducing conditions commonly found in swampy areas rather than human activities (Sargent and others, 1990).

Volatile Organic Compounds

An investigation by Imbrigiotta and others (1988) evaluated sampling devices used to collect well-water samples for analysis for VOC's in 1984. Well MW 12A, cited in their report as the "Northern New Jersey Site," was one of the wells used in their investigation. The following VOC's were detected in water samples collected from this well in August 1984.

Volatile organic compound	Range of concentrations (micrograms per liter)
1,1-Dichloroethane	48- 70
1,1-Dichloroethylene	32- 49
1,1,1-Trichloroethane	630-920
Trichloroethylene	42- 56
Tetrachloroethylene	170-260

Sargent and others (1990) defined the extent of ground-water contamination and rate of contaminant movement in the building 24 area, and identified the presence of several contaminants in the unsaturated zone and surface water. Their report includes the results of test drilling conducted in 1987 and the results of chemical analyses of ground-water and surface-water samples.

Samples from Wells, 1985-87

This section and the two sections that follow present sampling-site-location maps and discuss the results of chemical analyses of samples collected from wells during 1985-87, drive points during 1986 and 1988, and wells during 1989-90, respectively.

Inorganic Constituents and Trace Elements

All 12 monitoring wells were sampled in August 1985 by USGS personnel for analyses for chemical properties, inorganic constituents, nutrients, and trace elements. Results are summarized in table 4.

Table 3.--Concentrations of selected trace elements and volatile organic compounds in ground water from four wells in the vicinity of building 95, Picatinny Arsenal, 1981-84, and corresponding U.S. Environmental Protection Agency maximum contaminant levels

[Concentrations in micrograms per liter; <, less than]

Constituent	Range of concentrations	U.S. Environmental Protection Agency maximum contaminant level[1]
Trace elements		
Arsenic	<1 - 28	50
Cadmium	<1 - 23	5
Chromium	<1 - 180	100
Cyanide	<1 - 50	200
Iron	36 - 15,000	--
Lead	<1 - 64	5
Manganese	<3 - 1,700	--
Selenium	<1 - 14	50
Zinc	3 - 1,400	--
Volatile organic compounds		
1,1-Dichloroethane	<1 - 90	--
1,1-Dichloroethylene	<1 - 320	7
Trans-1,2-dichloroethylene	<1 - 15	100
Trichloroethylene	<1 - 129	5
1,1,1-Trichloroethane	<1 - 1,780	200
Tetrachloroethylene	<1 - 386	5
Methylene chloride	<1 - 90	--

[1] U.S. Environmental Protection Agency, 1988a

Table 4.--Results of analyses of ground-water samples for chemical properties, inorganic constituents, nutrients, and trace elements, 1985

[All constituents are dissolved, except as noted; concentrations in milligrams per liter, except as noted; µg/L, micrograms per liter; -, constituent not determined; <, less than; µS/cm, microsiemens per centimeter at 25 degrees Celsius; number in parentheses is constituent-analysis code used by U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado]

Local well identifier	Sample date	Field pH (units) (00400)	Field specific conductance (µS/cm) (00095)	Laboratory alkalinity (as $CaCO_3$) (90410)	Dissolved solids (70300)	Ammonia (as N) (00608)	Ammonia + organic N (as N) (00623)	Nitrite (as N) (00613)	Nitrite + nitrate (as N) (00631)
DH-3	8-21-85	7.0	424	39	180	0.26	0.9	<0.01	0.30
MW 11	8-12-85	6.0	452	37	247	.02	.3	<.01	1.20
MW 12A	8-12-85	6.3	1280	108	729	.44	.7	.02	.72
MW 12B	8-13-85	6.5	940	132	522	.03	.2	<.01	1.80
MW 12C	8-12-85	6.5	1020	102	597	.17	.4	<.01	1.10
MW 12D	8-13-85	7.4	785	154	430	.02	.2	.05	.90
MW 12E	8-12-85	7.5	744	136	577	.33	.7	<.01	<.10
MW 12F	8-13-85	7.0	1330	159	721	.15	.4	<.01	<.10
MW 12G	8-13-85	6.8	866	131	438	.03	.2	<.01	1.50
MW 12H	8-12-85	7.4	811	171	424	-	.2	<.01	.97
MW 12I	8-13-85	7.4	806	239	366	.04	.3	<.01	.70
MW 12J	8-16-85	6.6	792	104	515	-	-	<.01	<.10

Local well identifier	Phosphorus (00666)	Ortho-phosphate (00671)	Calcium (00915)	Magnesium (00925)	Sodium (00930)	Potassium (00935)	Chloride (00940)	Sulfate (00945)	Silica (as SiO_2) (00955)
DH-3	0.01	0.01	26	9.5	20	1.5	34	28	16
MW 11	.01	.01	22	6.7	55	3.5	94	29	10
MW 12A	<.01	<.01	79	25	150	5.9	300	74	14
MW 12B	<.01	<.01	59	23	100	2.6	190	56	7.7
MW 12C	<.01	.01	59	19	120	3.5	260	35	12
MW 12D	.01	<.01	59	24	66	1.7	140	28	11
MW 12E	.08	.06	120	34	8.9	.8	24	250	14
MW 12F	<.01	<.01	90	33	120	3.7	260	93	19
MW 12G	.02	.01	53	24	73	2.1	150	43	21
MW 12H	<.01	.01	77	29	50	2.1	140	34	18
MW 12I	.01	<.01	62	22	70	2.9	87	27	15
MW 12J	.02	<.01	61	21	62	2.0	130	93	19

Local well identifier	Arsenic (µg/L) (01000)	Barium (µg/L) (01005)	Beryllium (µg/L) (01010)	Cyanide (mg/L) (00723)	Cadmium (µg/L) (01025)	Chromium (µg/L) (01030)	Cobalt (µg/L) (01035)	Copper (µg/L) (01040)	Iron (µg/L) (01046)
DH-3	10	39	<0.5	<0.01	<1	<1	<3	10	1,800
MW 11	<1	32	<.5	<.01	<1	<1	<3	<10	10
MW 12A	<1	58	<.5	<.01	<1	<1	5	10	13
MW 12B	<1	51	<.5	<.01	<1	<1	<3	<10	6
MW 12C	<1	69	<.5	<.01	<1	<1	<3	<10	14
MW 12D	<1	51	<.5	<.01	<1	<1	<3	<10	6
MW 12E	12	68	<.5	<.01	<1	<1	<3	<10	1,600
MW 12F	<1	180	<.5	<.01	<1	<1	20	10	280
MW 12G	<1	43	<.5	<.01	<1	<1	<3	20	4
MW 12H	1	36	<.5	<.01	<1	<1	<3	20	4
MW 12I	<1	22	<.5	<.01	<1	<1	<3	<10	6
MW 12J	3	110	<.5	<.01	<1	<1	<3	<10	11,000

Local well identifier	Lead (µg/L) (01049)	Manganese (µg/L) (01056)	Molybdenum (µg/L) (01060)	Aluminum (µg/L) (01106)	Strontium (µg/L) (01080)	Vanadium (µg/L) (01085)	Zinc (µg/L) (01090)	Lithium (µg/L) (01130)	Selenium (µg/L) (01145)
DH-3	<10	190	<10	160	66	<6	34	6	<1
MW 11	<10	6	<10	10	100	<6	20	<4	<1
MW 12A	<10	760	<10	20	190	<6	24	11	<1
MW 12B	<10	10	<10	<10	140	<6	20	6	1
MW 12C	<10	50	<10	<10	210	<6	20	7	<1
MW 12D	<10	730	<10	<10	150	<6	6	21	<1
MW 12E	<10	2,100	<10	<10	290	<6	34	14	<1
MW 12F	<10	3,100	<10	<10	260	<6	9	26	<1
MW 12G	<10	45	<10	<10	120	<6	9	11	<1
MW 12H	<10	23	<10	<10	160	<6	4	9	<1
MW 12I	<10	600	<10	<10	170	<6	16	10	<1
MW 12J	<10	3,000	<10	290	140	<6	19	12	<1

The quality of water from wells DH-3 and MW 11 (fig. 4) is assumed to be typical of ground-water quality in an uncontaminated area at the arsenal. In theory, concentrations of inorganic constituents that can indicate the presence of contamination, such as sulfate, should be lower in these wells than the other 10 wells. Wells MW 12A, MW 12B, and MW 12C are on the site of the former lagoons, and the remaining wells are scattered around and downgradient from the site (locations shown in fig. 4).

As seen in table 4, dissolved-solids concentrations exceeded the USEPA secondary maximum contamination level[2] (SMCL) of 500 mg/L (U.S. Environmental Protection Agency, 1988c) in water from wells MW 12A, MW 12B, MW 12C, MW 12E, MW 12F, and MW 12J. Elevated concentrations of dissolved solids may reflect the high concentrations of ions that are typical in ground water contaminated with leachate (Kimmel and Braids, 1980, p. 11). Chloride concentrations exceeded the SMCL of 250 mg/L in three wells (MW 12A, MW 12C, and MW 12F). Sulfate concentrations exceeded the SMCL of 250 mg/L in one well (MW 12E).

Although concentrations of the trace elements cadmium, chromium, lead, and selenium in 1981-84 were found to exceed USEPA maximum contaminant levels[3] (MCL's) (U.S. Environmental Protection Agency, 1988a; U.S. Environmental Protection Agency, 1988b) (table 3), these elements were not detected in elevated concentrations in the 1985 samples. Several processes, such as the sorption of metals onto aquifer sediments or advection and dispersion, probably removed these metals from ground water since 1981. Naturally elevated concentrations of iron and manganese are found in ground water throughout the arsenal (Sargent and others, 1986), and the concentrations shown in table 4 are typical.

The areal distribution of dissolved solids, chloride, and sulfate are depicted in figure 9. Chloride concentrations probably reflect winter spreading of road salt. The lowest concentrations of sodium and chloride were found in wells DH-3 and MW 12E, the two wells that are farthest from roads that cross the site. The elevated sulfate concentrations detected in samples from well MW 12E could have been the result of wastewater discharges from building 95, sludge spreading adjacent to the sewage-treatment plant, or other operations at the sewage-treatment plant.

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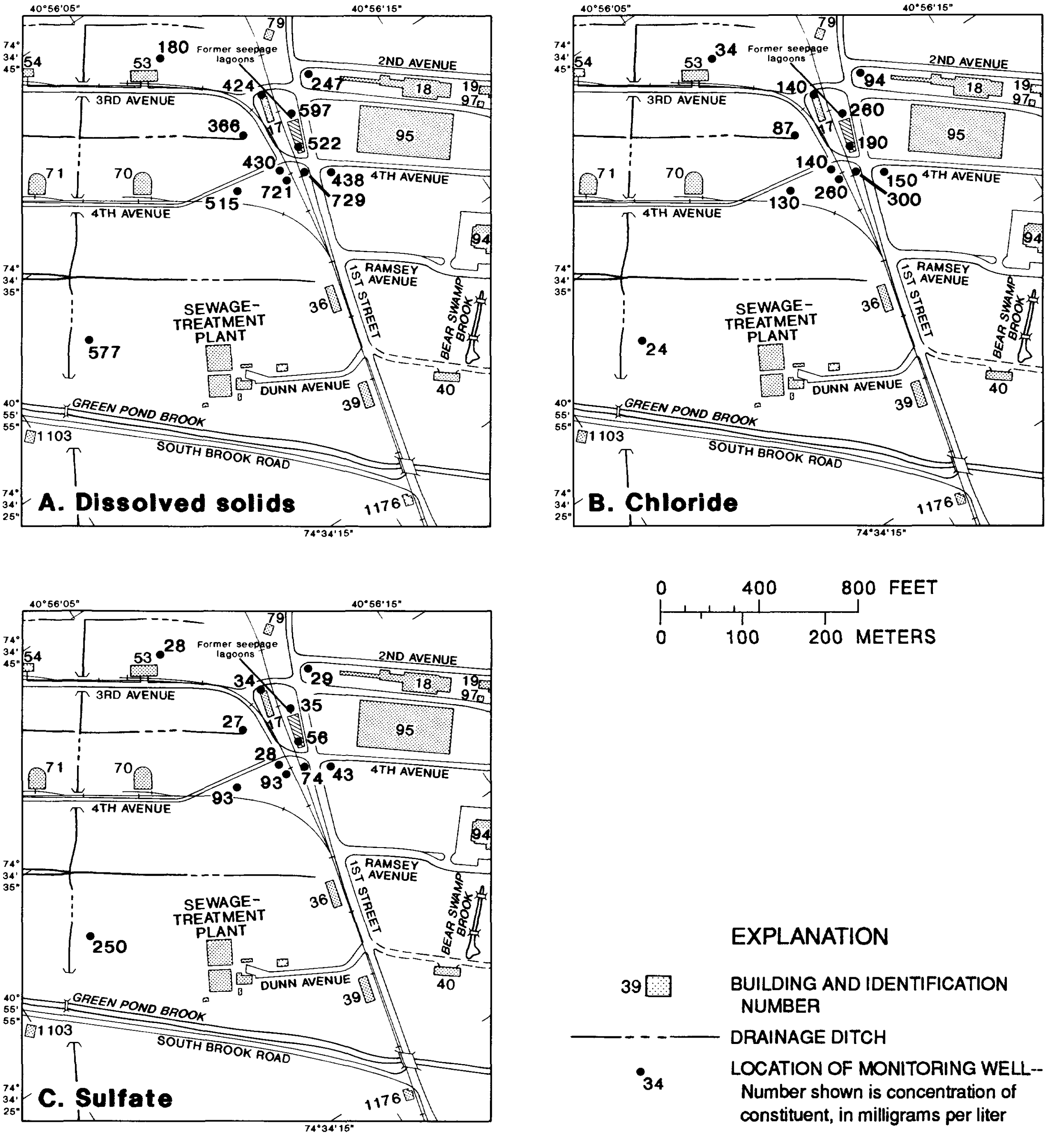
[2] Secondary Maximum Contaminant Level: Contaminants that affect the aesthetic quality of drinking water. At high concentrations or values, health implications as well as aesthetic degradation may also exist. Secondary Maximum Contaminant Levels are not Federally enforceable but are intended as guidelines for the States.

[3] 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 is 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).



Base from basic information maps of Picatinny Arsenal, 1975

Figure 9.--Concentrations of (A) dissolved solids, (B) chloride, and (C) sulfate in water from wells sampled in 1985.

Volatile Organic Compounds

Results of analyses of ground-water samples collected from March 6, 1985, through April 8, 1987, for selected VOC's are presented in table 5. The samples were collected by the USGS in August 1985 and by Acutest; Inc., on 13 other dates. The periodic sampling of each well, some at monthly intervals, enables detection of values not typical of ambient-water quality. For example, methylene chloride was detected at concentrations of 84 μg/L and 142 μg/L in samples collected on April 24, 1986, from wells MW 12B and MW 12C, respectively, but was not found in any of the other 15 samples from these wells. Methylene chloride is a chemical commonly used in the laboratory. Because both samples were analyzed in the same batch, the concentrations could be laboratory artifacts and not reflective of ground-water quality. No laboratory blanks or duplicate analyses are available for Acutest, Inc., data to verify this hypothesis, however. Chloroform also is likely to be present in the laboratory; therefore, the scattered detections shown in table 5 also could be the result of laboratory activities.

Multiple water-quality analyses of samples from each well provide a broad indication of the nature of ground-water contamination at the building 95 site. During the entire sampling period, from March 1985 through April 1987, no VOC's were detected in well MW 12E, but TCE, tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethylene, and 1,1-dichloroethane were consistently detected in at least one of the other wells.

TCE was consistently detected in water samples from well MW 11, a well upgradient from the lagoon site that was installed in 1981 to provide background (uncontaminated) water samples. The chemical concentrations detected in this well are similar to the concentrations shown in Sargent and others (1986) for 1981-84. The presence of TCE in this well indicates a source other than the former lagoon site associated with building 95. This hypothesis is reinforced by the distribution of TCE in August 1985 shown in figure 10. A water sample collected from monitoring well MW 12H on August 12, 1985, contained TCE in a concentration of 152 μg/L. Well MW 12H is not along the flow path from the former lagoon site.

Tetrachloroethylene was detected in most samples collected from wells MW 12A, MW 12B, MW 12C, and MW 12D during 1985-87. The maximum concentration of this compound, as shown in table 5, was 66 μg/L in a sample from well MW 12B. Figure 10 shows the areal distribution of tetrachloroethylene in ground water from wells sampled in August 1985. A source of tetrachloroethylene appears to have been the site of the former seepage lagoons because this compound was not detected in upgradient monitoring wells MW 11 and DH-3.

The VOC 1,1,1-trichloroethane has been detected in samples from well MW 12A in concentrations as high as 233 μg/L (table 5). This is the only well from which water samples consistently contain this contaminant in concentrations greater than 2 μg/L. The areal distribution of this compound in ground water from wells sampled in August 1985 is shown in figure 11. Analytical results from samples collected from wells at the lagoon site do not indicate that the lagoons were the source of 1,1,1-trichloroethane, but underground drainage lines, sewage lines, or a site directly upgradient from well MW 12A could be the source of this contamination.

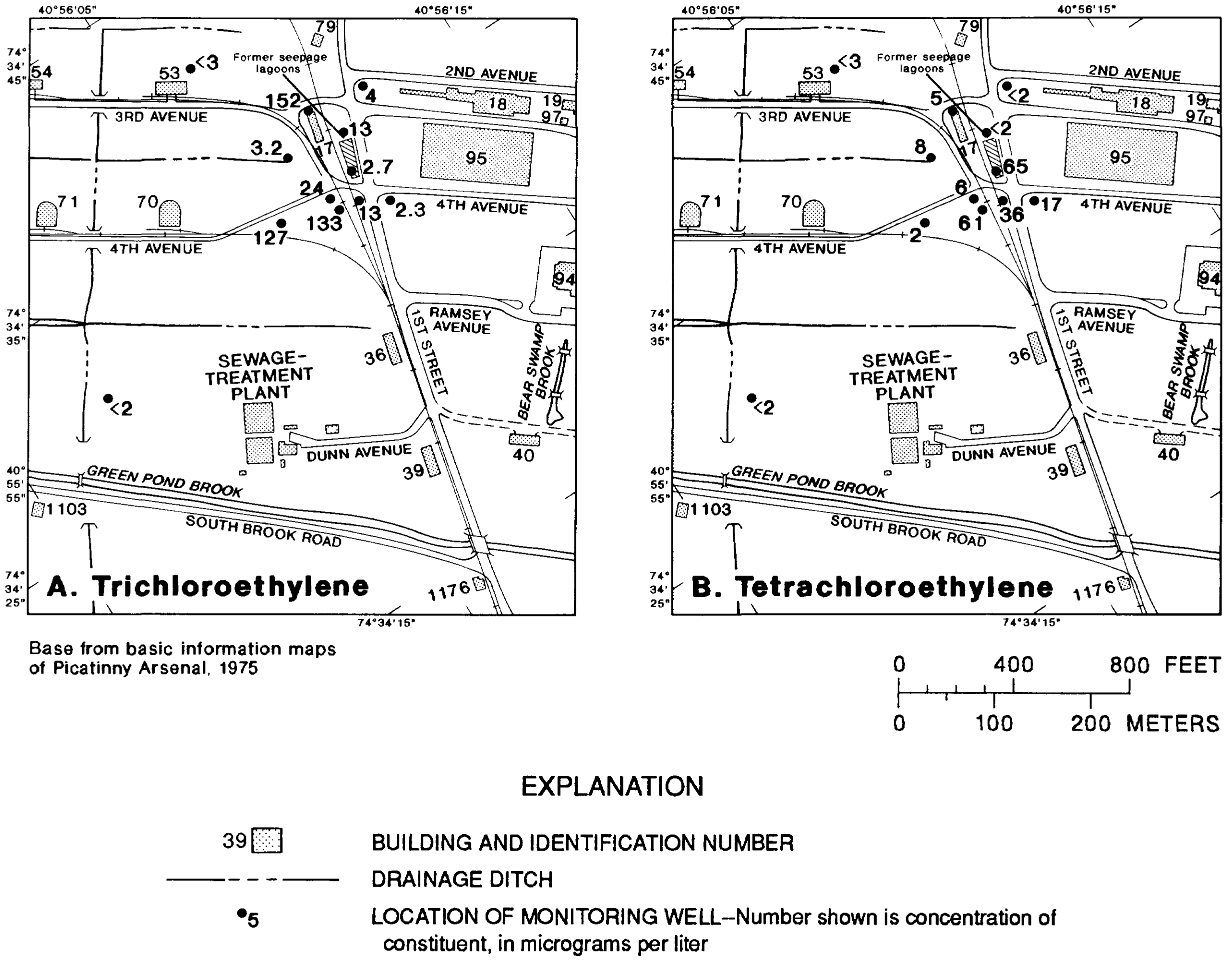
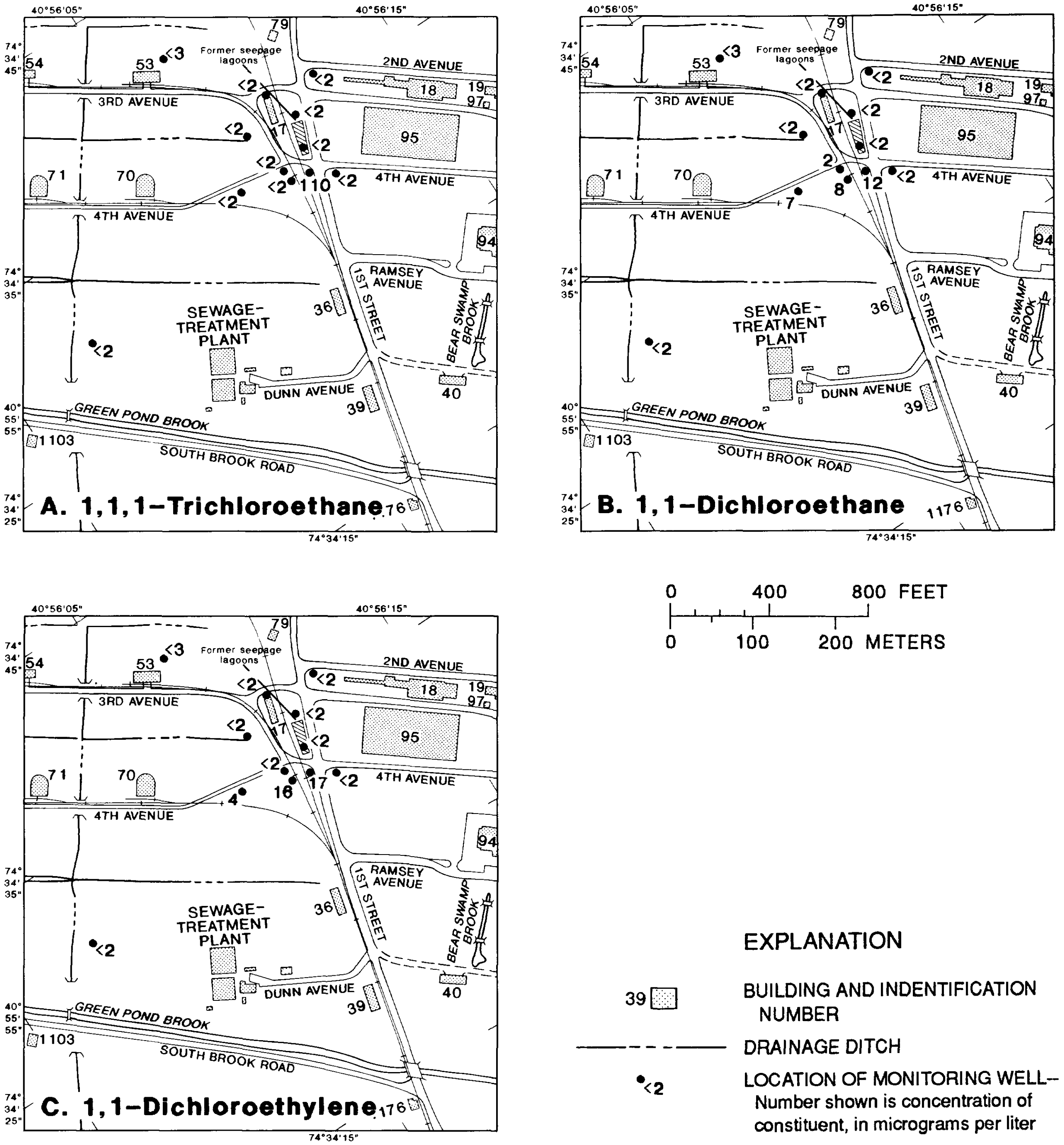


Figure 10.--Concentrations of (A) trichloroethylene and (B) tetrachloroethylene in water from wells sampled in 1985.



Base from basic information maps of Picatinny Arsenal, 1975

Figure 11.--Concentrations of (A) 1,1,1-trichloroethane, (B) 1,1-dichloroethane, and (C) 1,1-dichloroethylene in water from wells sampled in 1985.

The areal distribution of the VOC's 1,1-dichloroethylene and 1,1-dichloroethane follows the pattern of 1,1,1-trichloroethane and, similarly, multiple detections of these constituents were only in samples from well MW 12A (fig. 11). These compounds also were detected at wells downgradient from well MW 12A, but the concentrations were generally low, less than 20 μg/L. The maximum concentrations of 1,1-dichloroethylene and 1,1-dichloroethane were 29 and 32 μg/L, respectively. Both of these compounds have been identified as biological degradation products of other organic compounds (T.A. Ehlke, U.S. Geological Survey, oral commun., 1989). Their presence at this site could be due to biological degradation of TCE rather than the result of operation of the wastewater-treatment system, given their relatively low concentrations.

Benzene is of special interest at this site because it was first detected in ground-water samples in September 1986 but was not found in samples collected in January 1987 or subsequently. Benzene was detected in samples from wells MW 11, MW 12A, MW 12B, MW 12C, and MW 12D by October 21, 1986, but was not detected in samples collected from those same wells on January 21, 1987. Although the source of the benzene is unknown, its presence indicates the possible occurrence of a localized spill between May 29 and September 30, 1986.

Samples from Drive-Points, 1986 and 1988

Water samples collected at 13 drive-point sites (locations shown in fig. 12) were analyzed for chemical characteristics, inorganic constituents, nutrients, trace elements, and VOC's. The drive-point sites are distributed throughout the area downgradient from the former lagoons, except site G-4, which was selected to reveal possible ground-water contamination from the drainage ditch that received wastewater from the two lagoons. Site G-1 is adjacent to well MW 12F, and site G-7 is adjacent to well MW 12E. Water samples were collected from sites G-1 through G-6 during August-October 1986 and from sites G-7 through G-14 during September-October 1988. At each site, samples were collected at 10-ft intervals for analysis for inorganic constituents, nutrients, and trace elements, and samples were collected at 5-ft intervals for analysis for VOC's.

Inorganic Constituents and Trace Elements

Analyses for inorganic constituents, nutrients, and trace elements were done by the National Water-Quality Laboratory; the results are given in table 6. The spatial distribution of constituents, as indicated by the results of the 1986 drive-point sampling, is similar to that indicated by the results of the 1988 analyses, and both are similar to that indicated by the composition of the water samples collected in August 1985. Concentrations of dissolved solids, chloride, and sulfate were found to exceed the USEPA SMCL's at several depths and sites.

The areal extent of these constituents in 1986 and 1988 is shown in figures 13 and 14. Concentrations of dissolved solids were elevated with respect to background concentrations along Fourth Avenue, and between Fourth Avenue and the sewage-treatment plant. Concentrations of sulfate also were elevated in ground water from some of the sites in these areas. Because the drive points sampled in 1988 are different from those sampled in 1986, no determination regarding plume migration can be made.

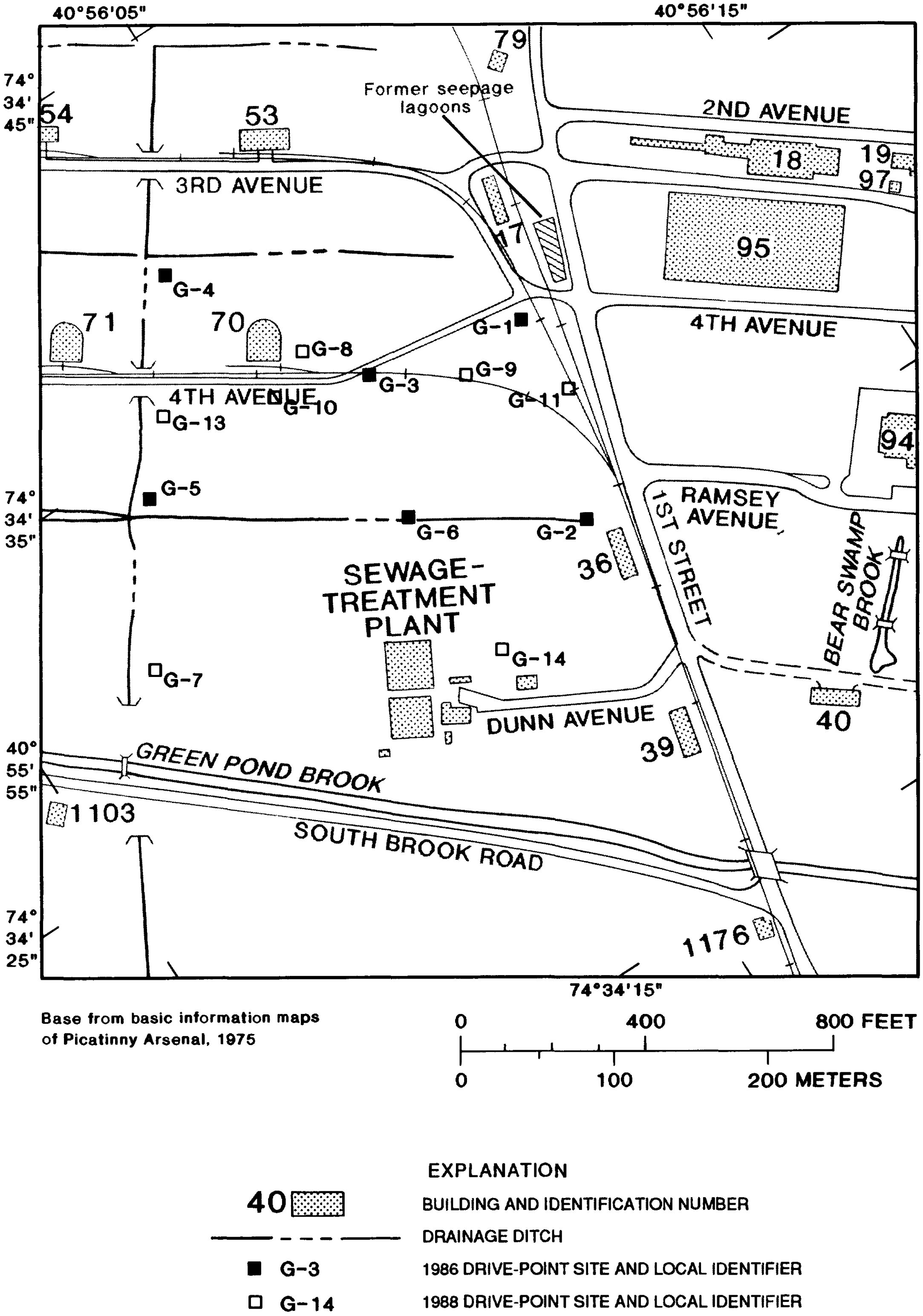


Figure 12.--Locations of drive-point sites in the study area.

Chloride concentrations were elevated (exceeded the USEPA SMCL's) at two sites along Fourth Avenue (G-1-10 and G-10-10). The absence of elevated chloride concentrations at sites G-4, G-5, G-6, G-7, and G-14 supports the hypothesis that elevated chloride concentrations are caused by road salt, especially because the chloride concentrations were greatest in the shallowest (10-ft-depth) sample from each site.

Calcium is typically the dominant cation in water in which sulfate is the dominant anion (Hem, 1985).. Stiff diagrams of the major ion components of ground water at the drive-point sites show that the chemical character of the water changes with depth (fig. 15). The 40-ft-depth sample from site G-2 clearly shows sulfate-calcium enrichment, and, at other sites, the sulfate concentrations reached their maximum in the 25- to 40-ft depth range. The proportion of sulfate appears to increase downgradient from site G-1, possibly through the oxidation of one or more reduced forms of sulfur. Other possible sources of elevated sulfate concentrations are leakage from sewage pipes to the treatment plant or from storm drains, and the site of the former lagoons. (Location of sewage-treatment plant is shown in fig. 4.)

Although concentrations of metals were elevated above background levels in soil from the former lagoon site, those in the drive-point water samples were below USEPA drinking-water regulations, as were those in samples from the wells. Metals could have precipitated out of solution or been adsorbed from solution by organic or clay colloids and by hydrous iron or manganese coatings on sediments (Kimmel and Braids, 1980, p. 19).

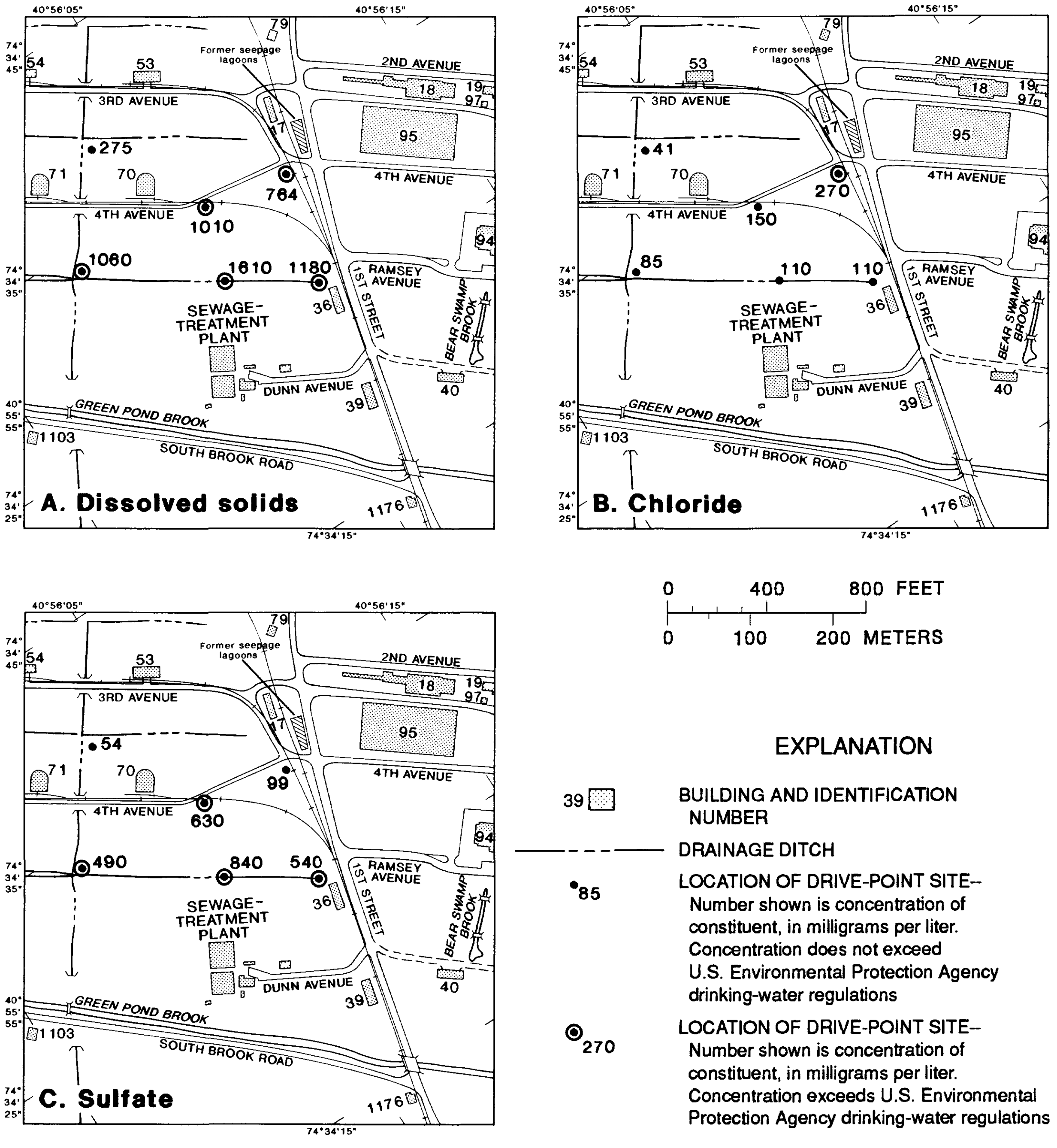
Volatile Organic Compounds

All 1986 water samples collected with the drive-point sampler were analyzed for VOC's and methane; the 1988 samples were analyzed only for VOC's. Analyses were performed at the USGS laboratory in Trenton, New Jersey. Eleven duplicate water samples were collected and sent to the NWQL for analysis for VOC's. Results from both laboratories are shown in table 7. Agreement between measurable concentrations of all VOC's reported by both laboratories was considered to be acceptable.

The VOC's detected in drive-point water samples included the five compounds detected in well-water samples--TCE, tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethane, and 1,1-dichloroethylene--in addition to toluene, methane, and 1,1,2-trichloroethane.

TCE and tetrachloroethylene were detected at the same drive-point sites. As seen in figure 16, both compounds were found at site G-1 in 1986 and at sites G-9 and G-11 in 1988. Sites G-9 and G-11 are downgradient from and within 300 ft of site G-1. The maximum TCE and tetrachloroethylene concentrations in all drive-point water samples analyzed (46.8 and 78.8 μg/L, respectively) were in samples collected at site G-9 from a depth of 15 ft. The maximum concentration at site G-11 also was at the 15-ft depth.

The areal distribution of 1,1,1-trichloroethane (fig. 17) differs from that of TCE and tetrachloroethylene (fig. 16); this supports the hypothesis that the contamination at this site originates from multiple sources. In 1986, 1,1,1-trichloroethane was detected in water samples from two drive-point sites (G-1 and G-3), and the maximum concentration was 200 μg/L. At



EXPLANATION

39 ▨ BUILDING AND IDENTIFICATION NUMBER

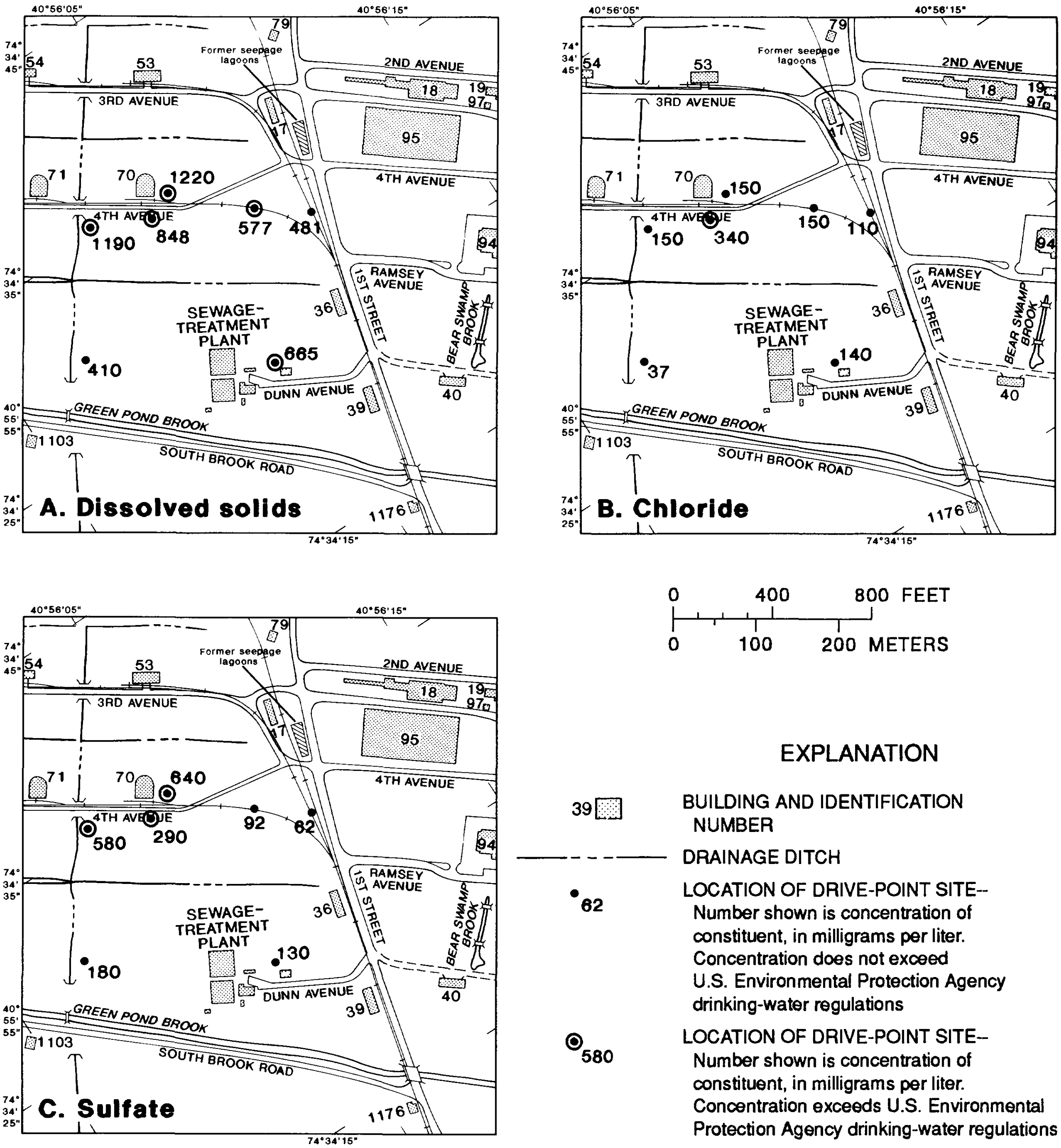
——— — — ——— DRAINAGE DITCH

•85 LOCATION OF DRIVE-POINT SITE--Number shown is concentration of constituent, in milligrams per liter. Concentration does not exceed U.S. Environmental Protection Agency drinking-water regulations

◉270 LOCATION OF DRIVE-POINT SITE--Number shown is concentration of constituent, in milligrams per liter. Concentration exceeds U.S. Environmental Protection Agency drinking-water regulations

Base from basic information maps of Picatinny Arsenal, 1975

Figure 13.--Maximum concentrations of (A) dissolved solids, (B) chloride, and (C) sulfate in water from drive points sampled in 1986.



Base from basic information maps of Picatinny Arsenal, 1975

Figure 14.--Maximum concentrations of (A) dissolved solids, (B) chloride, and (C) sulfate in water from drive points sampled in 1988.

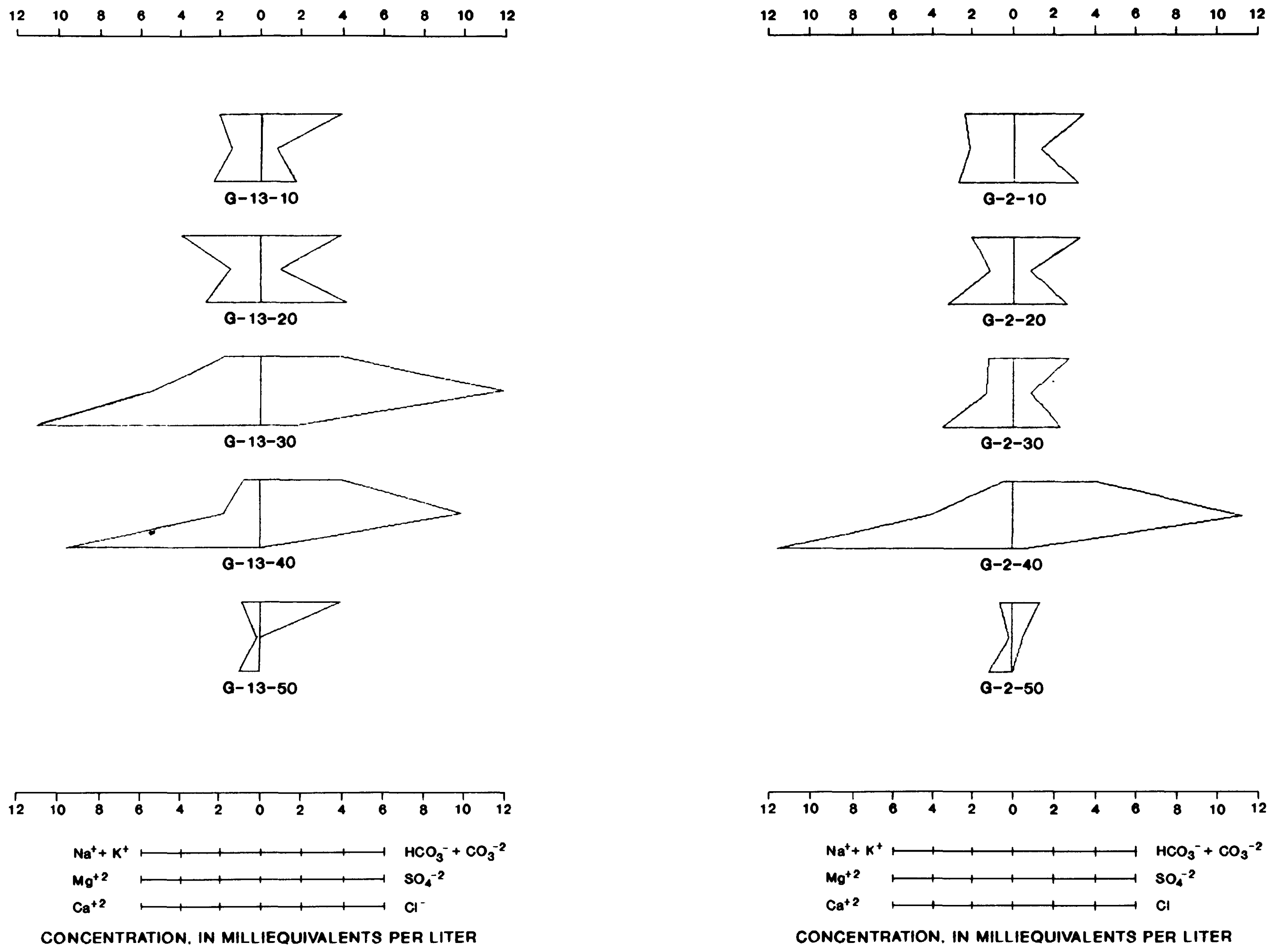
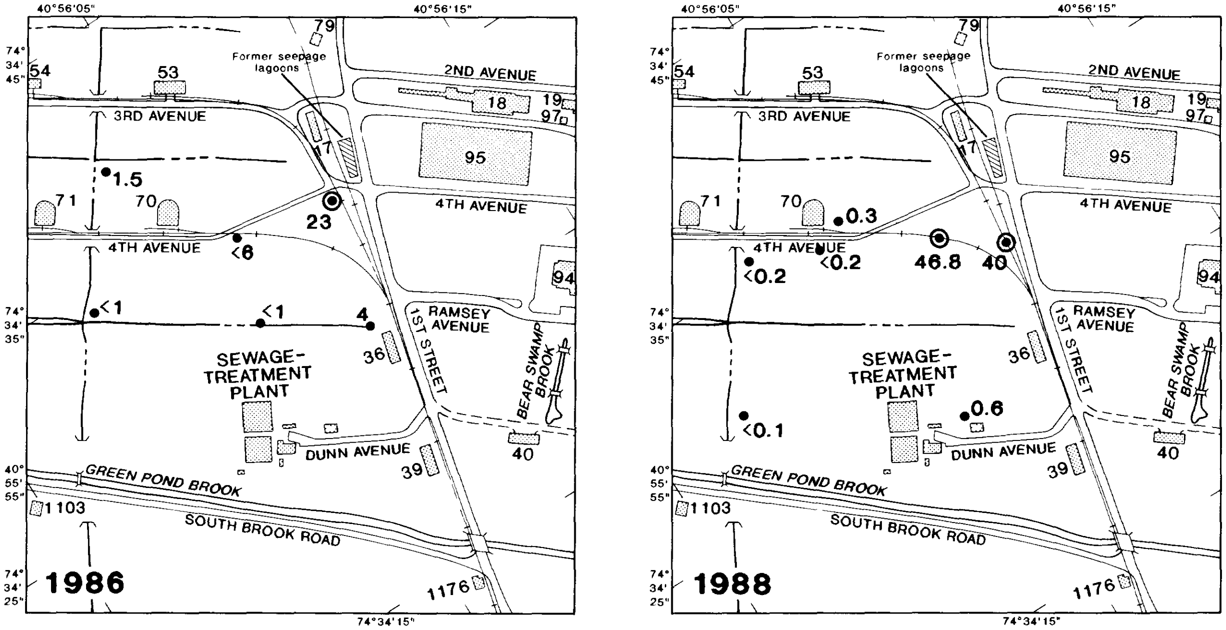
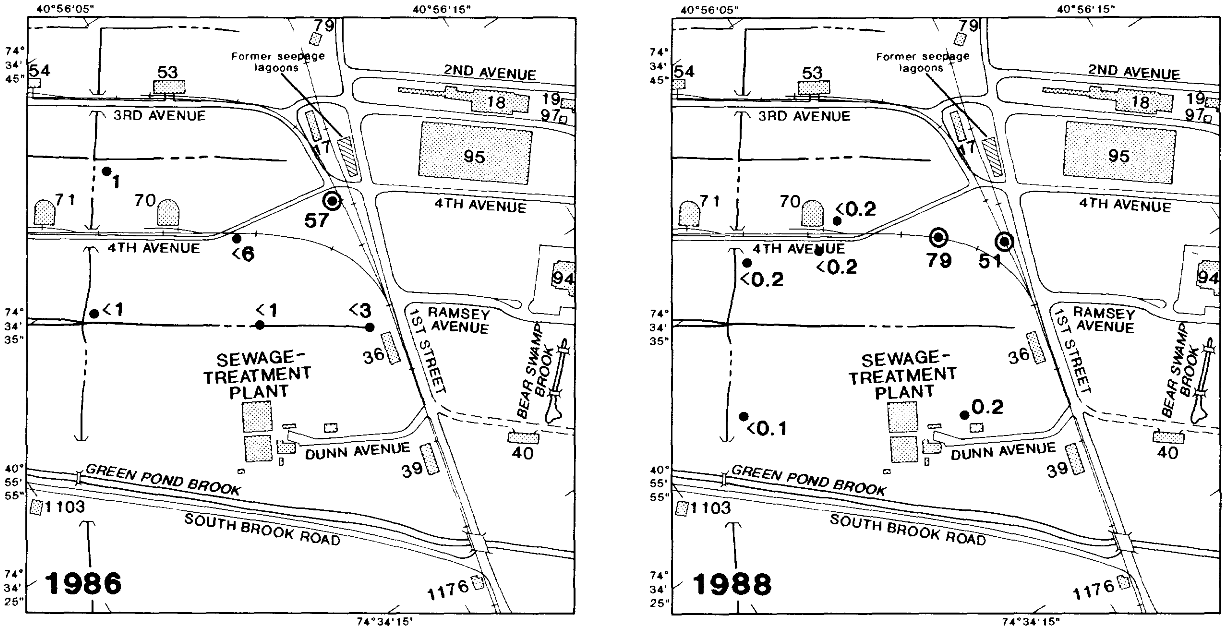


Figure 15.--Stiff diagrams showing concentrations of selected cations and anions in water samples collected at various depths at drive-point sites G-13 and G-2. (Locations of drive-point sites are shown in figure 12.)



A. Trichloroethylene



B. Tetrachloroethylene

Base from basic information maps of Picatinny Arsenal, 1975

EXPLANATION

39▨	BUILDING AND IDENTIFICATION NUMBER
———- - - ———	DRAINAGE DITCH
● <1	LOCATION OF DRIVE-POINT SITE--Number shown is concentration of constituent, in micrograms per liter. Concentration does not exceed 5 micrograms per liter
◉ 57	LOCATION OF DRIVE-POINT SITE--Number shown is concentration of constituent, in micrograms per liter. Concentration exceeds 5 micrograms per liter

Figure 16.--Maximum concentrations of (A) trichloroethylene and (B) tetrachloroethylene detected in water samples from drive points, 1986 and 1988.

both of these sites, the concentration was highest at a depth of 20 ft, not at a depth of 15 ft as it was for TCE and tetrachloroethylene. In 1988, 1,1,1-trichloroethane was detected in samples from drive-point sites G-9, G-11, and G-14. Site G-14 is near the sewage-treatment plant, and the presence of this compound indicates that, unless the sewage-treatment plant is a source, a contaminant plume from the building 95 area has extended more than 800 ft. The compounds 1,1-dichloroethylene and 1,1-dichloroethane were detected in a pattern similar to that indicated by the well-water samples--that is, they are typically present in association with 1,1,1-trichloroethane.

Toluene was not detected in concentrations above 5 μg/L in any of the 1986 drive-point water samples, but was detected in the 1988 drive-point samples from sites G-9, G-10, G-13, and G-14; the maximum concentration was 24.7 μg/L. The presence of toluene at these sites is consistent with the premise that toluene had moved downgradient from the wells by 1987 and, therefore, was not detected in well-water samples. The greatest concentrations were in samples from the 40- to 50-ft depth at sites G-9, G-10, and G-13; thus, toluene-contaminated water appears to have moved downward in the unconfined (water-table) aquifer. At site G-14, toluene was detected at the 30-ft depth.

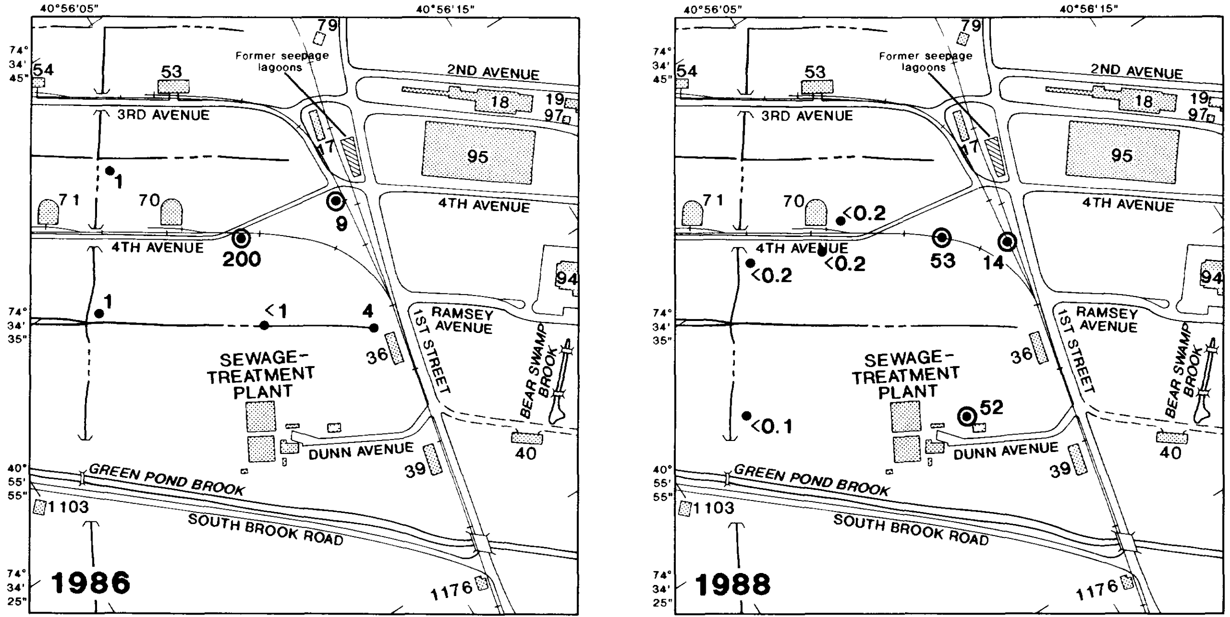
The 1986 drive-point water samples were analyzed for methane, and elevated concentrations were detected in samples from sites G-4, G-5, and G-6. The maximum concentration of methane (112 μg/L) was found in the sample from a depth of 25 ft at site G-4. No VOC's were detected in this sample. Methane is produced through natural biological activities, and its distribution does not correlate with the distribution of other organic compounds.

Samples from Wells, 1989-90

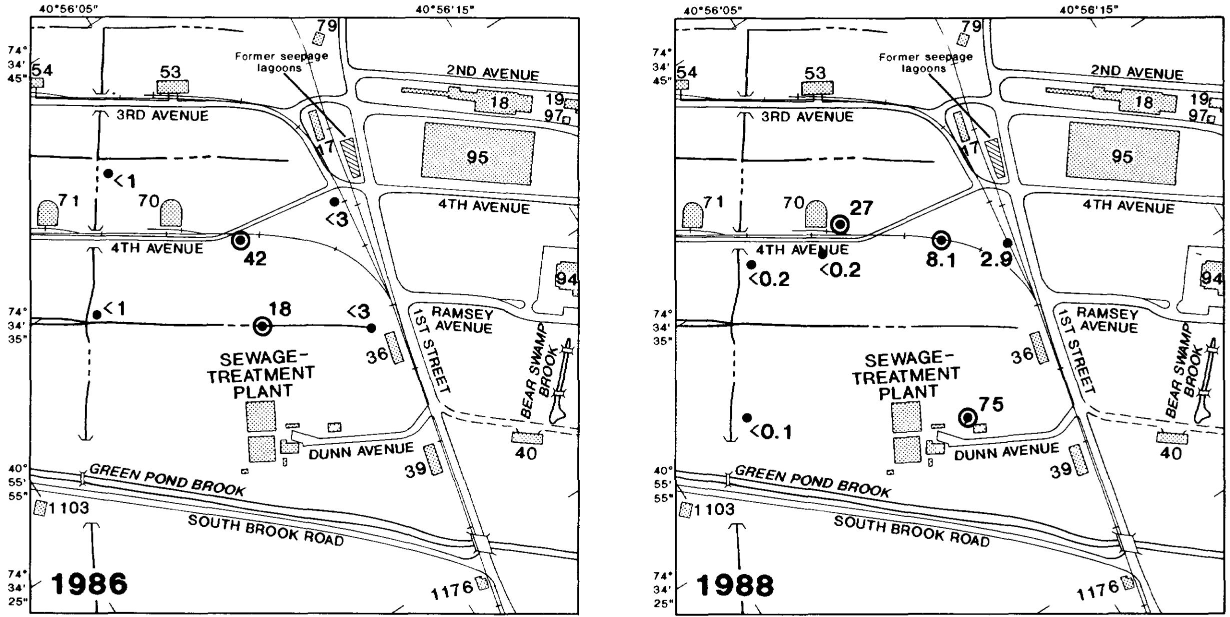
The monitoring-well network was expanded in 1989 by the addition of 32 monitoring wells. Typically a cluster of three wells was installed at a drive-point site. Each well in the cluster was screened at a different depth interval, typically 10 to 15, 20 to 25, and 30 to 35 ft below land surface. Three wells were installed adjacent to building 95 to determine whether contaminants originated from activities in the building. One (well 18-1) was placed upgradient from the building and the other two (95-3 and 95-4) were placed downgradient from it. All three wells were installed with 10-ft screened lengths in the 10 to 20 ft depth interval to ensure that any contaminants present would be detected in the water sample. After well installation, samples were collected from all previously installed and new monitoring wells and analyzed for inorganic constituents, nutrients, trace elements, and VOC's. Additional samples were collected from four wells for analysis for base/neutral- and acid-extractable compounds and pesticides.

Inorganic Constituents and Trace Elements

Results of analyses of the well-water samples for chemical properties, inorganic constituents, nutrients, and trace elements are given in table 8. All analyses were performed at the NWQL. Duplicate samples were collected from two wells; these results also are included in table 8.



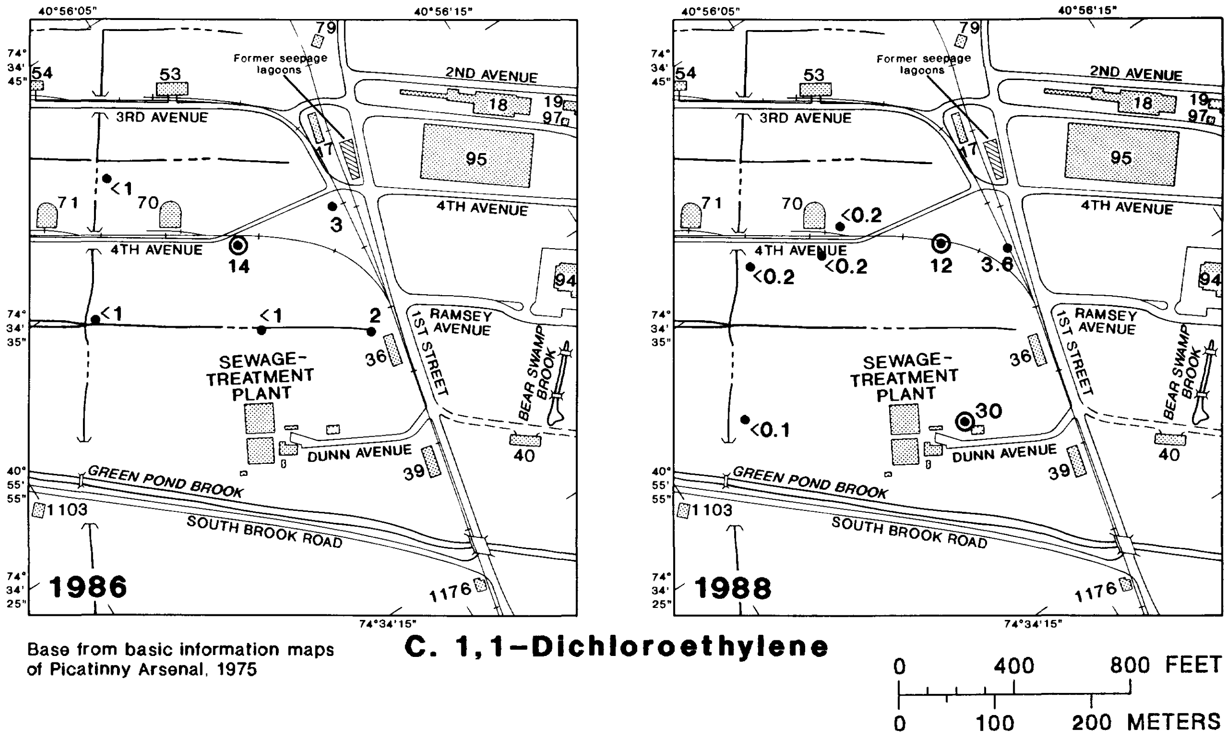
A. 1,1,1-Trichloroethane



B. 1,1-Dichloroethane

Base from basic information maps of Picatinny Arsenal, 1975

Figure 17.--Maximum concentrations of (A) 1,1,1-trichloroethane, (B) 1,1-dichloroethane, and (C) 1,1-dichloroethylene detected in water samples from drive points, 1986 and 1988.



Base from basic information maps of Picatinny Arsenal, 1975

C. 1,1-Dichloroethylene

EXPLANATION

39 ▨ BUILDING AND IDENTIFICATION NUMBER

———- - -——— DRAINAGE DITCH

●<1 LOCATION OF DRIVE-POINT SITE--Number shown is concentration of constituent, in micrograms per liter. Concentration does not exceed 5 micrograms per liter

◉14 LOCATION OF DRIVE-POINT SITE--Number shown is concentration of constituent, in micrograms per liter. Concentration exceeds 5 micrograms per liter

Figure 17.--Maximum concentrations of (A) 1,1,1-trichloroethane, (B) 1,1-dichloroethane, and (C) 1,1-dichloroethylene detected in water samples from drive points, 1986 and 1988.--Continued

The areal distribution of dissolved solids shown in figure 18 is similar to that observed in the previous sampling programs. The maximum concentration of dissolved solids (1,550 mg/L) was found in a sample from well 70-2, which also contained the maximum concentrations of calcium and sulfate. The distribution of sulfate in water from wells along Fourth Avenue is similar to that indicated by the drive-point data.

Chloride concentrations did not exceed the USEPA SMCL (250 mg/L) in any of the well-water samples. The maximum concentration (200 mg/L) was in a sample from well MW 12B, adjacent to First Street. Generally, the lower values were in wells far from roads that cross the site. These data support the conclusion that elevated concentrations are due to road salt and are not attributed to the wastewater-treatment system at building 95.

Trace-element concentrations in all wells sampled in 1989 and 1990 remained below the USEPA MCL's (U.S. Environmental Protection Agency, 1988a and 1988b). As expected, however, iron and manganese were detected at concentrations greater than 1,000 μg/L in some wells, probably as a result of the reducing conditions that are present in the area.

Volatile Organic Compounds

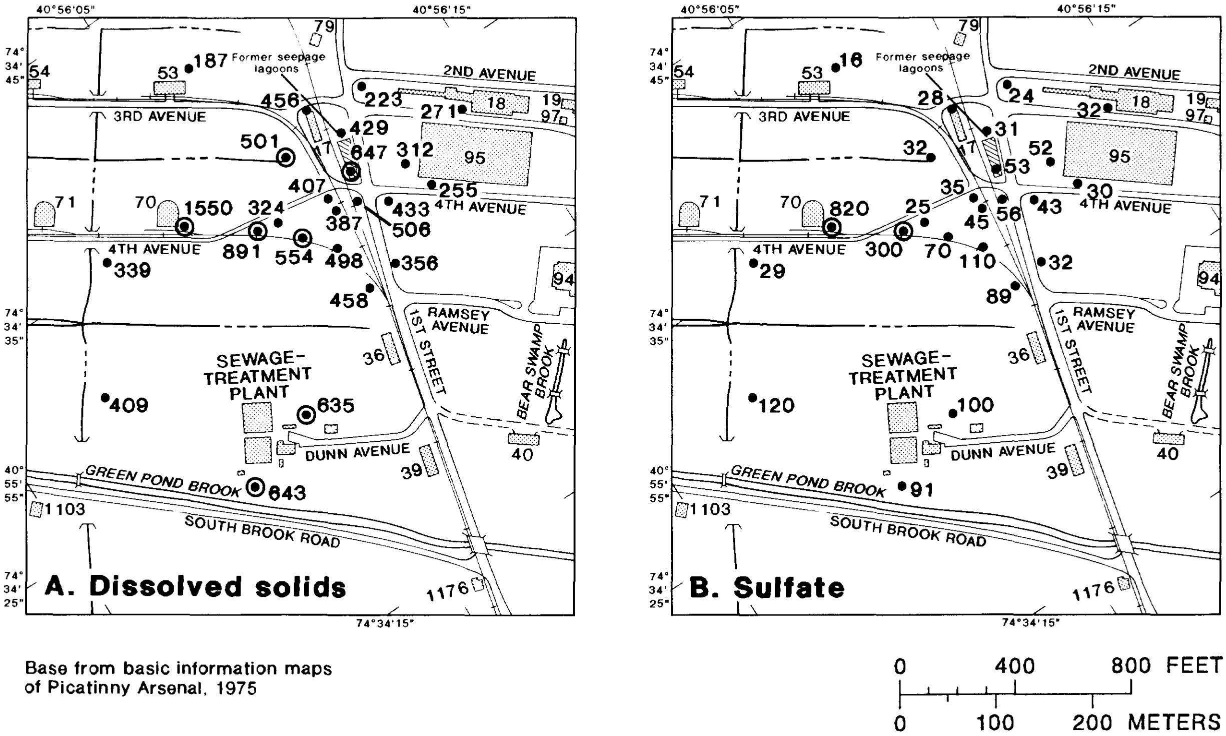
Results of analyses for VOC's in ground-water samples collected from 43 wells from June 1989 through March 1990 are given in table 9. Duplicate analysis results are provided for samples from wells WG 11-2 and WG 9-3, and triplicate results are provided for well MW 12G.

VOC's that were detected at concentrations greater than 5 μg/L include:

1,1-dichloroethylene
1,1-dichloroethane
cis-1,2-dichloroethylene
1,1,1-trichloroethane
trichloroethylene
bromodichloromethane
tetrachloroethylene
dibromochloromethane
bromoform

Bromodichloromethane, dibromochloromethane, and bromoform were detected in concentrations above 5 μg/L in only one sample and thus are not considered major contaminants. Cis-1,2-dichloroethylene has been identified as a degradation product of TCE (T.A. Ehlke, U.S. Geological Survey, oral commun., 1989), and its presence in low concentrations (maximum 27.9 μg/L) is attributed to degradation through biological processes.

The areal distribution of TCE in 1989-90 did not differ greatly from that indicated by results of previous well and drive-point sampling (fig. 19). Wells that contained water with detectable concentrations of TCE during the 1985 sampling also contained water with detectable concentrations during the 1989 and 1990 sampling. The two upgradient wells--MW 11 and MW 12H (fig. 4)--both contained water with detectable concentrations of this compound. The absence of TCE in well MW 12J and its presence in nearby well WG 3-2 is explained by their screened intervals (MW 12J, 3.8-8.8 ft; WG 3-2, 20.3-25.3 ft). TCE has moved down to the 20-ft depth in this area and thus was not detected in the sample from well MW 12J.



Base from basic information maps of Picatinny Arsenal, 1975

EXPLANATION

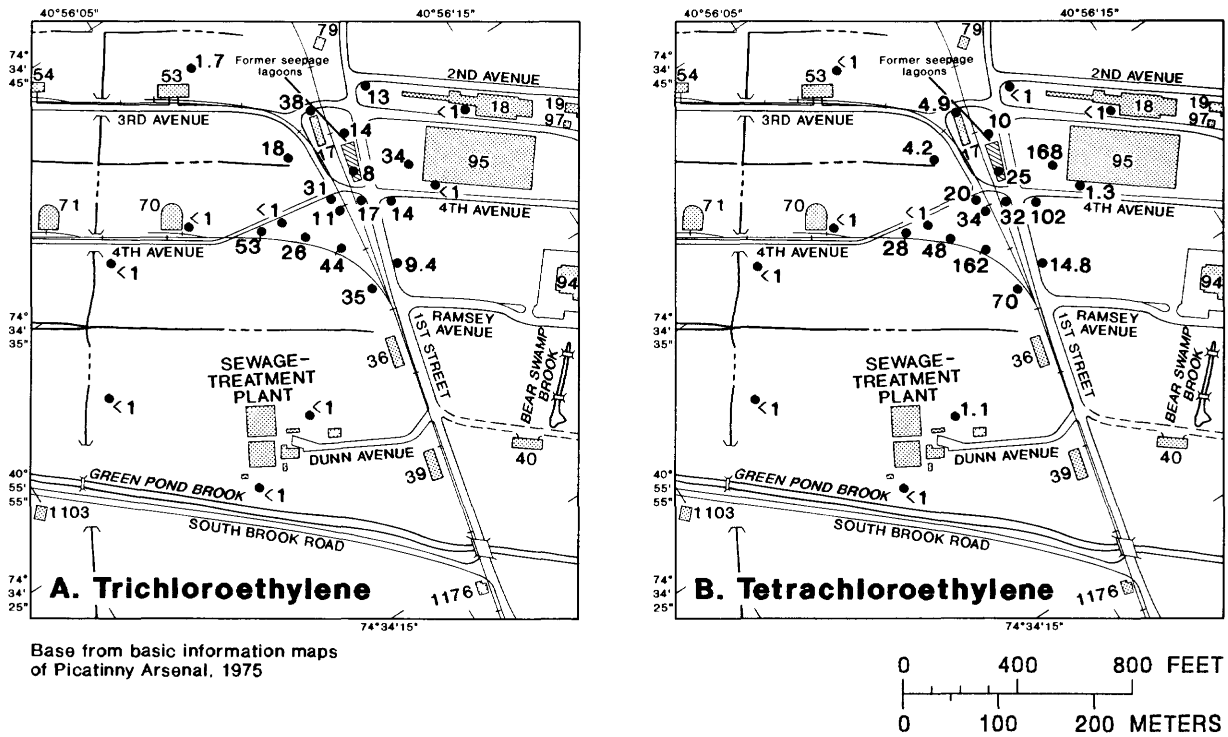
39 ▨ BUILDING AND IDENTIFICATION NUMBER

——— - - - ——— DRAINAGE DITCH

•91 LOCATION OF MONITORING WELL--Number shown is concentration of constituent, in milligrams per liter. Concentration does not exceed U.S. Environmental Protection Agency drinking-water regulations

◉ 300 LOCATION OF MONITORING WELL--Number shown is concentration of constituent, in milligrams per liter. Concentration exceeds U.S. Environmental Protection Agency drinking-water regulations

Figure 18.--Concentrations of (A) dissolved solids and (B) sulfate in water from wells sampled during 1989-90.



Base from basic information maps of Picatinny Arsenal, 1975

EXPLANATION

39 ▨	BUILDING AND IDENTIFICATION NUMBER
——- - -——	DRAINAGE DITCH
•<1	LOCATION OF MONITORING WELL--Number shown is concentration of constituent, in micrograms per liter

Figure 19.--Concentrations of (A) trichloroethylene and (B) tetrachloroethylene in water from wells sampled during 1989-90.

The areal distribution of tetrachloroethylene in 1989 also was similar to that indicated by the results of analyses of the 1985-88 well and drive-point samples (fig. 19). The absence of this compound at well MW 11, the original upgradient well, reinforces the premise that the source of tetrachloroethylene is not the same as the source of TCE. The maximum concentration detected, 168 μg/L, was in a sample from well 95-3, a new well installed to detect contaminants that originated in building 95 rather than the site of the former seepage lagoons. Concentrations at the site of the former lagoons were relatively low: 11.7 μg/L and 20.9 μg/L in samples from wells MW 12C and MW 12B, respectively.

The areal distributions of 1,1,1-trichloroethane, 1,1,-dichloroethylene, and 1,1-dichloroethane is shown in figure 20. 1,1,1-Trichloroethane was not detected at any wells at the former lagoon site (MW 12B and MW 12C), but was detected in a sample from monitoring well MW 12A (130 μg/L), about 100 ft downgradient. Concentrations of 1,1,1-trichloroethane in this well from April 1981 through April 1987 are plotted in figure 21. The initial elevated concentrations declined from about 1,000 μg/L in 1981 to 200 μg/L by 1987. This compound also was detected at an elevated concentration (184 μg/L) in well 95-3, adjacent to building 95, and at well 82-1, adjacent to the sewage-treatment plant. Therefore, three possible sources of contamination are hypothesized: (1) leaky tanks in building 95 that were installed as part of the excavation of the seepage lagoons in 1981, (2) the site of the former lagoons, and (3) leakage from sewage lines to the sewage-treatment plant. Differentiating among these three possible sources was beyond the scope of this investigation.

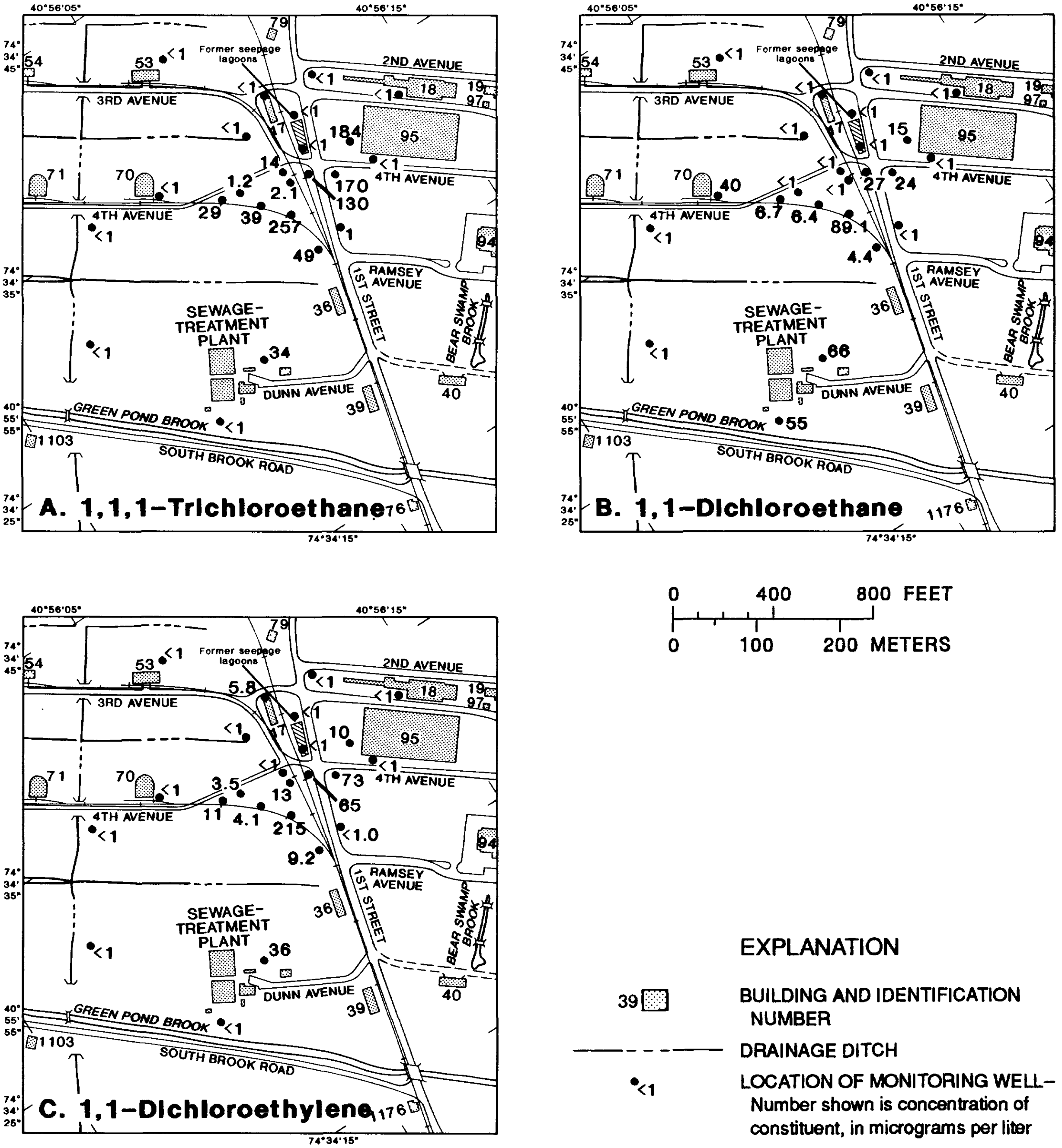
The areal distribution of 1,1-dichloroethane and 1,1-dichloroethylene did not exactly match that of 1,1,1-trichloroethane as indicated by results of analyses of previously collected samples (fig. 20). The concentrations of 1,1-dichloroethane in samples from well 70-4 (39.7 μg/L) and well 82-1 (65.6 μg/L) were similar to those in the 1988 drive-point samples at these sites. A possible explanation for the absence of 1,1,1-trichloroethane in samples from these two wells is removal through biological degradation.

Base/Neutral- and Acid-Extractable Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Samples from monitoring wells MW 12A, 82-1, WG 11-2, and WG 9-2 were analyzed for base/neutral- and acid-extractable compounds, pesticides, and PCB's. These compounds and their corresponding reporting limits are listed in table 10. Bis (2-ethylhexyl) phthalate was detected in six samples in concentrations less than 5 μg/L. This compound is abundant in the environment because of its extensive use in plastics. At low concentrations, its presence probably is an artifact of field or laboratory procedures rather than an indication of ground-water contamination.

CONTAMINATION IN THE UNSATURATED ZONE

Soil-gas probes at eight sites were sampled September 21-22, 1988, at points 1.5 to 3.5 ft above the water table; results are presented in table 11, and the site locations are shown in figure 22. 1,1,1-Trichloroethane was the predominant gas-phase contaminant. The maximum concentration (15.7 μg/L) was found at site VP95-6, within a few feet of well MW 12A. 1,1-Dichloroethylene, 1,1-dichloroethane, TCE, and tetrachloroethylene also were



Base from basic information maps of Picatinny Arsenal, 1975

Figure 20.--Concentrations of (A) 1,1,1-trichloroethane, (B) 1,1-dichloroethane, and (C) 1,1-dichloroethylene in water from wells sampled during 1989-90.

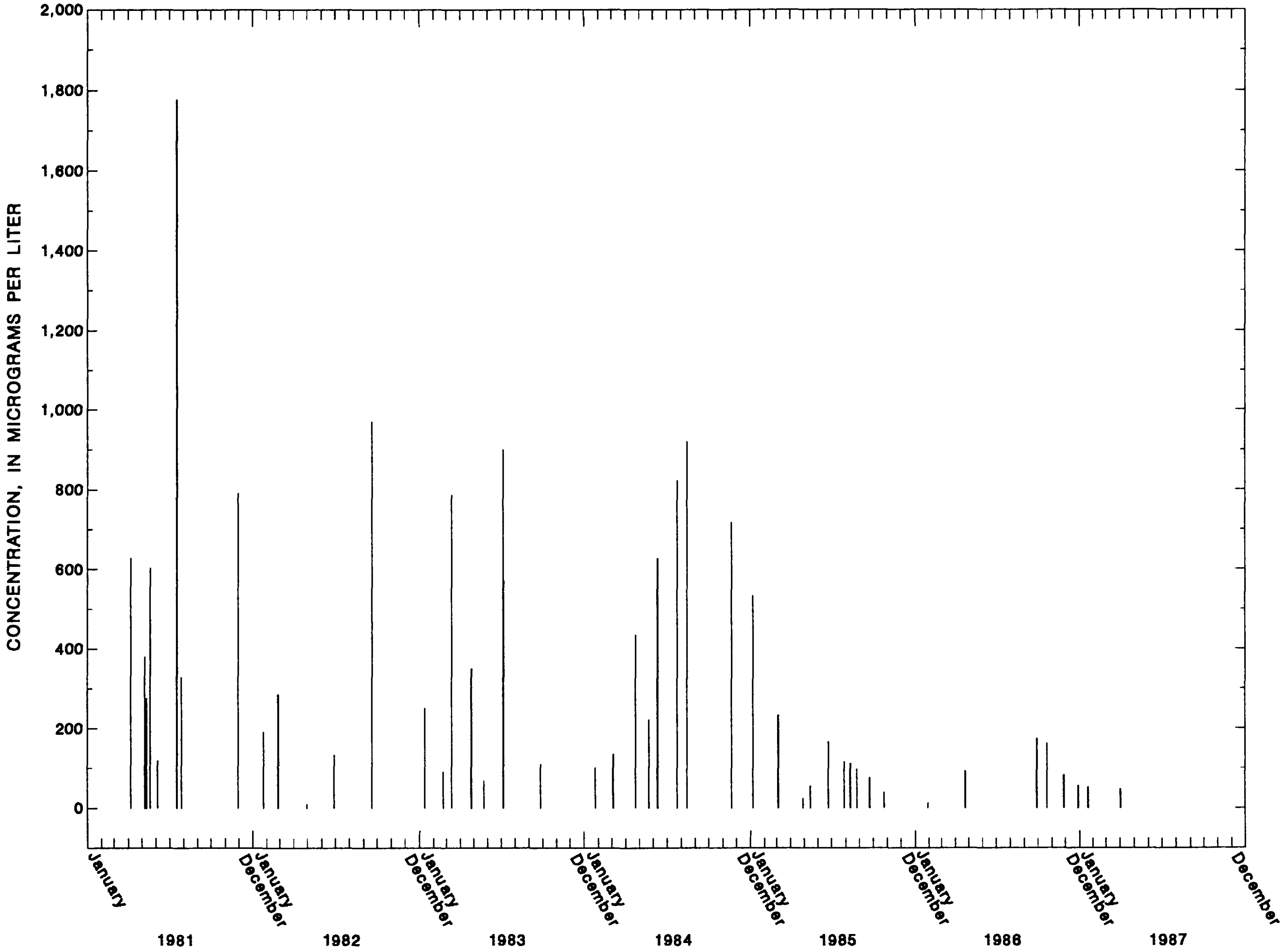


Figure 21.--Concentrations of 1,1,1-trichloroethane in ground water from well MW 12A, 1981-87.

Table 10.--Reporting limits of selected compounds determined in samples from wells MW 12A, WG 9-3, WG 11-3, and 82-1

Compound	Reporting limit (in micrograms per liter)	Compound	Reporting limit (in micrograms per liter)
Base/Neutral-Extractable Organic Compounds			
Benzo (g,h,i) perylene	10	Hexachloroethane	5
1,2-Dichlorobenzene	5	Indeno (1,2,3-c,d) pyrene	10
1,3-Dichlorobenzene	5	Bis (2-chloroethyl) ether	5
1,4-Dichlorobenzene	5	Bis (2-ethylhexyl) phthalate	5
Naphthalene	5	Isophorone	5
Nitrobenzene	5	N-Nitrosodi-n-propylamine	5
2,4-Dinitrotoluene	5	N-Nitrosodiphenylamine	5
2,6-Dinitrotoluene	5	1,2,4-Trichlorobenzene	5
4-Bromophenyl phenyl ether	5	Di-n-octyl-phthalate	10
Phenanthrene	5	Di-n-butyl phthalate	5
Pyrene	5	Hexachlorobutadiene	5
Anthracene	5	Benzo (k) fluoranthene	10
Benzo (a) anthracene	5	Benzo (a) pyrene	10
Benzo (b) fluoranthene	10	N-Butylbenzyl phthalate	5
Acenaphthylene	5	Chrysene	10
Acenaphthene	5	Diethyl phthalate	5
Dimethyl phthalate	5	N-Nitrosodimethylamine	5
Fluoranthene	5	1,2,5,6-Dibenzanthracene	10
Fluorene	5	2-Chloronaphthalene	5
Hexachlorocyclopentadiene	5		
Acid-Extractable Organic Compounds			
Phenol		2-Chlorophenol	30
2-Nitrophenol	5	2,4-Dichlorophenol	5
4-Nitrophenol	5	2,4,6-Trichlorophenol	20
2,4-Dinitrophenol	30	2,4-Dimethylphenol	5
Pentachlorophenol	20		
Pesticides and Polychlorinated Biphenyls			
Endosulfan	.01	Chlordane	.1
Methoxychlor	.01	Heptachlor	.01
Hexachlorobenzene	5	Heptachlor epoxide	.01
Aldrin	.01	Lindane	.01
Dieldrin	.01	Toxaphene	1
2,2-Bis (para-chlorophenyl)-1,1-dichloroethane	.01	Polychlorinated biphenyls	.1
		Endrin	.01
2,2-Bis (para-chlorophenyl)-1,1-dichloroethene	.01	Mirex	.01
		Perthane	.1
2,2-Bis (para-chlorophenyl)-1,1,1-trichloroethane	.01	PCN's (polychlorinated naphthalenes)	.1
Other Compounds			
Bis (2-chloroethoxy) methane	5	2-Methyl-4,6 dinitrophenol	30
Bis (2-chloroisopropyl) ether	5	3-Methyl-4-chlorophenol	30

Table 11.--Concentrations of organic compounds[1] in soil gas near building 95, September 21-22, 1988

[Concentrations in micrograms per liter; <, less than; all samples listed in this table were analyzed at the U.S. Geological Survey New Jersey District Laboratory, Trenton, New Jersey]

Site	Chloro-ethane	cis-1,2-Dichloro-ethylene	1,1-Dichloro-ethane	1,1-Dichloro-ethylene	Tetra-chloro-ethylene	1,1,1-Trichloro-ethane	Trichloro-ethylene
VP95-1	0.10	<0.10	<0.10	<0.10	2.60	0.43	3.55
VP95-2	<.10	<.10	<.10	<.10	0.61	.15	0.10
VP95-3	<.10	<.10	<.10	<.10	<.10	<.10	<.10
VP95-4	<.10	.18	.45	<.10	2.56	.85	4.32
VP95-5	.24	<.10	.41	<.10	5.22	.78	8.56
VP95-6	<.10	<.10	.78	.52	6.99	15.7	.26
VP95-7	<.10	<.10	<.10	<.10	<.10	<.10	<.10
VP95-8	<.10	<.10	<.10	<.10	<.10	1.32	<.10

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[1] Quantitation limit is about 0.10 micrograms per liter

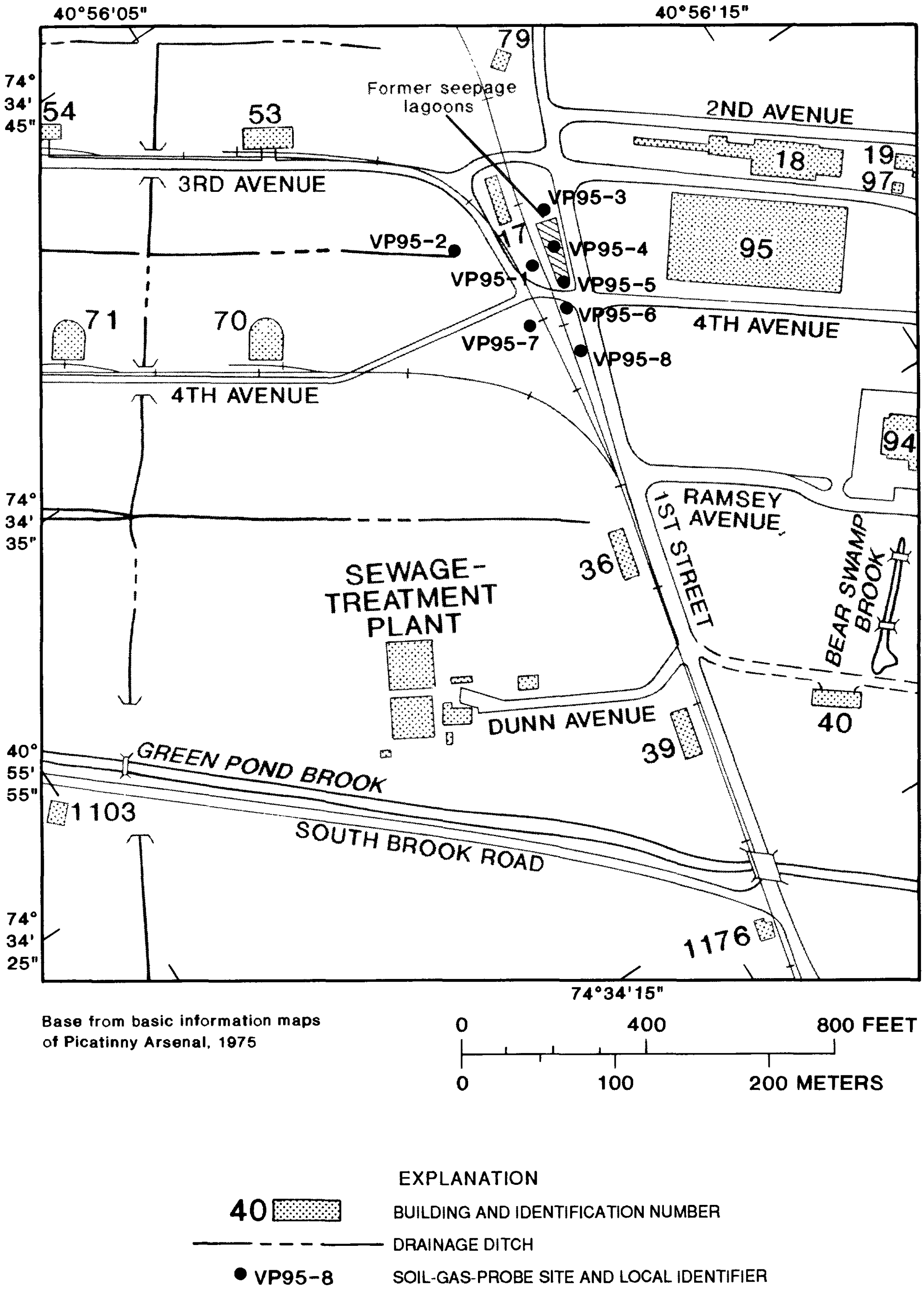

Figure 22.--Locations of soil-gas-probe sites.

detected in gas samples from this site. TCE was detected at a maximum concentration of 8.56 μg/L at site VP95-5, which is closer to the former seepage lagoons than site VP95-6 is. The presence of VOC's in soil gas indicates that volatilization and diffusion through the unsaturated zone may be a significant mechanism of contaminant loss from the aquifer.

SUMMARY AND CONCLUSIONS

A zone of contaminated ground water was produced by a metal-plating wastewater-treatment system that operated during 1960-81 at building 95 at Picatinny Arsenal, New Jersey. A drive-point reconnaissance survey was conducted in 1986 and 1988 to determine the optimum locations for wells and define the extent of ground-water contamination. Thirty-two wells were installed in 1989 to supplement the 12 previously installed monitoring wells. Water samples were collected in 1989 and 1990 for analysis for inorganic constituents, trace elements, volatile organic compounds, and nutrients, and samples from four of these wells also were analyzed for base/neutral- and acid-extractable compounds, pesticides, and polychlorinated biphenyls. Soil-gas probes were used at eight sites to sample soil gas in the unsaturated zone for analysis for volatile organic compounds.

Concentrations of dissolved solids and sulfate were consistently above the U.S. Environmental Protection Agency secondary maximum contaminant levels in the study area. Maximum concentrations of dissolved solids and sulfate in samples collected from wells in 1989 and 1990 were 1,550 and 820 milligrams per liter, respectively. The areal distribution of sulfate does not appear to parallel that of volatile organic compounds from the wastewater-treatment system because sulfate could originate from both the wastewater-treatment system and the sewage-treatment plant. Trace elements were present in the building 95 wastewater but were not detected in elevated concentrations downgradient from the source, possibly because of sorption of trace elements onto aquifer sediments. If contaminants are assumed to move with ground water by advection, the estimated average velocity of contaminant movement is 0.1 to 1.1 feet per day. Water-table maps constructed from water levels measured in April and September 1989 indicate that the direction of shallow ground-water flow was southward and toward Green Pond Brook during these periods.

Trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane are the major organic contaminants in the study area. The maximum concentrations of trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane in water samples collected in 1989 and 1990 were 52.7, 168, and 257 micrograms per liter, respectively. Trichloroethylene might not originate at the former wastewater-treatment site because it also was detected in upgradient wells. Tetrachloroethylene and 1,1,1-trichloroethane could have originated from tanks in the basement of building 95 rather than the adjacent site of the former wastewater-treatment system. Delineation of a plume was not possible because contaminants originated from several sources other than the former seepage lagoons.

1,1,1-Trichloroethane is the predominant gas-phase contaminant. Its maximum concentration (15.7 micrograms per liter) was found in gas samples from site VP95-6, within a few feet of well MW 12A near the former lagoons. Other compounds detected in soil-gas samples include 1,1-dichloroethylene, 1,1-dichloroethane, trichloroethylene, and tetrachloroethylene.

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Table 5.--Results of analyses of ground-water samples for selected volatile organic compounds, 1985-87

[All constituents are dissolved; concentrations in micrograms per liter; <, less than; NWQL, U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado; ACUT, Acutest, Inc.; TRN, U.S. Geological Survey New Jersey District Laboratory, Trenton, New Jersey; number in parentheses is constituent-analysis code used by U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado]

Local well identifier	Laboratory	Sample date	Trichloroethylene (39180)	Tetrachloroethylene (34475)	trans-1,2-Dichloroethylene (34546)	1,1,1-Trichloroethane (34506)	1,1-Dichloroethylene (34501)	1,1-Dichloroethane (34496)	1,1,2-Trichloroethane (34511)	1,1,2,2-Tetrachloroethane (34516)
DH-3	NWQL	08-21-1985	<3	<3	<3	<3	<3	<3	<3	<3
MW 11	ACUT	03-06-1985	9.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	9.6	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	12.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-25-1985	19.0	<1	<1	<1	<1	<1	<1	<1
	TRN	08-12-1985	4.0	<2	<2	<2	<2	<2	<2	<2
	ACUT	01-27-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-25-1986	5.3	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-29-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-30-1986	16.3	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	13.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	11.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	12-23-1986	13.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1987	23.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-08-1987	8.2	<1	<1	<1	<1	<1	<1	<1
MW 12A	ACUT	03-05-1985	17.0	59.0	<1	233	17.0	27.0	<1	<1
	ACUT	04-29-1985	6.7	8.6	<1	24.0	2.4	3.4	<1	<1
	ACUT	05-16-1985	10.0	15.0	1.3	55.0	4.5	6.5	<1	<1
	ACUT	06-24-1985	21.0	45.0	3.2	165	29.0	23.0	<1	<1
	ACUT	07-29-1985	16.0	14.3	<1	116	6.6	8.0	<1	<1
	NWQL	08-12-1985	13.0	36.0	<3	110	17.0	12.0	<3	<3
	ACUT	08-27-1985	14.0	18.0	2.0	97.0	13.0	11.0	<1	<1
	ACUT	09-24-1985	15.0	10.0	<1	75.0	9.0	<1	<1	<1
	ACUT	10-25-1985	11.0	22.0	<1	39.0	2.6	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	12.0	<1	<1	<1	<1
	ACUT	04-24-1986	6.6	<1	<1	92.0	<1	<1	<1	<1
	ACUT	09-29-1986	23.0	36.0	29.0	174	<1	<1	<1	<1
	ACUT	10-21-1986	22.0	28.0	<1	162	9.2	32.0	<1	<1
	ACUT	11-28-1986	15.0	28.0	<1	82.0	7.7	21.0	<1	<1
	ACUT	12-30-1986	17.0	27.0	<1	56.0	5.3	10.0	<1	<1
	ACUT	01-21-1987	13.0	17.0	<1	52.0	4.3	14.0	<1	<1
	ACUT	04-02-1987	16.0	12.0	<1	47.0	<1	6.3	<1	<1
MW 12B	ACUT	03-05-1985	8.1	45.0	<1	2.1	<1	<1	<1	<1
	ACUT	04-29-1985	23.0	1.7	1.9	<1	<1	<1	<1	<1
	ACUT	05-16-1985	11.0	28.0	<1	<1	<1	<1	<1	<1
	ACUT	06-24-1985	10.0	38.0	<1	<1	<1	<1	<1	<1
	ACUT	07-29-1985	9.2	22.0	<1	<1	<1	<1	<1	<1
	TRN	08-13-1985	2.7	65.0	<2	<2	<2	<2	<2	<2
	ACUT	08-27-1985	8.0	18.0	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	8.0	34.0	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-24-1986	5.2	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-30-1986	11.6	27.0	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	8.0	36.0	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	6.3	33.0	<1	<1	<1	<1	<1	<1
	ACUT	12-23-1986	8.2	66.0	<1	<1	<1	<1	<1	<1
	ACUT	01-21-1987	5.9	22.0	<1	<1	<1	<1	<1	<1
	ACUT	04-07-1987	9.6	20.0	<1	<1	<1	<1	<1	<1

Table 5. --Results of analyses of ground-water samples for selected volatile organic compounds, 1985-87--Continued

Local well identifier	Laboratory	Sample date	Toluene (34010)	Benzene (34030)	Ethylbenzene (34371)	Chlorobenzene (34301)	Methylene chloride (34423)	Chloroform (32106)	1,2-Dichloroethane (32103)	2-Chloroethyl vinyl ether (34576)
DH-3	NWQL	08-21-1985	<3	<3	<3	<3	<3	<3	<3	<3
MW 11	ACUT	03-06-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-25-1985	<1	<1	<1	<1	<1	<1	<1	<1
	TRN	08-12-1985	<2	<2	<2	<2	<2	<2	<2	<2
	ACUT	01-27-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-25-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-29-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-30-1986	<1	12	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	<1	12	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	11	<1	<1	<1	<1	<1	<1
	ACUT	12-23-1986	<1	11	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-08-1987	<1	<1	<1	<1	<1	<1	<1	<1
MW 12A	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	07-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	NWQL	08-12-1985	<3	<3	<3	<3	<3	<3	<3	<3
	ACUT	08-27-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-25-1985	<1	<1	<1	<1	2.3	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-24-1986	<1	<1	<1	<1	<1	3.8	7.9	<1
	ACUT	09-29-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	13.0	20.0	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	16.0	<1	<1	<1	<1	<1	<1
	ACUT	12-30-1986	<1	17.0	<1	<1	14.0	<1	<1	<1
	ACUT	01-21-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-02-1987	<1	<1	<1	<1	<1	<1	<1	<1
MW 12B	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	<1	<1	<1	<1	<1	1.5	<1	<1
	ACUT	05-16-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	07-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	TRN	08-13-1985	<2	<2	<2	<2	<2	<2	<2	<2
	ACUT	08-27-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-24-1986	<1	<1	<1	<1	84	2.1	<1	<1
	ACUT	09-30-1986	<1	7.6	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	7.6	<1	<1	<1	<1	<1	<1
	ACUT	12-23-1986	<1	7.8	<1	<1	<1	<1	<1	<1
	ACUT	01-21-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-07-1987	<1	<1	<1	<1	<1	<1	<1	<1

Table 5.--Results of analyses of ground-water samples for selected volatile organic compounds, 1985-87--Continued

Local well identifier	Labora-tory	Sample data	Tri-chloro-ethylene (39180)	Tetra-chloro-ethlene (34475)	trans-1,2-Dichloro-ethylene (34546)	1,1,1-Trichloro-ethane (34506)	1,1-Dichloro-ethylene (34501)	1,1-Dichloro-ethane (34496)	1,1,2-Trichloro-ethane (34511)	1,1,2,2-Tetra-chloro-ethane (34516)
MW 12C	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	10.0	7.9	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	18.0	14.0	1.6	<1	<1	<1	<1	<1
	ACUT	06-24-1985	14.0	21.0	<1	<1	<1	<1	<1	<1
	ACUT	07-29-1985	25.0	23.2	<1	<1	<1	<1	<1	<1
	TRN	08-12-1985	13.0	<2	<2	<2	<2	<2	<2	<2
	ACUT	08-27-1985	12.0	11.0	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	29.0	22.0	<1	<1	<1	<1	<1	<1
	ACUT	10-23-1985	18.0	12.0	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-24-1986	6.3	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-30-1986	4.5	4.7	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	19.0	12.0	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	12-23-1986	24.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-21-1987	15.0	7.5	<1	<1	<1	<1	<1	<1
	ACUT	04-07-1987	15.0	6.6	<1	<1	<1	<1	<1	<1
MW 12D	ACUT	03-05-1985	18.0	6.4	<1	1.6	<1	<1	<1	<1
	ACUT	04-29-1985	11.0	29.0	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	25.0	2.0	2.2	<1	<1	<1	<1	<1
	ACUT	06-24-1985	28.0	1.2	1.7	<1	<1	<1	<1	<1
	ACUT	07-29-1985	20.5	2.5	<1	<1	<1	<1	<1	<1
	TRN	08-13-1985	24.0	6.0	<2	<2	<2	2	<2	<2
	ACUT	08-27-1985	48.0	5.6	4.3	1.0	<1	<1	<1	<1
	ACUT	09-24-1985	22.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-22-1985	11.0	1.9	<1	<1	<1	<1	<1	<1
	ACUT	10-25-1985	6.8	50.0	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-25-1986	22.0	<1	3.3	<1	<1	<1	<1	<1
	ACUT	09-29-1986	53.0	5.0	<1	<1	<1	<1	<1	<1
	ACUT	10-24-1986	33.0	6.8	2.6	<1	<1	<1	<1	<1
	ACUT	11-28-1986	23.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	12-30-1986	19.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1987	12.0	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-02-1987	25.0	<1	2.2	<1	<1	<1	<1	<1
MW 12E	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	07-30-1985	<1	<1	<1	<1	<1	<1	<1	<1
	TRN	08-12-1985	<2	<2	<2	<2	<2	<2	<2	<2
	ACUT	08-26-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-22-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-27-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-17-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-22-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	12-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-14-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-08-1987	<1	<1	<1	<1	<1	<1	<1	<1
MW 12F	TRN	08-13-1985	133	61	<2	<2	16	8	6	<2
MW 12G	TRN	08-13-1985	2.3	17	<2	<2	<2	<2	<2	<2
MW 12H	TRN	08-12-1985	152	5	<2	<2	<2	<2	<2	<2
MW 12I	TRN	08-13-1985	3.2	8	<2	<2	<2	<2	<2	<2
MW 12J	TRN	08-16-1985	127	2	<2	<2	4	7	<2	<2

Table 5.--Results of analyses of ground-water samples for selected volatile organic compounds, 1985-87--Continued

Local well identifier	Laboratory	Sample date	Toluene (34010)	Benzene (34030)	Ethylbenzene (34371)	Chlorobenzene (34301)	Methylene chloride (34423)	Chloroform (32106)	1,2-Dichloroethane (32103)	2-Chloroethyl vinyl ether (34576)
MW 12C	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	2.8	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	07-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	TRN	08-12-1985	<2	<2	<2	<2	<2	<2	<2	<2
	ACUT	08-27-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-23-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-24-1986	<1	<1	<1	<1	142	<1	<1	<1
	ACUT	09-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-21-1986	<1	21.0	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	12-23-1986	8.5	20.0	<1	<1	<1	<1	<1	<1
	ACUT	01-21-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-07-1987	<1	<1	<1	<1	<1	<1	<1	<1
MW 12D	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	05-16-1985	<1	<1	<1	<1	<1	1.1	<1	<1
	ACUT	06-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	07-29-1985	<1	<1	<1	<1	<1	<1	<1	<1
	TRN	08-13-1985	<2	<2	<2	<2	<2	<2	<2	<2
	ACUT	08-27-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-22-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-25-1985	<1	<1	<1	<1	2.5	<1	<1	<1
	ACUT	01-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-25-1986	<1	<1	<1	<1	<1	2.0	<1	<1
	ACUT	09-29-1986	<1	48	<1	<1	<1	<1	<1	<1
	ACUT	10-24-1986	<1	30	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	24	<1	<1	<1	<1	<1	<1
	ACUT	12-30-1986	<1	22	<1	<1	<1	<1	<1	<1
	ACUT	01-30-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-02-1987	<1	<1	<1	<1	<1	<1	<1	<1
MW 12E	ACUT	03-05-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	06-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	07-30-1985	<1	<1	<1	<1	<1	<1	<1	<1
	TRN	08-12-1985	<2	<2	<2	<2	<2	<2	<2	<2
	ACUT	08-26-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-24-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-22-1985	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-27-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	09-17-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	10-22-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	11-28-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	12-30-1986	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	01-14-1987	<1	<1	<1	<1	<1	<1	<1	<1
	ACUT	04-08-1987	<1	<1	<1	<1	<1	<1	<1	<1
MW 12F	TRN	08-13-1985	<2	<2	<2	10	<2	<2	12	5
MW 12G	TRN	08-13-1985	<2	<2	<2	<2	<2	<2	<2	<2
MW 12H	TRN	08-12-1985	<2	<2	<2	<2	<2	<2	<2	<2
MW 12I	TRN	08-13-1985	<2	<2	<2	<2	<2	<2	<2	<2
MW 12J	TRN	08-16-1985	<2	<2	<2	<2	<2	<2	24	<2

Table 6.--Results of analyses of drive-point water samples for chemical properties, inorganic constituents, nutrients, and trace elements

[All constituents are dissolved, except as noted; concentrations in milligrams per liter, except as noted; µg/L, micrograms per liter; <, less than; -, constituent not determined; TRN, U.S. Geological Survey New Jersey District Laboratory, Trenton, New Jersey; µS/cm, microsiemens per centimeter at 25 degrees Celsius; number in parentheses is constituent-analysis code used by U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado]

Local identifier[1]	Sample date	Field pH (units) (00400)	Field specific conductance (µS/cm) (00095)	TRN Laboratory alkalinity (as $CaCO_3$) (90410)	Dissolved solids (70300)	Ammonia (as N) (00608)	Ammonia + organic N (as N) (00623)	Nitrite (as N) (00613)	Nitrite + Nitrate (as N) (00631)
G-01-10	08-06-86	6.9	1,350	155	764	0.35	0.3	<0.01	<0.1
G-01-15	08-06-86	7.4	811	176	453	.04	<.2	<.01	<.1
G-01-25	08-06-86	7.6	809	168	441	.07	.2	<.01	<.1
G-01-35	08-06-86	7.9	711	134	392	.06	.2	.01	<.1
G-01-40	08-06-86	8.1	498	133	279	.04	<.2	.01	<.1
G-02-10	09-09-86	6.9	768	169	467	.16	<.2	<.01	<.1
G-02-20	09-09-86	7.6	672	161	567	.16	<.2	<.01	<.1
G-02-30	09-09-86	7.6	617	134	387	.18	.2	<.01	<.1
G-02-40	09-09-86	7.6	1,130	205	1,180	.40	.5	<.01	<.1
G-02-50	09-09-86	8.5	245	68	134	.25	<.2	<.01	<.1
G-03-10	09-10-86	6.1	475	63	360	.17	.6	.01	<.1
G-03-20	09-10-86	6.5	1,070	205	575	.21	<.2	<.01	<.1
G-03-30	09-10-86	6.8	1,250	195	716	.14	.2	<.01	<.1
G-03-40	09-10-86	7.2	1,420	168	1,010	.35	.4	<.01	<.1
G-03-45	09-10-86	7.6	278	118	165	.18	.4	<.01	<.1
G-04-10	10-22-86	7.6	425	145	275	.09	.5	<.01	.15
G-04-20	10-22-86	7.4	418	166	260	.26	1	<.01	<.1
G-04-30	10-22-86	8.3	389	105	249	.05	<.2	<.01	.1
G-04-40	10-22-86	8.8	135	55	117	.07	.3	<.01	.49
G-05-10	10-21-86	6.9	597	141	372	.30	1	<.01	<.1
G-05-20	10-21-86	7.5	752	156	482	.21	.9	<.01	<.1
G-05-30	10-21-86	7.9	1,370	255	1,060	.23	.6	<.01	.28
G-06-10	10-23-86	7.6	635	147	414	.25	.7	<.01	<.1
G-06-20	10-24-86	7.6	810	216	512	.31	.9	<.01	<.1
G-06-25	10-24-86	7.4	1,930	323	1,610	.32	.4	<.01	<.1
G-06-35	10-24-86	8.7	665	145	453	.15	.4	<.01	<.1
G-07-06	09-27-88	[2]7.3	[3]354	-	254	.54	1.3	<.01	<.1
G-07-15	09-27-88	[2]7.9	[3]630	-	410	.77	1	<.01	<.1
G-07-25	09-27-88	[2]8.2	[3]578	-	382	.34	.3	<.01	<.1
G-08-10	09-28-88	[2]7.3	[3]877	-	507	.22	.6	<.01	<.1
G-08-20	09-28-88	[2]7.4	[3]965	-	560	.21	.5	<.01	<.1
G-08-30	09-28-88	[2]7.3	[3]1,110	-	711	.17	<.2	<.01	<.1
G-08-40	09-28-88	[2]7.5	[3]1,500	-	1,220	.35	.6	<.01	<.1
G-09-10	09-29-88	[2]7.0	[3]996	-	577	.24	.4	<.01	<.1
G-09-20	09-29-88	[2]7.5	[3]824	-	480	.29	.3	<.01	<.1
G-09-30	09-29-88	[2]7.8	[3]729	-	436	.07	.2	<.01	<.1
G-09-40	09-29-88	[2]7.8	[3]421	-	239	.15	.2	<.01	<.1
G-10-10	09-30-88	[2]6.7	[3]1,360	-	814	.16	.9	<.01	<.1
G-10-20	09-30-88	[2]7.3	[3]867	-	527	.56	.8	<.01	<.1
G-10-30	09-30-88	[2]7.3	[3]1,250	-	848	.37	.6	<.01	<.1
G-11-10	10-03-88	[2]5.8	[3]515	-	363	<.01	.2	<.01	<.1
G-11-20	10-03-88	[2]7.8	[3]833	-	481	.01	.2	.05	1.5
G-11-30	10-03-88	[2]7.8	[3]668	-	294	<.01	.3	<.01	2.7
G-13-10	10-05-88	[2]7.2	[3]560	-	341	.35	.9	<.01	<.1
G-13-20	10-05-88	[2]7.3	[3]825	-	492	.49	1	<.01	<.1
G-13-30	10-05-88	[2]7.2	[3]1,500	-	1,190	.41	.4	<.01	<.1
G-13-40	10-05-88	[2]8.0	[3]1,020	-	806	.31	.4	<.01	<.1
G-13-50	10-05-88	[2]8.6	[3]191	-	113	.17	.3	<.01	<.1
G-14-10	10-04-88	[2]7.2	[3]1,080	-	665	.13	.8	<.01	<.1
G-14-20	10-04-88	[2]7.5	[3]949	-	549	.16	.6	<.01	<.1

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[1] Last two digits represent depth (in feet below land surface) from which the sample was collected
[2] Laboratory pH
[3] Laboratory specific conductance

Table 6.--Results of analyses of drive-point water samples for chemical properties, inorganic constituents, nutrients, and trace elements--Continued

Local identifier[1]	Sample date	Phosphorus (00666)	Ortho-phosphate (00671)	Calcium (00915)	Magnesium (00925)	Sodium (00930)	Potassium (00935)	Chloride (00940)	Sulfate (00945)
G-01-10	08-06-86	0.01	<0.01	76	28	140	5.1	270	99
G-01-15	08-06-86	<.01	<.01	66	28	54	2.3	120	58
G-01-25	08-06-86	<.01	<.01	65	24	59	1.8	130	49
G-01-35	08-06-86	.02	.01	64	21	45	2.4	110	39
G-01-40	08-06-86	.02	<.01	60	15	15	1.9	61	34
G-02-10	09-09-86	.75	<.01	55	26	53	5.8	110	62
G-02-20	09-09-86	.06	<.01	65	14	44	4.6	92	39
G-02-30	09-09-86	<.01	<.01	70	16	25	4.7	82	41
G-02-40	09-09-86	.01	.01	230	50	8.8	2.5	21	540
G-02-50	09-09-86	.01	.04	22	1.8	14	1.2	1.8	23
G-03-10	09-10-86	.03	<.01	19	6.2	52	3.2	81	51
G-03-20	09-10-86	<.01	<.01	78	19	110	5.1	150	97
G-03-30	09-10-86	<.01	<.01	130	23	87	4.1	150	180
G-03-40	09-10-86	<.01	<.01	240	36	16	3.0	9.4	630
G-03-45	09-10-86	.02	<.01	31	2.4	16	1.6	2.3	55
G-04-10	10-22-86	.03	.01	43	15	23	2.6	28	54
G-04-20	10-22-86	.02	.01	49	15	15	2.0	18	20
G-04-30	10-22-86	.03	.01	43	13	18	1.4	41	27
G-04-40	10-22-86	.08	.07	19	2.2	6.6	1.0	2.7	27
G-05-10	10-21-86	.05	.06	39	16	51	1.9	63	56
G-05-20	10-21-86	.02	.02	82	24	33	1.5	85	91
G-05-30	10-21-86	.02	<.01	210	66	11	1.6	29	490
G-06-10	10-23-86	.49	.02	59	19	36	3.5	66	82
G-06-20	10-24-86	.03	<.01	98	20	53	5.0	110	99
G-06-25	10-24-86	.03	<.01	300	100	13	2.5	49	840
G-06-35	10-24-86	.06	<.01	91	23	14	1.8	3.7	190
G-07-06	09-27-88	.07	.06	37	16	15	.9	25	45
G-07-15	09-27-88	.02	<.01	83	27	9.9	.8	37	120
G-07-25	09-27-88	.06	.03	88	12	17	1.0	9.2	180
G-08-10	09-28-88	.04	.03	56	21	94	4.4	140	70
G-08-20	09-28-88	.03	.01	67	24	95	4.5	150	80
G-08-30	09-28-88	.03	<.01	110	28	77	6.6	120	210
G-08-40	09-28-88	.03	.01	240	85	12	1.6	15	640
G-09-10	09-29-88	.18	.09	51	22	120	5.1	150	92
G-09-20	09-29-88	.02	<.01	70	20	77	2.6	110	64
G-09-30	09-29-88	.03	.02	69	20	52	2.1	110	41
G-09-40	09-29-88	.04	.01	55	13	7.9	1.2	35	32
G-10-10	09-30-88	.02	.01	65	34	140	2.0	340	54
G-10-20	09-30-88	.03	.02	73	22	74	4.0	110	99
G-10-30	09-30-88	.04	.03	150	44	60	1.8	110	290
G-11-10	10-03-88	<.01	<.01	56	18	51	3.5	100	41
G-11-20	10-03-88	.01	.01	67	28	62	5.5	110	62
G-11-30	10-03-88	.01	<.01	22	9	60	4.3	100	51
G-13-10	10-05-88	.06	.05	47	17	46	1.6	64	40
G-13-20	10-05-88	.04	.03	54	18	88	2.9	150	48
G-13-30	10-05-88	.01	.03	220	65	39	2.1	64	580
G-13-40	10-05-88	.02	.03	190	22	17	1.4	6.2	480
G-13-50	10-05-88	.07	.06	20	1.6	19	1.2	1.4	13
G-14-10	10-04-88	.01	<.01	91	36	83	4.5	140	130
G-14-20	10-04-88	<.01	.02	90	27	68	4.5	130	82

Table 6.--Results of analyses of drive-point water samples for chemical properties, inorganic constituents, nutrients, and trace elements--Continued

Local identifier[1]	Sample date	Silica (as SiO_2) (00955)	Arsenic (μg/L) (01000)	Barium (μg/L) (01005)	Beryllium (μg/l) (01010)	Cadmium (μg/L) (01025)	Chromium (μg/L) (01030)	Cobalt (μg/L) (01035)	Copper (μg/L) (01040)
G-01-10	08-06-86	15	<1	120	<0.5	<1	<1	3	<10
G-01-15	08-06-86	12	<1	61	<.5	<1	<1	<3	<10
G-01-25	08-06-86	14	<1	29	<.5	<1	<1	7	<10
G-01-35	08-06-86	14	1	62	<.5	<1	<1	<3	<10
G-01-40	08-06-86	12	<1	39	<.5	<1	<1	<3	<10
G-02-10	09-09-86	24	2	93	<.5	1	3	100	<10
G-02-20	09-09-86	15	1	64	<.5	<1	<1	50	<10
G-02-30	09-09-86	12	<1	71	<.5	<1	<1	20	<10
G-02-40	09-09-86	12	6	38	<.5	<1	<1	<3	<10
G-02-50	09-09-86	11	3	11	<.5	<1	<1	<3	<10
G-03-10	09-10-86	24	2	150	<.5	<1	<1	<3	<10
G-03-20	09-10-86	16	2	48	2	1	<1	<3	<10
G-03-30	09-10-86	16	1	29	2	2	<1	<3	<10
G-03-40	09-10-86	14	2	39	1	<1	<1	<3	<10
G-03-45	09-10-86	9.3	2	15	.8	<1	<1	<3	<10
G-04-10	10-22-86	15	1	45	<.5	1	<1	<3	<10
G-04-20	10-22-86	15	3	79	<.5	1	<1	<3	<10
G-04-30	10-22-86	13	4	25	<.5	<1	<1	<3	<10
G-04-40	10-22-86	10	3	6	<.5	<1	<1	<3	<10
G-05-10	10-21-86	14	1	81	<.5	<1	<1	<9	<30
G-05-20	10-21-86	17	10	92	<.5	2	<1	<9	<30
G-05-30	10-21-86	16	13	30	<.5	1	<1	<3	<10
G-06-10	10-23-86	18	2	170	<.5	2	1	<3	<10
G-06-20	10-24-86	20	15	62	<.5	1	<1	<3	<10
G-06-25	10-24-86	23	15	43	<.5	2	<1	<3	<10
G-06-35	10-24-86	13	10	21	<.5	1	2	<3	<10
G-07-06	09-27-88	15	3	52	<.5	<1	<1	<3	<10
G-07-15	09-27-88	13	17	45	<.5	<1	<1	<3	<10
G-07-25	09-27-88	10	8	54	<.5	<1	<1	<3	<10
G-08-10	09-28-88	17	3	130	<.5	<1	<1	<3	<10
G-08-20	09-28-88	15	3	110	<.5	<1	<1	<3	<10
G-08-30	09-28-88	20	8	39	<.5	<1	<1	<3	<10
G-08-40	09-28-88	21	9	22	<.5	<1	<1	<3	<10
G-09-10	09-29-88	22	<1	58	<.5	<1	<1	<3	<10
G-09-20	09-29-88	16	<1	63	<.5	<1	<1	<3	<10
G-09-30	09-29-88	18	4	100	<.5	<1	<1	<3	<10
G-09-40	09-29-88	19	3	48	<.5	<1	<1	<3	<10
G-10-10	09-30-88	14	<1	170	<.5	1	<2	<3	<10
G-10-20	09-30-88	19	5	85	<.5	<1	<1	<3	<10
G-10-30	09-30-88	22	13	29	<.5	<1	<1	<3	<10
G-11-10	10-03-88	12	<1	53	<.5	<1	<1	<3	<10
G-11-20	10-03-88	14	<1	41	<.5	<1	<1	<3	<10
G-11-30	10-03-88	25	<1	37	<.5	<1	<1	20	<10
G-13-10	10-05-88	14	2	66	<.5	<1	<1	<3	<10
G-13-20	10-05-88	15	2	170	<.5	<1	<1	<3	<10
G-13-30	10-05-88	12	8	52	<.5	<1	<1	<3	<10
G-13-40	10-05-88	11	4	60	<.5	<1	<1	<3	<10
G-13-50	10-05-88	9.5	3	17	<.5	<1	<1	<3	<10
G-14-10	10-04-88	21	2	130	<.5	<1	<1	<3	<10
G-14-20	10-04-88	16	3	61	<.5	<1	<1	<3	<10

Table 6.--Results of analyses of drive-point water samples for chemical properties, inorganic constituents, nutrients, and trace elements--Continued

Local identifier[1]	Sample date	Iron (μg/L) (01046)	Lead (μg/L) (01049)	Manganese (μg/L) (01056)	Molybdenum (μg/L) (01060)	Strontium (μg/L) (01080)	Vanadium (μg/L) (01085)	Zinc (μg/L) (01090)	Lithium (μg/L) (01130)
G-01-10	08-06-86	<3	<10	330	<10	310	<6	3	15
G-01-15	08-06-86	820	<10	1,300	<10	120	<6	5	20
G-01-25	08-06-86	520	<10	940	<10	130	<6	4	25
G-01-35	08-06-86	430	<10	410	<10	210	<6	<3	18
G-01-40	08-06-86	270	<10	300	<10	280	<6	3	16
G-02-10	09-09-86	3,200	<10	1,700	<10	120	<6	8	32
G-02-20	09-09-86	2,000	<10	1,300	<10	170	<6	5	26
G-02-30	09-09-86	870	<10	920	<10	290	<6	5	26
G-02-40	09-09-86	1,500	<10	2,000	<10	680	<6	45	26
G-02-50	09-09-86	19	<10	64	<10	120	<6	<3	5
G-03-10	09-10-86	13	<10	3	<10	45	8	3	13
G-03-20	09-10-86	1,500	<10	2,200	<10	260	<6	3	38
G-03-30	09-10-86	2,100	<10	2,200	<10	410	<6	11	36
G-03-40	09-10-86	1,400	<10	1,300	<10	1,200	<6	8	24
G-03-45	09-10-86	4	<10	91	10	200	<6	3	9
G-04-10	10-22-86	3,800	<10	730	<10	110	<6	13	12
G-04-20	10-22-86	7,900	<10	830	<10	100	<6	5	12
G-04-30	10-22-86	560	<10	370	<10	140	<6	10	9
G-04-40	10-22-86	91	<10	93	<10	86	<6	8	7
G-05-10	10-21-86	5,000	<10	910	<10	91	<6	11	16
G-05-20	10-21-86	7,600	10	2,400	<10	230	<6	16	19
G-05-30	10-21-86	1,900	<10	1,800	<10	360	<6	15	27
G-06-10	10-23-86	9,600	10	1,000	<10	140	<6	21	29
G-06-20	10-24-86	6,500	<10	1,500	<10	280	<6	13	38
G-06-25	10-24-86	8,600	<10	8,800	10	380	<6	16	34
G-06-35	10-24-86	600	10	690	<10	270	<6	10	14
G-07-06	09-27-88	5,400	<10	770	<10	77	<6	<3	9
G-07-15	09-27-88	1,400	<10	770	<10	210	<6	4	13
G-07-25	09-27-88	340	<10	400	20	490	<6	5	11
G-08-10	09-28-88	7,300	<10	1,900	<10	160	<6	7	15
G-08-20	09-28-88	6,100	<10	1,500	<10	180	<6	9	16
G-08-30	09-28-88	6,100	<10	2,200	<10	330	<6	6	26
G-08-40	09-28-88	1,600	<10	2,900	<10	600	<6	5	32
G-09-10	09-29-88	5,600	<10	1,700	<10	120	<6	9	9
G-09-20	09-29-88	550	<10	1,400	<10	160	<6	<3	24
G-09-30	09-29-88	1,100	<10	850	<10	430	<6	<3	13
G-09-40	09-29-88	670	<10	920	<10	320	<6	4	14
G-10-10	09-30-88	14,000	<10	620	<10	110	7	8	17
G-10-20	09-30-88	9,100	<10	1,200	<10	220	<6	5	32
G-10-30	09-30-88	4,500	<10	4,000	<10	390	<6	5	30
G-11-10	10-03-88	380	<10	490	<10	160	<6	5	19
G-11-20	10-03-88	390	<10	220	<10	180	<6	<3	21
G-11-30	10-03-88	870	<10	400	<10	86	<6	22	14
G-13-10	10-05-88	5,800	<10	1,500	<10	110	<6	4	9
G-13-20	10-05-88	6,700	<10	1,100	<10	140	<6	4	16
G-13-30	10-05-88	380	<10	490	<10	160	<6	5	20
G-13-40	10-05-88	550	<10	630	<10	900	<6	<3	20
G-13-50	10-05-88	8	10	74	10	130	<6	<3	<4
G-14-10	10-04-88	8,600	<10	1,700	<10	210	<6	<3	19
G-14-20	10-04-88	2,700	<10	1,300	<10	320	<6	<3	25

Table 7.--Results of analyses of drive-point water samples for volatile organic compounds

[All constituents are total; concentrations in micrograms per liter; <, less than; -, constituent not determined; NWQL, U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado; TRN, U.S. Geological Survey New Jersey District Laboratory, Trenton, New Jersey; number in parenthesis is constituent-analysis code used by U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado]

Local identifier[1]	Sample date	Laboratory	Trichloroethylene (39180)	Tetrachloroethylene (34475)	trans-1,2-Dichloroethylene[2] (34546)	1,1,1-Trichloroethane (34506)	1,1-Dichloroethylene (34501)	1,1-Dichloroethane (34496)	1,1,2-Trichloroethane (34511)	1,1,2,2-Tetrachloroethane (34516)
G-01-10	08-06-86	NWQL	<3	57	<3	5.2	<3	<3	<3	<3
	08-06-86	TRN	19	45	<1	6	2	1	<1	<1
G-01-15	08-06-86	TRN	23	24	<1	2	3	<1	<1	<1
	08-06-86	NWQL	16	24	<3	<3	<3	<3	<3	<3
G-01-20	08-06-86	TRN	23	23	<1	9	1	1	<1	<1
G-01-25	08-06-86	TRN	15	4	<1	2	<1	<1	<1	<1
G-01-30	08-06-86	TRN	2	1	<1	<1	<1	<1	<1	<1
G-01-35	08-06-86	TRN	2	1	<1	<1	<1	<1	<1	<1
G-01-40	08-06-86	TRN	1	<1	<1	<1	<1	<1	<1	<1
G-01-45	08-06-86	TRN	2	<1	<1	<1	<1	<1	<1	<1
G-02-10	09-09-86	TRN	4	<1	<1	3	2	<1	<1	<1
G-02-15	09-09-86	NWQL	<3	<3	<3	<3	<3	<3	<3	<3
	09-09-86	TRN	<1	<1	<1	4	<1	<1	<1	<1
G-02-20	09-09-86	TRN	<1	<1	<1	1	<1	<1	<1	<1
G-02-25	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-02-30	09-09-86	TRN	3	<1	<1	<1	<1	<1	<1	<1
G-02-35	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-02-40	09-09-86	NWQL	<3	<3	<3	<3	<3	<3	<3	<3
	09-09-86	TRN	<1	<1	<1	<1	2	<1	<1	<1
G-02-45	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-02-50	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-03-10	09-10-86	TRN	<1	<1	<1	3	<1	4	<1	<1
G-03-15	09-10-86	TRN	<1	<1	<1	18	3	14	<1	<1
G-03-20	09-10-86	NWQL	<6	<6	8	200	11	42	<6	<6
	09-10-86	TRN	<1	<1	<1	140	14	33	<1	<1
G-03-25	09-10-86	TRN	<1	<1	<1	120	6	3	<1	<1
G-03-30	09-10-86	TRN	<1	<1	<1	170	8	2	<1	<1
G-03-35	09-10-86	TRN	<1	<1	<1	14	<1	<1	<1	<1
G-03-40	09-10-86	TRN	<1	<1	<1	3	<1	<1	<1	<1
G-03-45	09-10-86	TRN	<1	<1	<1	2	<1	<1	<1	<1
G-04-10	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-04-15	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-04-20	10-22-86	TRN	<1	1	<1	1	<1	<1	<1	<1
G-04-25	10-22-86	TRN	1.5	<1	<1	<1	<1	<1	<1	<1
G-04-30	10-22-86	TRN	<1	<1	<1	1	<1	<1	<1	<1
G-04-35	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-04-40	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-04-45	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-05-05	10-21-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-05-10	10-21-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-05-15	10-21-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-05-20	10-21-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-05-25	10-21-86	TRN	<1	<1	<1	1	<1	<1	<1	<1
G-05-30	10-21-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-05-35	10-21-86	TRN	<1	<1	<1	1	<1	<1	<1	<1
G-05-40	10-21-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-06-10	10-23-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-06-15	10-24-86	TRN	<1	<1	<1	<1	<1	18	<1	<1
G-06-20	10-24-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-06-25	10-24-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-06-30	10-24-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-06-35	10-24-86	TRN	<1	<1	<1	<1	<1	<1	<1	<1
G-07-06	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-07-10	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-07-15	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-07-20	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-07-25	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-08-10	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-08-15	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	.5	<.1	<.1
G-08 20	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	9.7	<.1	<.1
G-08-25	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	26.9	<.1	<.1
G-08-30	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-08-35	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-08-40	09-28-88	NWQL	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1

Table 7.--Results of analyses of drive-point water samples for volatile organic compounds--Continued

Local identifier[1]	Sample date	Laboratory	Toluene (34010)	1,2-Dichloroethane (32103)	Chlorobenzene (34301)	Ethylbenzene (34371)	Trichlorofluoromethane (34488)	Vinyl chloride (39175)	Methane (76994)	cis-1,2-Dichloroethylene (77093)
G-01-10	08-06-86	NWQL	<3	<3	<3	<3	<3	<3	-	-
	08-06-86	TRN	<1	<1	-	<1	<1	<1	3	2
G-01-15	08-06-86	TRN	<1	<1	1	<1	<1	<1	<2	1
	08-06-86	NWQL	<3	<3	<3	<3	66	<3	-	-
G-01-20	08-06-86	TRN	<1	<1	1	<1	<1	<1	<2	1
G-01-25	08-06-86	TRN	<1	<1	<1	<1	<1	<1	<2	1
G-01-30	08-06-86	TRN	<1	<1	<1	<1	<1	<1	-	<1
G-01-35	08-06-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-01-40	08-06-86	TRN	<1	<1	<1	<1	<1	<1	-	<1
G-01-45	08-06-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-10	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-15	09-09-86	NWQL	<3	<3	<3	<3	<3	<3	-	-
	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-20	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-25	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-30	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-35	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-40	09-09-86	NWQL	<3	<3	<3	<3	<3	<3	-	-
	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-45	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-02-50	09-09-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-03-10	09-10-86	TRN	<1	<1	<1	<1	<1	<1	2	<1
G-03-15	09-10-86	TRN	<1	<1	<1	<1	<1	3	7	<1
G-03-20	09-10-86	NWQL	<6	<6	<6	<6	<6	12	-	-
	09-10-86	TRN	<1	<1	<1	<1	<1	9	26	6
G-03-25	09-10-86	TRN	<1	<1	<1	<1	<1	1	56	<1
G-03-30	09-10-86	TRN	<1	<1	<1	<1	<1	<1	37	<1
G-03-35	09-10-86	TRN	<1	<1	<1	<1	<1	<1	13	<1
G-03-40	09-10-86	TRN	<1	<1	<1	<1	<1	<1	7	<1
G-03-45	09-10-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-04-10	10-22-86	TRN	<1	<1	<1	<1	<1	2	28	<1
G-04-15	10-22-86	TRN	<1	<1	<1	<1	<1	1	68	2
G-04-20	10-22-86	TRN	<1	<1	<1	<1	<1	1	100	<1
G-04-25	10-22-86	TRN	<1	<1	<1	<1	<1	1	112	<1
G-04-30	10-22-86	TRN	<1	<1	<1	<1	<1	1	<2	<1
G-04-35	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-04-40	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-04-45	10-22-86	TRN	<1	<1	<1	<1	<1	<1	<2	<1
G-05-05	10-21-86	TRN	2	<1	<1	<1	<1	<1	4	<1
G-05-10	10-21-86	TRN	<3	<1	<1	<1	<1	<1	2	<1
G-05-15	10-21-86	TRN	1	<1	<1	<1	<1	<1	50	<1
G-05-20	10-21-86	TRN	<1	<1	<1	<1	<1	<1	33	<1
G-05-25	10-21-86	TRN	<1	<1	<1	<1	<1	<1	30	<1
G-05-30	10-21-86	TRN	<1	<1	<1	<1	<1	<1	19	<1
G-05-35	10-21-86	TRN	2	<1	<1	<1	<1	<1	6	<1
G-05-40	10-21-86	TRN	2	<1	<1	<1	<1	<1	11	<1
G-06-10	10-23-86	TRN	<1	<1	<1	<1	<1	<1	3	<1
G-06-15	10-24-86	TRN	<1	<1	<1	<1	<1	<1	26	<1
G-06-20	10-24-86	TRN	<1	<1	<1	<1	<1	<1	8	<1
G-06-25	10-24-86	TRN	<1	<1	<1	<1	<1	<1	3	<1
G-06-30	10-24-86	TRN	<1	<1	<1	<1	<1	<1	4	<1
G-06-35	10-24-86	TRN	<1	<1	<1	<1	<1	<1	2	<1
G-07-06	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-07-10	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-07-15	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-07-20	09-27-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-07-25	09-27-88	TRN	1.2	<.1	<.1	<.1	<.1	<.1	-	<.1
G-08-10	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-08-15	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-08-20	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-08-25	09-28-88	TRN	<.1	<.1	<.1	.2	<.1	<.1	-	<.1
G-08-30	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-08-35	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-08-40	09-28-88	NWQL	1.7	<.2	<.2	<.2	<.2	<.2	-	-
	09-28-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1

Table 7.--Results of analyses of drive-point water samples for volatile organic compounds--Continued

Local identifier[1]	Sample date	Laboratory	Trichloroethylene (39180)	Tetrachloroethylene (34475)	trans-1,2-Dichloroethylene[2] (34546)	1,1,1-Trichloroethane (34506)	1,1-Dichloroethylene (34501)	1,1-Dichloroethane (34496)	1,1,2-Trichloroethane (34511)	1,1,2,2-Tetrachloroethane (34516)
G-08-43	09-28-88	TRN	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
G-09-10	09-29-88	TRN	19.8	31.8	.2	53.4	5.0	8.1	<.1	<.1
G-09-15	09-29-88	TRN	46.8	78.8	.9	23.0	5.5	4.8	<.1	<.1
G-09-20	09-29-88	TRN	20.4	18.7	<.1	11.4	12.3	4.1	<.1	<.1
G-09-25	09-29-88	NWQL	.3	.3	<.2	.5	<.2	.2	<.2	<.2
	09-29-88	TRN	.2	.6	<.1	.3	<.1	<.1	<.1	<.1
G-09-30	09-29-88	TRN	<.1	.3	<.1	<.1	<.1	<.1	<.1	<.1
G-09-35	09-29-88	TRN	<.1	.2	<.1	<.1	<.1	<.1	<.1	<.1
G-09-40	09-29-88	TRN	<.1	.1	<.1	<.1	<.1	<.1	<.1	<.1
G-09-45	09-29-88	TRN	.1	.4	<.1	<.1	<.1	<.1	<.1	<.1
G-10-10	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-15	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-20	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-25	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-30	09-30-88	NWQL	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-35	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-40	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-45	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-10-50	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-11-10	10-03-88	TRN	9.7	14.2	<.1	3.2	<.1	<.1	<.1	<.1
G-11-15	10-03-88	TRN	40.0	51.1	<.1	4.6	1.2	<.1	<.1	<.1
G-11-20	10-03-88	TRN	19.9	36.4	<.1	14.3	3.0	2.9	<.1	<.1
G-11-25	10-03-88	TRN	.6	.4	<.1	12.6	3.6	2.3	<.1	<.1
G-11-30	10-03-88	NWQL	.3	.5	<.2	4.6	.4	.6	<.2	<.2
	10-03-88	TRN	.1	.4	<.1	4.3	<.1	.2	<.1	<.1
G-11-35	10-03-88	TRN	<.1	.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-10	10-05-88	NWQL	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-15	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-20	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-25	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-30	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-35	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-40	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-45	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-13-50	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
G-14-10	10-04-88	TRN	.3	<.1	<.1	19.9	19.5	31.0	.9	<.1
G-14-15	10-04-88	TRN	.4	<.1	<.1	52.3	30.2	56.7	1.3	<.1
G-14-20	10-04-88	NWQL	<.2	<.2	<.2	4.5	4.2	75.0	.2	<.2
	10-04-88	TRN	<.1	<.1	<.1	2.0	<.1	40.0	<.1	<.1
G-14-25	10-04-88	TRN	<.1	<.1	<.1	.1	<.1	.7	<.1	<.1
G-14-30	10-04-88	TRN	.6	.2	<.1	.4	<.1	1.9	<.1	<.1

Table 7.--Results of analyses of drive-point water samples for volatile organic compounds--Continued

Local identifier[1]	Sample date	Laboratory	Toluene (34010)	1,2-Dichloroethane (32103)	Chlorobenzene (34301)	Ethylbenzene (34371)	Trichlorofluoromethane (34488)	Vinyl chloride (39175)	Methane (76994)	cis-1,2-Dichloroethylene (77093)
G-08-43	09-28-88	TRN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1
G-09-10	09-29-88	TRN	<.1	<.1	.7	<.1	<.1	<.1	-	3.7
G-09-15	09-29-88	TRN	<.1	<.1	2.3	<.1	<.1	<.1	-	4.0
G-09-20	09-29-88	TRN	1.7	<.1	<.1	<.1	<.1	<.1	-	5.1
G-09-25	09-29-88	NWQL	<.2	<.2	<.2	<.2	<.2	<.2	-	-
	09-29-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-09-30	09-29-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-09-35	09-29-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-09-40	09-29-88	TRN	3.6	<.1	<.1	<.1	<.1	<.1	-	<.1
G-09-45	09-29-88	TRN	7.4	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-10	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-15	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-20	09-30-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-25	09-30-88	TRN	<.1	<.1	<.1	<.1	3.9	<.1	-	<.1
G-10-30	09-30-88	NWQL	1.6	<.2	<.2	<.2	<.2	<.2	-	-
	09-30-88	TRN	1.8	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-35	09-30-88	TRN	1.8	<.1	<.1	<.1	.5	<.1	-	<.1
G-10-40	09-30-88	TRN	13.3	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-45	09-30-88	TRN	14.7	<.1	<.1	<.1	<.1	<.1	-	<.1
G-10-50	09-30-88	TRN	7.6	<.1	<.1	<.1	<.1	<.1	-	<.1
G-11-10	10-03-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-11-15	10-03-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	1.1
G-11-20	10-03-88	TRN	1.9	<.1	<.1	<.1	<.1	<.1	-	2.2
G-11-25	10-03-88	TRN	<.1	<.1	<.1	<.1	<.1	1.1	-	<.1
G-11-30	10-03-88	NWQL	.2	<.2	<.2	<.2	<.2	<.2	-	-
	10-03-88	TRN	<.1	<.1	<.1	<.1	.2	1.0	-	<.1
G-11-35	10-03-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-10	10-05-88	NWQL	.7	<.2	<.2	<.2	<.2	<.2	-	-
	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-15	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	.3	-	<.1
G-13-20	10-05-88	TRN	1.0	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-25	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	.2	-	<.1
G-13-30	10-05-88	TRN	.4	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-35	10-05-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-40	10-05-88	TRN	5.9	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-45	10-05-88	TRN	9.8	<.1	<.1	<.1	<.1	<.1	-	<.1
G-13-50	10-05-88	TRN	2.7	<.1	<.1	<.1	<.1	1.5	-	<.1
G-14-10	10-04-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-14-15	10-04-88	TRN	<.1	.8	<.1	<.1	<.1	<.1	-	<.1
G-14-20	10-04-88	NWQL	.7	<.2	<.2	<.2	<.2	<.2	-	-
	10-04-88	TRN	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1
G-14-25	10-04-88	TRN	4.7	<.1	<.1	<.1	<.1	2.2	-	<.1
G-14-30	10-04-88	TRN	24.7	<.1	<.1	<.1	<.1	<.1	-	<.1

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[1] The last two digits in the local identifier represent the depth from which the sample was collected.

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

Table 8.--Results of analyses of ground-water samples for chemical properties, inorganic constituents, nutrients, and trace elements, 1989-90

[All constituents are dissolved, except as noted; concentrations in milligrams per liter, except as noted; <, less than; DUP, duplicate sample; -, constituent not determined; µS/cm, microsiemens per centimeter at 25 degrees Celsius; number in parentheses is constituent-analysis code used by U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado]

Local well identifier	Sample date	Field pH (units) (00400)	Field specific conductance (µS/cm) (00095)	Laboratory alkalinity (as $CaCO_3$) (90410)	Dissolved solids (70300)	Ammonia (as N) (00608)	Ammonia + organic n (as N) (00623)	Nitrite (as N) (00613)	Nitrite + nitrate (as N) (00631)
18-1	07-12-89	6.0	488	32	271	<0.01	0.6	<0.01	1.6
36-1	07-13-89	8.1	367	83	243	.15	.3	<.01	<.1
36-2	07-13-89	7.5	781	195	458	.02	.3	<.01	<.1
36-3	07-13-89	6.4	597	84	362	.37	.9	<.01	2.6
70-1A	07-12-89	7.3	539	152	339	.15	.6	<.01	<.1
70-2	07-12-89	7.2	1,860	331	1,510	.36	1.3	<.01	<.1
70-2 DUP	07-12-89	7.2	1,860	332	1,550	.36	.5	<.01	<.1
70-3	07-06-89	7.2	1,020	193	606	.18	.5	<.01	<.1
70-4	07-07-89	7.3	1,040	195	633	.15	.3	<.01	<.1
80-1	07-24-89	7.2	802	184	506	.70	.9	<.01	<.1
80-2	07-24-89	6.3	457	105	309	.07	.4	<.01	.13
80-3	03-22-90	7.0	1,000	211	643	.26	.6	.01	<.1
82-1	07-24-89	7.2	1,060	227	635	.19	.2	<.01	<.1
82-2	07-24-89	7.0	851	195	556	.16	<.2	<.01	<.1
82-3	07-18-89	8.7	224	100	138	.14	.4	<.01	<.1
95-3	07-13-89	6.1	584	48	312	.02	.5	<.01	2.3
95-4	07-12-89	6.2	486	51	255	<.01	.6	<.01	1.7
95-5	03-27-90	7.1	757	194	433	<.01	.3	<.01	1.4
95-6	03-27-90	6.5	648	138	340	<.01	<.2	<.01	1.4
95-7	03-27-90	7.2	643	120	356	<.01	<.2	.01	.80
DH-3	07-05-89	6.2	282	64	187	.11	.3	<.01	.28
MW 11	06-22-89	6.1	392	42	223	.01	<.2	<.01	1.30
MW 12A	07-06-89	6.6	990	111	506	.13	.4	<.01	1.40
MW 12B	07-06-89	7.6	1,130	141	647	.02	<.2	<.01	.86
MW 12C	07-07-89	6.7	2,010	152	429	.08	.3	<.01	.99
MW 12D	07-06-89	8.0	525	156	338	.02	<.2	.02	.26
MW 12E	06-27-89	7.6	670	145	409	.26	.5	<.01	<.1
MW 12F	06-30-89	7.3	658	153	387	<.01	<.2	.32	.65
MW 12G	07-06-89	6.5	665	111	372	.04	.6	<.01	1.80
MW 12H	06-22-89	7.4	766	195	456	.03	<.2	.02	1.10
MW 12I	06-23-89	6.4	941	232	501	.01	.3	<.01	2.00
MW 12J	06-30-89	7.0	509	82	324	.17	1.0	<.01	<.1
MW 12K	07-25-89	7.7	698	153	407	<.01	<.2	<.01	<.1
MW 12L	07-25-89	7.5	676	174	402	<.01	<.2	.05	1.2
WG 11-1	07-14-89	7.3	833	189	486	.04	.8	<.01	.22
WG 11-2	07-14-89	6.1	832	34	487	.88	1	.02	.73
WG 11-3	07-14-89	7.7	912	190	498	.05	.3	<.01	<.1
WG 3-1	07-25-89	7.2	1,150	208	891	.12	.2	<.01	<.1
WG 3-2	07-13-89	7.3	1,040	213	591	.67	.5	<.01	<.1
WG 3-3	07-13-89	7.1	471	92	304	.43	1.1	<.01	<.1
WG 9-1	07-26-89	7.4	689	169	440	.07	<.2	<.01	<.1
WG 9-2	07-26-89	7.4	921	189	554	.11	<.2	<.01	<.1
WG 9-3	07-26-89	7.1	817	169	526	.57	.7	<.01	<.1
WG 9-3 DUP	07-26-89	7.1	817	168	523	.59	.8	<.01	<.1

Table 8.--Results of analyses of ground-water samples for chemical properties, inorganic constituents, nutrients, and trace elements, 1989-90--Continued

Local well identifier	Phosphorus (00666)	Ortho-phosphate (00671)	Calcium (00915)	Magnesium (00925)	Sodium (00930)	Potassium (00935)	Chloride (00940)	Sulfate (00945)	Silica (as SiO_2) (00955)
18-1	0.02	<0.01	16	6.5	63	7.7	99	32	9.8
36-1	.04	.04	59	7	7.6	.8	12	89	13
36-2	<.01	<.01	60	24	61	4.7	110	52	13
36-3	<.01	<.01	41	16	54	4.4	89	68	23
70-1A	.04	.04	42	16	48	1.3	63	29	13
70-2	<.01	<.01	280	99	15	1.6	48	820	21
70-2 DUP	-	-	290	99	15	1.6	50	810	21
70-3	.01	.04	65	24	98	4.5	160	59	17
70-4	<.01	.01	70	24	95	5.3	160	68	16
80-1	<.01	<.01	73	22	45	3.6	77	89	18
80-2	.02	.02	45	14	25	3.3	40	52	14
80-3	<.01	<.01	87	27	72	5.6	140	91	20
82-1	<.01	<.01	87	30	88	5.8	150	100	20
82-2	<.01	<.01	90	27	51	3.6	110	92	18
82-3	.07	.06	24	1.5	23	.4	1.2	12	9.3
95-3	<.01	<.01	35	7.7	63	4.9	100	52	6.6
95-4	<.01	<.01	21	9.0	54	3.8	92	30	6.6
95-5	.03	.03	55	26	63	2.7	91	36	19
95-6	.01	<.01	40	19	57	4.4	98	32	13
96-7	<.01	<.01	50	19	51	3.2	110	25	13
DH-3	.02	.02	23	8.9	17	1.0	29	16	13
MW 11	.04	.01	22	6.3	46	2.0	79	24	10
MW 12A	<.01	<.01	50	18	98	2.8	170	56	8.9
MW 12B	<.01	<.01	69	25	99	4.2	200	53	15
MW 12C	.02	.01	47	12	89	3.6	120	31	21
MW 12D	<.01	<.01	48	19	42	1.5	75	26	10
MW 12E	.14	.12	80	22	12	.8	32	120	13
MW 12F	.03	<.01	42	16	72	2.4	100	45	15
MW 12G	<.01	<.01	40	17	56	2.8	98	43	18
MW 12H	.02	<.01	60	27	65	2.2	130	28	16
MW 12I	.02	<.01	72	27	77	2.9	140	32	14
MW 12J	.03	<.01	31	8.1	59	1.4	93	25	17
MW 12K	.02	.01	52	24	56	1.7	110	35	15
MW 12L	<.01	<.01	56	22	50	1.9	94	29	12
WG 11-1	.02	.01	63	23	69	2.8	120	56	9.6
WG 11-2	<.01	<.01	54	10	85	4.0	160	110	12
WG 11-3	<.01	<.01	73	25	65	4.9	150	39	15
WG 3-1	<.01	<.01	140	45	53	2.2	110	300	18
WG 3-2	.01	<.01	79	20	98	4.5	170	60	16
WG 3-3	.01	<.01	22	6.8	63	2.0	67	24	19
WG 9-1	<.01	<.01	83	9.4	52	2.2	100	42	18
WG 9-2	<.01	<.01	91	17	67	2.4	130	70	15
WG 9-3	<.01	<.01	69	18	73	4.0	130	68	18
WG 9-3 DUP	<.01	<.01	65	18	74	4.0	130	70	18

Table 8.--Results of analyses of ground-water samples for chemical properties, inorganic constituents, nutrients, and trace elements, 1989-90--Continued

Local well identifier	Sample date	Arsenic (µg/L) (01000)	Barium (µg/L) (01005)	Beryllium (µg/L) (01010)	Cadmium (µg/L) (01025)	Chromium (µg/L) (01030)	Cobalt (µg/L) (01035)	Copper (µg/L) (01040)	Iron (µg/L) (01046)
18-1	07-12-89	<1	56	<0.5	<1	<5	<3	<10	9
36-1	07-13-89	4	40	<.5	1	<5	<3	20	5
36-2	07-13-89	1	74	<.5	2	<5	<3	30	480
36-3	07-13-89	<1	40	<.5	<1	<5	10	40	23
70-1A	07-12-89	1	76	<.5	<1	<5	<3	<10	3,600
70-2	07-12-89	12	19	<.5	6	7	<3	<10	3,000
70-2 DUP	07-12-89	13	19	<.5	4	<5	<3	<10	3,000
70-3	07-06-89	4	130	<.5	2	<5	<3	<10	5,300
70-4	07-07-89	4	130	<.5	1	<5	<3	<10	4,600
80-1	07-24-89	2	250	<.5	2	<5	<3	<10	17,000
80-2	07-24-89	1	96	<.5	<1	<5	10	<10	4,700
80-3	03-22-90	11	160	<.5	2	<5	10	<10	6,700
82-1	07-24-89	5	110	<.5	<1	<5	<3	<10	6,900
82-2	07-24-89	7	62	<.5	<1	<5	<3	<10	2,100
82-3	07-18-89	6	11	<.5	<1	<5	<3	<10	9
95-3	07-13-89	<1	55	<.5	1	<5	<3	<10	11
95-4	07-12-89	<1	60	<.5	<1	<5	<3	30	<3
95-5	03-27-90	3	26	<.5	<1	<5	<3	<10	4
95-6	03-27-90	<1	24	<.5	<1	10	<3	<10	<3
96-7	03-27-90	<1	25	<.5	3	<5	<3	<10	4
DH-3	07-05-89	3	36	<.5	<1	<5	5	20	1,400
MW 11	06-22-89	<1	28	<.5	<1	<5	<3	<10	5
MW 12A	07-06-89	<1	36	<.5	<1	<5	<3	<10	7
MW 12B	07-06-89	1	52	<.5	<1	20	<3	<10	4
MW 12C	07-07-89	1	49	<.5	<1	<5	<3	<10	5
MW 12D	07-06-89	<1	37	<.5	<1	<5	<3	<10	4
MW 12E	06-27-89	10	57	<.5	<1	<5	<3	<10	950
MW 12F	06-30-89	<1	65	<.5	<1	<5	6	<10	8
MW 12G	07-06-89	<1	31	<.5	2	<5	5	<10	9
MW 12H	06-22-89	<1	42	<.5	<1	<5	<3	<10	3
MW 12I	06-23-89	<1	32	<.5	<1	<5	<3	<10	<3
MW 12J	06-30-89	3	47	<.5	<1	<5	4	<10	3,200
MW 12K	07-25-89	1	90	<.5	<1	<5	<3	<10	66
MW 12L	07-25-89	<1	24	<.5	<1	<5	<3	<10	31
WG 11-1	07-14-89	1	73	<.5	3	<5	<3	60	470
WG 11-2	07-14-89	<1	35	<.5	<1	<5	<3	110	53
WG 11-3	07-14-89	5	130	<.5	3	<5	<3	30	680
WG 3-1	07-25-89	4	22	<.5	<1	<5	<3	<10	530
WG 3-2	07-13-89	1	60	<.5	4	<5	<3	<10	160
WG 3-3	07-13-89	1	48	<.5	<1	<5	5	<10	6,500
WG 9-1	07-26-89	7	63	<.5	<1	<5	4	<10	1,600
WG 9-2	07-26-89	3	82	<.5	<1	<5	<3	<10	780
WG 9-3	07-26-89	<1	33	<.5	<1	<5	5	<10	610
WG 9-3 DUP	07-26-89	<1	30	<.5	<1	<5	7	<10	600

Table 8.--Results of analyses of ground-water samples for chemical properties, inorganic constituents, nutrients, and trace elements, 1989-90--Continued

Local well identifier	Lead (μg/L) (01049)	Manganese (μg/L) (01056)	Molybdenum (μg/L) (01060)	Nickel (μg/L) (01065)	Silver (μg/L) (01075)	Strontium (μg/L) (01080)	Vanadium (μg/L) (01085)	Zinc (μg/L) (01090)	Lithium (μg/L) (01130)
18-1	<10	39	<10	<10	<1	65	<6	10	<4
36-1	<10	270	<10	<10	<1	310	<6	3	5
36-2	10	590	<10	<10	2	150	<6	48	18
36-3	<10	280	<10	<10	<1	97	<6	13	7
70-1A	<10	1,600	<10	<10	1	85	7	11	8
70-2	<10	3,700	<10	<10	2	700	<6	9	26
70-2 DUP	<10	3,800	<10	<10	<1	710	<6	28	26
70-3	<10	1,700	<10	<10	2	210	<6	7	17
70-4	10	1,600	<10	<10	1	220	<6	7	20
80-1	<10	2,600	10	<10	3	180	<6	8	12
80-2	20	560	<10	20	2	150	<6	53	5
80-3	<10	1,600	<10	<10	<1	270	<6	7	26
82-1	20	1,400	<10	<10	1	220	<6	7	25
82-2	10	1,400	<10	<10	2	360	<6	7	22
82-3	<10	42	40	<10	2	150	<6	28	<4
95-3	<10	5	<10	<10	<1	130	<6	53	<4
95-4	<10	5	<10	<10	<1	77	<6	4	<4
95-5	<10	<1	<10	<10	<1	98	<6	4	7
95-6	<10	<1	<10	<10	<1	74	<6	5	7
95-7	<10	330	<10	<10	2	130	<6	4	15
DH-3	<10	140	<10	<10	<1	63	<6	26	<4
MW 11	<10	<1	<10	<10	<1	100	<6	16	<4
MW 12A	<10	340	<10	<10	<1	120	<6	3	7
MW 12B	10	1	<10	<10	1	190	<6	9	8
MW 12C	<10	5	<10	<10	<1	190	<6	4	<4
MW 12D	10	500	<10	<10	1	120	<6	<3	17
MW 12E	<10	1,500	<10	<10	1	190	<6	37	10
MW 12F	<10	1,000	<10	<10	<1	85	<6	45	11
MW 12G	<10	64	<10	<10	<1	98	<6	11	8
MW 12H	<10	590	<10	<10	<1	130	<6	6	8
MW 12I	<10	570	<10	<10	2	180	<6	8	7
MW 12J	<10	1,000	<10	<10	<1	79	<6	6	7
MW 12K	10	870	<10	<10	2	150	<6	<3	12
MW 12L	<10	840	<10	10	1	120	<6	<3	15
WG 11-1	<10	920	<10	<10	<1	160	<6	35	13
WG 11-2	<10	360	<10	<10	<1	190	<6	21	<4
WG 11-3	<10	510	<10	<10	2	250	<6	13	16
WG 3-1	<10	2,100	<10	10	<1	360	<6	11	27
WG 3-2	<10	2,100	<10	<10	<1	250	<6	5	29
WG 3-3	<10	1,400	<10	<10	2	56	<6	8	7
WG 9-1	10	970	<10	<10	3	380	<6	<3	19
WG 9-2	10	1,300	<10	<10	<1	300	<6	120	30
WG 9-3	10	2,500	<10	<10	2	180	<6	13	17
WG 9-3 DUP	<10	2,400	<10	<10	3	190	<6	92	18

Table 9.--Results of analyses of ground-water samples for selected volatile organic compounds, 1989-90

[All constituents are total; concentrations in micrograms per liter; <, less than; DUP, duplicate sample; TRI, triplicate sample; all samples listed in this table were analyzed at the U.S. Geological Survey New Jersey District Laboratory, Trenton, New Jersey; number in parentheses is constituent-analysis code used by U.S. Geological Survey National Water-Quality Laboratory, Denver, Colorado]

Local well identifier	Sample date	Vinyl chloride (39175)	Chloroethane (34311)	Bromomethane (30202)	Trichlorofluoromethane (34488)	1,1-Dichloroethylene (34501)	Methylene chloride (34423)	trans-1,2-Dichloroethylene (34546)	1,1-Dichloroethane (34496)	cis-1,2-Dichloroethylene (77093)	Chloroform (32106)
18-1	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
36-1	07-13-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
36-2	07-13-89	<1	<1	<1	<1	9.2	<1	<1	3.0	1.1	<1
36-3	07-13-89	<1	<1	<1	<1	5.2	<1	<1	4.4	3.5	<1
70-1	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-1A	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-2	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-3	07-06-89	<1	<1	<1	<1	<1	<1	<1	4.8	<1	<1
70-4	07-07-89	<1	<1	<1	<1	<1	<1	<1	39.7	<1	<1
80-1	07-24-89	<1	<1	<1	<1	<1	<1	<1	7.1	<1	<1
80-2	07-24-89	<1	<1	<1	<1	<1	<1	<1	2.2	<1	<1
80-3	03-22-90	<1	<1	<1	<1	<1	<1	<1	54.6	<1	<1
82-1	07-24-89	<1	<1	<1	<1	35.6	<1	<1	65.6	<1	<1
82-2	07-24-89	<1	<1	<1	<1	<1	<1	<1	23.1	<1	<1
82-3	07-18-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-3	07-13-89	<1	<1	<1	<1	10	<1	<1	15	9.3	<1
95-4	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-5	03-27-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-6	03-27-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-7	03-27-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
DH-3	07-05-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 11	06-22-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.9
MW 12A	07-06-89	<1	<1	<1	<1	64.9	<1	<1	27.0	1.1	1.1
MW 12B	07-06-89	<1	<1	<1	<1	<1	<1	<1	<1	1.1	1.2
MW 12C	07-07-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.1
MW 12D	07-06-89	<1	<1	<1	<1	<1	<1	<1	<1	2.0	<1
MW 12E	06-27-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12F	06-30-89	<1	<1	<1	<1	12.6	<1	<1	<1	1.1	1
MW 12G	07-06-89	<1	<1	<1	<1	72.6	<1	<1	24.4	5.8	<1
MW 12G TRI	07-06-89	<1	<1	<1	<1	56.1	<1	<1	20.6	2.5	<1
MW 12G TRI	07-06-89	<1	<1	<1	<1	54.7	<1	<1	19.7	1.9	<1
MW 12H	06-22-89	<1	<1	<1	<1	5.8	<1	<1	<1	5.7	<1
MW 12I	06-23-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12J	06-30-89	<1	<1	<1	<1	3.5	<1	<1	1	1	<1
MW 12K	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12L	07-25-89	<1	<1	<1	<1	<1	1.1	<1	<1	1.2	<1
WG 11-1	07-14-89	<1	<1	<1	<1	178	1.2	<1	39.5	4.9	<1
WG 11-2	07-14-89	<1	<1	<1	<1	215	1.9	<1	88.2	10.8	1.1
WG 11-2 DUP	07-14-89	<1	<1	<1	<1	211	1.8	<1	89.1	11.1	1.3
WG 11-3	07-14-89	<1	<1	<1	<1	23.1	<1	<1	5.1	<1	<1
WG 3-1	07-25-89	<1	<1	<1	<1	<1	<1	<1	2.8	<1	<1
WG 3-2	07-13-89	1.5	<1	<1	<1	10.7	<1	<1	6.7	27.9	<1
WG 3-3	07-13-89	<1	<1	<1	<1	1.9	<1	<1	1.6	3.7	<1
WG 9-1	07-26-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 9-2	07-26-89	<1	<1	<1	<1	4.1	<1	<1	6.4	5.9	<1
WG 9-2 DUP	07-26-89	<1	<1	<1	<1	3.9	<1	<1	5.5	7.1	<1
WG 9-3	07-26-89	<1	<1	<1	<1	3.9	<1	<1	2.1	3.7	<1

Table 9.--Results of analyses of ground-water samples for selected volatile organic compounds, 1989-90--Continued

Local well identifier	Sample date	1,1,1-Trichloroethane (34506)	Carbon tetrachloride (32102)	1,2-Dichloroethane (32103)	Benzene (34030)	Trichloroethylene (39180)	1,2-Dichloropropane (34541)	Bromodichloromethane (32101)	2-Chloroethylvinyl ether (34576)	trans-1,3-Dichloropropene (34699)	Toluene (34010)
18-1	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
36-1	07-13-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
36-2	07-13-89	27.6	<1	<1	<1	18.8	<1	<1	<1	<1	<1
36-3	07-13-89	48.7	<1	<1	<1	35.3	<1	<1	<1	<1	<1
70-1	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-1A	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-2	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-3	07-06-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-4	07-07-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
80-1	07-24-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
80-2	07-24-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
80-3	03-22-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
82-1	07-24-89	34.2	<1	<1	<1	<1	<1	<1	<1	<1	<1
82-2	07-24-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
82-3	07-18-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-3	07-13-89	184	<1	<1	<1	34	<1	<1	<1	<1	<1
95-4	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-5	03-27-90	4.3	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-6	03-27-90	1.0	<1	<1	<1	9.4	<1	<1	<1	<1	<1
95-7	03-27-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
DH-3	07-05-89	<1	<1	<1	<1	1.7	<1	<1	<1	<1	<1
MW 11	06-22-89	<1	<1	<1	<1	12.9	<1	<1	<1	<1	<1
MW 12A	07-06-89	130	<1	<1	<1	17.5	<1	<1	<1	<1	<1
MW 12B	07-06-89	<1	<1	<1	<1	7.9	<1	<1	<1	<1	<1
MW 12C	07-07-89	<1	<1	<1	<1	7.8	<1	<1	<1	<1	<1
MW 12D	07-06-89	<1	<1	<1	<1	30.6	<1	<1	<1	<1	<1
MW 12E	06-27-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12F	06-30-89	2.1	<1	<1	<1	11.3	<1	<1	<1	<1	<1
MW 12G	07-06-89	138	<1	<1	<1	12.5	<1	<1	<1	<1	<1
MW 12G TRI	07-06-89	170	<1	<1	<1	14.5	<1	6.6	<1	<1	<1
MW 12G TRI	07-06-89	163	<1	<1	<1	13.0	<1	<1	<1	<1	<1
MW 12H	06-22-89	<1	<1	<1	<1	38.5	<1	<1	<1	<1	<1
MW 12I	06-23-89	<1	<1	<1	<1	18.2	<1	<1	<1	<1	<1
MW 12J	06-30-89	1.2	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12K	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12L	07-25-89	1.4	<1	<1	<1	24.8	<1	<1	<1	<1	<1
WG 11-1	07-14-89	119	<1	<1	<1	29.4	1.5	<1	<1	<1	<1
WG 11-2	07-14-89	257	<1	<1	<1	44.1	1.0	<1	1.9	<1	<1
WG 11-2 DUP	07-14-89	254	2	<1	<1	44.1	<1	<1	2.8	<1	<1
WG 11-3	07-14-89	4.4	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 3-1	07-25-89	18.1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 3-2	07-13-89	28.6	<1	<1	<1	52.7	<1	<1	<1	<1	<1
WG 3-3	07-13-89	1.9	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 9-1	07-26-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 9-2	07-26-89	38.6	<1	<1	<1	24.5	<1	<1	<1	<1	<1
WG 9-2 DUP	07-26-89	29.5	<1	<1	<1	25.6	<1	<1	<1	<1	<1
WG 9-3	07-26-89	8.8	<1	<1	<1	4.0	<1	<1	<1	<1	<1

Table 9.--Results of analyses of ground-water samples for selected volatile organic compounds, 1989-90--Continued

Local well identifier	Sample date	cis-1,3-Di-chloro-propene (34704)	1,1,2-Tri-chloro-ethane (34511)	Tetra-chloro-ethyl-ene (34475)	Di-bromo-chloro-methane (32105)	Chloro-benzene (34301)	Ethyl-benzene (34371)	Bromo-form (32104)	1,1,2,2-Tetra-chloro-ethane (34516)	1,3-Di-chloro-benzene (34566)	1,2-Di-chloro-benzene (34536)
18-1	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
36-1	07-13-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
36-2	07-13-89	<1	<1	56.5	<1	3.7	<1	<1	<1	<1	<1
36-3	07-13-89	1	<1	70.4	<1	1.9	<1	<1	<1	<1	<1
70-1	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-1A	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-2	07-12-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-3	07-06-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
70-4	07-07-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
80-1	07-24-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
80-2	07-24-89	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
80-3	03-22-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
82-1	07-24-89	<1	1.1	1.1	<1	<1	<1	<1	<1	<1	<1
82-2	07-24-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
82-3	07-18-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
95-3	07-13-89	<1	<1	168	4.9	1.7	<1	<1	<1	<1	<1
95-4	07-12-89	<1	<1	1.3	<1	<1	<1	<1	<1	<1	<1
95-5	03-27-90	<1	<1	1.7	<1	<1	<1	<1	<1	<1	<1
95-6	03-27-90	<1	<1	14.8	<1	<1	<1	<1	<1	<1	<1
95-7	03-27-90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
DH-3	07-05-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 11	06-22-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12A	07-06-89	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1
MW 12B	07-06-89	<1	<1	20.9	<1	<1	<1	<1	<1	<1	<1
MW 12C	07-07-89	<1	<1	11.7	1.2	<1	<1	<1	<1	<1	<1
MW 12D	07-06-89	<1	<1	4.4	<1	<1	<1	<1	<1	<1	<1
MW 12E	06-27-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12F	06-30-89	<1	<1	34.4	<1	1.7	<1	<1	<1	1.2	1.4
MW 12G	07-06-89	<1	<1	91.8	2.3	<1	<1	2.8	<1	<1	<1
MW 12G TRI	07-06-89	<1	<1	95.1	<1	<1	<1	<1	<1	<1	<1
MW 12G TRI	07-06-89	<1	4.5	102	<1	<1	<1	<1	<1	<1	<1
MW 12H	06-22-89	<1	<1	4.9	<1	<1	<1	<1	<1	<1	<1
MW 12I	06-23-89	<1	<1	4.2	1.2	<1	<1	<1	<1	<1	<1
MW 12J	06-30-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12K	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW 12L	07-25-89	<1	<1	20.5	<1	1.9	<1	<1	<1	<1	1.1
WG 11-1	07-14-89	<1	<1	99.6	1.2	<1	<1	4.3	<1	1	1
WG 11-2	07-14-89	<1	<1	157	3.0	<1	<1	<1	<1	1.8	2.2
WG 11-2 DUP	07-14-89	<1	<1	162	5.7	1.6	<1	26.1	<1	1.9	2.4
WG 11-3	07-14-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 3-1	07-25-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 3-2	07-13-89	<1	<1	28.1	<1	<1	<1	<1	<1	<1	<1
WG 3-3	07-13-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 9-1	07-26-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WG 9-2	07-26-89	<1	<1	45.4	<1	3.6	3.4	<1	<1	<1	<1
WG 9-2 DUP	07-26-89	<1	<1	47.5	<1	2.4	<1	<1	<1	<1	<1
WG 9-3	07-26-89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

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