U.S. Department of the Interior
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RECONNAISSANCE OF HYDROGEOLOGY AND GROUND-WATER QUALITY IN PENNSAUKEN TOWNSHIP AND VICINITY, CAMDEN COUNTY, NEW JERSEY, 1996-98

Water-Resources Investigations Report 03-4247

Prepared in cooperation with the

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

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By Richard L. Walker and Eric Jacobsen

U.S. GEOLOGICAL SURVEY

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West Trenton, New Jersey

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U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS, DATUMS, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square meter
	Volume	
million gallons (Mgal)	3,785	cubic meter
	Flow	
gallon per minute (gal/min)	0.06308	liter per second
million gallons per day (Mgal/d)	0.04381	cubic meter per second
	Temperature	
degree Fahrenheit (°F)	°C = 5/9 x (°F-32)	degree Celsius (°C)

Datums:

Vertical coordinate information used in this report is referenced to the National Geodetic Vertical Datum of 1929 (NGVD of 1929). Horizontal coordinate information used in this report is referenced to the North American Datum of 1983 (NAD 83).

Water-quality abbreviations:

µg/L	-micrograms per liter	DO	-dissolved oxygen
mg/L	-milligrams per liter	VOC	-volatile organic compound
µS/cm	-microsiemens per centimeter at 25 degrees Celsius	TCE	- trichloroethylene
		PCE	-perchloroethylene

RECONNAISSANCE OF HYDROGEOLOGY AND GROUND-WATER QUALITY IN PENNSAUKEN TOWNSHIP AND VICINITY, CAMDEN COUNTY, NEW JERSEY, 1996-98

By Richard L. Walker and Eric Jacobsen

ABSTRACT

The Potomac-Raritan-Magothy aquifer system in the New Jersey Coastal Plain is the primary source of potable water supplies in northwestern Camden County. In Pennsauken Township and vicinity, local drinking-water supplies from this aquifer system have been affected by contaminants identified in the soils and ground water. The discovery of contaminated water in wells in Camden City's Puchack well field in the early 1970's led to the cessation of all pumping from the well field in April 1998. Contaminants identified at the well field include chromium, mercury, and organic compounds (principally trichloroethylene), all of which were detected at concentrations that exceeded the respective New Jersey Department of Environmental Protection (NJDEP) maximum contaminant levels. Hexavalent chromium, the most toxic and mobile form, represented about 90 percent of the chromium detected. Ground water at some nearby well fields also was contaminated with volatile organic compounds.

By 1996, as part of its Site Remediation Program, NJDEP had identified more than 38 contaminant sites in Pennsauken Township, most of which are in the outcrop area of the Potomac-Raritan-Magothy aquifer system. Many water-supply wells also are in the outcrop area of the aquifer system. The juxtaposition of the wells and contaminant sites maximizes the vulnerability of the ground-water resources to contamination in the Pennsauken Township area. Hydraulic gradients induced by pumping have facilitated the transport of shallow contaminants into the aquifer system, and the southeasterly direction of ground-water flow indicates that contaminants in the outcrop area eventually could reach other, downgradient water-supply wells.

In 1996, the U.S. Geological Survey (USGS), in cooperation with the NJDEP, began a ground-water investigation that included collecting new hydrogeologic and water-quality information in order to describe local conditions in the Potomac-Raritan-Magothy aquifer system in the Pennsauken Township area. Water levels in 128 wells were used to prepare potentiometric-surface maps, and analyses of water-quality samples from 55 wells were used to describe the nature and extent of the ground-water contamination. Hydrogeologic and geophysical data obtained from 72 wells, including the 12 new monitoring-well clusters installed in 1997, were used to refine the concept of the local hydrostratigraphic framework of the aquifer system, which previously had been described as Upper, Middle, and Lower aquifers separated by confining units. These analyses were done using data obtained from the USGS's National Water Information system (NWIS) database in 1998.

Local discontinuities in the permeable sand and gravel aquifers and low-permeability silt and clay confining units were identified during the study. Discontinuities in the confining units increase the likelihood of contaminant transport within the aquifer system. An Intermediate Sand layer within the confining unit between the Middle and Lower aquifers is connected hydraulically to the Lower aquifer and likely is an important pathway through which chromium-contaminated

water reaches the Lower aquifer. To date (1998), high concentrations of chromium (as high as 3,320 μg/L) deep in the Lower aquifer have been found only near the Puchack well field, indicating that the historical pumping stress at the well field has contributed to the transport of chromium to the Lower aquifer in this area.

Analysis of ground-water samples revealed the widespread presence of volatile organic compounds, principally dissolved trichloroethylene and tetrachloroethylene, in both the Middle and Lower aquifers. Although concentrations of these and other chlorinated compounds typically were less than 100 micrograms per liter, concentrations of at least one compound in most of the samples exceeded the NJDEP maximum contaminant levels for drinking water. Delineation of the extent of both inorganic and organic contamination is limited by the number and distribution of existing wells. Available data are insufficient to define the actual extent of the contamination or to determine its source(s).

INTRODUCTION

The aquifers (Upper, Middle, and Lower) of the Potomac-Raritan-Magothy aquifer system are the primary source of potable water supplies in northwestern Camden County and nearby areas of New Jersey. Withdrawals from wells in this area totaled about 9,920 Mgal in 1996, averaging about 27 Mgal/d. About 98 percent of these withdrawals are from the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. The study area is a small part of an eight-county Water Supply Critical Area established for the Potomac-Raritan-Magothy aquifer system by the N.J. Department of Environmental Protection (NJDEP) in 1994. Although aquifer recharge in this area may be sufficient to meet the demand for water, continued declines in water levels may steepen hydraulic gradients and, thus, increase the potential for contaminants present in the aquifers to reach downgradient water-supply wells (Navoy and Carleton, 1995). Contamination[1] originating from sources at land surface on the aquifer-system outcrops could move into the aquifers through surface infiltration, presenting an additional, more local threat to ground-water quality.

Metallic trace elements and organic chemicals identified in water from the Camden City Puchack well field in Pennsauken Township during the early 1970's compromised the quality of the water supply and necessitated a substantial reduction in pumping. The well field had provided a substantial part of the water supply for the city of Camden until that time. By 1988, general use of the Puchack well field had ceased except for an interim contaminant plume-control measure that was initiated by using Puchack well 1. Well 1 was pumped to maintain hydraulic gradients toward the Puchack well field in an attempt to limit the migration of contaminants to other wells. In late 1997, concerns about treating water withdrawn from Puchack well 1 led water managers to consider discontinuing pumping of the well (Akshay Parikh, N.J. Department of Environmental Protection, oral commun., 1998). Pumping at Puchack well 1 (070366) was stopped temporarily on April 20, 1998, because of those concerns.

Contaminants identified at the well field included chromium, mercury, and volatile organic compounds (VOCs), all of which were detected at concentrations greater than their respective NJDEP maximum contaminant levels (MCLs) for drinking water. Concentrations of chromium were as high as 1 mg/L at Puchack well 7 (070528) in 1984; furthermore, 90 percent of the chromium detected in samples from the Puchack field wells was in the highly toxic and mobile hexavalent form (Camp Dresser & McKee Inc., 1986). Concentrations of mercury as high as 8.4 μg/L and concentrations of trichloroethylene (TCE) ranging from 30 to 70 μg/L also were reported[2].

[1]In this report, contamination is defined as the presence of one or more constituents at a concentration greater than the applicable maximum contaminant level(s).

[2]Constituent concentrations reported by Camp Dresser and McKee Inc. (1986) are in parts per million (ppm) and parts per billion (ppb); in this report, all concentrations are reported in the equivalent milligrams per liter (mg/L) and micrograms per liter (μg/L), respectively.

The U.S. Geological Survey (USGS), in cooperation with the NJDEP, initiated a study in 1996 to develop a detailed understanding of the hydrogeology of the area and to investigate the nature, extent, and transport of contaminants in the vicinity of the Puchack well field. Results of this work are based on data obtained from the USGS NWIS database in 1998.

Purpose and Scope

This report summarizes the results of a ground-water investigation conducted during 1996-98 to define the hydrogeology and investigate the nature, extent, and transport of ground-water contaminants in the vicinity of the Puchack well field. The report documents the data-collection phase of the study, which included drilling 26 monitoring wells; collecting water-level measurements, water-quality samples, and ground-water-withdrawal data; determining ground-water flow directions; and interpreting the hydrostratigraphy to be used in the development of ground-water flow and transport models of the area. A revised hydrostratigraphic framework, based on new information collected during this investigation as well as historical data, is presented in cross-sections and structure-contour maps. The potentiometric surface of, and ground-water flow directions in, the Middle and Lower Potomac-Raritan-Magothy aquifers based on water levels measured in 128 wells are illustrated. Analytical results for organic and inorganic constituents in water samples collected from 55 new and previously installed wells during December 1997-May 1998 are documented, and the nature and extent of ground-water contamination as of 1998 are described.

Description of Study Area

The study area encompasses about 60 mi^2 in northwestern Camden and southwestern Burlington Counties (fig. 1). Although the principal focus of this study is the area immediately surrounding the Puchack well field, the study area extends from the Delaware River to the east, slightly beyond the boundary of Pennsauken Township. This enlarged study area allows local hydrogeology to be correlated with regional interpretations made by previous investigators.

Area Well Fields

The Puchack well field, although currently unused, consists of six wells with a combined capacity of about 6 Mgal/d. Several other, currently active water-supply systems are in the study area. The Delair and Morris well fields, also owned by the City of Camden, are situated between the Puchack well field and the Delaware River. The Merchantville-Pennsauken Water Supply Commission owns six well fields (shown on plate 1) that are distributed in an arc extending from the National Highway wells (about 1 mi north of the Puchack well field) to the Park Avenue and Marion well fields to the east, the Woodbine and Browning well fields to the south, and the wells at Delaware Garden to the southwest, near the Delaware River. Some additional commercial and industrial supply wells screened in the Potomac-Raritan-Magothy aquifers are present in the study area. Ground-water contaminants are not confined to the area of the Puchack well field; VOCs were detected at some of the Merchantville-Pennsauken Water Supply Commissions wells at the Park Avenue and National Highway well fields as early as 1980 (Barton and Krebs, 1990).

Land Use

Land use in the study area is mixed residential, commercial, and industrial; some facilities have conducted on-site operations that resulted in localized releases of hazardous materials to the soils and the ground water (R.A. Gallagher, N.J. Department of Environmental Protection, written commun., 1990). As part of its Site Remediation Program, NJDEP had identified more than 38 contaminant sites in Pennsauken Township as of 1996 (Known Contaminated Sites List, N.J. Department of Environmental Protection

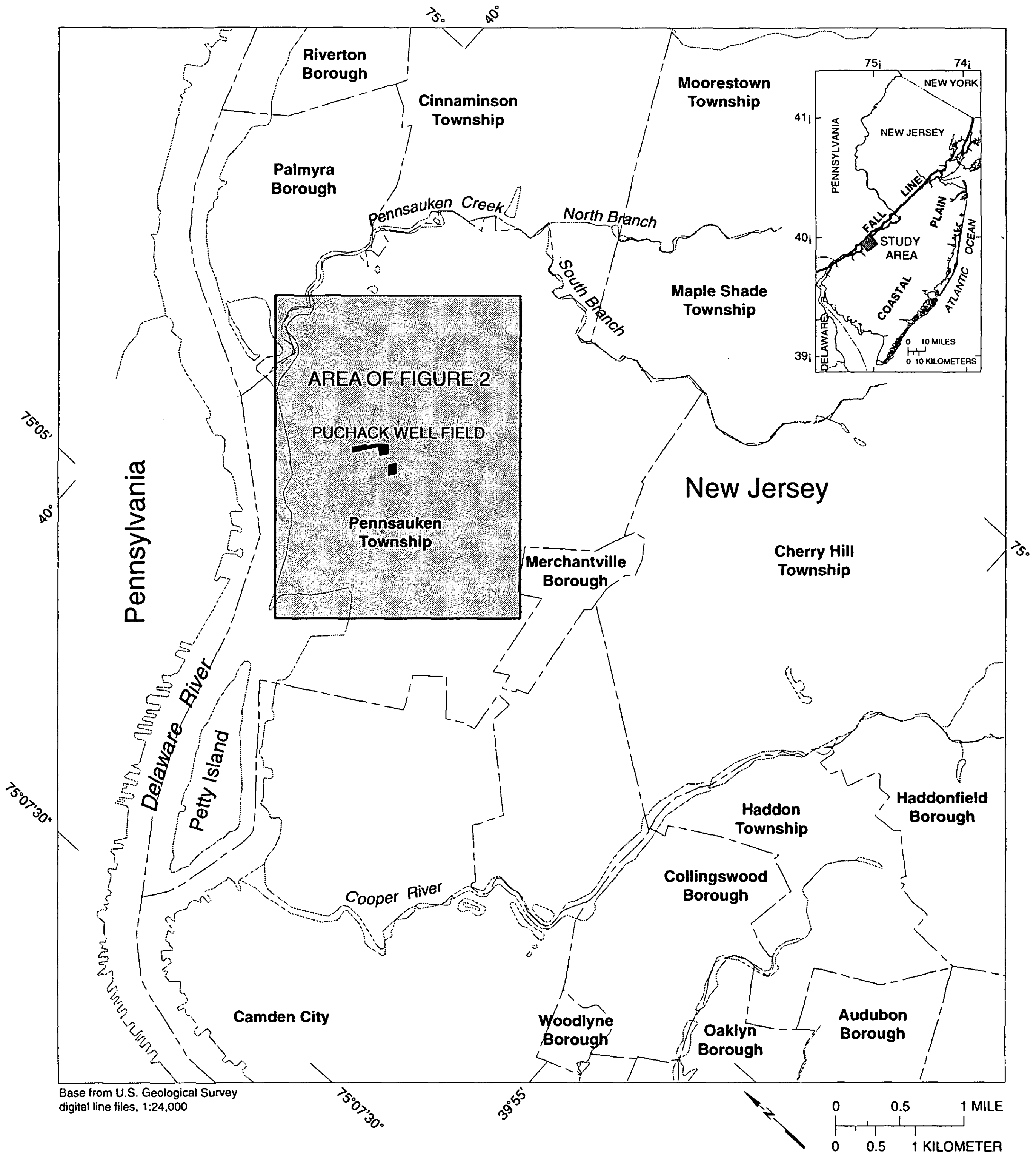

Figure 1. Location of the study area, Pennsauken Township and vicinity, Camden County, New Jersey.

database, Trenton, N.J., February 1996). Most of these contaminant sites are in the outcrop area of the Upper Potomac-Raritan-Magothy aquifer, as are the Puchack, Park Avenue, National Highway, and Browning well fields, and parts of the Delair and Morris well fields (pl. 1).

Hydrogeologic Setting

The Potomac-Raritan-Magothy aquifer system is part of a wedge-shaped sequence of sediments composed of sand and gravel aquifers with intervening silt and clay confining units that thicken and dip from the western edge of the Coastal Plain sediments at the Fall Line toward the southeast (Zapecza, 1989). The Potomac-Raritan-Magothy aquifer system in the Camden County area can be divided into Upper, Middle, and Lower aquifers. These three aquifers are separated by confining units of varying thickness and hydraulic properties. In the study area, the Lower aquifer is confined or semiconfined and lies directly on the weathered-schist bedrock. In some areas near the updip extent of the aquifer system, the lower aquifer is hydraulically connected to, and recharged by, the Delaware River (Navoy and Carleton, 1995). The general direction of regional ground-water flow in the aquifer system in the study area is southeast (Navoy and Carleton, 1995, p. 34).

Previous Investigations

Farlekas and others (1976) divided the Potomac-Raritan-Magothy aquifer system in the Camden County area into five layers--the Upper, Middle, and Lower aquifers separated by two intervening confining units. Zapecza (1989) described the hydrogeologic framework of the New Jersey Coastal Plain, including the structure and extent of the Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers, and provided a regional-scale delineation of the Coastal Plain and a basis for more detailed local investigations. Navoy and Carleton (1995) compiled a detailed structural interpretation of the Potomac-Raritan-Magothy aquifers in the Camden County area from well logs and the results of surface geophysical surveys conducted by Duran (1986) along the course of the Delaware River in order to characterize the river/aquifer interaction in the Camden County area.

Fusillo and others (1984) compiled water-quality data for wells in and near the outcrop of the Potomac-Raritan-Magothy aquifer system in Mercer, Burlington, Camden, Gloucester, and Salem Counties collected during various USGS and NJDEP studies conducted from 1923 to 1983. Ervin and others (1994) described the distribution of chemical constituents in ground water and their relation to ground-water flow on the basis of data collected from 1980 to 1986. They found that VOC contamination was detected most commonly in the Lower Potomac-Raritan-Magothy aquifer in and near the outcrop area, and concluded that the presence of VOCs was the result of human activities in the extensive urbanized areas overlying the outcrops. Barton and Krebs (1990) compiled geochemical, geohydrologic, and geophysical data from wells and boreholes in the vicinity of the Swope Oil Superfund site in Pennsauken Township.

A Ground-Water Pollution Assessment Audit of the Puchack, Morris, and Delair well fields was conducted by NJDEP; 15 contaminated sites where ground-water investigations were underway were identified, and water levels, flow, and constituent concentrations in ground water in the vicinity of the Camden City well fields were described (R.A. Gallagher, written commun., 1990). The presence of chromium contamination at the Puchack well field was investigated by use of a preliminary conceptual model of the aquifer system. A ground-water flow and transport model also was used to evaluate potential sources of the chromium and determine the potential effects of various water-supply and treatment alternatives (Camp Dresser and McKee Inc., 1986). Other unpublished environmental reports that describe site-specific investigations of contaminated sites at nearby locations include James C. Anderson Associates (1988), Environmental Strategies Corporation (1990), and John G. Reutter Associates (1983). These reports contain additional site-specific hydrogeologic and geochemical information about the study area.

Well-Numbering System

Various numbering systems have been used by previous investigators to identify wells and boreholes in the study area. This report follows the numbering system used by the USGS, New Jersey District office. Well numbers consist of a two-digit county code number followed by a four-digit sequence number. The sequence number generally reflects the order in which sites were added to the Ground-Water Site Inventory (GWSI) file at the USGS office in West Trenton, N.J. The county code numbers used in this report are 05 for Burlington County and 07 for Camden County.

Acknowledgments

The authors thank the many individuals of Burlington and Camden Counties who provided information and assistance by allowing access to their files and facilities and the well owners who provided access to their wells for water-level measurements and ground-water sampling. The authors also gratefully acknowledge Robert Gallagher and Akshay Parikh of the NJDEP for providing information, assistance, and access to NJDEP files.

METHODS OF INVESTIGATION

Study activities included drilling and installation of monitoring wells, synoptic measurements of water levels, ground-water sampling, and collection and refinement of ground-water withdrawal data. During the course of the study, 26 new monitoring wells were installed at 12 sites. A detailed hydrostratigraphic framework was developed from hydrogeologic and geophysical data obtained from 72 wells. These data included drillers', geologic, and geophysical logs from the new monitoring wells and similar types of data from other wells in the study area. Synoptic water-level measurements were made in 128 wells screened in the Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers. Ground-water samples from 55 new and previously installed wells were collected and analyzed. Locations of selected wells in the study area, including the 26 new monitoring wells, are shown on plate 1. Well-construction and other details for wells shown on plate 1 are summarized in table 1.

All altitudes in this report are referenced to NGVD 1929. The altitudes in table 1 are from the USGS GWSI file (computerized data file available at the USGS office in West Trenton, N.J.). Altitudes of wells in GWSI were determined by one of various methods. The accuracy of the altitudes varies depending on the method used. The GWSI file contains qualifying information on determination method and altitude accuracy. Altitudes at many of the monitoring-well locations were established by means of a leveling survey. Land-surface altitudes at other well sites in Pennsauken Township were estimated from a 2-ft contour-interval topographic map prepared by professional engineers (James C. Anderson Associates, Inc., Mt. Laurel, N.J., unpublished maps, 1996) for the Township of Pennsauken. Land-surface altitudes at other wells were estimated from USGS 7-1/2-minute topographic maps with contour intervals of either 10 or 20 ft. An altimeter was used to determine land-surface altitudes at some locations.

Well Drilling and Installation

Drilling and installation of monitoring wells began on July 21, 1997, and was completed on December 18, 1997. Twenty-six monitoring wells were installed at 12 locations in the vicinity of the Puchack well field (pl. 1). Locations of these wells were selected to provide needed information so that the previously developed conceptual aquifer-system model could be refined and extended, the extent of ground-water contamination could be determined, and potential contaminant pathways could be identified.

Table 1. Records of selected wells screened in the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey

[--, data unavailable. Data type: F, hydrostratigraphic framework; P, pumpage; Q, water-quality analysis; W, measured water level. Well use: W, withdrawal; U, unused; O, observation; T, test; Z, destroyed. Water use: P, public supply; U, unused; I, irrigation; N, industrial; A, air conditioning; H, domestic; R, recreation; Z, other]

U.S. Geological Survey well number	Local identifier	Latitude	Longitude	Municipality	Site identifier	Type(s) of data available	Aquifer	Land-surface altitude (feet above NGVD of 1929)	Well depth (feet below land surface)	Top of opening (feet below land surface)	Bottom of opening (feet below land surface)	Well use	Water use
050123	DVWC 28	395904	750009	CINNAMINSON TWP	395904075000901	P W	211MRPAL	25	262	226	261	W	P
050124	STEPHENS DR	395906	750006	CINNAMINSON TWP	395906075000601	F P	211MRPAL	30	270	--	--	W	P
050125	DVWC 10	395929	745922	CINNAMINSON TWP	395929074592201	P W	211MRPAL	79	281	239	281	W	P
050126	DVWC 12-POMONA	395929	745922	CINNAMINSON TWP	395929074592202	P W	211MRPAM	73	196	157	196	U	U
050129	RIVERTON CC IRR-2	395945	750011	CINNAMINSON TWP	395945075001101	F	211MRPAL	60	174	--	--	W	I
050130	RIVERTON 13	400002	750044	CINNAMINSON TWP	400002075004401	P W	211MRPAL	70	198	167	198	W	P
050131	DVWC 27	400002	750044	CINNAMINSON TWP	400002075004402	P	211MRPAL	75	176	--	--	W	P
050228	MSWD 10	395630	745855	MAPLE SHADE TWP	395631074584601	F W	211MRPAL	40	500	--	--	W	P
050229	MSWD 9	395630	745855	MAPLE SHADE TWP	395632074584501	W	211MRPAU	40	200	--	--	W	P
050231	MSWD 5	395725	745914	MAPLE SHADE TWP	395725074591401	F P	211MRPAL	20	494	--	--	W	P
050232	MSWD 8	395727	745915	MAPLE SHADE TWP	395725074591501	F P W	211MRPAM	20	270	210	270	W	P
050233	MSWD 4/SEALED	395728	745917	MAPLE SHADE TWP	395728074591701	P	211MRPAM	10	272	--	--	Z	U
050264	MTWD 5	395704	745812	MOORESTOWN TWP	395702074580701	W	211MRPAM	38	288	--	--	W	P
050268	LAYNE 1	395751	745832	MOORESTOWN TWP	395751074583201	W	211MRPAM	70	288	--	--	W	N
050274	CAMPBELL 1 OBS	395841	745905	MOORESTOWN TWP	395838074590501	F W	211MRPAL	40	268	241	262	O	U
050277	CAMPBELL 3	395841	745905	MOORESTOWN TWP	395841074590502	W	211MRPAL	40	369	339	369	W	A
050350	RIVERTON 11/SEALED	400039	750134	PALMYRA BORO	400039075013401	P	211MRPAL	10	98	--	--	Z	U
050729	MSWD 2	395725	745914	MAPLE SHADE TWP	395726074591501	P W	211MRPAU	20	121	91	121	W	P
050746	MSWD 11	395727	745915	MAPLE SHADE TWP	395727074591501	P W	211MRPAL	13	450	389	450	W	P
050801	OW 10	400020	750114	PALMYRA BORO	400020075011401	W	211MRPAM	20	25	5	25	O	U
070061	CITY 4	395541	750622	CAMDEN CITY	395541075062201	P W	211MRPAM	41	156	131	156	W	U
070064	CITY 17	395546	750533	CAMDEN CITY	395546075053301	P W	211MRPAL	34	265	230	265	W	P
070068	CITY 13	395557	750535	CAMDEN CITY	395552075053501	P W	211MRPAL	30	225	185	225	W	P
070070	CITY 3A/SEALED	395557	750629	CAMDEN CITY	395557075062901	P	211MRPAL	15	115	--	--	Z	U
070078	CITY 5N	395616	750632	CAMDEN CITY	395615075063301	F P	211MRPAL	22	169	--	--	W	P
070083	CITY 1A	395638	750622	CAMDEN CITY	395638075062201	P	211MRPAL	10	170	--	--	W	U
070090	CITY 10	395652	750607	CAMDEN CITY	395652075060701	P W	211MRPAL	10	158	126	158	W	U
070094	CITY 16	395706	750553	CAMDEN CITY	395706075055301	F P W	211MRPAL	23	179	149	179	W	U
070096	36 OBS 27TH ST/SEALED	395711	750534	CAMDEN CITY	395711075053401	F	211MRPAL	50	202	185	195	Z	U
070097	CAMDEN DIV 44/SEALED	395715	750517	CAMDEN CITY	395715075051701	P	211MRPAL	20	198	--	--	Z	U
070098	CAMDEN DIV 52	395715	750519	CAMDEN CITY	395715075051901	P	211MRPAL	18	200	--	--	W	P
070104	CAMDEN DIV 47/SEALED	395718	750513	CAMDEN CITY	395718075051301	P	211MRPAL	20	175	--	--	Z	U
070106	CAMDEN DIV 45/SEALED	395719	750517	CAMDEN CITY	395719075051701	P	211MRPAL	12	173	--	--	Z	U
070107	CAMDEN DIV 51	395720	750513	CAMDEN CITY	395720075051301	P	211MRPAL	20	192	--	--	W	P
070108	CAMDEN DIV 10/SEALED	395719	750518	CAMDEN CITY	395722075051401	F P	211MRPAL	11	150	--	--	Z	U
070109	CAMDEN DIV 46/SEALED	395722	750523	CAMDEN CITY	395722075052301	P	211MRPAL	11	178	--	--	Z	U
070110	CAMDEN DIV 49/SEALED	395725	750521	CAMDEN CITY	395725075052101	P	211MRPAL	9	169	--	--	Z	U
070111	CAMDEN DIV 50	395726	750518	CAMDEN CITY	395726075051801	P W	211MRPAL	9	170	139	170	W	P
070112	CAMDEN DIV 48	395728	750520	CAMDEN CITY	395728075052001	P	211MRPAL	10	164	--	--		
070113	CAMDEN DIV 27	395732	750532	CAMDEN CITY	395732075053201	P	211MRPAL	10	135	--	--	W	P
070142	ELLISBURG 23	395438	750107	CHERRY HILL TWP	395438075010701	W	211MRPAM	32	378	--	--	W	P
070143	ELLISBURG 16	395441	750104	CHERRY HILL TWP	395441075010401	W	211MRPAU	40	220	--	--	W	P
070144	ELLISBURG 13	395442	750103	CHERRY HILL TWP	395442075010301	W	211MRPAL	39	527	--	--	W	P
070151	RACE TRACK	395514	750213	CHERRY HILL TWP	395514075021301	W	211MRPAU	30	158	--	--	W	I
070157	COLUMBIA 31	395600	750031	CHERRY HILL TWP	395603075003101	P W	211MRPAL	45	427	376	427	W	P
070162	COLUMBIA 24	395608	750025	CHERRY HILL TWP	395615075002701	P W	211MRPAU	34	167	112	167	W	P
070163	COLUMBIA 22	395609	750028	CHERRY HILL TWP	395616075002701	F P	211MRPAL	39	453	--	--	W	P
070171	CWD 7(B)	395426	750514	COLLINGSWOOD BORO	395426075051401	W	211MRPAL	15	313	--	--	W	P
070175	CWD 1R	395521	750439	COLLINGSWOOD BORO	395515075043601	P W	211MRPAL	25	306	266	306	W	P
070176	CWD 2R	395519	750432	COLLINGSWOOD BORO	395519075043201	P	211MRPAL	12	278	--	--	W	P

Table 1. Records of selected wells screened in the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey--Continued

U.S. Geological Survey well number	Local identifier	Latitude	Longitude	Municipality	Site identifier	Type(s) of data available	Aquifer	Land-surface altitude (feet above NGVD of 1929)	Well depth (feet below land surface)	Top of opening (feet below land surface)	Bottom of opening (feet below land surface)	Well use	Water use
070177	CWD 4	395521	750435	COLLINGSWOOD BORO	395521075043501	P	211MRPAL	9	304	--	--	W	P
070178	CWD 3	395522	750432	COLLINGSWOOD BORO	395522075043201	F P	211MRPAL	15	287	--	--	W	P
070179	CWD 5	395526	750424	COLLINGSWOOD BORO	395526075042401	P	211MRPAL	10	278	--	--	W	P
070289	HTWD 2/SEALED	395403	750322	HADDON TWP	395403075032201	P	211MRPAL	60	470	--	--	Z	P
070290	HTWD 1/SEALED	395406	750317	HADDON TWP	395406075031701	P	211MRPAL	56	468	--	--	Z	P
070291	HTWD 1-R/SEALED	395406	750317	HADDON TWP	395406075031702	P	211MRPAL	56	480	--	--	Z	P
070292	HTWD 4	395406	750332	HADDON TWP	395412075033801	P W	211MRPAL	45	448	417	448	W	P
070293	HADDON TWP HS1	395416	750336	HADDON TWP	395416075033601	W	211MRPAU	15	165	142	162	W	I
070303	TEST WELL 1965	395404	750202	HADDONFIELD BORO	395404075020201	F	211MRPAL	55	510	--	--	T	U
070304	LAKE ST WELL	395404	750202	HADDONFIELD BORO	395404075020202	W	211MRPAM	50	372	--	--	W	P
070319	1R/BROWNING 1A	395627	750404	MERCHANTVILLE BORO	395627075040403	P W	211MRPAM	15	152	132	152	W	P
070320	WOODBINE 1	395652	750307	MERCHANTVILLE BORO	395652075030701	W	211MRPAL	69	285	245	285	W	P
070322	OAKLYN TEST	395359	750445	OAKLYN BORO	395358075044701	W	211MRPAU	32.6	112	--	--	O	U
070325	BROWNING RD 2/SEALED	395621	750405	PENNSAUKEN TWP	395621075040501	P	211MRPAL	25	240	--	--	Z	U
070326	BROWNING 1/SEALED	395627	750404	PENNSAUKEN TWP	395627075040401	P	211MRPAM	25	137	--	--	Z	P
070329	BROWNING 2A/BROWNING 1	395628	750406	PENNSAUKEN TWP	395628075040602	P W	211MRPAM	16	140	110	140	W	P
070332	MARION 2	395711	750220	PENNSAUKEN TWP	395711075022001	F P	211MRPAL	72	258	--	--	W	P
070333	AMON HGTS 2/SEALED	395713	750405	PENNSAUKEN TWP	395713075040501	F	211MRPAL	69	176	157	176	Z	U
070334	MARION T 1/SEALED	395719	750225	PENNSAUKEN TWP	395719075022501	F	211MRPAL	60	312	247	268	Z	U
070335	MARION 1	395720	750225	PENNSAUKEN TWP	395720075022501	P W	211MRPAL	61	278	243	278	W	P
070339	1962 WELL	395743	750448	PENNSAUKEN TWP	395743075044801	F	211MRPAL	32	108	--	--	W	N
070341	DELA GARDEN 2	395800	750417	PENNSAUKEN TWP	395752075041102	P W	211MRPAL	45	145	115	145	W	P
070342	DELA GARDEN 1A	395756	750411	PENNSAUKEN TWP	395752075041103	F P	211MRPAL	28	139	--	--	W	P
070345	PARK AVE 5	395758	750120	PENNSAUKEN TWP	395758075012001	F P W	211MRPAL	17	288	248	288	W	P
070346	PARK AVE 3A	395800	750115	PENNSAUKEN TWP	395800075011501	P	211MRPAL	15	260	--	--	W	P
070347	PARK AVE 4/SEALED	395800	750125	PENNSAUKEN TWP	395800075012501	P	211MRPAL	20	181	--	--	Z	U
070348	PARK AVE 3/SEALED	395801	750119	PENNSAUKEN TWP	395801075011901	P	211MRPAL	25	275	--	--	Z	P
070349	PARK AVE 1	395802	750117	PENNSAUKEN TWP	395802075011701	P W	211MRPAL	8	270	240	270	W	P
070350	PARK AVE 2	395802	750118	PENNSAUKEN TWP	395802075011801	P W	211MRPAL	12	257	232	257	W	P
070353	1958	395811	750233	PENNSAUKEN TWP	395811075023301	F	211MRPAM	40	106	100	106	W	N
070358	PUCHACK 4R/6-70	395830	750310	PENNSAUKEN TWP	395830075531001	F PQW	211MRPAL	48	220	170	220	U	Z
070359	PUCHACK 5/5A	395835	750308	PENNSAUKEN TWP	395835075030801	F PQW	211MRPAL	28	208	181	206	U	Z
070361	PUCHACK 4/SEALED	395839	750306	PENNSAUKEN TWP	395839075030601	F P	211MRPAL	10	184	--	--	Z	U
070363	PUCHACK 2	395842	750310	PENNSAUKEN TWP	395842075031201	F PQW	211MRPAL	14	170	124	164	W	P
070365	PRR TEST 1	395748	750435	PENNSAUKEN TWP	395844075035201	F	211MRPAL	50	122	102	122	W	N
070366	PUCHACK 1	395844	750316	PENNSAUKEN TWP	395845075031201	PQW	211MRPAL	12	140	107	137	W	P
070367	PUCHACK 3/3A	395839	750307	PENNSAUKEN TWP	395845075031701	PQW	211MRPAL	14	176	139	176	U	Z
070368	DELAIR 1	395847	750348	PENNSAUKEN TWP	395848075034701	F PQW	211MRPAL	10	138	106	126	W	P
070369	DELAIR 2	395851	750353	PENNSAUKEN TWP	395851075035501	P W	211MRPAL	5	146	111	141	W	P
070370	DELAIR 3	395853	750348	PENNSAUKEN TWP	395853075034801	F P W	211MRPAL	6	132	87	127	W	P
070371	BASS DOM	395854	750113	PENNSAUKEN TWP	395854075011301	F	211MRPAU	57	78	73	78	W	H
070372	NATIONAL HWY 1	395853	750208	PENNSAUKEN TWP	395902075015301	PQW	211MRPAL	68	231	195	230	W	P
070373	MORRIS 6	395900	750318	PENNSAUKEN TWP	395902075031801	F PQ	211MRPAL	8	138	98	133	W	P
070374	MORRIS 9/9N	395905	750313	PENNSAUKEN TWP	395906075031301	F P W	211MRPAL	7	143	89	143	W	U
070375	MORRIS 8	395911	750307	PENNSAUKEN TWP	395910075030701	PQW	211MRPAL	6	128	89	124	W	P
070377	MORRIS 7	395909	750315	PENNSAUKEN TWP	395916075030301	F P	211MRPAL	6	120	--	--	W	P
070379	MORRIS 10	395919	750302	PENNSAUKEN TWP	395923075030001	F P W	211MRPAL	8	118	75	115	W	P
070380	TRAP RK IND 2	395925	750230	PENNSAUKEN TWP	395925075023001	F	211MRPAL	35	123	115	123	W	N
070382	MORRIS 4A	395932	750245	PENNSAUKEN TWP	395929075025301	F P W	211MRPAL	6	134	95	134	W	P
070385	PENNSAUKEN TWP	395932	750214	PENNSAUKEN TWP	395932075021401	F	211MRPAL	10	110	99	110	W	N

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070386	MORRIS 3A	395934	750233	PENNSAUKEN TWP	395934075022901	P	211MRPAL	10	107	--	--	W	P
070387	MORRIS 2	395938	750222	PENNSAUKEN TWP	395938075022201	F P W	211MRPAL	6	123	93	123	W	U
070388	MORRIS 5/SEALED	395939	750229	PENNSAUKEN TWP	395939075022901	P	211MRPAL	5	115	--	--	Z	U
070390	MORRIS 1	395944	750211	PENNSAUKEN TWP	395943075021201	P W	211MRPAL	6	107	--	--	W	P
070527	PARKSIDE 18	395550	750537	CAMDEN CITY	395556075053701	P	211MRPAL	40	288	--	--	W	P
070528	PUCHACK 6-75/7	395836	750304	PENNSAUKEN TWP	395835075030201	F P QW	211MRPAL	20	180	140	180	W	U
070530	4R-A/PARK AVE 6	395755	750127	PENNSAUKEN TWP	395755075012701	P W	211MRPAL	40	270	240	270	W	P
070533	1	395932	750238	PENNSAUKEN TWP	395932075023801	F	211MRPAL	8	117	92	117	W	U
070534	GARDEN STATE RACING 2	395553	750207	CHERRY HILL TWP	395553075020701	W	211MRPAM	40	219	198	219	W	C
070535	TW-1-79	395857	750344	PENNSAUKEN TWP	395857075034401	F	211MRPAL	10	132	100	130	T	U
070536	TW-3-79/SEALED	395905	750336	PENNSAUKEN TWP	395905075033301	W	211MRPAL	10	117	85	115	Z	U
070537	TW-4-79/SEALED	395907	750332	PENNSAUKEN TWP	395909075032801	W	211MRPAL	10	128	97	128	Z	U
070538	TW-5-79/SEALED	395910	750330	PENNSAUKEN TWP	395914075032401	W	211MRPAL	10	129	80	110	Z	U
070539	TW-6-79	395901	750326	PENNSAUKEN TWP	395902075032501	F	211MRPAL	15	144	101	142	T	U
070540	TW-7-79/SEALED	395856	750324	PENNSAUKEN TWP	395858075032501	F W	211MRPAL	10	141	98	138	Z	U
070541	TW-8-79	395611	750546	CAMDEN CITY	395611075054601	F W	211MRPAL	20	255	215	253	T	U
070545	MORRIS 11	395901	750325	PENNSAUKEN TWP	395838075033401	P W	211MRPAL	15	149	102	144	W	P
070547	54	395731	750458	CAMDEN CITY	395731075045801	F P W	211MRPAL	35	200	160	200	W	P
070552	WELL 3-58	395713	750420	CAMDEN CITY	395713075042001	F	211MRPAL	35	170	154	170	W	N
070555	Jan-68	395850	750230	PENNSAUKEN TWP	395713075051301	F	211MRPAM	50	80	75	80	W	N
070557	FARNHAM 1	395607	750553	CAMDEN CITY	395607075055301	F	211MRPAL	25	217	186	217	W	R
070560	WOODBINE 2	395650	750315	MERCHANTVILLE BORO	395652075030702	F	211MRPAL	58	226	196	226	W	P
070568	LANDFILL 1	395921	750210	PENNSAUKEN TWP	395921075021001	W	211MRPAM	24.9	60	59	60	O	U
070570	LANDFILL 3	395903	750217	PENNSAUKEN TWP	395903075021701	QW	211MRPAM	62.4	90	--	--	Z	U
070571	LANDFILL 4	395912	750248	PENNSAUKEN TWP	395912075024801	F QW	211MRPAM	24.6	48	47	48	O	U
070586	MORRIS 12	395910	750330	PENNSAUKEN TWP	395914075032402	P W	211MRPAL	10	122	86	117	W	P
070587	MORRIS 13	395905	750335	PENNSAUKEN TWP	395905075033302	F P W	211MRPAL	10	135	90	130	W	P
070597	55	395718	750513	CAMDEN CITY	395718075051302	P W	211MRPAL	11	176	136	176	W	P
070602	NATIONAL HWY 2	395903	750143	PENNSAUKEN TWP	395917075012501	F P W	211MRPAL	35	206	182	206	W	P
070674	HTWD 2A	395403	750322	HADDON TWP	395403075032202	P	211MRPAL	60	473	--	--	W	P
070687	BETSY ROSS BR E1B/SEALED	395904	750358	PENNSAUKEN TWP	395904075035801	F	211MRPAL	-53	--	--	--	Z	U
070723	RHOADES AVE 3A	395355	750315	HADDON TWP	395355075031501	P W	211MRPAL	64	475	418	470	W	P
070724	CLEVELAND AVE PW 53	395728	750502	CAMDEN CITY	395728075050201	P	211MRPAL	32	194	--	--	W	P
070848	BISHOP EUSTACE PREP 1	395549	750356	PENNSAUKEN TWP	395549075035601	W	211MRPAM	25	150	135	150	W	I
070851	CAMDEN CITY MW-1A	395814	750329	PENNSAUKEN TWP	395814075032901	F QW	211MRPAL	73.4	141	131	141	O	U
070852	CAMDEN CITY MW-1B	395814	750329	PENNSAUKEN TWP	395814075032902	QW	211MRPAM	73.4	104	93	104	O	U
070853	CAMDEN CITY MW-2A	395814	750254	PENNSAUKEN TWP	395814075025401	F QW	211MRPAL	57.4	174	164	174	O	U
070854	CAMDEN CITY MW-2B	395814	750254	PENNSAUKEN TWP	395814075025402	QW	211MRPAM	57.3	120	110	120	O	U
070855	CAMDEN CITY MW-4A	395828	750316	PENNSAUKEN TWP	395828075031601	F QW	211MRPAL	56.7	202	192	202	O	U
070856	CAMDEN CITY MW-4B	395828	750316	PENNSAUKEN TWP	395828075031602	QW	211MRPAM	56.5	86	76	86	O	U
070906	PUCHACK MW-1D	395814	750352	PENNSAUKEN TWP	395814075035203	F QW	211MRPAL	39.2	177	162	172	O	U
070907	PUCHACK MW-1S	395814	750352	PENNSAUKEN TWP	395814075035201	QW	211MRPAM	39.2	61	51	56	O	U
070908	PUCHACK MW-1M	395814	750352	PENNSAUKEN TWP	395814075035202	QW	211MRPAL	39.3	100	85	95	O	U
070909	PUCHACK MW-2M	395801	750358	PENNSAUKEN TWP	395801075035801	F QW	211MRPAL	31.8	103	88	98	O	U
070910	PUCHACK MW-2D	395801	750358	PENNSAUKEN TWP	395801075035802	QW	211MRPAL	31.0	155	140	150	O	U
070911	PUCHACK MW-3M	395801	750306	PENNSAUKEN TWP	395801075030601	QW	211MRPAM	79.0	138	128	133	O	U
070912	PUCHACK MW-3D	395801	750306	PENNSAUKEN TWP	395801075030602	F QW	211MRPAL	79.3	287	272	282	O	U
070913	PUCHACK MW-4M	395806	750258	PENNSAUKEN TWP	395806075025801	QW	211MRPAM	61.0	123	108	118	O	U
070914	PUCHACK MW-4I	395806	750258	PENNSAUKEN TWP	395806075025802	QW	211MRPAL	60.7	201	186	196	O	U
070915	PUCHACK MW-4D	395806	750258	PENNSAUKEN TWP	395806075025803	F QW	211MRPAL	61.1	260	245	255	O	U

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070916	PUCHACK MW-5M	395823	750309	PENNSAUKEN TWP	395823075030901	QW	211MRPAM	36.2	78	63	73	O	U
070917	PUCHACK MW-5I	395823	750309	PENNSAUKEN TWP	395823075030902	QW	211MRPAL	35.9	135	120	130	O	U
070918	PUCHACK MW-5D	395823	750309	PENNSAUKEN TWP	395823075030903	F QW	211MRPAL	36.0	190	175	185	O	U
070919	PUCHACK MW-6M	395827	750302	PENNSAUKEN TWP	395827075030201	QW	211MRPAM	26.8	74	59	69	O	U
070920	PUCHACK MW-6D	395827	750302	PENNSAUKEN TWP	395827075030202	F QW	211MRPAL	26.8	193	178	188	O	U
070921	PUCHACK MW-7D	395836	750319	PENNSAUKEN TWP	395836075031901	F QW	211MRPAL	58.5	202	187	197	O	U
070922	PUCHACK MW-7M	395836	750319	PENNSAUKEN TWP	395836075031902	QW	211MRPAM	58.3	110	95	106	O	U
070923	PUCHACK MW-8M	395844	750342	PENNSAUKEN TWP	395844075034201	QW	211MRPAM	24.0	55	40	50	O	U
070924	PUCHACK MW-8D	395844	750342	PENNSAUKEN TWP	395844075034202	F QW	211MRPAL	24.0	165	150	160	O	U
070925	PUCHACK MW-9S	395846	750255	PENNSAUKEN TWP	395846075025501	QW	211MRPAM	22.6	49	36	46	O	U
070926	PUCHACK MW-9M	395846	750255	PENNSAUKEN TWP	395846075025502	QW	211MRPAM	22.9	70	55	65	O	U
070927	PUCHACK MW-9D	395846	750255	PENNSAUKEN TWP	395846075025503	F QW	211MRPAL	23.7	181	166	176	O	U
070928	PUCHACK MW-10M	395828	750336	PENNSAUKEN TWP	395828075033601	QW	211MRPAM	43.8	91	76	86	O	U
070929	PUCHACK MW-10D	395828	750336	PENNSAUKEN TWP	395828075033602	F QW	211MRPAL	43.8	202	187	197	O	U
070930	PUCHACK MW-12M	395755	750232	PENNSAUKEN TWP	395755075023201	F QW	211MRPAL	34.3	170	155	165	O	U
070931	PUCHACK MW-14	395812	750315	PENNSAUKEN TWP	395812075031501	F QW	211MRPAL	56.8	133	118	128	O	U
070932	DELA GARDEN R-1	395759	750415	PENNSAUKEN TWP	395759075041501	W	211MRPAL	27	145	125	145	O	U
070933	HOLMAN ENT P-47-D	395808	750118	PENNSAUKEN TWP	395808075011801	W	211MRPAL	28.4	182	177	182	O	U
070934	HOLMAN ENT P-45-D	395814	750119	PENNSAUKEN TWP	395814075011901	W	211MRPAM	28.5	120	100	120	O	U
070935	HOLMAN ENT P-17-B	395832	750117	PENNSAUKEN TWP	395832075011701	W	211MRPAU	36.9	68	48	68	O	U
070940	SUPER TIRE MW-2D	395808	750248	PENNSAUKEN TWP	395808075024801	QW	211MRPAM	36.9	75	55	75	O	U
070941	KING ARTHUR MW-6D	395810	750332	PENNSAUKEN TWP	395810075033201	F	211MRPAL	88.6	165	150	165	O	U
070942	KING ARTHUR MW-3	395811	750333	PENNSAUKEN TWP	395811075033301	F Q	211MRPAL	75.6	142	127	142	O	U
070943	KING ARTHUR MW-5S	395814	750338	PENNSAUKEN TWP	395814075033801	QW	211MRPAM	64.7	91	71	91	O	U
070944	KING ARTHUR MW-5D	395814	750338	PENNSAUKEN TWP	395814075033802	W	211MRPAL	64.6	140	125	140	O	U
070946	SGL CHROME MW-3	395815	750354	PENNSAUKEN TWP	395815075035401	Q	211MRPAL	33.0	85	65	85	O	U
070947	APS-4	395825	750336	PENNSAUKEN TWP	395825075033601	Q	211MRPAM	47.2	67	52	67	O	U
070948	GSM MW-11	395841	750233	PENNSAUKEN TWP	395841075023301	F W	211MRPAM	34.0	63	53	63	O	U
070949	GSM MW-1	395842	750231	PENNSAUKEN TWP	395842075023101	Q	211MRPAU	35	38	23	38	O	U
070950	SWOPE OIL GM-8S	395847	750206	PENNSAUKEN TWP	395847075020601	W	211MRPAM	71.0	130	110	130	O	U
070951	SWOPE OIL GM-8D	395847	750206	PENNSAUKEN TWP	395847075020602	W	211MRPAL	71.1	205	185	205	O	U
070952	SWOPE OIL GM-7S	395852	750204	PENNSAUKEN TWP	395852075020401	W	211MRPAM	65.1	130	110	130	O	U
070953	SWOPE OIL GM-7D	395852	750204	PENNSAUKEN TWP	395852075020402	W	211MRPAL	64.9	200	180	200	O	U
070954	PSLF MW-7	395900	750210	PENNSAUKEN TWP	395900075021001	W	211MRPAM	71.4	115	95	115	O	U
070955	SWOPE OIL GM-2S	395901	750206	PENNSAUKEN TWP	395901075020601	W	211MRPAM	61.4	130	110	130	O	U
070956	SWOPE OIL GM-2D	395901	750206	PENNSAUKEN TWP	395901075020602	W	211MRPAL	61.4	197	177	197	O	U
070957	PSLF MW-3D	395903	750217	PENNSAUKEN TWP	395903075021702	F QW	211MRPAL	60.6	177	157	177	O	U
070958	PSLF MW-5	395903	750226	PENNSAUKEN TWP	395903075022601	QW	211MRPAM	72.3	110	90	110	O	U
070959	PSLF MW-5D	395903	750226	PENNSAUKEN TWP	395903075022602	F QW	211MRPAL	72.0	187	167	187	O	U
070960	PSLF MW-6	395907	750234	PENNSAUKEN TWP	395907075023401	QW	211MRPAM	37.4	80	60	80	O	U
070961	PSLF MW-6D	395907	750234	PENNSAUKEN TWP	395907075023402	F QW	211MRPAL	38.4	149	129	149	O	U
070965	PSLF MW-11D	395936	750201	PENNSAUKEN TWP	395936075020102	W	211MRPAL	18.7	105	85	105	O	U
070986	CARSON SCHOOL OBS	395630	750409	PENNSAUKEN TWP	395630075040902	W	211MRPAM	28	180	--	--	O	U

All new wells were screened in sands and gravels of the Potomac-Raritan-Magothy aquifer system. The Middle and Lower aquifers were the principal targeted zones; however, four intermediate-depth wells were installed in a sand layer within the confining unit that separates the Middle and Lower aquifers. Wells generally were arranged in clusters of as many as three wells each, representing the important aquifers encountered at each site. The well clusters were named Puchack MW-1 through MW-10, MW-12, and MW-14. (Wells at two proposed locations (MW-11 and MW-13) were not drilled.) A letter suffix (for example, MW-5S) was added to the well-cluster name to identify the wells with respect to their relative depths. The letter suffixes used were S, shallow; M, middle; I, intermediate; and D, deep. The depth of an intermediate well is greater than that of a middle well and less than that of a deep well for any given cluster; these suffixes do not necessarily signify the Upper, Middle, and Lower aquifers of the Potomac-Raritan-Magothy aquifer system, however.

Drilling and Sampling Methods

All wells were drilled by use of standard hydraulic rotary drilling methods. The drilling mud was composed of potable water mixed with a bentonite-clay-based drilling fluid additive. Drilling-mud viscosity was tailored to the conditions of the drilled hole in order to maintain an adequate flow of cuttings washed from the hole and to stabilize the drill-hole wall. To prevent cross-contamination between boreholes or wells, all equipment that potentially could come in contact with hazardous materials was decontaminated. All drilling equipment, including drill rods, bits, sampling tools, mud tubs, hoses, pumps, and all other associated equipment, was decontaminated thoroughly by steam cleaning and (or) manual scrubbing with a laboratory-grade detergent and then rinsed with potable water before work was begun at each new open-hole interval or well location.

The lithology of the deepest borehole in each well cluster was described during drilling. Lithologic descriptions (app. 1) were based on observed drilling characteristics, examination of drill cuttings washed from the hole, and properties of samples collected by use of split-spoon sampling methods.

Most split-spoon samples were collected through the drill rods by use of a non-standard, nominal 1-in.-diameter split-tube soil sampler. The samples typically were collected at the end of each 15-ft-interval drill-rod run. The drilling tools were left at the bottom of the hole, allowing the split-spoon sampler to be driven through the open-bottomed bit directly into the undisturbed formation materials. This method maximized the recovery of representative geologic materials by minimizing the risk of cuttings entering the sampler. The 1-in.-diameter sampler was driven through the drilling rods with a 70-pound driving hammer that was attached to the head of the sampler. This assembly was suspended on a cable within the drill rods. The sampler was driven by raising and quickly lowering the cable the distance of the hammer travel. The effectiveness of this method for collecting sufficient quantities of representative sample was limited by the small diameter of the sampler, the lightweight drive hammer, and the energy losses from operating the sampling tools within the mud-filled drilling rods. When the 1-in. sampler collected an insufficient sample volume or when a larger volume sample was required, some samples were collected by use of the American Society for Testing and Materials (ASTM) standard 2-in. split-spoon sampling method, requiring removal of the drill-rod string. It commonly was not possible to collect a split-spoon sample in very coarse-grained sediments because the sampling tube diameter was insufficient for some site conditions.

Borehole Geophysical Methods

Borehole geophysical logs commonly are used as a correlation tool for subsurface mapping of lithologic units. Keys (1988) describes the use of geophysical-logging equipment, operational principals for each tool, limitations, log-analysis procedures, and application of the logs to ground-water investigations. Geophysical logs used in this study include natural-gamma, borehole-caliper, and a suite of electric logs, including spontaneous potential (SP), single-point resistance (spr), and 16-in. and 64-in. normal resistivity. During this study, geophysical logs were collected from both open and partially cased segments of drill holes in the deepest borehole at each of the 12 new monitoring-well-cluster locations.

All geophysical logs were compared with lithologic sample descriptions and drilling characteristics to develop a comprehensive interpretation of the lithology at each borehole location. These interpretations provided the basis for selecting screened intervals during well construction. (Well-construction methods are described below.) The geophysical and lithologic interpretations also were used to correlate the significant stratigraphic layers encountered. Because of the double-cased and, at one well (Puchack MW-1D, 070906), triple-cased well-construction techniques used, none of the deep boreholes drilled was completed to its maximum depth without the use of a protective surface casing. Geophysical logs were run in each open-hole interval before the casings were installed whenever possible. Open-hole logging was conducted to collect both electric and gamma logs to aid in the interpretation of lithology without effects from the presence of casing in the borehole. Geophysical logs from the deepest borehole drilled at each location along with the corresponding lithologic logs are presented in appendix 1. These geophysical logs were collected after all surface casing had been installed and before the inner casing and screen were installed, with the exception of that for well MW-14, which was collected within the finished well. The length of casing illustrated with the geophysical logs (app. 1) shows the borehole conditions at the time the logs were collected.

The geophysical logs were examined for changes that represent a contact (intersection) of two dissimilar stratigraphic materials, such as sand and clay. The effects of changes in the log response because of borehole conditions, such as casing, variations in diameter, or fluid chemistry, were considered during log interpretation.

Substantial changes in log response are interpreted as resulting from changes in lithology and define the top and bottom of the lithologic units penetrated by the borehole. The response obtained with each geophysical tool provides additional information for the comprehensive evaluation of the log responses. For example, the caliper log may identify variations in the borehole diameter that may account for a response on the gamma or the single-point-resistance log, or the presence of a thin, layered sand/clay sequence may bias the response of the gamma log more than that of the electric log as a result of differences in the principals governing the response of the individual tools.

When the gamma log is collected within the casing where the annulus is sealed in the formation with cement grout, the construction materials attenuate some of the natural-gamma radiation that reaches the gamma tool, thereby altering its response. Natural-gamma logs run in the uncased borehole segments were compared with those traversing the same depth intervals following casing installation. Results of this comparison indicate that substantial changes on the log traces, interpreted to represent lithologic contacts, still were discernable on the gamma-log trace following casing installation.

Well Construction

Well-construction information for the monitoring wells installed during this investigation are listed in table 1. All wells were constructed according to NJDEP specifications for monitoring wells installed in unconfined and confined unconsolidated aquifers (Schoenleber and Morton, 1992). The use of double- and triple-casing procedures was specified by the NJDEP on a well-by-well basis in accordance with the New Jersey monitoring-well construction specifications. Multiple-casing well construction was used to prevent the transport of contaminants from shallow zones to deeper, confined zones during well drilling and installation. Work began by drilling a mud-filled hole, of a diameter (8-in. minimum) tailored to the intended well design and depth, into the top of the first substantial clay layer. Geophysical logs were run in this uncased borehole segment and compared with the lithologic data collected during drilling. This information was used to determine the depths of casings and (or) the well screens to be installed in this depth interval. A well installed above the first substantial clay layer was constructed as a single-cased well. Wells completed below the shallowest aquifer were installed with a second, outer casing sealed into the first substantial clay layer. Drilling then proceeded though this outer casing seal through the clay confining layer into the underlying aquifer to the proposed completion depth. Installing the inner well casing and screen resulted in a double-cased well. In the same way, a third casing string was used to finish deeper wells where there was a potential for contamination to extend below the shallowest aquifer. Double- and triple-case construction required repeating the drilling and logging procedures at greater depths before each new casing interval was installed. Two shallow wells, MW-1S (070907) and MW-9S (070925), were completed in the first water-bearing zone as single-cased wells. At the location of monitoring-well cluster MW-1, a potentially contaminated area, the middle well was double-cased and the deepest well was triple-cased. At the MW-2 well cluster, both the middle and deep wells were double-cased. At all other drilling sites, only the intermediate-depth and deep wells were double-cased.

During well construction, the borehole diameter was selected to accommodate the diameter of the outermost casing used for each well. Outer steel casings for double- and triple-cased wells (8-in. or 12-in. diameter) were installed into the top of the first substantial clay layer encountered. The casings were fitted with a drillable bottom cap and then filled with potable water to equalize the hydraulic pressure required to set the pipe and to isolate the interior of the casing from the potentially contaminated drilling mud, or formation water, during installation. After the casings were set, they were sealed by pressure grouting with a neat-cement/bentonite slurry. When a second protective casing string was required at the triple-cased well (Puchack well MW-1D, 070906), the construction procedure was repeated at the greater depth.

All outer protective casings were constructed of either 8-in.- or 12-in.-diameter welded black steel. The finished wells were constructed of 4-in. flush-joint schedule 40 PVC well casings and screens. Standard PVC monitoring-well casings were fitted with 10-ft 0.010-in. slot-size well screens with a 5-ft-long casing tailpiece and bottom cap. All wells were finished flush with land surface and secured with a watertight lockable cap. Precise locations of all monitoring wells and altitudes of the well measuring points and land surface were determined by a licensed, professional New Jersey land surveyor. The wells were developed by pumping, beginning at least 24 hours after each well was completed.

Water-Level Measurements

Water levels were measured in 128 wells in the study area from March 23 to March 30, 1998. Wells selected for water-level measurements are listed in table 1 and are identified by data-type code W; their locations are shown on plate 1. All water-level measurements are presented in table 2. These wells are screened in the Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers underlying the study area. The water-level measurements represent the conditions in the Potomac-Raritan-Magothy aquifers while supply wells were being pumped as usual. Local aquifer conditions and conditions associated with wells containing pumps can affect the precision of water-level measurements in and near the pumped wells. At a few locations, water levels were measured in pumped wells to determine the lowest possible water level that could be expected at those wells. These measurements were used qualitatively to estimate water levels immediately surrounding the pumping centers. Water levels also were measured in non-pumped wells surrounding the well fields while the supply wells were being pumped as usual. These water-level measurements provided detailed information in these areas under pumping stress and their relation to the regional water levels in the Potomac-Raritan-Magothy aquifers.

Water levels were measured directly with either an electric tape or a steel tape whenever possible. In two wells (050729 and 070162) in which a direct water-level measurement with a tape was not possible, static water levels were measured by using the owners' airlines. Pumping levels were measured at 14 well locations, identified in table 2 with a well status of "P." The owners' airlines were used to measure water levels in six of these wells. The accuracy of the airline measurements depends on the condition of the airline, the accuracy of the pressure gage, and the accuracy of the airline length, which could not be verified during the study. All water-level measurements were referenced to a fixed measuring point and the depth to water below the measuring point was adjusted to the NGVD of 1929 datum on the basis of the altitude of the measuring point. All well measuring-point altitudes and water-level altitudes are listed in table 2.

In this report, land-surface altitudes at surveyed wells are rounded to the nearest 0.1 ft, and measuring-point altitudes, determined during the same leveling survey, are rounded to the nearest 0.01 ft. Land-surface altitudes derived by methods other than a leveling survey are rounded to the nearest foot. The altitudes of measuring points at non-surveyed wells were determined by measuring the distance of the measuring points above or below the estimated altitudes of the land surface derived from the most detailed topographic maps available.

Water-Quality Sampling

Ground-water samples were collected once during December 1997-May 1998 from 55 wells at 34 locations (19 single wells and 15 clustered wells) in Pennsauken Township. Information characterizing the sampled wells is identified in table 1 with the data-type code Q. All samples were analyzed for VOCs and the following dissolved constituents: total chromium, hexavalent chromium, ferrous and ferric iron, manganese, and mercury (designated "list 1 constituents"). In addition, 14 samples were analyzed for calcium, magnesium, potassium, sodium, sulfate, dissolved organic carbon, ammonia, nitrite, nitrate, organic nitrogen, orthophosphate, silica, alkalinity, and the following dissolved metallic trace elements: aluminum, cadmium, cobalt, copper, nickel, and zinc (designated "list 2 constituents"). Well locations and the constituent-list designation associated with each well are shown in figure 2.

Well Selection

New wells were located and previously installed wells were selected for sampling to define the lateral and vertical extent of chromium contamination in the vicinity of the Puchack well field, and to locate possible source areas. Well locations were selected in consideration of the following factors:

- proximity to the Puchack well field
- proximity to areas where water-quality data were lacking
- proximity to previously identified chromium-contaminated sites and suspected source areas
- well depth and length of screen.

Most of the wells selected for the determination of list 2 constituents are located between known contaminated areas and the Puchack well field. Two public-supply wells, 070366 in the Puchack field and 070368 in the Delair field (fig. 2), also were selected for the determination of list 2 constituents because they represent possible endpoints of contaminant transport.

Sample Collection

Ground-water samples were collected by use of an ultra-clean trace-element sampling technique described by Ivahnenko and others (1996). Use of the technique increases the reliability of analytical results for concentrations in the parts-per-billion range. Systematic contamination of samples

Table 2. Water levels in wells screened in the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey, March 23-30, 1998
[Vertical datum is NGVD of 1929]

U.S. Geological Survey well number	Local identifier	Aquifer	Well depth (feet below land surface)	Land-surface altitude (feet)	Measuring-point altitude (feet)	Depth to water (feet below measuring point)	Water-level altitude (feet)	Status during measure-ment
050123	DVWC 28	211MRPAL	262	25	28.05	43.40	-15.35	S
050125	DVWC 10	211MRPAL	281	79	79.90	96.16	-16.26	S
050126	DVWC 12-POMONA	211MRPAM	196	73	75.00	88.95	-13.95	S
050130	RIVERTON 13	211MRPAL	198	70	71.65	81.65	-10.00	S
050228	MSWD 10	211MRPAL	500	40	41.50	78.81	-37.31	S
050229	MSWD 9	211MRPAU	200	40	41.70	80.60	-38.90	S
050232	MSWD 8	211MRPAM	270	20	24.35	52.48	-28.13	S
050264	MTWD 5	211MRPAM	288	38	39.00	74.96	-35.96	S
050268	LAYNE 1	211MRPAM	288	70	69.00	97.69	-28.69	S
050274	CAMPBELL 1 OBS	211MRPAL	268	40	41.50	68.20	-26.70	S
050277	CAMPBELL 3	211MRPAL	369	40	42.50	70.81	-28.31	S
050729	MSWD 2	211MRPAU	121	20	22.50	48.08	-25.58	S
050746	MSWD 11	211MRPAL	450	13	14.50	48.86	-34.36	S
050801	OW 10	211MRPAM	25	20	20.00	22.34	-2.34	S
070061	CITY 4	211MRPAM	156	41	41.70	59.80	-18.10	S
070064	CITY 17	211MRPAL	265	34	34.80	51.09	-16.29	S
070068	CITY 13	211MRPAL	225	30	31.40	44.80	-13.40	S
070090	CITY 10	211MRPAL	158	10	12.20	19.48	-7.28	S
070094	CITY 16	211MRPAL	179	23	24.90	32.07	-7.17	S
070111	CAMDEN DIV 50	211MRPAL	170	9	12.60	22.17	-9.57	S
070142	ELLISBURG 23	211MRPAM	378	32	35.65	77.09	-41.44	S
070143	ELLISBURG 16	211MRPAU	220	40	42.25	83.05	-40.80	S
070144	ELLISBURG 13	211MRPAL	527	39	41.90	84.70	-42.80	S
070151	RACE TRACK	211MRPAU	158	30	32.18	65.13	-32.95	S
070157	COLUMBIA 31	211MRPAL	427	45	47.10	83.95	-36.85	S
070162	COLUMBIA 24	211MRPAU	167	34	37.70	68.85	-31.15	S
070171	CWD 7(B)	211MRPAL	313	15	17.65	112.5	-94.85	P
070175	CWD 1R	211MRPAL	306	25	26.10	56.64	-30.54	S
070292	HTWD 4	211MRPAL	448	45	47.30	88.14	-40.84	S
070293	HADDON TWP HS1	211MRPAU	165	15	15.40	52.18	-36.78	S
070304	LAKE ST WELL	211MRPAM	372	50	53.10	99.29	-46.19	S
070319	1R/BROWNING 1A	211MRPAM	152	15	17.70	39.59	-21.89	S
070320	WOODBINE 1	211MRPAL	285	69	70.60	99.00	-28.40	S
070322	OAKLYN TEST	211MRPAU	112	32.6	35.05	66.89	-31.84	S
070329	BROWNING 2A/BROWNING 1	211MRPAM	140	16	18.95	84.52	-65.57	P
070335	MARION 1	211MRPAL	278	61	62.90	91.68	-28.78	S
070341	DELA GARDEN 2	211MRPAL	145	45	47.00	56.55	-9.55	S
070345	PARK AVE 5	211MRPAL	288	17	19.10	96.15	-77.05	P
070349	PARK AVE 1	211MRPAL	270	8	15.10	97.69	-82.59	P
070350	PARK AVE 2	211MRPAL	257	12	15.40	45.35	-29.95	S
070358	PUCHACK 4R/6-70	211MRPAL	220	48	49.10	64.92	-15.82	S
070359	PUCHACK 5/5A	211MRPAL	208	28	28.70	45.15	-16.45	S
070363	PUCHACK 2	211MRPAL	170	14	15.00	33.06	-18.06	S
070366	PUCHACK 1	211MRPAL	141	12	14.30	78.70	-64.40	P
070367	PUCHACK 3/3A	211MRPAL	176	14	14.70	31.78	-17.08	S
070368	DELAIR 1	211MRPAL	138	10	12.10	93.8	-81.70	P
070369	DELAIR 2	211MRPAL	146	5	6.00	19.62	-13.62	S
070370	DELAIR 3	211MRPAL	132	6	7.20	18.44	-11.24	S
070370	DELAIR 3	211MRPAL	132	6	7.20	72.10	-64.90	P
070372	NATIONAL HWY 1	211MRPAL	231	68	70.70	88.75	-18.05	S
070374	MORRIS 9/9N	211MRPAL	143	7	7.70	27.51	-19.81	S
070375	MORRIS 8	211MRPAL	124	6	8.20	78.6	-70.40	P
070379	MORRIS 10	211MRPAL	115	8	9.40	26.29	-16.89	S
070379	MORRIS 10	211MRPAL	115	8	9.40	80.46	-71.06	P
070382	MORRIS 4A	211MRPAL	134	6	9.20	96.92	-87.72	P
070387	MORRIS 2	211MRPAL	123	6	10.00	22.84	-12.84	S
070390	MORRIS 1	211MRPAL	107	6	7.30	73.07	-65.77	P
070528	PUCHACK 6-75/7	211MRPAL	180	20	22.45	39.63	-17.18	S
070530	4R-A/PARK AVE 6	211MRPAL	270	40	41.70	76.10	-34.40	S
070534	GARDEN STATE RACING 2	211MRPAM	219	40	41.75	73.25	-31.50	S

Table 2. Water levels in wells screened in the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey, March 23-30, 1998--Continued

U.S. Geological Survey well number	Local identifier	Aquifer	Well depth (feet below land surface)	Land-surface altitude (feet)	Measuring-point altitude (feet)	Depth to water (feet below measuring point)	Water-level altitude (feet)	Status during measurement
070536	TW-3-79/SEALED	211MRPAL	117	10	9.20	31.16	-21.96	S
070537	TW-4-79/SEALED	211MRPAL	128	10	11.00	30.21	-19.21	S
070538	TW-5-79/SEALED	211MRPAL	129	10	11.60	35.63	-24.03	S
070540	TW-7-79/SEALED	211MRPAL	141	10	12.90	28.45	-15.55	S
070541	TW-8-79	211MRPAL	255	20	22.20	36.58	-14.38	S
070545	MORRIS 11	211MRPAL	144	15	16.50	34.64	-18.14	S
070547	54	211MRPAL	200	35	36.90	48.91	-12.01	S
070568	LANDFILL 1	211MRPAM	60	24.9	24.66	39.26	-14.60	S
070570	LANDFILL 3	211MRPAM	90	62.4	64.47	82.00	-17.53	S
070571	LANDFILL 4	211MRPAM	48	24.6	23.65	39.13	-15.48	S
070586	MORRIS 12	211MRPAL	122	10	12.50	88.20	-75.70	P
070587	MORRIS 13	211MRPAL	130	10	12.40	81.80	-69.40	P
070597	55	211MRPAL	176	11	13.25	23.50	-10.25	S
070602	NATIONAL HWY 2	211MRPAL	206	35	37.75	52.23	-14.48	S
070602	NATIONAL HWY 2	211MRPAL	206	35	39.30	73.08	-33.78	P
070723	RHOADES AVE 3A	211MRPAL	475	64	67.44	111.19	-43.75	S
070848	BISHOP EUSTACE PREP 1	211MRPAM	150	25	25.35	53.88	-28.53	S
070851	CAMDEN CITY MW-1A	211MRPAL	141	73.4	73.29	87.30	-14.01	S
070852	CAMDEN CITY MW-1B	211MRPAM	104	73.4	73.15	86.03	-12.88	S
070853	CAMDEN CITY MW-2A	211MRPAL	174	57.4	57.12	74.53	-17.41	S
070854	CAMDEN CITY MW-2B	211MRPAM	120	57.3	57.08	71.61	-14.53	S
070855	CAMDEN CITY MW-4A	211MRPAL	202	56.7	56.31	72.27	-15.96	S
070856	CAMDEN CITY MW-4B	211MRPAM	86	56.5	56.32	69.19	-12.87	S
070906	PUCHACK MW-1D	211MRPAL	177	39.2	38.90	49.67	-10.77	S
070907	PUCHACK MW-1S	211MRPAM	61	39.2	38.95	48.29	-9.34	S
070908	PUCHACK MW-1M	211MRPAL	100	39.3	38.93	49.40	-10.47	S
070909	PUCHACK MW-2M	211MRPAL	103	31.8	30.88	41.73	-10.85	S
070910	PUCHACK MW-2D	211MRPAL	155	31.0	30.65	41.55	-10.90	S
070911	PUCHACK MW-3M	211MRPAM	138	79.0	78.60	93.25	-14.65	S
070912	PUCHACK MW-3D	211MRPAL	287	79.3	79.00	95.39	-16.39	S
070913	PUCHACK MW-4M	211MRPAM	123	61.0	60.63	75.05	-14.42	S
070914	PUCHACK MW-4I	211MRPAL	201	60.7	60.34	77.72	-17.38	S
070915	PUCHACK MW-4D	211MRPAL	260	61.1	60.83	78.15	-17.32	S
070916	PUCHACK MW-5M	211MRPAM	78	36.2	35.82	49.05	-13.23	S
070917	PUCHACK MW-5I	211MRPAL	135	35.9	35.63	51.45	-15.82	S
070918	PUCHACK MW-5D	211MRPAL	190	36.0	35.59	51.41	-15.82	S
070919	PUCHACK MW-6M	211MRPAM	74	26.8	26.45	39.65	-13.20	S
070920	PUCHACK MW-6D	211MRPAL	193	26.8	26.37	42.71	-16.34	S
070921	PUCHACK MW-7D	211MRPAL	202	58.5	58.00	74.12	-16.12	S
070922	PUCHACK MW-7M	211MRPAM	110	58.3	58.04	71.47	-13.43	S
070923	PUCHACK MW-8M	211MRPAM	55	24.0	23.27	34.74	-11.47	S
070924	PUCHACK MW-8D	211MRPAL	165	24.0	23.48	37.45	-13.97	S
070925	PUCHACK MW-9S	211MRPAM	49	22.6	22.25	37.91	-15.66	S
070926	PUCHACK MW-9M	211MRPAM	70	22.9	22.51	38.15	-15.64	S
070927	PUCHACK MW-9D	211MRPAL	181	23.7	23.29	40.85	-17.56	S
070928	PUCHACK MW-10M	211MRPAM	91	43.8	43.50	55.63	-12.13	S
070929	PUCHACK MW-10D	211MRPAL	202	43.8	43.54	56.19	-12.65	S
070930	PUCHACK MW-12M	211MRPAL	170	34.3	34.07	54.52	-20.45	S
070931	PUCHACK MW-14	211MRPAL	133	56.8	56.47	70.75	-14.28	S
070932	DELA GARDEN R-1	211MRPAL	145	27	30.00	40.13	-10.13	S
070933	HOLMAN ENT P-47-D	211MRPAL	182	28.4	28.15	50.31	-22.16	S
070934	HOLMAN ENT P-45-D	211MRPAM	120	28.5	28.14	48.34	-20.20	S
070935	HOLMAN ENT P-17-B	211MRPAU	68	36.9	36.60	51.82	-15.22	S
070940	SUPER TIRE MW-2D	211MRPAM	75	36.9	36.51	51.35	-14.84	S
070943	KING ARTHUR MW-5S	211MRPAM	91	64.7	66.48	78.10	-11.62	S
070944	KING ARTHUR MW-5D	211MRPAL	140	64.6	66.56	79.32	-12.76	S
070948	GSM MW-11	211MRPAM	63	34.0	36.05	51.59	-15.54	S
070950	SWOPE OIL GM-8S	211MRPAM	130	71.0	71.35	88.26	-16.91	S
070951	SWOPE OIL GM-8D	211MRPAL	205	71.1	70.44	87.85	-17.41	S
070952	SWOPE OIL GM-7S	211MRPAM	130	65.1	66.78	83.53	-16.75	S

Table 2. Water levels in wells screened in the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey, March 23-30, 1998--Continued

U.S. Geological Survey well number	Local identifier	Aquifer	Well depth (feet below land surface)	Land-surface altitude (feet)	Measuring-point altitude (feet)	Depth to water (feet below measuring point)	Water-level altitude (feet)	Status during measurement
070953	SWOPE OIL GM-7D	211MRPAL	200	64.9	66.36	83.40	-17.04	S
070954	PSLF MW-7	211MRPAM	115	71.4	71.11	87.57	-16.46	S
070955	SWOPE OIL GM-2S	211MRPAM	130	61.4	60.51	76.98	-16.47	S
070956	SWOPE OIL GM-2D	211MRPAL	197	61.4	60.80	77.26	-16.46	S
070957	PSLF MW-3D	211MRPAL	177	60.6	62.81	79.10	-16.29	S
070958	PSLF MW-5	211MRPAM	110	72.3	73.52	88.40	-14.88	S
070959	PSLF MW-5D	211MRPAL	187	72.0	74.33	90.37	-16.04	S
070960	PSLF MW-6	211MRPAM	80	37.4	40.42	56.99	-16.57	S
070961	PSLF MW-6D	211MRPAL	149	38.4	40.92	57.55	-16.63	S
070965	PSLF MW-11D	211MRPAL	105	18.7	21.44	33.26	-11.82	S
070986	CARSON SCHOOL OBS	211MRPAM	180	28	29.50	51.31	-21.81	S

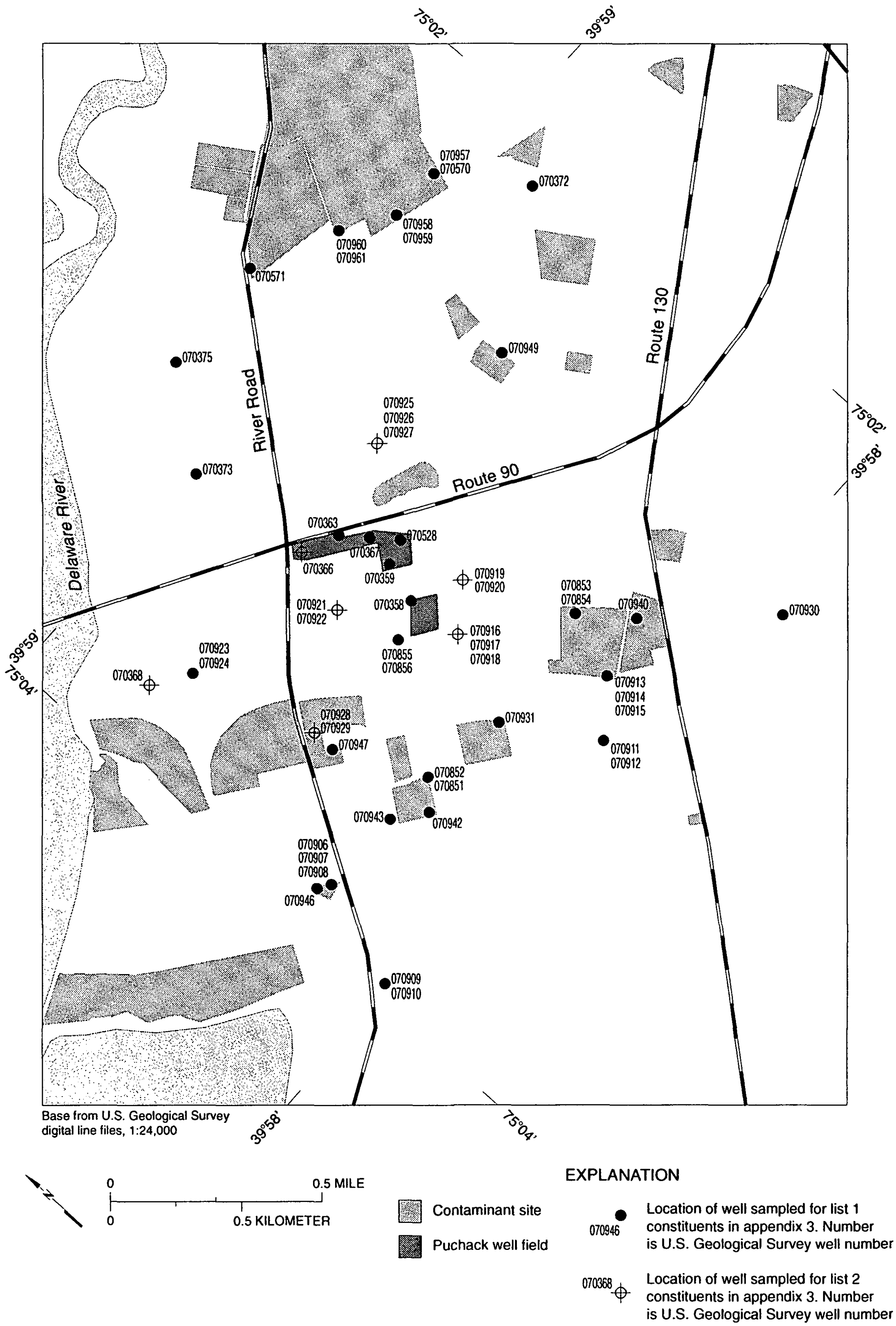


Figure 2. Selected ground-water-sampling locations, Pennsauken Township and vicinity, Camden County, New Jersey. (Relation to study area shown in figure 1)

through contact with sampling equipment, sample handling, and airborne dust particles is minimized. A dedicated clean sampling vehicle was used to collect all samples. Sampling pumps were completely disassembled and cleaned prior to collecting an environmental sample. All tubing, filters, and glove bags were disposed of after each environmental sample was collected.

Temperature, pH, specific conductance, and dissolved-oxygen concentration were monitored during well purging, as described by Wilde and Radtke (1998). Samples were collected after purging three casing volumes and after field measurements did not vary more than 5 percent in three consecutive sets of measurements made at 5-minute intervals. Turbidity was monitored with a Hach 2100P portable turbidity meter. The pump intake was placed approximately 5 ft below the initial water level and was maintained at that depth during pumping.

Samples were collected from most observation wells by using a stainless-steel Grundfos submersible pump. Setting pump rates as low as possible within daily time constraints minimized drawdown. The median pumping rate was 2 gal/min and the median drawdown was 1 ft, excluding the five large-diameter wells sampled in the Puchack well field. The Puchack field wells were purged and sampled with a high-capacity submersible pump supplied by the well-field operator. Previously installed, dedicated polyethylene tubing and stainless-steel Grundfos submersible pumps were used to purge and sample wells at the Pennsauken Landfill.

All samples to be analyzed for inorganic constituents were collected in an anoxic environment. High-purity nitrogen was fed continuously into the sample-collection glove-box bag through a disposable silicon tube. The nitrogen environment was used in order to prevent potential iron oxidation and precipitation of ferric iron hydroxide in the sample, a process that artificially could lower concentrations of dissolved chromium through sorption of chromium to the iron hydroxides.

All samples collected for analysis for VOCs were unfiltered and were collected in unrinsed 40-mL vials through a clean Teflon tube in a manner that minimized aeration. The samples were adjusted to a pH less than 2 with hydrochloric acid, and then were chilled to 4 °C.

Laboratory Analysis

Chemical analyses of environmental samples reported in this study were performed at the New Jersey Department of Health and Senior Services (NJDOH) Public Health and Environmental Laboratory in Trenton, N.J. Analyses of quality-assurance samples for list 1 and list 2 constituents and for organic compounds also were performed by the NJDOH. Methods used to analyze samples for inorganic constituents are described in U.S. Environmental Protection Agency (1993), U.S. Environmental Protection Agency (1994), and Fishman and Friedman (1989). Constituents determined by inductively coupled plasma optical emission spectroscopy (ICP-OES) include aluminum, cadmium, calcium, total chromium, cobalt, copper, ferrous iron, magnesium, manganese, nickel, potassium, sodium, and zinc. Hexavalent chromium was determined by use of the colorimetric method (USGS-I1230-85) with a minimum reporting level (MRL) of 5 µg/L. Mercury was determined by cold vapor atomic-absorption spectrophotometry (CVAAS) with a MRL of 0.04 µg/L. Samples were analyzed for 84 purgeable organic compounds by gas chromatography/mass spectrometry (GC/MS) (EPA Method 524.2) as described in U.S. Environmental Protection Agency (1992).

Chemical analyses of quality-assurance samples for trace elements were performed at the USGS National Water Quality Laboratory (NWQL) in Arvada, Colo. Blank samples were analyzed by inductively coupled plasma mass spectroscopy (ICP-MS), a method that provides lower detection limits than the method used to analyze the environmental samples. Methods used to analyze samples for inorganic constituents are described in Fishman and Friedman (1989). Constituents determined by ICP-MS include aluminum, antimony, barium, beryllium, boron, cadmium, calcium, total chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, silica, silver, sodium, strontium, thallium, uranium, and zinc. Mercury was determined by CVAAS with a MRL of 0.1 µg/L. MRLs for analytes determined by ICP-MS and ICP-OES are shown in table 3. MRLs for VOCs varied because some samples required dilution before analysis; these MRLs are reported in table 4.

Quality Assurance and Quality Control

Quality-assurance samples were collected to determine the presence or absence of sample contamination and the reproducibility and precision of the analysis results. Quality-assurance samples collected during the sampling period consisted of equipment blanks, field blanks, split samples, and trip blanks, as described by Horowitz and others (1994). Reagent-grade deionized water supplied by the USGS was used for all trace-element blanks. Deionized water supplied by NJDOH was used for all other blanks. Overall, 22 quality-assurance samples, 40 percent of the number of environmental samples, were collected.

Equipment blanks were collected in the USGS laboratory under controlled conditions to assess the potential for contamination from sampling and processing equipment. A stainless-steel Grundfos submersible pump was used to move deionized water from a polyethylene standpipe through tubing and a filter, and into a sample bottle. Two equipment blanks were collected during the study period and were analyzed for list 1 and list 2 constituents at the NJDOH laboratory and for metallic trace elements at the NWQL.

Field blanks were collected at nine sites during the sampling period to assess the potential for contamination resulting from sample collection and preservation under field conditions. All were analyzed for metallic trace elements at the NWQL and for list 1 constituents and VOCs at the NJDOH laboratory. A subset of four field blanks also was analyzed for list 2 constituents at the

Table 3. Minimum reporting levels for inorganic analytes determined by inductively coupled plasma (ICP) techniques

[MS, mass spectroscopy; OES, optical emission spectroscopy; µg/L, micrograms per liter; --, technique not used to determine concentration of analyte]

Analyte	ICP-MS minimum reporting level (µg/L)	ICP-OES minimum reporting level (µg/L)
Aluminum	0.3	5
Antimony	.2	--
Barium	.2	--
Beryllium	.2	--
Boron	2	--
Cadmium	.3	1
Calcium	2.0	100
Chromium	.2	1
Cobalt	.2	2
Copper	.2	1
Iron	3	1
Lead	.3	--
Magnesium	1.00	100
Manganese	.1	1
Molybdenum	.2	--
Nickel	.5	2
Potassium	--	100
Silica	20	--
Silver	.2	--
Sodium	25	100
Strontium	.1	--
Thallium	.1	--
Uranium	.2	--
Zinc	.5	2

Table 4. Minimum reporting levels for organic analytes determined by gas chromatography/mass spectrometry (GC/MS)

[μg/L, micrograms per liter; minimum reporting levels vary as a result of differences in sample dilution]

Analyte	GC/MS minimum reporting levels (μg/L)	Analyte	GC/MS minimum reporting levels (μg/L)
Acetone	0.73, 0.85, 0.9	Ethylbenzene	0.11,0.3, 0.5
Acrylonitrile	0.35, 0.6, 0.78	Ethyl ether	0.32, 0.44, 0.5
Benzene	0.13, 0.23, 0.4	Ethylmethacrylate	0.5, 0.55, 0.64
Bromobenzene	0.21, 0.3, 0.31	Hexachlorobutadiene	0.12, 0.5, 0.52
Bromochloromethane	0.2, 0.3, 0.5	Hexachloroethane	0.14, 0.3, 0.46
Bromodichloromethane	0.2, 0.21, 0.55	2-Hexanone	0.5, 0.53, 1.26
Bromoform	0.2, 0.41, 0.62	Isopropylbenzene	0.08, 0.33, 0.6
tert-Butyl alcohol	0.3, 0.63, 0.99	*p*-Isopropyl toluene	0.11, 0.37, 0.5
Butyl chloride	0.23, 0.4, 0.5	Methacrylonitrile	0.5, 0.63, 0.88
n-Butylbenzene	0.09, 0.34, 0.4	Methyl acrylate	0.45, 0.39, 0.5
sec-Butylbenzene	0.08, 0.34, 0.5	Methyl bromide	0.33, 0.57, 0.6
tert-Butylbenzene	0.12, 0.37, 0.4	Methyl *tert*-butyl ether	0.5, 0.52
Carbon disulfide	0.09, 0.26, 0.4	Methyl chloride	0.7, 0.67, 1.0, 1.04
Carbon tetrachloride	0.13, 0.41, 0.5	Methylene chloride	0.28, 0.4, 0.44
Chloroacetonitrile	0.34, 0.5, 0.87	Methyl ethyl ketone	0.5, 0.48, 0.55
Chlorobenzene	0.14, 0.3, 0.37	Methyl iodide	0.34, 0.45, 0.6
Chlorodibromomethane	0.2, 0.33, 0.59	Methyl isobutyl ketone	0.1, 0.49, 0.93
Chloroethane	0.2, 0.45, 0.57	Methyl methacrylate	0.47, 0.5, 0.63
Chloroform	0.14, 0.3, 0.42	Naphthalene	0.2, 0.48, 0.52
3-Chloropropylene	0.1, 0.25	Nitrobenzene	1.00, 1.19, 1.54
o-Chlorotoluene	0.12, 0.25, 0.6	2-Nitropropane	0.4, 0.68, 0.88
p-Chlorotoluene	0.1, 0.4, 0.69	Pentachloroethane	0.12, 0.3, 0.71
Dibromochloropropane	0.3, 0.76, 0.88	Propionitrile	0.63, 0.64, 0.8
1,2-Dibromoethane	0.3, 0.44, 0.48	*n*-Propylbenzene	0.08, 0.5, 0.92
Dibromomethane	0.2, 0.3, 0.7	Styrene	0.15, 0.23, 0.3
o-Dichlorobenzene	0.2, 0.24, 0.36	1,1,1,2-Tetrachloroethane	0.22, 0.3, 0.48
1,3-Dichlorobenzene	0.16, 0.28, 0.4	1,1,2,2-Tetrachloroethane	0.2, 0.56, 0.73
1,4-Dichlorobenzene	0.21, 0.24, 0.3	Tetrachloroethylene	0.37, 0.45, 0.5
trans-1,4-Dichloro-2-butene	0.49, 0.6, 0.73	Tetrahydrofuran	0.37, 0.7, 0.82
1,1-Dichloroethane	0.09, 0.36, 0.4	Toluene	0.1, 0.21, 0.4
1,2-Dichloroethane	0.2, 0.3, 0.4	1,2,3-Trichlorobenzene	0.3, 0.35, 0.43
cis-1,2-Dichloroethylene	0.1, 0.4, 0.55	1,2,4-Trichlorobenzene	0.28, 0.35, 0.4
trans-1,2-Dichloroethylene	0.16, 0.25, 0.4	1,1,1-Trichloroethane	0.07, 0.44, 0.5
1,1-Dichloroethylene	0.12, 0.33, 0.5	1,1,2-Trichloroethane	0.2, 0.36, 0.48
Dichlorodifluoromethane	0.3, 0.53, 0.8	Trichloroethylene	0.14, 0.29, 0.4
1,2-Dichloropropane	0.17, 0.3, 0.49	Trichlorofluoromethane	0.1, 0.6, 0.84
1,3-Dichloropropane	0.2, 0.39, 0.54	1,2,3-Trichloropropane	0.3, 0.44, 0.68
2,2-Dichloropropane	0.25, 0.45, 0.5	1,2,4-Trimethylbenzene	0.1, 0.25, 0.4
1,1-Dichloro-2-propanone	0.1, 0.39, 0.94	1,3,5-Trimethylbenzene	0.09, 0.17, 0.5
1,1-Dichloropropylene	0.19, 0.41, 0.6	Vinyl chloride	0.21, 0.46, 0.6
cis-1,3-Dichloropropylene	0.2, 0.26, 0.51	*m/p*-Xylene	0.2, 0.9
trans-1,3-Dichloropropylene	0.2, 0.31, 0.59	*o*-Xylene	0.09, 0.4

NJDOH laboratory. A stainless-steel Grundfos submersible pump was placed in a polyethylene standpipe filled with deionized water outside the sampling vehicle. The water was pumped into the sampling vehicle through tubing, fittings, and a filter, and ultimately into a sample bottle. Equipment used to collect the field blank then was used to collect the environmental sample. All blanks were collected and preserved prior to collecting the environmental sample.

Split samples are used to assess the precision of analysis results for various constituents measured in the laboratory. Seven split samples were collected, as described by Ivanenko and others (1996). All split samples were analyzed at the NJDOH laboratory. Three split samples were analyzed for list 1 and list 2 constituents; four split samples were analyzed for list 2 constituents only.

Trip blanks were used to determine whether shipping, storage, and handling procedures had caused sample contamination. Trip blanks were prepared at the laboratory and shipped in the same coolers as the empty sample bottles. The trip blanks remained unopened in the cooler and were returned with the environmental samples to the laboratory for analysis. During the sampling activities, 31 trip blanks were analyzed for VOCs at the NJDOH laboratory.

Ground-Water Withdrawals

Ninety-eight percent of ground-water withdrawals in the Pennsauken Township area in 1996 were from the Lower Potomac-Raritan-Magothy aquifer. All water-supply wells at the Delair, Morris, and Puchack well fields and most of those operated by the Merchantville-Pennsauken Water Supply Commission are screened in the Lower aquifer. The Upper and Middle aquifers are used more commonly east of the study area, although some local private, commercial, and industrial supply wells are screened in these aquifers. Wells for which reported withdrawal data are available are listed in table 1 and are identified by the data-type code P. Ground-water withdrawals reported for the Potomac-Raritan-Magothy aquifers in the study area in 1996 totaled about 9,920 Mgal, an average of more than 27 Mgal/d. A historical perspective of the distribution and magnitude of ground-water withdrawals within the study area is shown in figure 3. Total yearly withdrawals from supply wells at 10-year intervals from 1956 to 1996 illustrate the withdrawal history that led to the conditions observed in 1997-98. The history of withdrawals shows an upward trend both spatially and in magnitude until about 1976, when pumping from the Puchack well field was curtailed as a result of contamination. Since that time, the withdrawals have shifted to the Morris well field, as new wells were installed (fig. 3). Ground-water withdrawals in the City of Camden (southern part of the study area, fig. 3) also declined after 1976 because water-supply wells were removed from service as a result of widespread contamination. This contamination is unrelated to the contamination that affects the Puchack well field and investigation of its cause is beyond the scope of this study.

Ground-water withdrawal data for 1956-96 were compiled from NJDEP, Bureau of Water Allocation, paper and computer files; USGS computer files; and information from well owners. Wherever possible, these data were disaggregated to represent withdrawals from individual wells. Because some wells were not individually metered, the withdrawal data reported by the well owners may represent a well-field aggregated value. Withdrawals from individual wells in these cases were estimated as a percentage of the total reported value for the well field. The method used to estimate this percentage was based on the history of well use according to the well owner, the reported well capacity, or an equal apportionment of the total withdrawal for the well field to all the wells. In each case, the method chosen was the method that was believed to most closely represent actual pumping conditions. Ground-water pumpage data compiled during this investigation are provided in appendix 4.

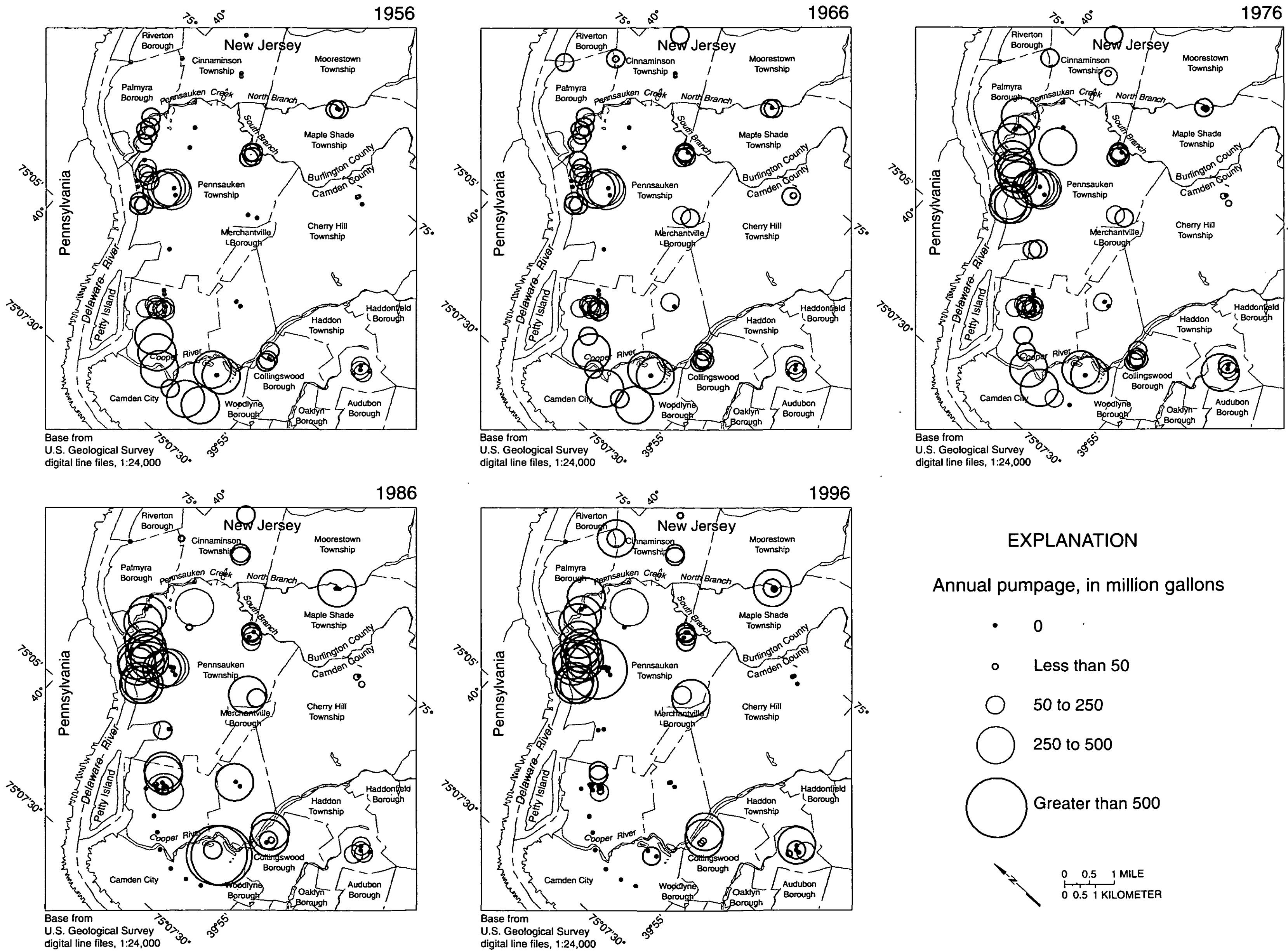


Figure 3. Distribution of ground-water withdrawals from the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey, 1956-96.

HYDROGEOLOGY

The Potomac-Raritan-Magothy aquifer system is part of a wedge-shaped sequence of Cretaceous sediments of the Potomac Group and the Raritan and Magothy Formations that lies directly on the erosional, pre-Cretaceous bedrock surface. These sediments comprise sand and gravel aquifers with intervening silt and clay confining units that thicken and dip from the western edge of the Coastal Plain at the Fall Line toward the southeast (Zapecza, 1989). They are of fluvial/ marginal marine origin (Farlekas and others, 1976) and are indicative of a complex depositional and erosional environment. In the study area, the outcrop of the Potomac-Raritan-Magothy aquifer system is capped throughout most of its extent with a variable thickness of permeable layers of sand and gravel of the Miocene Pensauken Formation (old spelling) and Pleistocene deposits (Owens and Denny, 1979; Farlekas and others, 1976). These younger surficial units are hydraulically connected to the underlying Potomac-Raritan-Magothy aquifers and, therefore, are considered to be part of the Potomac-Raritan-Magothy aquifer system. The Potomac-Raritan-Magothy aquifer system receives recharge through surface infiltration of precipitation on the outcrop areas and from the Delaware River, Pennsauken Creek, and other surface-water bodies that overlie the outcrop areas locally.

Farlekas and others (1976) divided the Potomac-Raritan-Magothy aquifer system in the Camden County area into five layers, described as Upper, Middle, and Lower aquifers separated by two confining units. The Upper aquifer consists of sands of the Magothy Formation, and the Middle and Lower aquifers are composed of sands of the Raritan Formation and Potomac Group. A more detailed structural framework of the Potomac-Raritan-Magothy aquifer system in Burlington, Camden, and Gloucester Counties (Navoy and Carleton, 1995) builds on the regional hydrogeologic framework of the Potomac-Raritan-Magothy aquifer system in the New Jersey Coastal Plain defined by Zapecza (1989). Nevertheless, the density of geologic and geophysical control points in and near the outcrop areas is insufficient to develop a detailed local interpretation of these aquifers and confining units because of their complex depositional history. The Upper and Middle aquifers and the associated confining units thin in the outcrop areas, and lithologic changes are common.

All three aquifers and the confining units contain local, discontinuous sand and clay lenses; the confining units have varying thicknesses and hydraulic properties. In some instances, individual units cannot be traced over distances as short as 1,000 ft. These discontinuous units may be important structural barriers to, and hydraulic connections resulting from discontinuities may be important pathways for, contaminant transport.

Framework

The five-layer Potomac-Raritan-Magothy aquifer system described by Farlekas and others (1976), Zapecza (1989), and Navoy and Carleton (1995) is the commonly accepted conceptual model of the aquifer-system hydrostratigraphy in the study area. Previously collected geophysical logs (mostly natural-gamma logs) and lithologic descriptions from well logs were used to refine the concept of the local framework during this study. Logs of the 26 new monitoring wells installed in 1997 provided the stratigraphic data needed to re-examine the previously published geophysical correlations at a local scale. The new wells revealed the presence of traceable sand and clay units not previously identified, confirming the need for a more detailed framework interpretation that would be appropriate for use in the development of ground-water flow and transport models of the area. Therefore, for the purposes of this study, the previously delineated Middle and Lower aquifers and the intervening confining unit have been subdivided to account for some of their apparent structural variability and to provide the detail needed for ground-water flow and contaminant-transport modeling purposes.

The detailed conceptualization of the framework of the Potomac-Raritan-Magothy aquifer system that was developed as part of this study is shown in figure 4 together with the five-layer framework developed by previous investigators. The Upper Potomac-Raritan-Magothy aquifer and the underlying confining unit correlate directly with layer A-1 and layer C-1, respectively. The framework below the contact between the confining unit and the top of the Middle aquifer was subdivided further, as follows:

1. The Middle aquifer is divided into two sand layers, A-2a and A-2b, separated by a thin, discontinuous confining layer, A-2C1. These three layers make up the commonly recognized Middle aquifer.

2. The confining unit separating the Middle aquifer layers from the Lower aquifer is subdivided from top to bottom into an upper clay unit, C-2a; an Intermediate Sand layer, C-2AI; and a lower sandy/silty clay unit, C-2b. Previous investigators have included the Intermediate Sand (C-2AI) as part of the Lower aquifer in some locations where the C-2b confining unit is sandy. The Intermediate Sand, although physically separated from the Lower aquifer by a confining unit in many areas, appears to be hydraulically connected to the Lower aquifer in the study area. For the purpose of interpreting water-quality and water-level data in this study, wells screened in the Intermediate Sand layer (C-2AI) are considered to be screened in the upper part of the Lower aquifer.

3. The Lower aquifer, unlike the Middle aquifer, does not consist of well-defined layers. Rather, it consists of a gradational sequence of sediments, ranging in size from clays to gravels, that generally coarsens with depth. For modeling purposes, the Lower aquifer was divided into three zones characterized from top to bottom as a silt-clay-sand sequence, a sand-and-gravel zone, and a very coarse gravel zone. In some locations thin clay layers mark the contacts between the zones. The zones are identified in the framework as layers A-3a, A-3b, and A-3c, respectively.

4. The confining unit beneath the Lower aquifer is referred to as layer C-3. This unit acts as the basal confining unit for the Potomac-Raritan-Magothy aquifer system and is represented by either the pre-Cretaceous bedrock surface or a clay unit lying directly on the bedrock.

Four vertical sections through the study area (pl. 2) were used to correlate the hydrostratigraphic units both spatially and vertically. Some of the control points used in these sections were interpreted by Zapecza (1989) and Navoy and Carleton (1995), permitting the detailed framework described for the study area to be correlated with those described in previously published regional investigations of Coastal Plain sediments. Three of the sections are oriented roughly perpendicular to strike, and the fourth is oriented roughly parallel to strike. Records of wells used to describe the framework are listed in table 1 and are identified by the data-type code F. Locations of these wells are shown on plates 1 and 2.

Geophysical logs (predominantly natural-gamma logs) were used extensively with subsurface lithologic information obtained from wells drilled in the study area to correlate units along the lines of section and to determine the depths to the tops of important hydrostratigraphic units. The altitudes of the tops of the hydrostratigraphic units (table 5) were calculated on the basis of land-surface altitudes obtained from the GWSI file, rounded to the nearest foot. The hydrostratigraphic sections were plotted from data points projected to the lines of section shown on plate 2. The altitudes of the tops of stratigraphic units listed in table 5 were plotted and connected graphically with a line representing the generalized altitude of the top of each unit. At the downdip edge of the outcrops, the altitudes of the tops of units are considered to be equal to the land-surface altitudes. The hydrostratigraphic sections developed were used to refine all interpretations of the tops of these units throughout the study area.

The altitudes of the tops of the hydro-stratigraphic units at 72 well locations (table 5) were used to prepare a structure-contour map of the 12 units; these maps are presented in appendix 2. Land-surface altitudes and a 30-meter-resolution digital elevation model (DEM) were used to determine the structure contours in those areas where the shallow units crop out. Because

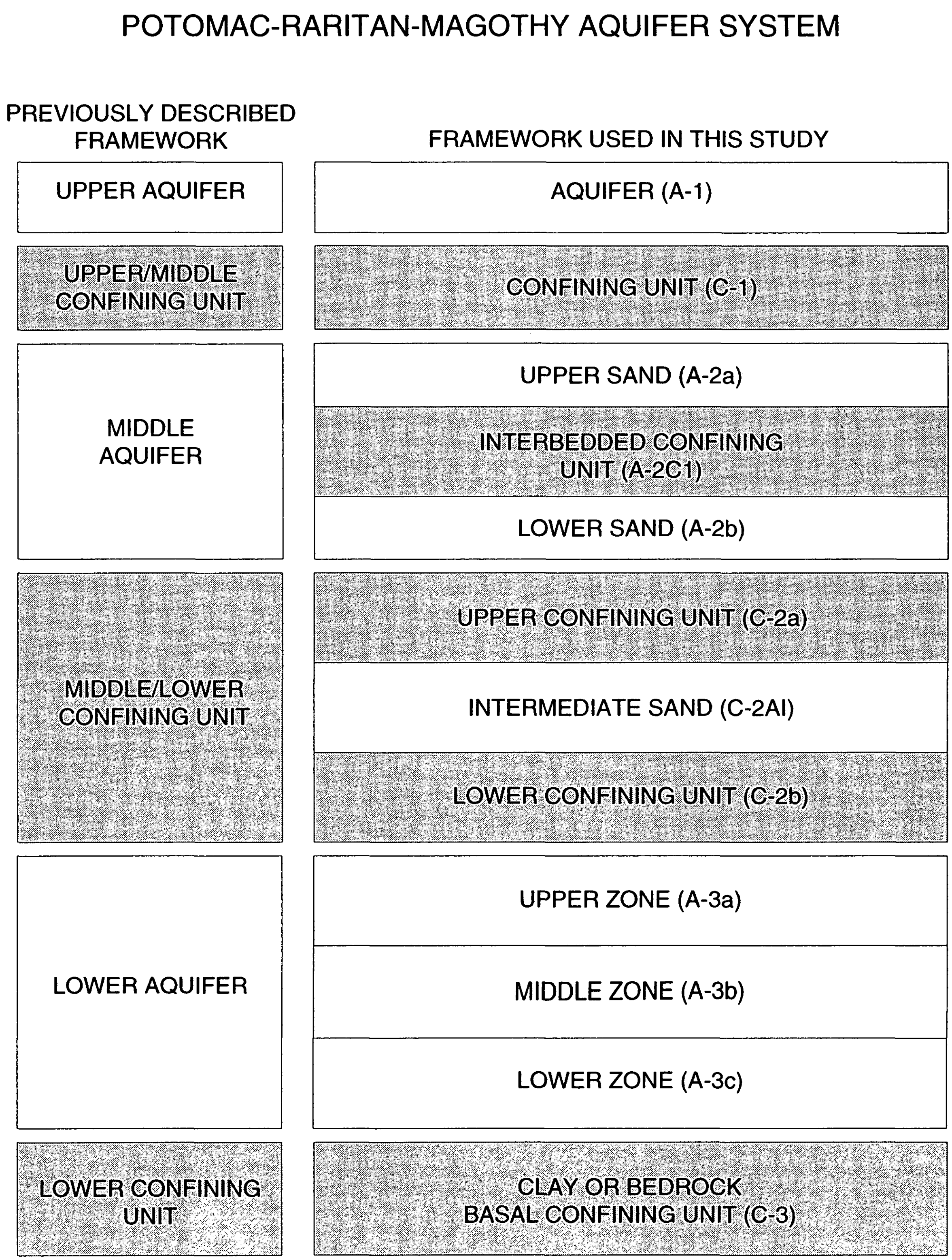


Figure 4. Hydrostratigraphic framework of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.

Table 5. Altitudes of tops of hydrostratigraphic layers in the Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers, Pennsauken Township and vicinity, Camden County, New Jersey

[Layers are shown in figure 4; --, altitude of top of hydrostratigraphic layer not available; vertical datum is NGVD of 1929]

U.S. Geological Survey well number	Altitude of land surface (feet)	Altitude of top of hydrostratigraphic layer (feet)												
		A-1	C-1	A-2a	A-2c1	A-2b	C-2a	C-2AI	C-2b	A-3a	A-3b	A-3c	C-3	Bedrock
050124	30	30	-10	-44	-88	-100	-128	-140	-149	-154	-206	--	-230	-235
050129	60	60	38	-20	-43	-61	--	--	--	--	--	--	--	--
050228	40	-111	-176	-198	-209	-229	-280	-335	-348	-402	-423	--	-471	-471
050231	20	--	--	--	--	--	--	--	--	--	--	--	-406	-474
050232	20	-53	-124	-152	-166	-196	-240	--	--	--	--	--	--	--
050274	40	-20	-86	-126	-154	-194	--	--	--	--	--	--	--	--
070078	22	22	-1	-19	-46	-51	-57	-70	-74	-80	-90	-105	--	--
070094	23	23	3	-12	-31	-42	-53	-73	-109	-123	-137	-157	--	--
070096	50	50	9	0	-8	-20	-40	-55	-61	-82	-120	-142	--	--
070108	11	11	1	-11	-21	-34	-48	-52	-76	--	-89	--	--	--
070163	39	-62	-135	-176	-185	-192	-215	-237	-269	-331	-357	-385	-431	-435
070178	15	-42	-91	-109	-138	-165	-201	--	--	-235	--	--	-279	-282
070303	55	-98	-188	-239	-280	-289	-325	-344	-364	-387	-411	--	-461	--
070332	72	21	-46	-67	-88	-91	-108	-148	-158	-168	--	--	--	--
070333	69	69	14	-16	--	--	--	--	--	--	--	--	--	--
070334	60	27	-60	-70	-97	-101	--	-155	-162	-172	--	--	-223	-233
070339	32	--	32	17	7	-6	-16	-23	-43	-56	-76	--	--	--
070342	28	--	28	8	-2	-12	-31	-46	-56	-95	--	--	--	--
070345	17	17	-45	-58	-97	-112	-129	-159	-186	-221	--	--	--	--
070353	40	40	-24	-45	--	--	--	--	--	--	--	--	--	--
070358	48	48	28	-12	--	--	-47	--	--	-117	-142	--	--	--
070359	28	28	16	2	-18	-23	-38	-70	-80	-118	-126	-150	-178	-178
070361	10	--	10	-10	--	-31	-55	-81	-91	--	-116	-164	--	--
070363	14	--	14	8	-6	-19	-48	-66	-82	-104	-116	-141	-151	-151
070365	50	--	--	--	--	--	-25	-30	-40	-50	--	--	-90	-90
070368	10	--	--	10	--	--	-35	-40	-45	--	-86	-106	-131	--
070370	6	--	--	6	--	-14	--	-39	--	--	-96	--	-129	-129
070371	57	57	22	-16	--	--	--	--	--	--	--	--	--	--
070373	8	--	8	-2	-18	-23	-30	-40	-52	-90	-101	--	-127	--
070374	7	--	7	0	-19	-21	-48	-57	-59	-73	-96	-106	-133	-133
070377	6	--	6	1	-20	-26	-54	-62	-62	-73	-99	-115	-129	-129
070379	8	--	--	8	-19	-37	-52	-62	-89	-91	--	--	-124	-129
070380	35	35	-2	-8	--	--	-32	-47	-62	-65	-83	--	-85	-88
070382	6	--	--	6	--	--	-39	-60	-74	-93	--	--	-124	--
070385	10	--	--	10	-29	-51	-54	-63	-67	-88	--	--	--	--

Table 5. Altitudes of tops of hydrostratigraphic layers in the Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers, Pennsauken Township and vicinity, Camden County, New Jersey--Continued

U.S. Geological Survey well number	Altitude of land surface (feet)	Altitude of top of hydrostratigraphic layer (feet)												
		A-1	C-1	A-2a	A-2cl	A-2b	C-2a	C-2AI	C-2b	A-3a	A-3b	A-3c	C-3	Bedrock
070387	6	--	--	6	--	--	-45	--	--	-65	-95	--	-130	-130
070528	20	--	20	-14	--	--	-44	-64	-79	-96	-119	-128	--	--
070533	8	--	--	8	-8	-17	-48	--	--	-68	-88	--	--	--
070535	10	--	--	10	-6	-12	-22	-34	-47	-85	-92	-112	-129	-140
070539	15	--	--	15	0	-7	-20	-27	-46	-83	-98	-118	-134	-150
070540	10	--	--	10	--	--	-25	-32	-53	-84	-92	-131	-167	-175
070541	20	20	-38	-52	-71	-82	-101	-111	-118	-130	-148	-178	--	--
070547	35	--	35	17	7	-2	-21	-27	-53	-67	-97	-127	-168	--
070552	35	35	18	4	-30	-33	-57	-67	-82	-90	--	--	-134	-134
070555	50	50	17	-10	--	--	--	--	--	--	--	--	--	--
070557	25	25	-35	-55	-67	-80	-88	-105	-115	-130	-155	--	--	--
070560	58	16	-49	-76	-104	-107	-111	--	--	--	--	--	-186	--
070571	25	25	9	1	-6	-23	--	--	--	--	--	--	--	--
070587	10	--	--	10	-4	-16	-27	-45	-54	-88	-102	-116	-122	--
070602	35	35	14	-11	-50	-54	-70	-84	-98	-104	-120	-147	-194	-194
070687	-53	--	--	--	--	--	--	--	--	-53	-83	--	-112	-112
070851	73	73	21	17	1	-2	-32	-57	--	--	--	--	--	--
070853	57	57	-7	-25	-38	-47	-64	-98	--	--	--	--	--	--
070855	57	57	12	-12	--	--	-38	-74	-93	-115	-133	--	--	--
070906	39	--	39	25	15	-7	-16	-34	-58	-95	-109	-121	-176	-181
070909	32	--	26	20	10	6	-2	-16	-35	-80	-108	-124	-170	-178
070912	79	79	25	-10	-29	-37	-58	-97	-107	-131	-167	-193	-229	--
070915	61	61	5	-17	-39	-49	-71	-91	-97	-124	-169	-196	-232	-232
070918	36	36	18	-12	--	--	-40	-80	-95	-124	-138	-164	-196	--
070920	27	27	7	-4	-38	-50	-61	-74	-100	-129	--	-150	-205	-210
070921	59	59	45	9	-15	-33	-53	-59	-74	-97	-111	-133	-150	-153
070924	24	--	--	24	-6	-16	-30	-40	-55	-91	-99	-118	-147	-151
070927	24	24	14	-10	-22	-28	-52	-61	-69	-98	-106	-126	-167	-167
070929	44	44	36	18	-6	-26	-46	-57	-71	-93	-106	-126	-186	-186
070930	34	34	-9	-32	-50	-57	-79	-120	-145	-159	-196	--	--	--
070931	57	57	0	-16	-29	-37	-49	-53	-73	--	--	--	--	--
070941	89	89	34	24	9	-1	-31	-61	--	--	--	--	--	--
070942	76	76	31	16	6	1	-37	-54	--	--	--	--	--	--
070948	34	34	2	-17	--	--	--	--	--	--	--	--	--	--
070957	61	61	18	-3	-32	-38	-55	-60	-79	-87	-115	--	--	--
070959	72	72	12	-3	-32	-44	-48	-60	-74	-92	-112	--	--	--
070961	38	38	-2	-6	-20	-34	-65	-77	-87	-94	-106	--	--	--

the resolution of the DEM is lower than that of the actual land-surface altitudes determined from topographic contour maps or leveling, the altitudes determined from maps or leveling may differ from those determined from the DEM. The locations of the wells used to prepare the structure-contour maps are shown on plate 1 and on the maps in appendix 2.

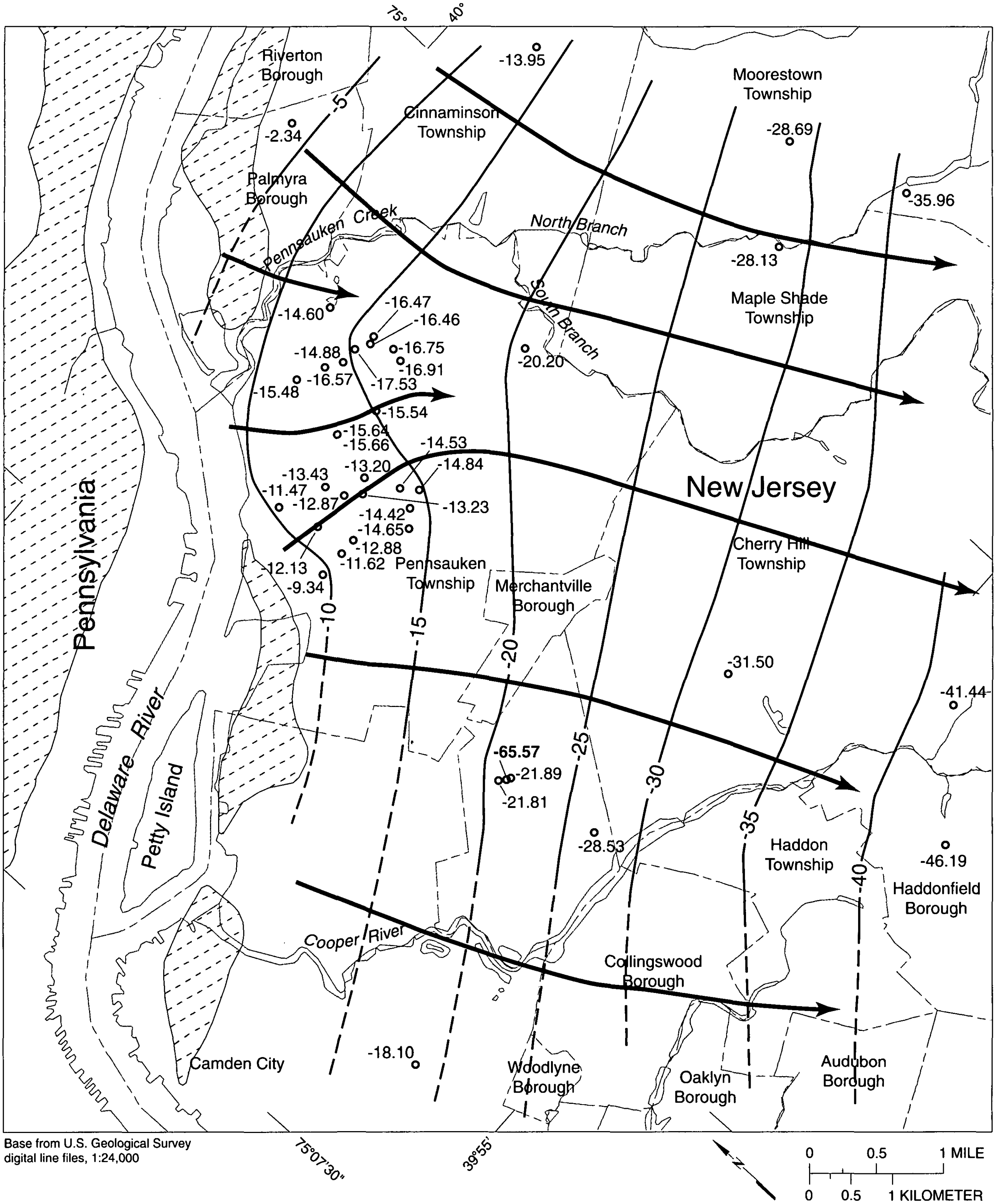
The structure contours on the 12 maps in appendix 2 are affected not only by the local stratigraphic variability that is typical of the Potomac-Raritan-Magothy aquifer system, but also by the range of data quality and density in the study area. The structural variability shown, therefore, is affected by the interpretations required by the variations in data quality and density. For example, two or more closely spaced values representing the top of a confining unit may differ because of actual variations in stratigraphy, or because of differences in the interpretations or quality of the available drilling logs. In some areas, data may be insufficient to represent structure accurately. In addition, the altitudes of the tops of the hydrostratigraphic units are constrained by the altitudes of the tops of the overlying and underlying units, because, for example, the contours representing the top of a stratigraphic unit cannot be shown as lying above the top of the overlying unit. The need for interpretation of the altitudes of the tops of the units shown in the 12 structure-contour maps were greatest in the areas where the data are sparse. In such areas, the positions of the structure contours were estimated on the basis of both the available data values for the altitudes of the tops of the hydrostratigraphic layers and the estimated positions of the contours for the overlying and underlying units.

Water Levels and Flow Patterns

The outcrop of the Upper aquifer, the least used of the Potomac-Raritan-Magothy aquifers for water supply, covers a large part of the study area. Unconfined conditions generally prevail in this part of the aquifer. Previously reported historical water levels in monitoring wells screened in the outcrop of the Upper aquifer at some of the known contaminant sites are inconsistent. In some wells, water levels are well below sea level, indicating the effects of pumping from the underlying Middle aquifer; there is no known pumping from the Upper aquifer in this area. In other wells, water levels are higher and spatially variable, indicating either perched conditions in the Upper aquifer or a more effective confinement from the Middle aquifer. The Upper aquifer is unsaturated in the vicinity of the Puchack well field as a result of the downward movement of water caused by pumping from the underlying, more heavily used aquifers.

A potentiometric-surface map of the Upper aquifer was not prepared because only eight measurements were available. Seven of these eight measurements were made in the confined part of the aquifer. Although these measurements were not sufficient to prepare a reliable potentiometric-surface map, they provide important information on water levels near the edge of the outcrop area and in the confined, downdip parts of the aquifer. A comparison of the water levels in the Upper aquifer with those in the underlying Middle aquifer indicates the presence of a downward hydraulic gradient between these aquifers in downdip areas where both aquifers are confined.

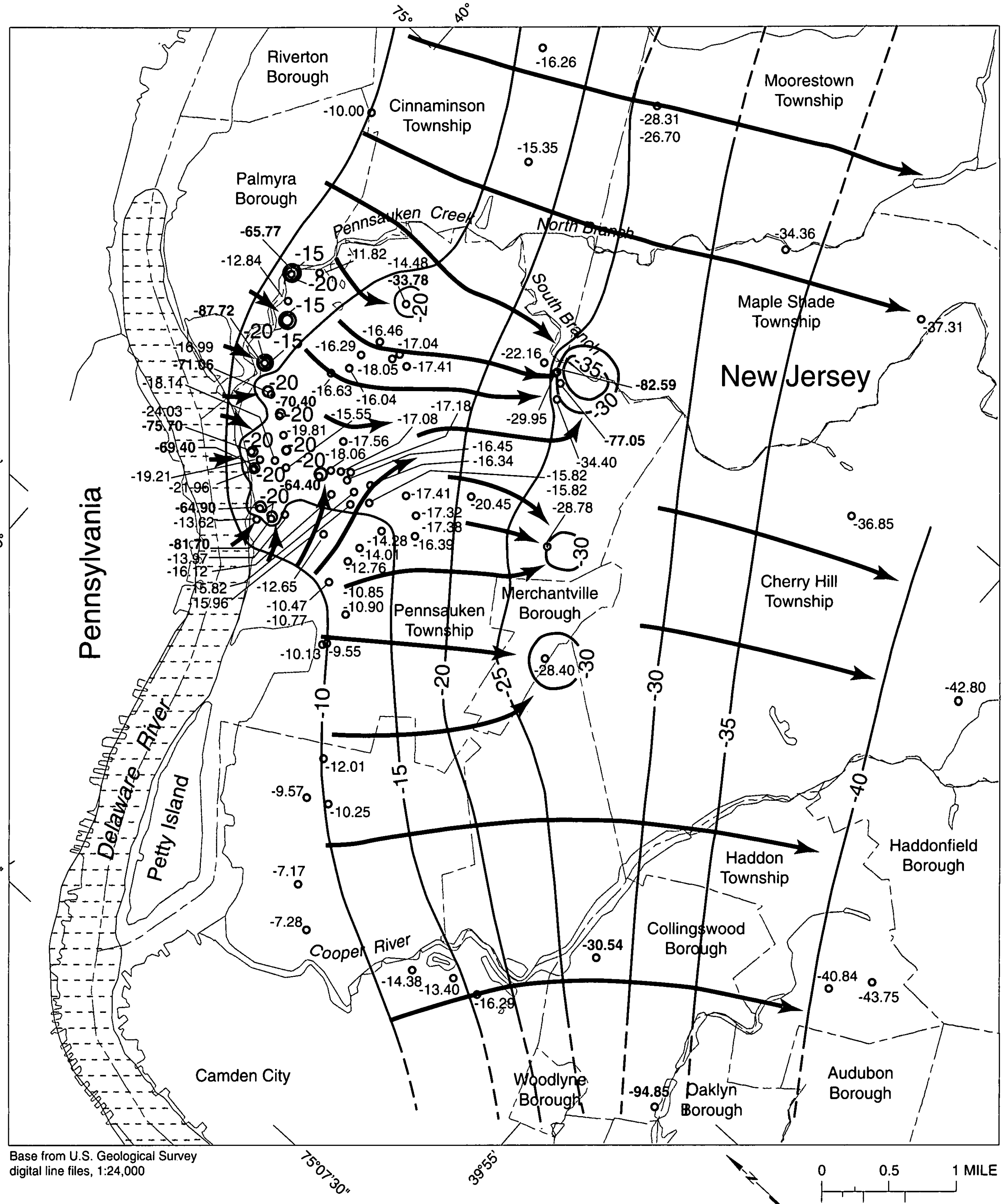
Potentiometric-surface maps of the Middle and Lower Potomac-Raritan-Magothy aquifers (figs. 5 and 6, respectively) were prepared using synoptic water-level measurements made from March 23 to 30, 1998 (table 2). The accuracy of the water-level altitudes varies depending on the accuracy of the water-level measurement and the method used to determine the altitude of the measuring point. (The accuracy of water levels and altitudes was described previously, in the "Methods of Investigation" section. Potentiometric contours were interpreted, for the most part, on the basis of static water levels in wells. Water levels in the Lower aquifer in and near pumping centers (shown in blue in figure 6) were measured under stressed conditions. Potentiometric contours in and near pumping centers (also shown in blue in figure 6) were estimated on the basis of static water levels, stressed water levels in and near pumped wells, and the locations of the pumped wells. These maps, therefore, represent stressed conditions in and near pumping centers.



EXPLANATION

- Outcrop area of the Middle aquifer of the Potomac-Raritan-Magothy aquifer system. (Outcrop area from Navoy and Carleton, 1995)
- General direction of ground-water flow
- —-20— — WATER-LEVEL CONTOUR--Shows estimated altitude at which water would have stood in tightly cased wells. Dashed where approximately located. Contour interval 5 feet. Vertical datum is NGVD of 1929
- 10 o LOCATION OF WELL--Number is altitude of water level, in feet. Datum is NGVD of 1929. Water levels shown in blue are affected by pumping. (Water levels are listed in table 2)

Figure 5. Potentiometric surface of the Middle aquifer of the Potomac-Raritan-Magothy aquifer system, March 1998, Pennsauken Township and vicinity, Camden County, New Jersey.



EXPLANATION

Outcrop area of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. (Outcrop area from Navoy and Carleton, 1995)

General direction of ground-water flow

—-20— — WATER-LEVEL CONTOUR--Shows estimated altitude at which water would have stood in tightly cased wells. Dashed where approximately located. Contours shown in blue were estimated from static water levels, stressed water levels in and near pumped wells, and the location of the pumped wells. Contour interval 5 feet. Vertical datum is NGVD of 1929

-9.55 o LOCATION OF WELL--Number is altitude of water level, in feet. Datum is NGVD of 1929. Water levels shown in blue are affected by pumping. (Water levels are listed in table 2)

Figure 6. Potentiometric surface of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system, March 1998, Pennsauken Township and vicinity, Camden County, New Jersey.

Ground water in both the Middle and Lower aquifers generally flows southeast. Flow directions, illustrated by arrows drawn normal to the potentiometric contours from areas of highest to lowest water levels in figures 5 and 6, are controlled largely by the regional effect of the lowest water levels in the Potomac-Raritan-Magothy aquifer system. These heads are centered in large cones of depression in the Upper, Middle, and Lower aquifers about 6 mi southeast of the study area (Lacombe and Rosman, 1997).

The Middle aquifer is used little in the study area; therefore, its potentiometric surface (fig. 5) reflects the combined effects of the regional cones of depression in the Middle and Lower aquifers (Lacombe and Rosman, 1997) and the downward hydraulic gradient between the Middle and Lower aquifers. Local areas of depressed water levels in the Lower aquifer in the study area (fig. 6) are centered at well fields operated by the City of Camden and the Merchantville-Pennsauken Water Supply Commission. These well fields control the local ground-water-flow direction within the context of the regional flow conditions.

GROUND-WATER QUALITY

Results of analyses of environmental samples indicate that the most prevalent contaminants included chromium and organic compounds such as chlorinated solvents and benzene compounds. Quality-assurance samples, with two exceptions, contained no detectable amounts of chromium, although traces of other inorganic constituents were detected in some of the blank samples. Details of the analytical results are discussed below.

Quality-Assurance Samples

Results of analyses of field- and equipment-blank samples for trace elements by ICP-MS at the NWQL indicated no concentrations of cadmium, chromium, iron, or lead greater than MRLs (app. 3, table 3-1). Seven blank samples were analyzed for mercury, and no concentrations exceeded the MRL of 0.1 μg/L. Trace elements detected in most blank samples included aluminum, barium, boron, copper, and zinc. Glass ampoules used to contain acid for sample preservation can contaminate samples with aluminum, barium, and boron and, to a lesser extent, with chromium, silica, and zinc (Horowitz and others, 1994). A list of analyses for which the results are considered to be questionable on the basis of the results of analysis of the quality-assurance samples is given in table 6. The concentrations of copper or zinc in four field-blank samples were greater than one-third the concentration measured in the environmental sample. In two cases, copper was present in the field-blank sample but not in the associated environmental sample.

Table 6. Concentrations of copper and zinc in selected environmental and associated blank samples, Pennsauken Township and vicinity, Camden County, New Jersey

[μg/L, micrograms per liter; <, less than; --, no data]

		Copper, dissolved (μg/L)		Zinc, dissolved (μg/L)	
Date	Well name	Blank sample	Environmental sample	Blank sample	Environmental sample
4-21-98	Puchack MW-9S	1.68	1.4	10.15	20
4-22-98	Puchack MW-6M	2.79	4.9	--	--
4-28-98	Puchack MW-7D	1.31	<1	4.59	5.0
4-29-98	Puchack MW-10M	1.34	<1	--	--

Results of analyses of field blanks for VOCs at the NJDOH laboratory indicate that concentrations of some compounds exceeded MRLs. VOCs were detected in 4 of the 32 trip-blank samples collected. The trip blank associated with the sample collected at well 070368 contained 2.5 µg/L of acetone and the environmental sample contained 2.8 µg/L, indicating that the environmental sample may have been contaminated with acetone during transport to the laboratory. The trip blank associated with the samples collected at wells 070372 and 070373 contained 0.8 µg/L of 2-butanone, whereas the concentration of 2-butanone was 0.9 µg/L in the sample from well 070372 and was below the MRL in the sample from 070373. The trip blank associated with the samples collected at wells 070855 and 070856 contained 0.34 µg/L of TCE, whereas the concentration of TCE was below the MRL in the sample from 070856 and 12.0 µg/L in the sample from well 070855. The trip blank associated with the sample collected at well 070940 contained 2.5 µg/L of TCE, whereas the environmental sample contained 20 µg/L.

Environmental Samples

Results of analyses of water samples from the 55 wells in Pennsauken Township and vicinity are presented in appendix 3. Concentrations of selected inorganic constituents are shown on plate 3. Fifteen samples contained concentrations of one or more inorganic constituents that exceed the applicable MCLs adopted by NJDEP from the U.S. Environmental Protection Agency (USEPA) (U.S. Environmental Protection Agency, 1996); these were cadmium (MCL 5 µg/L), chromium (MCL 100 µg/L), and mercury (MCL 2 µg/L). In samples in which these constituents were detected, the MCL for cadmium was exceeded in 1 of 2 samples, the MCL for total chromium was exceeded in 13 of 27 samples, and the MCL for mercury was exceeded in 1 of 20 samples.

A sample from one Puchack well (070366) was analyzed for cadmium, which was not detected. Of the six samples collected from wells in the Puchack field, all contained detectable concentrations of chromium and trace amounts of mercury. Concentrations of chromium ranged from 25.9 to 788 µg/L; the MCL was exceeded in four samples. Samples from three wells in the Puchack field contained concentrations of chromium that were much lower than those reported for the same wells sampled during 1981-89 (R.A. Gallagher, written commun., 1990). In 1989, samples from wells 070367, 070363, and 070359 contained chromium at concentrations of 4,180, 2,620, and 757 µg/L, respectively, whereas samples collected from the same three wells in 1998 contained chromium at concentrations of 147, 180, and 25.9 µg/L, respectively. Chromium concentrations in samples from wells 070366 and 070528 in 1989 (R.A. Gallagher, written commun., 1990) were similar to those in samples collected during this study (1998).

Dissolved chromium may be present as trivalent cations or as hexavalent anions (Hem, 1985). Hexavalent chromium is more toxic and mobile than the trivalent form (Davis and Olsen, 1995), and its presence generally is indicative of contamination from industrial sources (Stollenwerk and Grove, 1985). Separate analyses were made for total and hexavalent chromium; the presence of trivalent chromium was inferred by the difference between the measurements. Hexavalent chromium was predominant in most of the samples where chromium was reported, and in all samples where total chromium exceeded the MCL. Except in samples from wells 070571 and 070930, concentrations of dissolved chromium greater than 2 µg/L were associated with dissolved-oxygen concentrations less than 2 mg/L.

Concentrations of dissolved iron plus manganese ranged from 31.9 to 106,560 µg/L. Concentrations of dissolved (filtered) iron plus manganese greater than 718 µg/L were associated with concentrations of dissolved oxygen less than 2 mg/L (fig. 7). Concentrations of dissolved oxygen ranged from 0.1 to 9.1 mg/L and were greater than 2 mg/L in 38 samples. The association of high concentrations of iron and manganese with low concentrations of dissolved oxygen is indicative of reduction and solubilization of iron and manganese, likely present in hydroxide coatings on soil particles and aquifer materials.

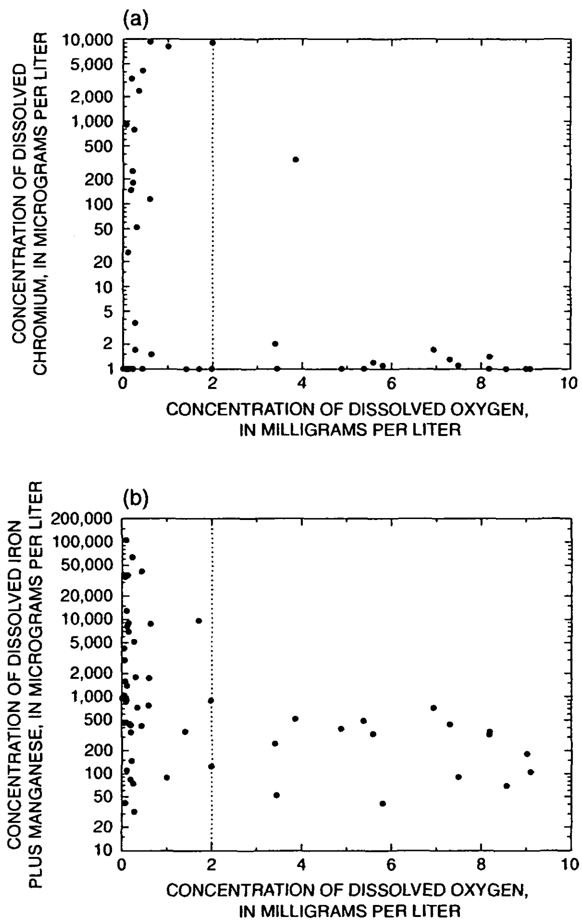


Figure 7. Relations of the concentrations of (a) dissolved chromium and (b) dissolved iron plus manganese to the concentration of dissolved oxygen in samples from the Potomac-Raritan-Magothy aquifer system in Pennsauken Township and vicinity, New Jersey, 1997-98. (The dotted lines represent the dissolved-oxygen concentration below which chromium, iron, and manganese concentrations tend to be large in filtered samples.)

When concentrations of dissolved oxygen are greater than 2 mg/L, the less soluble oxidized forms of iron and manganese tend to dominate and, if present as suspended particles, are removed to a large degree by filtering the water sample. The precipitation of ferric iron as a hydroxide could tend to remove dissolved chromium and other metallic trace elements from solution; these metals also would be retained on the filter media.

Concentrations of selected organic compounds in samples from 55 wells are shown on plate 4. Some organic compounds were present in samples from most of the wells. The types of compounds detected include chlorinated solvents and their degradation products; benzene, toluene, ethylbenzene, and xylenes (BTEX), and related compounds; and oxygenated compounds. Concentrations of one or more organic compounds exceeded the applicable New Jersey MCL (New Jersey Department of Environmental Protection, 1998) in samples from 34 wells. TCE, 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethylene (PCE), and 1,1-dichloroethylene (1,1-DCE) were the compounds commonly detected; of these, TCE and PCE were the compounds whose concentrations most frequently exceeded an MCL. TCE was detected in 40 samples at concentrations ranging from 0.1 to 310 µg/L; concentrations in 28 samples exceeded the MCL of 1 µg/L. 1,1,1-TCA was detected in 27 samples at concentrations ranging from 0.1 to 12,500 µg/L; concentrations in 2 samples exceeded the MCL of 30 µg/L. PCE was detected in 24 samples at concentrations ranging from 0.28 to 280 µg/L; concentrations in 14 samples were at (3 samples) or exceeded (11 samples) the MCL of 1 µg/L. 1,1-DCE was detected in 19 samples at concentrations ranging from 0.3 to 3,580 µg/L; concentrations in 9 samples exceeded the MCL of 2 µg/L. The highest concentration of any organic compound detected was 12,500 µg/L of 1,1,1-TCA in the sample from well 070940.

Distribution of Ground-Water Contaminants

The distributions of inorganic and organic contaminants in ground water in the study area are different. The principal inorganic contaminant, chromium, is present in discrete parts of the Middle and Lower aquifers, whereas organic contaminants, which include a variety of chlorinated solvents and gasoline-related compounds, are found throughout both aquifers in the study area.

Inorganic Constituents

Results of sample analysis for total chromium in water from the Potomac-Raritan-Magothy aquifers are shown on plate 3. The total chromium concentration at each well is characterized by a symbol representing one of four ranges of concentrations in the Upper and Middle aquifers, Intermediate Sand, and Lower aquifer. Three separate areas of chromium contamination (A, B, and C) were delineated by estimating the position of the 100-µg/L chromium isoconcentration lines. Areas A and B together represent the estimated spatial distribution of chromium concentrations exceeding the MCL in the Middle aquifer. Area C represents the estimated spatial distribution of chromium concentrations exceeding the MCL in the Lower aquifer, including the Intermediate Sand.

Although the Middle aquifer is contaminated with chromium in areas A and B, the Lower aquifer, including the Intermediate Sand, apparently is unaffected. The concentrations of total chromium in samples from wells 070960 and 070571 in the Middle aquifer in area A were 114 and 341 µg/L, respectively, whereas chromium was not detected in the sample from the well in the Lower aquifer (070961) at the same location as well 070960. The concentration of total chromium in the sample from well 070907 in the Middle aquifer in area B was 10,250 µg/L, whereas chromium was not detected in samples from wells 070906 and 070908 in the Lower aquifer at the same location.

Analytical results for samples from the Intermediate Sand and the Lower aquifer in area C were combined because these layers are hydraulically connected. Combining the total-chromium concentrations for these two layers allows for a delineation of the spatial distribution of chromium in this area that otherwise could not have been illustrated because of the limited number of wells screened in each individual layer. The sample-analysis results indicate that parts of the Intermediate Sand and Lower aquifer are contaminated with chromium.

Concentrations of total chromium in samples from the seven wells (070851, 070853, 070855, 070914, 070917, 070930, and 070942) screened in the Intermediate Sand ranged from 2 to 9,070 µg/L. Four of the seven samples contained total chromium at levels that exceeded the MCL; concentrations in all four samples were greater than 2,000 µg/L (pl. 3). Concentrations of hexavalent chromium in samples from the seven wells generally were similar to those of total chromium, indicating that most, if not all, of the chromium present is in the more toxic and mobile oxidation state.

Concentrations of total chromium in samples from 24 wells screened in the Lower aquifer ranged from <1 to 3,454 µg/L (pl. 3). Samples from six of the wells (070358, 070363, 070367, 070528, 070918, and 070926) contained total chromium at levels that exceeded the MCL. As in samples from wells in the Intermediate Sand, concentrations of hexavalent chromium were similar to those of total chromium in most samples from Lower aquifer wells.

Area C encompasses three to four clusters of wells screened in different units of the aquifer system. Concentrations of total chromium in samples from clustered wells 070917 (Intermediate Sand) and 070918 (Lower aquifer) were 8,100 and 904 µg/L, respectively, indicating that both units are contaminated at this location. The sample from the Middle aquifer well in this cluster contained only 1.4 µg/L of total chromium, however. At four other well clusters where samples from deeper wells (Intermediate Sand or Lower aquifer) contained chromium at concentrations that exceeded the MCL, three samples from the corresponding well screened in the Middle aquifer did not contain detectable concentrations of chromium (<1 μg/L); one contained chromium at 1.2 μg/L. On the basis of chromium concentrations in samples from wells located outside areas A, B, and C (pl. 3), which ranged from <1 to 22.1 μg/L (median <1 μg/L), concentrations of chromium typical of uncontaminated parts of the aquifer system probably are <3 μg/L.

On the basis of results of this study, the presence of inorganic constituents other than chromium in concentrations that exceed an MCL apparently is minimal. The MCLs for cadmium and mercury were exceeded in samples from only two wells screened in the Middle aquifer, 070931 and 070928. Concentrations of other inorganic constituents in samples from all wells were below their respective MCLs (where applicable).

Because the extent of chromium contamination beyond the locations of the sampled wells cannot be determined, the areas where chromium concentrations exceed 100 μg/L (pl. 3) are based on a combination of sampling results and estimated directions of ground-water flow. The density of wells in area C is relatively high compared to that in the other areas, but there are few wells east and south of it. For example, no data are available for the area directly south of wells 070942 and 070851, where analytical results indicate high levels of chromium in the Intermediate Sand. There are no sampled wells north of area A, and the closest sampled well to the south is approximately 2,000 ft away. Additional water-quality data from these areas would help to determine the extent of chromium contamination with greater accuracy.

Organic Compounds

Results of sample analysis for selected organic compounds in water from the Potomac-Raritan-Magothy aquifers are shown on plate 4. Concentrations of organic constituents that exceed New Jersey MCLs were widespread in the Potomac-Raritan-Magothy aquifer system in the study area. Many of the 55 sampled wells were clustered in groups of 2 or 3, resulting in a total of 34 locations. At 32 locations, concentrations of organic compounds in samples from one or more well(s), including all supply wells sampled in the Puchack well field, exceeded an MCL. The sample from the well screened in the Upper aquifer contained TCE at a concentration (310 μg/L) that is well above the MCL. Samples from 11 of 23 wells (48 percent) screened in the Middle aquifer contained one or more organic compounds at concentrations exceeding an MCL. Samples from 21 of 31 wells (68 percent) screened in the Intermediate Sand and the Lower aquifer contained at least one organic compound at a concentration exceeding an MCL. The most common compounds found in both aquifers were the dissolved-phase chlorinated solvents TCE, PCE, 1,1,1-TCA, and various forms of DCE and dichloroethane, some of which may be breakdown products of the more highly chlorinated compounds. Gasoline-related compounds, such as methyl tert-butyl ether (MTBE), were detected in a substantial number of samples from both the Middle and Lower aquifers. Detections of MTBE, a compound in common use only within the last decade, indicate how rapidly some contaminants can reach the Lower aquifer. Various BTEX compounds were detected; in particular, benzene concentrations exceeded the MCL in water from three Middle aquifer wells, one Intermediate Sand well, and two Lower aquifer wells.

Potential for Contaminant Transport

A simplified concept of the potential for ground-water transport of inorganic and organic contaminants in the Potomac-Raritan-Magothy aquifer system in the study area can be formulated on the basis of hydraulic gradients, flow directions, the hydrostratigraphic framework, and the demonstrated extent of contamination. Conceptual pathways of contaminant transport identified in this manner generally are similar to ground-water flow paths, resulting in a simplified transport concept that omits common geochemical effects of attenuation, retardation, and degradation.

The small number of samples and the complex hydrogeology of the area further limit the ability to predict the transport of contaminants reliably.

The largest area of chromium contamination is in the Lower aquifer (pl. 3). Many of the wells used to identify and delineate this area of chromium contamination actually are screened in the Intermediate Sand. Prior to the identification of the Intermediate Sand (this study), a water-bearing zone near the base of the confining unit between the Middle and Lower aquifers was considered part of the Lower aquifer. Although the Intermediate Sand is separated physically from the Lower aquifer by a confining unit at many locations, it is well connected hydraulically to the Lower aquifer. This physical and hydraulic connection between the Intermediate Sand (C-2AI) and the upper part of the Lower aquifer (A-3a) appears to represent an important transport pathway to deeper parts of the Lower aquifer for any contaminants that reach the Intermediate Sand from above. This pathway is important particularly in area C (pl. 3) because of the high chromium concentrations found in the Intermediate Sand there. Water levels in the Intermediate Sand are only slightly higher than those in the Lower aquifer under present-day (1998) pumping conditions; therefore, additional local pumping stresses in the Lower aquifer could induce the chromium-contaminated water to move from the Intermediate Sand into the more extensive Lower aquifer.

Directions of ground-water flow in the Lower aquifer and areas of chromium-contaminated water in the Middle and Lower aquifers are shown in figure 8. Area C is elongated and widens from west to east in the general direction of ground-water flow (fig. 8). This shape may result from (1) contaminant spreading because of advective flow and dispersion; (2) historically variable pumping conditions at the Puchack well field; and (or) (3) the presence of multiple chromium plumes. Available data are insufficient to determine whether the contamination represents a single plume of chromium-contaminated ground water or two or more plumes that have coalesced. The latter is likely because the NJDEP has identified potential sources of chromium in this area (R.A. Gallagher, written commun., 1990).

The shape of area C indicates that contaminant transport likely is to the east and southeast in the general direction of the Park Avenue and Marion well fields. The present eastern and southeastern extent of chromium contamination is unknown because no samples were collected between area C and the Park Avenue and Marion well fields (pl. 3). Area C also includes the Puchack well field, which was removed from service in April 1998. If the Puchack well field is returned to service, the wells probably would capture some of the chromium-contaminated water; pumping also could alter the path and (or) rate of contaminant transport.

Analysis of ground-water samples also has identified extensive VOC contamination in both the Middle and Lower aquifers. Regional ground-water flow likely would transport organic contaminants to the southeast. Contaminants present within the cones of depression in local well fields would migrate toward those wells, however.

Chromium concentrations in the Middle aquifer are greater than the MCL in area A (pl. 3), as indicated by analysis of samples from two wells about 0.7 mi north of the Puchack well field. Ground water flows southeast in both the Middle and Lower aquifers in this area. Locally, the confining layers between the Middle and Lower aquifers may be thin or discontinuous. The vertical hydraulic gradients in this area appear to vary, but generally indicate a potential for downward movement of ground water and contaminants.

Chromium contamination at area B (pl. 3), in the uppermost water-bearing zone (A-2b) of the Middle aquifer, was identified on the basis of a sample from a single well (MW-1S (070907)) in which a concentration of 10,250 µg/L was measured. Transport of this chromium can be assessed effectively only by considering the local hydrogeologic conditions. The direction of ground-water flow in the Middle aquifer is similar to that in the Lower aquifer, and the contaminated water in the Middle aquifer is directly upgradient

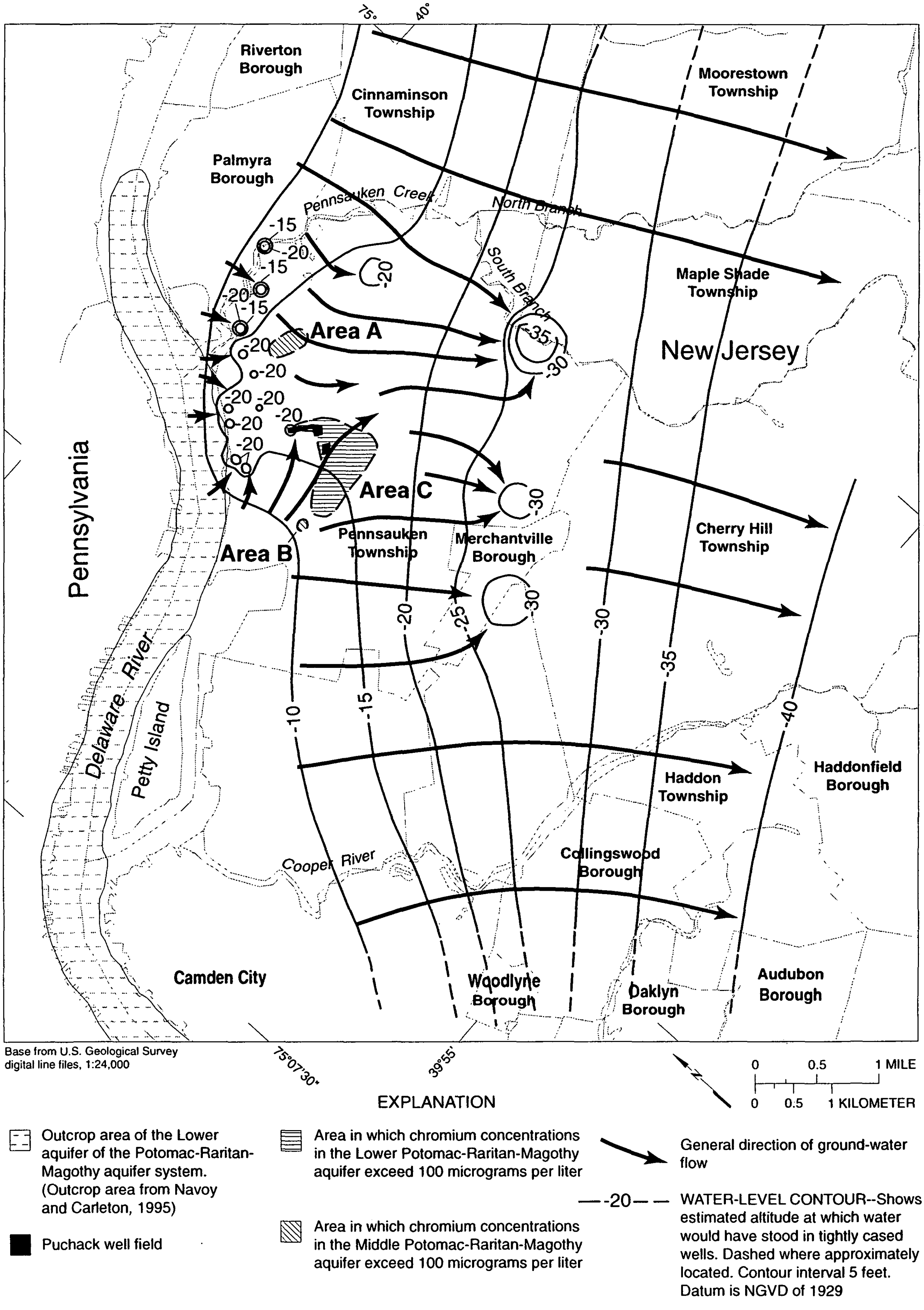


Figure 8. Generalized ground-water-flow direction in the Lower Potomac-Raritan-Magothy aquifer, March 1998, and extent of chromium-contaminated ground water, December 1, 1997-May 14, 1998, Pennsauken Township and vicinity, Camden County, New Jersey.

from area C in the Intermediate Sand and Lower aquifer (fig. 8). Additionally, the water level in the Middle aquifer at Puchack MW-1S (070907) is about 1 ft higher than that in the underlying Intermediate Sand at Puchack MW-1M (070908). The hydraulic gradient between these two wells indicates possible downward contaminant migration locally, but the total chromium concentration in the sample from well MW-1M was less than the detection limit (<1 μg/L). The Middle aquifer may be hydraulically connected to the Intermediate Sand or the Lower aquifer at other locations, but because chromium was not detected in deeper wells in the Puchack MW-1 well cluster, confining unit C-2A probably is effective in retarding the vertical migration of chromium-contaminated water at that location.

The direction of potential contaminant transport within the Middle aquifer is southeast, in the direction of regional ground-water flow (fig. 7). On the basis of this ground-water-flow direction, chromium-contaminated water in area A is upgradient from local cones of depression in the Lower aquifer, and chromium-contaminated water in area B in the Middle aquifer is upgradient from the underlying chromium-contaminated water in area C (fig. 8). Locally, the Middle aquifer contains high concentrations of VOCs that appear to be related to point sources. One of these areas is about 2,000 ft upgradient from the Puchack well field, as indicated by water-quality data for monitoring well MW-10M (070928). The samples from this well contained multiple VOCs, including BTEX compounds: benzene at a concentration of 1,200 μg/L, 1,2,4-trimethylbenzene at a concentration of 1,300 μg/L, ethylbenzene at a concentration of 1,000 μg/L, and o-xylene at a concentration of 1,700 μg/L. At another location about 2,600 ft southeast of the Puchack well field (well 070940), 1,1,1-trichloroethane was detected at a concentration of 12,500 μg/L. Identification of potential point-source-related areas of contamination in the Middle aquifer was limited by the small number of wells sampled and the small areal extent of the sampling. Given the large number of known contaminant sites listed by the NJDEP (Known Contaminated Sites List, N.J. Department of Environmental Protection database, Trenton, N.J., 1996), the presence of other such areas that were not identified during this study or previous investigations is likely.

The surficial deposits in the outcrop areas of both the Upper and Middle aquifers are highly permeable, and the Upper aquifer is dewatered locally as a result of the pumping-induced hydraulic gradients in the underlying aquifers. These conditions contribute to the potential for substantial amounts of a variety of contaminants to be transported into the Middle aquifer. The transport pathway may be characterized by the initial migration of contaminants from the outcrop areas of the Upper and Middle aquifers through the vadose zone to the uppermost water-bearing zone. Contaminants would migrate both vertically and laterally into the underlying Middle aquifer, driven mostly by the generally downward hydraulic gradients in the Potomac-Raritan-Magothy aquifer system. After reaching the Middle aquifer, transport may be affected by either lateral or vertical migration controlled largely by the direction of ground-water flow, the hydraulic-head relations between water levels in adjacent aquifers, the degree to which these units are connected, and the geochemical factors affecting transport. The hydraulic gradient between the Middle and Lower aquifers in most parts of the study area provides the physical potential for contaminants to move downward to the Lower aquifer.

SUMMARY AND CONCLUSIONS

After ground water from the Puchack well field in Pennsauken Township, Camden County, New Jersey, was found to be contaminated with metallic trace elements (principally chromium) and organic compounds in the early 1970's, pumping from the well field was reduced sharply and eventually stopped completely. Organic compounds also have been detected at some other well fields in the vicinity. The New Jersey Department of Environmental Protection, as part of its Site Remediation Program, had identified more than 38 known contaminant sites in Pennsauken Township as of 1996. Most of the contaminant sites and the water-supply wells are in the outcrop areas of the Potomac-Raritan-Magothy aquifer system, the source of all major ground-water supplies in the area. Because the Potomac-Raritan-Magothy aquifers are recharged by infiltration through the outcrop area, the area's water supply is vulnerable to contamination. Pumping-induced hydraulic gradients in the Potomac-Raritan-Magothy aquifers have increased the transport of shallow contaminants deeper into the aquifer system, and the prevailing flow directions indicate that the contaminants eventually could reach other water-supply wells nearby.

Contaminants detected at the Puchack well field include chromium, mercury, and organic chemicals (predominantly TCE), all of which were detected at concentrations exceeding applicable drinking-water standards. About 90 percent of the chromium detected was hexavalent chromium, the most toxic and mobile form.

The results of this study, conducted by the USGS in cooperation with the NJDEP during 1996-98, provide new information about the hydrogeology of the Potomac-Raritan-Magothy aquifer system in the study area. Hydrogeologic and geophysical data from 26 new monitoring wells installed in 1997 and results of analysis of 55 ground-water samples were used to refine the existing concept of the hydrogeologic framework of the Potomac-Raritan-Magothy aquifer system in the study area and to determine the nature and extent of ground-water contaminants that threaten the local water supplies. Ground-water-flow directions derived from water-level measurements were used as an indication of the potential direction of contaminant transport. The findings of this study, listed below, are based on data obtained from the USGS's NWIS database in 1998:

- The presence of permeable geologic materials and the complexity of the hydrogeologic framework in the study area have resulted in rapid infiltration of surficial contaminants.

- Discontinuities in confining units make the Potomac-Raritan-Magothy aquifers vulnerable to the transport of contaminants from shallow to deeper aquifers.

- The Intermediate Sand, a layer within the confining unit separating the Middle and Lower Potomac-Raritan-Magothy aquifers, is a locally traceable unit that is hydraulically connected to the Lower aquifer.

- Most of the high chromium concentrations previously attributed to the Lower aquifer actually were detected in wells screened in the Intermediate Sand.

- The Intermediate Sand likely is an important pathway by which chromium has been transported to the Lower aquifer.

- High chromium concentrations have been identified only in the lower part of the Lower aquifer in areas near the Puchack well field, indicating that the historical pumping stress at the well field has contributed to the transport of chromium to the Lower aquifer in this area.

- The location, extent, and configuration of areas where chromium concentrations are elevated above background concentrations and their proximity to the Puchack well field indicate that chromium probably has been transported to the well-field area from the southwest in response to historic pumping-induced gradients.

- VOCs, principally dissolved-phase TCE and some PCE, are present in extensive areas in both the Middle and Lower Potomac-Raritan-Magothy aquifers. Concentrations of these and other chlorinated compounds commonly exceeded the applicable New Jersey MCLs, but were less than 100 μg/L in most samples. The concentration of BTEX compounds exceeded 1,000 μg/L in the sample from one Middle aquifer well.

- The delineation of the extent of contaminated ground water is limited by the distribution and number of existing wells sampled. Additional data are needed to determine the actual extent of the contamination and to identify its source(s).

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APPENDIX 1. Lithologic and geophysical logs of selected monitoring wells penetrating the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey, 1997

The wells described in this appendix are listed in the table below. Well logs include information on drilling conditions from the driller, observations of drill cuttings, and descriptions of materials collected in 2-ft split-spoon samples (indicated with an asterisk (*)). Depth intervals overlap in some instances as a result of combining these sources of information. Grain sizes, typically reported in metric units, also are reported in English units.

Local well name	U.S. Geological Survey well number
Puchack Well MW-1D	070906
Puchack Well MW-2M	070909
Puchack Well MW-3D	070912
Puchack Well MW-4D	070915
Puchack Well MW-5D	070918
Puchack Well MW-6D	070920
Puchack Well MW-7D	070921
Puchack Well MW-8D	070924
Puchack Well MW-9D	079027
Puchack Well MW-10D	070929
Puchack Well MW-12M	070930
Puchack Well MW-14	070931

LITHOLOGIC DESCRIPTION OF PUCHACK MW-1D (WELL NUMBER 070906)

Depth, in feet below land surface	
0- 2	Fill soil, dark, gravelly, grading to sand, light brown (5YR 5/6), medium-grained
2- 8	Cuttings: Sand, medium- to very coarse-grained; trace of gravel, clay indicated by drilling at 8 ft
13- 20	Cuttings: Clay and lignite; sand lenses indicated by drilling at 20 ft
28- 30*	Clay, very pale orange (10YR 8/2), silty; silt and very fine sand laminations, dark yellowish-orange (10YR 6/6) staining
30- 43	Cuttings: Clay, dark gray with thin lenses of coarse sand and fine gravel at 30 and 38 ft, some iron-cemented sand
43- 45*	Clay, brownish-gray (5YR 4/1), stiff, low plasticity with 1-in. lens of silty sand, light brownish-gray (5YR 6/1), very fine-grained
51-	Sand indicated by drilling at 51 ft; sand becomes coarse by 53 ft
56-	Clay indicated by drilling at 56 ft
58- 60*	Clay, very pale orange (10YR 8/2), mottled moderate reddish-brown (10R 4/6), silty, stiff, medium plasticity
73- 75*	Clay, yellowish-gray (5Y 8/1), mottled dark yellowish-orange (10YR 6/6), silty, firm, medium plasticity, moist
79-	Sand lenses indicated by drilling at 79 ft
79- 84	Cuttings: Clay; sand, very fine-grained, silty; cemented gravel indicated by drilling at 84 ft
88- 90*	Sand, very pale orange (10YR 8/2), medium- to coarse-grained
103-	Sand and gravel with clay lenses indicated by drilling at 103 ft
103-105*	Clay, very pale orange (10YR 8/2), silty, low plasticity, trace mica, grading to sand, very pale orange (10YR 8/2), medium-grained quartz
118-120*	Sand, pinkish-gray (5Y 8/1), clayey, medium-grained; trace clay; trace mica
120-135	Cuttings: Clay, light gray; sand indicated by drilling at 135 ft
135-145	Cuttings: Sand; clay indicated by drilling at 145 ft
148-150*	Clay, very pale orange (10YR 8/2), silty, firm, wet, medium plasticity, grading to silt and then fine sand
150-170	Cuttings: Sand, increasing in grain size with depth; very coarse gravel (0.2-3.0 cm (0.08-1.2 in.)), quartz; large sandstone shards; changed to diamond-button-tricone bit at 170 ft
170-211	Cuttings: Sand and gravel, very coarse-grained, quartz; subrounded and angular sandstone shards
211-217	Cuttings: Clay, yellow and tan; sand, coarse-grained; abundant biotite; hard smooth drilling
217-220	Cuttings: Weathered rock; clay; biotite, muscovite, and quartz sand
220-227	Very hard smooth drilling

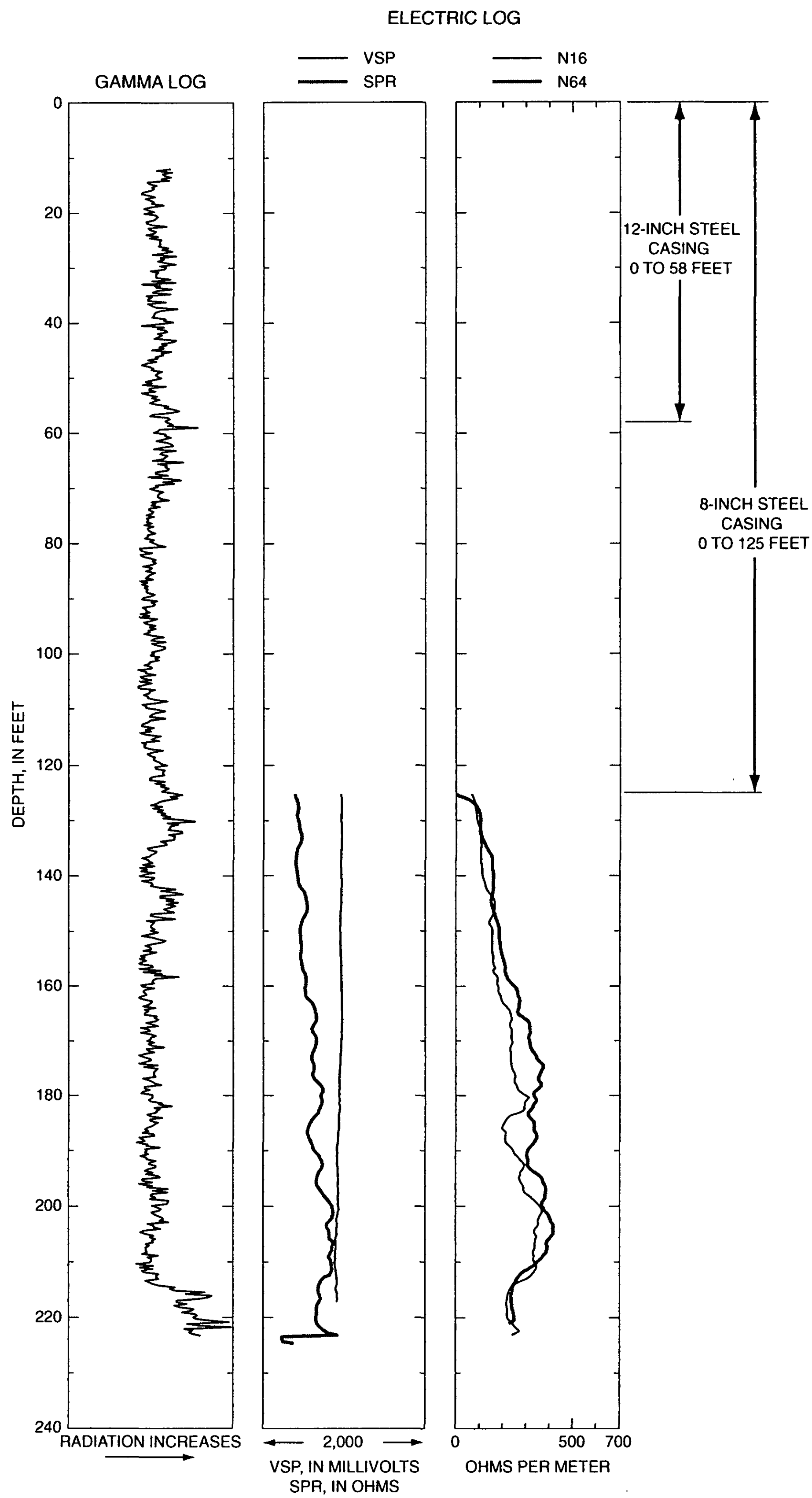


Figure 1-1. Geophysical logs of Puchack MW-1D (well number 070906)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-2M (WELL NUMBER 070909)

Depth, in feet below land surface	
0- 2*	Soil, dark yellowish-brown (10YR 4/2), sandy
6-	Clay indicated by drilling at 6 ft
13- 15*	Clay, dark yellowish-brown (10YR 4/4), soft, medium plasticity, grading to sand, dark yellowish-brown (10YR 4/2), medium-grained
26-	Clay indicated by drilling at 26 ft
28- 30*	Clay, yellowish-gray (5Y 8/1), silty, soft to firm, low plasticity
28- 40	Clay with thin sand and gravel lenses indicated by drilling at 28 ft to 40 ft, very hard drilling at 40 ft
43- 45*	Clay, yellowish-gray (5Y 8/1), mottled reddish-brown and reddish-orange, stiff, medium plasticity
50-	Cuttings: Sand, iron-cemented; clay, dark gray
53-	Sand indicated by drilling at 53 ft
58- 60*	Sand, very pale orange (10YR 8/2), medium-grained
58- 73	Cuttings: Sand, very fine to very coarse, and fine gravel with clay lenses
73- 75 *	Sand, pale yellowish-brown (10YR 6/2), fine- to medium-grained, trace to little silt, iron-stained and mottled, dark gray
73- 85	Sand indicated by drilling 73 to 85 ft
85- 88	Sand with 6-in. clay lenses indicated by drilling
88- 90*	Sand, very pale orange (10YR 8/2), medium-grained, trace mica, trace biotite
90- 92	Clay indicated by drilling 90 to 92 ft
92-102	Cuttings: Sand, very coarse, quartz; gravel, fine; little clay
103-105*	Clay, white (N9), stiff, low plasticity, mottled orange
105-118	Sand with thin clay lenses (about 1-18 in. thick) indicated by drilling at 105 to 118 ft
118-120*	Sand, very pale orange (10YR 8/2), medium-grained, quartz
120-133	Cuttings: Sand, with trace clay
133-135*	Sand, pinkish-gray (5YR 8/1), poorly sorted, fine- to very coarse-grained, little fine gravel (<0.2 cm (<0.08 in.))
133-135	Clay lenses indicated by drilling at 133 to 135 ft
141-143	Clay indicated by drilling at 141 to 143 ft
148-150*	Sand and gravel, pinkish-gray (5YR 8/1), poorly sorted, fine-grained sand and very coarse gravel (<3.0 cm (<1.2 in.)), little clay binder
150-163	Cuttings: Gravel, very coarse-grained, quartz, angular sandstone shards, black opaques
149-160	Very hard drilling at 149 to 150 ft, 155 to 160 ft
163-178	Cuttings: Changed to diamond-button-tricone bit at 163 ft, quartz gravel, very coarse-grained, sandstone cobbles cut to angular shards, clay layer indicated by drilling at 177 to 178 ft
178-201	Cuttings: Cobbles and very coarse gravel
201-210	Cuttings: Sand and gravel, orange clay, hard smooth drilling
210-218	Cuttings: Weathered rock, medium dark gray (N4), mica-rich, soft clay, fine- to medium-grained; quartz sand, some biotite, very hard drilling

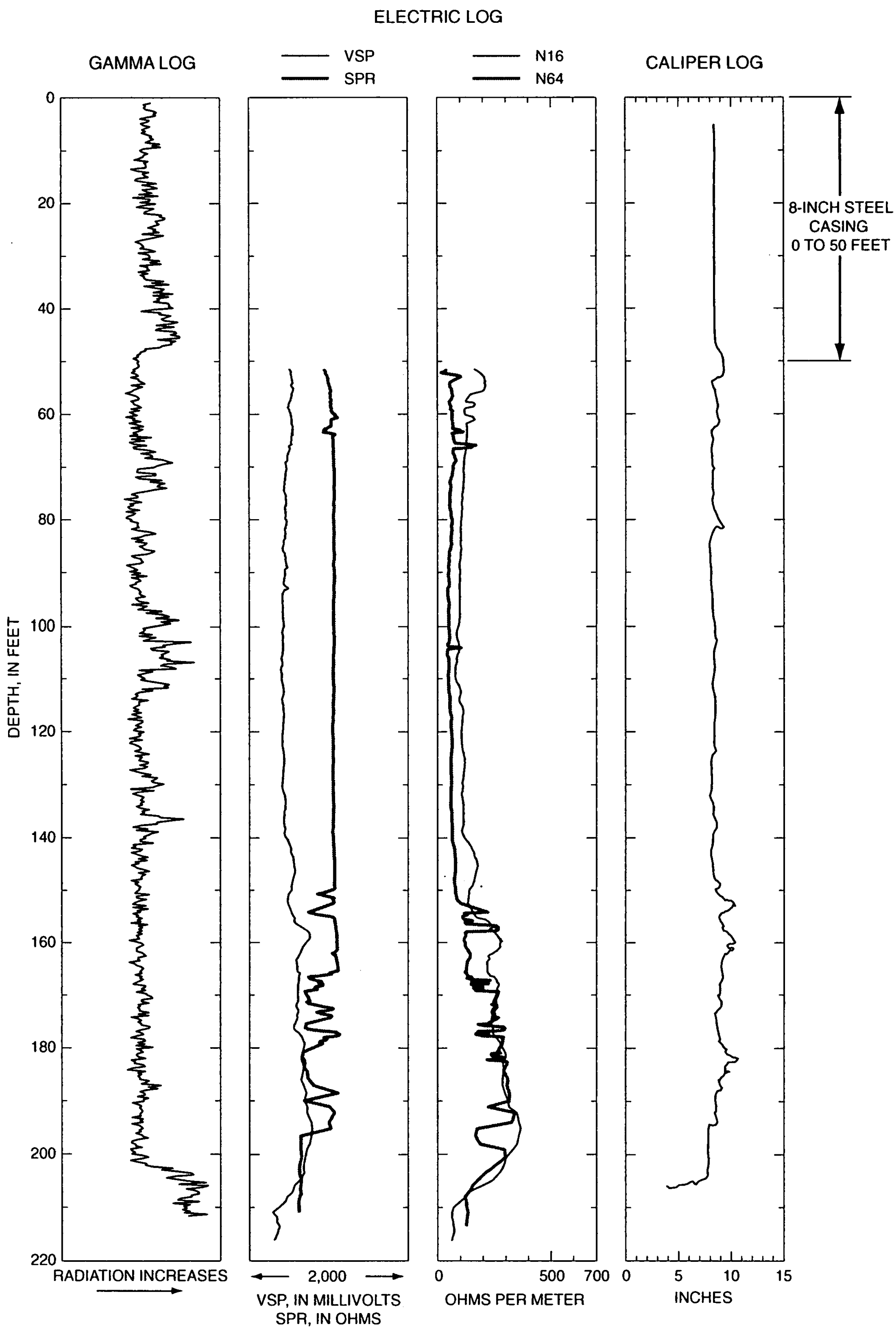


Figure 1-2. Geophysical logs for Puchack MW-2M (well number 070909)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-3D (WELL NUMBER 070912)

Depth, in feet below land surface	
0- 2	Fill soil, sandy
13- 15*	Silt, olive-gray (5Y 3/2), very fine-grained, sandy silt, dark yellowish-brown (10YR 4/2), fine grained, moist
28- 30*	Sand, light brown (5YR 5/6), fine- to medium-grained, moist
43- 45*	Silt and silty clay layers, pale yellowish-brown (10YR 6/2), moist
45- 73	Cuttings: Sand; coarse material indicated by drilling at 65 ft, and mud loss
73- 75*	Sand, moderate yellowish-brown (10YR 5/4), medium-grained
88- 90*	Sand, light olive-gray (5Y 5/2), fine- to medium-grained, trace mica
103-105*	Sand, yellowish-gray (5Y 7/2), fine- to medium-grained, clayey; little coarse sand with thin (<0.6 in.) clay lenses
118-120*	Sand, dark yellowish-brown (10YR 4/2), fine- to very coarse-grained; thin clay and clayey sand lenses, very pale orange (10YR 8/2)
133-135*	Sand, very pale orange (10YR 8/2), fine- to medium-grained; trace gravel (0.2 to 2.0 cm (0.08-0.8 in.))
141-	Clay indicated by drilling at 141 ft
148-150*	Clay, mottled grayish-pink (5R 8/2) and moderate red (5R 4/6), medium plasticity
163-165*	Clay, moderate reddish-brown (10R 4/6), mottled with grayish-orange-pink (10R 8/2) banding, stiff, medium to high plasticity; iron-stained and cemented gravel layer
178-180*	Clay, mottled very pale orange (10YR 8/2), silty, sandy, firm to stiff, low plasticity, little mica, with thin, very fine-grained sand lenses
184-	Sand indicated by drilling at 184 ft
193-195*	Sand, very pale orange (10YR 8/2), quartz, medium-grained
208-210*	Sand, very pale orange (10YR 8/2), quartz, coarse- to very coarse-grained
208-223	Cuttings: Sand, quartz, coarse- to very coarse-grained; sandstone fragments, clay, and cemented sand
223-238	Cuttings: Sand, very coarse-grained; fine gravel, subrounded to subangular, little clay, some mica
238-240*	Sand, light gray (N7), fine- to very coarse-grained, trace fine gravel
240-	Clay indicated by drilling at 240 ft
240-255	Clay, indicated by hard smooth drilling at 240 to 255 ft
251-253	Clay, very pale orange (10YR 8/2), very stiff, low plasticity, mottled with very thin sandy iron-stained zones
255 -	Sand indicated by drilling at 255 ft
268-270*	Gravel, quartz and sandstone, fine- to very coarse-grained (0.1-1.0 cm (0.04-0.4 in.)), subrounded to subangular; some fine to very coarse sand, poorly sorted
270-280	Cuttings: Boulders, cobbles, very coarse-grained gravel, and some clay; also indicated by hard drilling
280-308	Cuttings: Cobbles, angular quartz shards, and some clay
308-313	Cuttings: Clay, dusky yellowish-brown (10YR 2/2), some biotite, grades to dusky yellowish-orange clay at about 310 ft, appears to be weathered rock; hard smooth drilling

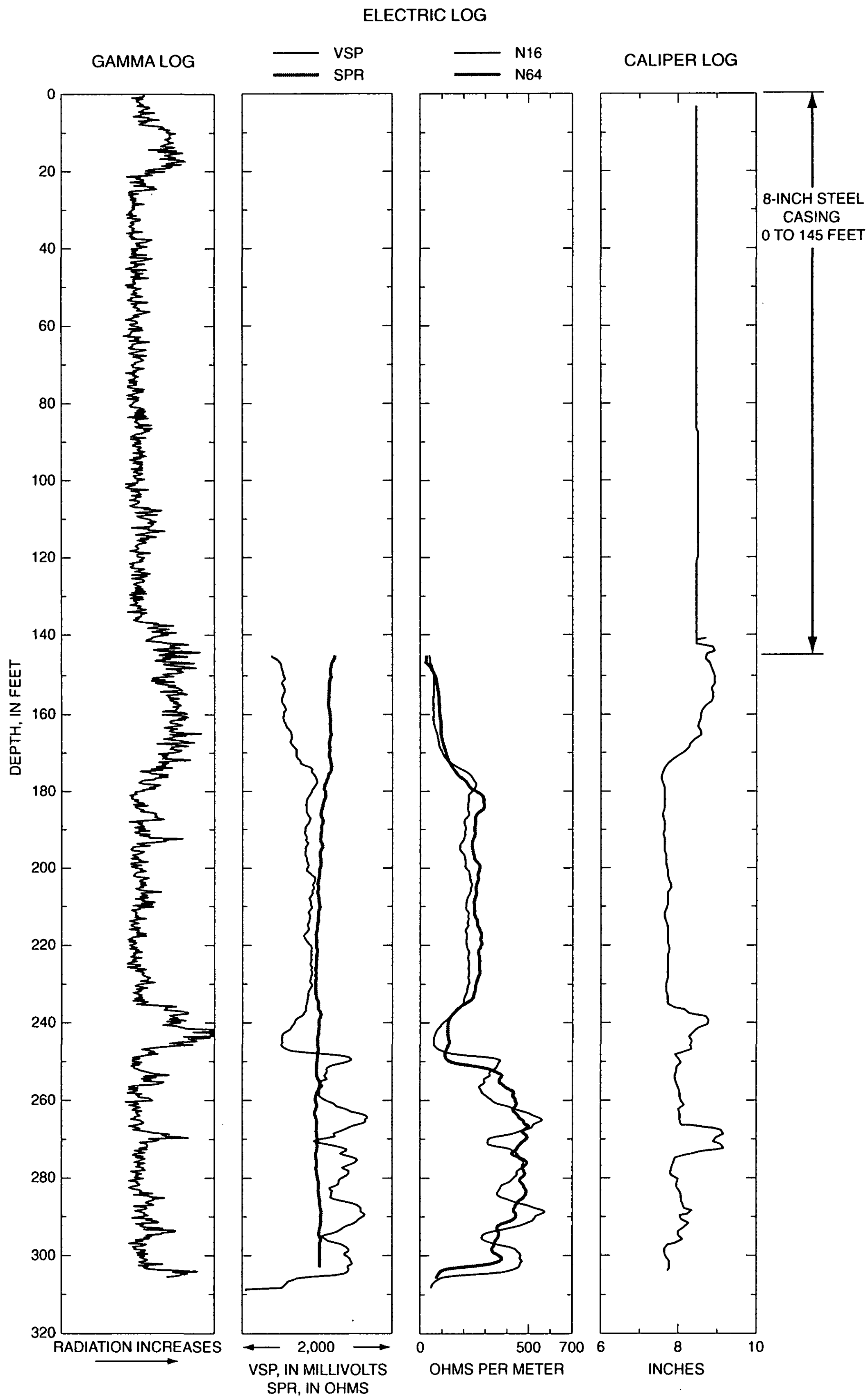


Figure 1-3. Geophysical logs for Puchack MW-3D (well number 070912)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-4D (WELL NUMBER 070915)

Depth, in feet below land surface	
0- 2*	Soil, moderate brown (5YR 4/4), loamy fine- to medium-grained sand
13- 15*	Sand, iron-stained, orange, fine- to medium-grained, dry
28- 30*	Sand, dark yellowish-orange (10YR 6/6), fine- to medium-grained, grading to fine- to medium-grained sand and coarse-grained gravel
43- 45*	Sand and gravel, dark yellowish-orange (10YR 6/6), fine- to very coarse-grained
58- 60*	Sand and gravel, very pale orange (10YR 8/2), fine- to very coarse-grained; little clay with sand and gravel in matrix
73- 75*	Sand, dark yellowish-orange (10YR 6/6), very fine- to medium-grained; contact (about 74 ft), silty clay, yellowish-gray (5Y 7/2), some iron staining
74- 81	Clay indicated by drilling at 74 to 81 ft
81- 88	Sand and very coarse gravel indicated by drilling at 81 to 88 ft, lost circulation
88- 90*	Sand, very pale orange (10YR 8/2), medium- to coarse-grained, saturated
103-105*	Clay, light brownish-gray (5YR 6/1), stiff, low plasticity; some sandy clay, some sand and gravel layers
118-120*	Sand, grayish-orange (10YR 7/4), medium- to coarse-grained
120-133	Cuttings: Sand, gravel, and trace clay
133-135*	Sand, iron-stained, fine- to medium-grained, clayey, some very coarse-grained gravel, grading to silty clay, pale yellowish-brown (10YR 6/2), reddish mottling
148-150*	Clay, very pale orange (10YR 8/2), sandy, firm, low plasticity, sand is fine- grained
163-165*	Sand, yellowish-gray (5Y 7/2), medium-grained; overlying clay, pale yellowish-brown (10YR 6/2), fine-grained, sandy, stiff, medium plasticity; grading to clay, yellowish-gray (5Y 7/2), sandy, silty, soft, slight plasticity, sand is fine-grained
178-180*	Sand, very pale orange (10YR 8/2), medium- to coarse-grained
193-195*	Sand, pinkish-gray (5YR 8/1), fine-grained, silty, dark gray mottling
208-210*	Sand, pinkish-gray (5YR 8/1), fine-grained, silty, dark gray mottling
223-225*	Sand, fine- to very coarse-grained; little gravel, lenses of silty clay, pinkish-gray (5YR 8/1), soft, medium plasticity
238-240*	Sand, very fine- to very coarse-grained; gravel, very fine- to coarse-grained, with lenses of clayey sand and gravel
253-255*	Sand and gravel, mottled yellowish-gray (5Y 7/2) and very pale orange (10YR 8/2), sand is medium- to very coarse-grained and gravel is fine- to very coarse-grained
255-283	Cuttings: Gravel, sand, sandstone, some clay, black opaques, very coarse- grained, increasing biotite content with depth
283-285*	Sand, yellowish-gray (5Y 7/2), very coarse-grained and very coarse-grained gravel
293-	Very hard smooth drilling, bedrock indicated by drilling at 293 ft
298-300*	Weathered rock, mottled green, iron-stained, trace mica, biotite, some quartz gravel in soft clay, medium plasticity

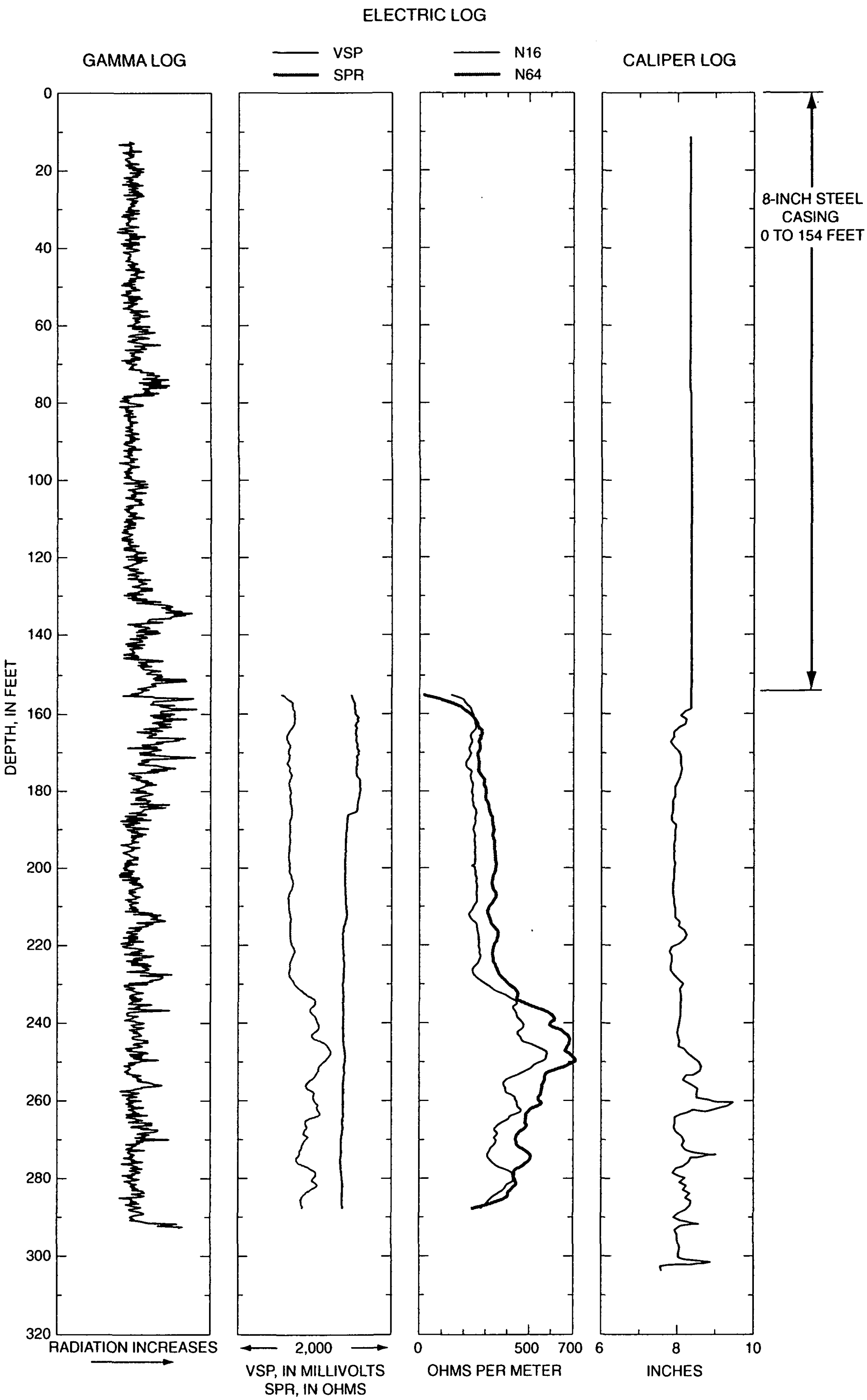


Figure 1-4. Geophysical logs for Puchack MW-4D (well number 070915)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-5D (WELL NUMBER 070918)

Depth, in feet below land surface	
0- 2*	Sand, light brown (5YR 5/6), fine- to medium-grained
10- 12*	Sand, moderate yellowish-brown (10YR 5/4), fine-grained; gravel, very coarse-grained
20- 22*	Clay, very pale orange (10YR 8/2), sandy, sand is very fine-grained, occasional iron-cemented layers
30- 32*	Clay, very pale orange (10YR 8/2), silty
32- 40	Cuttings: Clay with sand and gravel lenses
40- 42*	Clay, pale yellowish-brown (10YR 6/2), grades to sandy clay, very fine- grained
50- 52*	Clay, pale yellowish-brown (10YR 6/2), sandy, sand is fine-grained; sand lenses, fine- to medium-grained
55-	Sand and gravel indicated by drilling at 55 ft
60- 62*	Sand, yellowish gray (5Y 7/2), very coarse-grained
70- 72*	Sand, yellowish gray (5Y 7/2), fine- to coarse-grained; gravel, fine- to very coarse-grained, some silt
80- 82*	Clay, moderate brown (5YR 4/4), silty, soft, medium plasticity
90- 92*	Clay, moderate reddish-brown (10R 4/6) and grayish-pink (5R 8/2), mottled, stiff
100-102*	Clay, grayish-pink (5R 8/2), mottled with moderate reddish-brown (10R 4/6), iron staining, stiff
110-112*	Clay, dusky yellowish-brown (10YR 2/2), organic, very stiff, medium plasticity
113-	Cuttings: Clay and lignite; sand indicated by drilling at 113 ft
120-122*	Sand, pinkish-gray (5YR 8/1), medium- to coarse-grained, trace quartz gravel (0.2 cm (0.08 in.))
130-132*	Sand, pinkish-gray (5YR 8/1), fine- to medium-grained, trace quartz gravel (0.2 cm (0.08 in.))
140-142*	Clay, yellowish-gray (5Y 8/1), mottled with dark yellowish-orange (10YR 6/6), stiff, sandy, silty
142-143*	Sand and gravel, yellowish-gray (5Y 8/1), very fine- to very coarse-grained; trace of gravel, dark yellowish-orange (10YR 6/6)
150-152*	Clay, very light gray (N8), silty, iron-stained, grading to sand, grayish-orange (10YR 7/4), fine- to very coarse-grained, trace iron staining, some subrounded quartz gravel (0.2-0.5 cm (0.08-0.2 in.))
160-162*	Sand and gravel, pinkish-gray (5YR 8/1), fine- to very coarse-grained, gravel is subangular (0.1-0.5 cm (0.04-0.2 in.)); trace silt, very light gray (N8)
170-172*	Sand, very light gray (N8), fine- to very coarse-grained; some gravel, fine (0.1-0.5 cm (0.04-0.2 in.)), trace clay lenses (< 1 in.)
180-182*	Clay, white, very soft; gravel (1-2 cm (0.4-0.8 in.)), grading to sand and gravel, grayish-orange (10YR 7/4), fine- to very coarse-grained
190-192*	Gravel, light brown (5YR 6/4), very fine- to very coarse-grained; sand, very fine- to very coarse-grained; trace silty clay, pinkish-gray (5YR 8/1)
192-200	Cuttings: Sand and gravel, grayish-orange (10YR 7/4), coarse-grained, trace white clay
202-230	Cuttings and drilling indicate sand and gravel, large mineral assemblage, coarse sand to coarse gravel, cobbles, trace mica
232-235	Cuttings: Clay, dark yellowish-orange (10YR 6/6), sandy, fine-grained; gravel, very coarse-grained (0.3-1.0 cm (0.1-0.4 in.))
235-243	Cuttings: Clay, grayish-olive green (5GY 3/2), biotite-rich, very hard drilling, possibly weathered rock

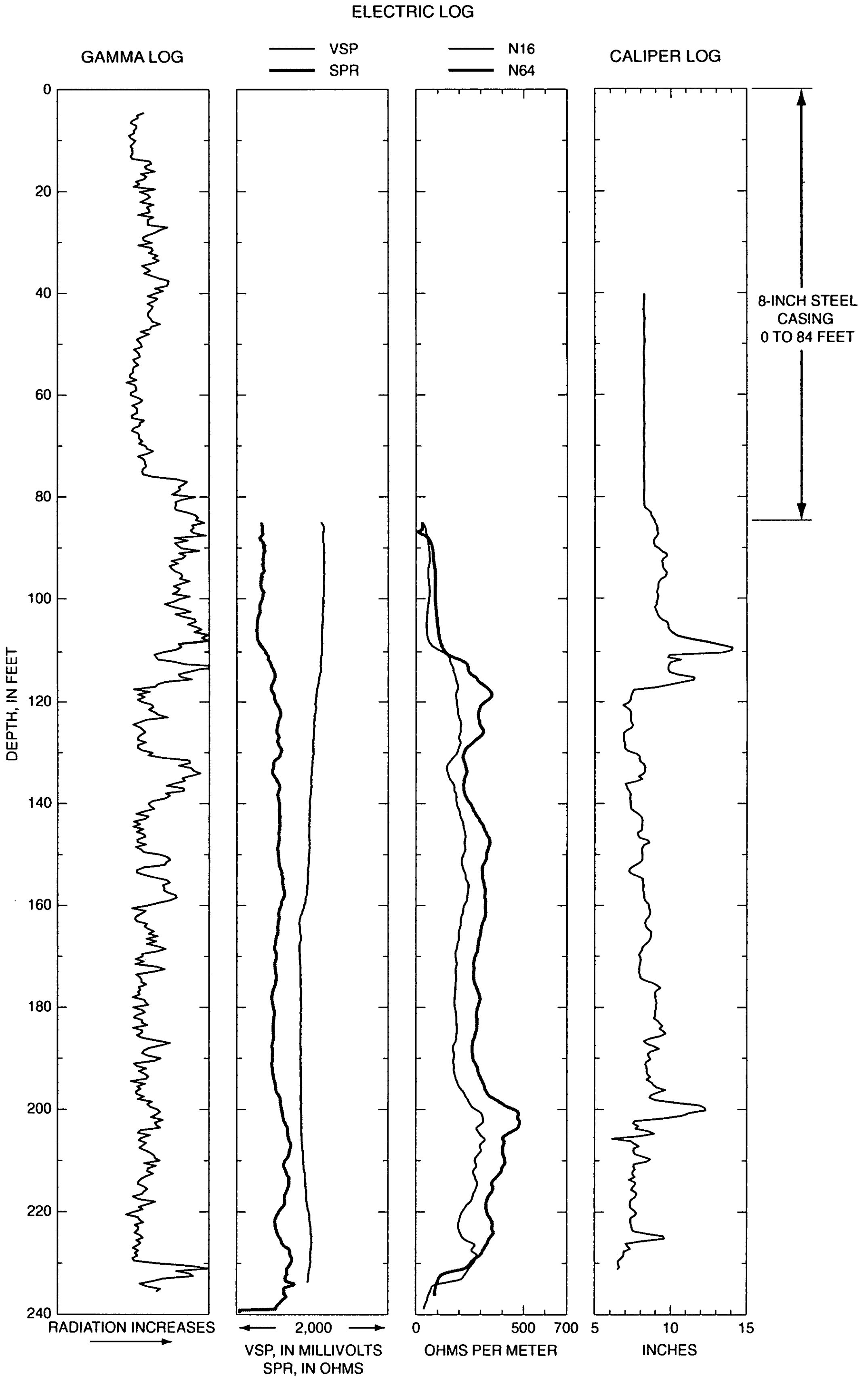


Figure 1-5. Geophysical logs for Puchack MW-5D (well number 070918)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-6D (WELL NUMBER 070920)

Depth, in feet in land surface	
0- 2*	Sand, brown, poorly sorted, medium- to coarse-grained
10- 12*	Sand, yellowish-brown, poorly sorted, large quartz gravel, pebbles
20- 22*	Gravel, moderate yellowish-brown (10YR 5/4), poorly sorted, some clay
30- 32*	Sand, dark yellowish-orange (10YR 6/6), interbedded with yellowish-gray (5Y 8/1) clay
40- 42*	Sand, dark yellowish-orange (10YR 6/6), medium-grained, interbedded with very light gray (N8) clayey sand and gravel
50- 52*	Clay and gravel, pale yellowish-orange (10YR 8/6), sand and gravel, dark yellowish-orange (10YR 6/6), poorly sorted
60- 62*	Sand and gravel, dark yellowish-orange (10YR 6/6)
70- 72*	Clay, very light gray (N8), fine- to coarse-grained, sandy, stiff
80- 82*	Sand and gravel, very light gray (N8), clayey
90- 92*	Sand and gravel, moderate yellowish-brown (10YR 5/4), with very light gray (N8) layers, clayey
100-102*	Clay, light gray (N7), mottled with dark yellowish-orange (10YR 6/6) staining, high plasticity
110-112*	Sand, yellowish-gray (5Y 8/1), fine- to medium-grained, trace silt, trace gravel, trace clay, occasional 1-in.-thick gravel lenses
114-120	Clay indicated by drilling at 114 to 120 ft
120-128	Cuttings: Gravel, fine- to coarse-grained, quartz
128-	Clay indicated by drilling at 128 ft
130-132*	Silt, very pale orange (10YR 8/2), clayey, laminated, stiff, low plasticity, little mica
132-140	Sand with clay lens indicated by drilling at 132 to 140 ft
140-142*	Sand, yellowish-gray (5Y 7/2), medium-grained, trace mica
143-	Clay indicated by drilling at 143 ft
150-152*	Sand, pale yellowish-brown (10YR 6/2), fine- to medium-grained, trace coarse gravel; contact (about 74 ft), silty clay, dusky yellowish-brown (10YR 2/2), laminated, stiff, low plasticity, some mica, trace lignite
153-	Sand indicated by drilling at 153 ft
160-162*	Sand, grayish-orange (10YR 7/4), fine- to very coarse-grained, trace fine gravel (0.1-0.2 cm (0.04-0.08 in.))
170-172*	Sand, brownish-gray (5YR 4/1), fine- to coarse-grained, poorly sorted, some quartz gravel (0.1-2.0 cm (0.04-0.08 in.))
170-180	Cuttings: Sand and gravel, very coarse-grained
180-192	Cuttings: Gravel, very coarse-grained, angular cuttings, trace clay, mica
192-194*	Sand and gravel, fine- to very coarse-grained, in sandy clay matrix, light olive-gray (5Y 6/1)
192-207	Cuttings: Sand and gravel, fine- to very coarse-grained, with some sandy clay ranging from pale red (10R 6/2) to pinkish-gray (5YR 8/1), fine- to medium- grained
207-209*	Sand, yellowish-gray (5Y 8/1), very fine- to very coarse-grained; multicolored gravel, fine- to very coarse-grained; trace black opaques, trace clay
215-225	Clay indicated by drilling at 215 ft and sand indicated by drilling at 217 ft
225-232	Clay indicated by drilling at 225 to 228 ft, cuttings indicate sand and clay lenses, increasing biotite
232-237	Cuttings: Clay and biotite, light olive-gray (5Y 5/2), fine- to medium-grained, sandy, little mica
237-239*	Weathered rock, black and white, soft, friable, biotite-rich, trace to little mica, trace quartz gravel, foliations visible

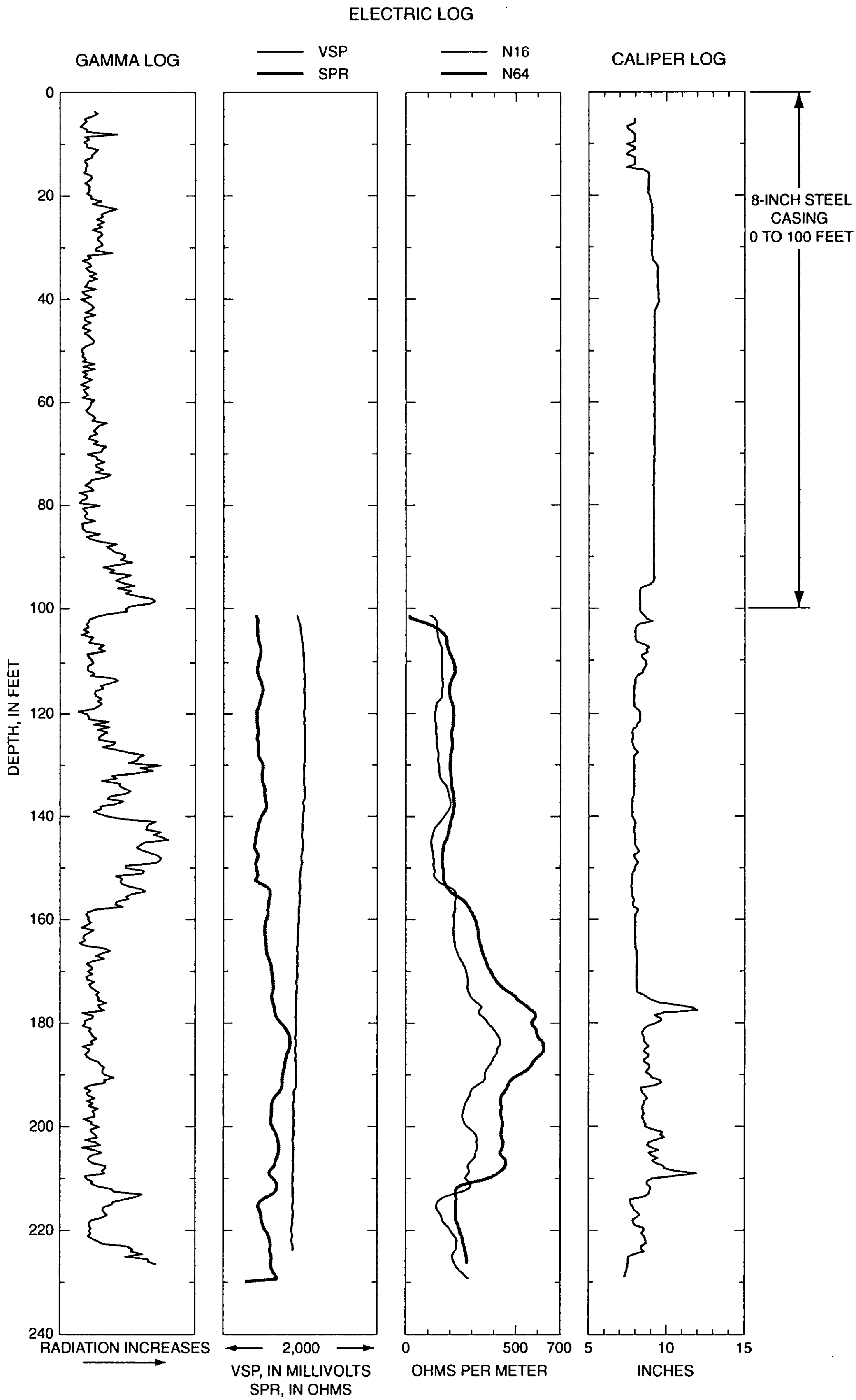


Figure 1-6. Geophysical logs for Puchack MW-6D (well number 070920)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-7D (WELL NUMBER 070921)

Depth, in feet below land surface	
0- 2	Soil
8- 23	Clay layers indicated by drilling at 8 to 23 ft
13- 15*	Clay, light brownish-gray (5YR 6/1) with red streaks, sandy, high plasticity
20-	Cuttings: Clay and coarse sand
23-	Sand indicated by drilling at 23 ft
28- 30*	Clay, moderate yellowish-brown (10YR 5/4), sandy, high plasticity
40-	Gravel indicated by drilling at 40 ft
43- 45*	Sand and gravel, moderate yellowish-brown (10YR 5/4), sand is coarse, gravel up to 1.9 cm (0.75 in.)
43- 58	Sand with gravel layers indicated by drilling at 43 to 58 ft
58- 60*	Sand, moderate yellowish-brown (10YR 5/4), coarse-grained
58- 73	Gravel indicated by drilling from 58 to 73 ft
73- 75*	Sand, moderate yellowish-brown (10YR 5/4), coarse-grained
88-	Sand and gravel with small clay layers indicated by drilling at 88 ft
88- 90*	Sand, moderate yellowish-brown (10YR 5/4), coarse-grained
95-100	Cuttings: Sand and gravel
103-105*	Sand, moderate yellowish-brown (10YR 5/4), coarse-grained
115-	Clay indicated by drilling at 115 ft
118-120*	Clay, light gray (N7), sandy, very fine-grained
118-123	Cuttings: Sand and gravel, coarse-grained, clay
123-133	Cuttings: Sand, medium to very coarse-grained, some gravel, clay content increasing with depth; sand and gravel bedded in clay lenses
133-135*	Sand, moderate yellowish-brown (10YR 5/4), fine- to medium-grained; trace clay, very pale orange (10 YR 8/2)
136-140	Cuttings: Clay, white, interbedded with sand, very coarse-grained, grading to very coarse gravel or cobbles by 146 ft
146-155	Cuttings: Sand and gravel, very coarse-grained, with clay, light gray, mixed with little lignite
155-160	Cuttings: Clay, pinkish-gray (5YR 8/1), sandy
160-163	Cuttings: Sand and gravel, very coarse-grained, trace mica
163-165*	Sand and gravel, very pale orange (10YR 8/2), very fine- to very coarse- grained sand and coarse gravel, quartz, trace to little clay
165-	Clay lense indicated by drilling
170-178	Cuttings: Sand and gravel, very coarse-grained, quartz, little mica, little biotite
178-180*	Sand and gravel, moderate yellowish-brown (10YR 5/4); sand is rounded and subrounded, very fine- to very coarse-grained, quartz; gravel is subrounded, fine- to coarse-grained quartz; trace biotite and clay
193-195*	Gravel, very coarse-grained, densely packed in little fine-grained sandy clay, pinkish-gray (5YR 8/1)
208-210*	Gravel, very pale orange (10YR 8/2), very coarse-grained, in silty clay matrix, very compact
209-	Cuttings: Clay, very pale orange (10YR 8/2), containing quartz gravel, angular, gravel may be bedded in the clay, hard drilling
214-	Cuttings: Clay, light olive-gray (5Y 5/2), little biotite
215-219	Cuttings: Weathered rock, extremely hard drilling, increasing biotite, increasing mica, very coarse-grained quartz sand

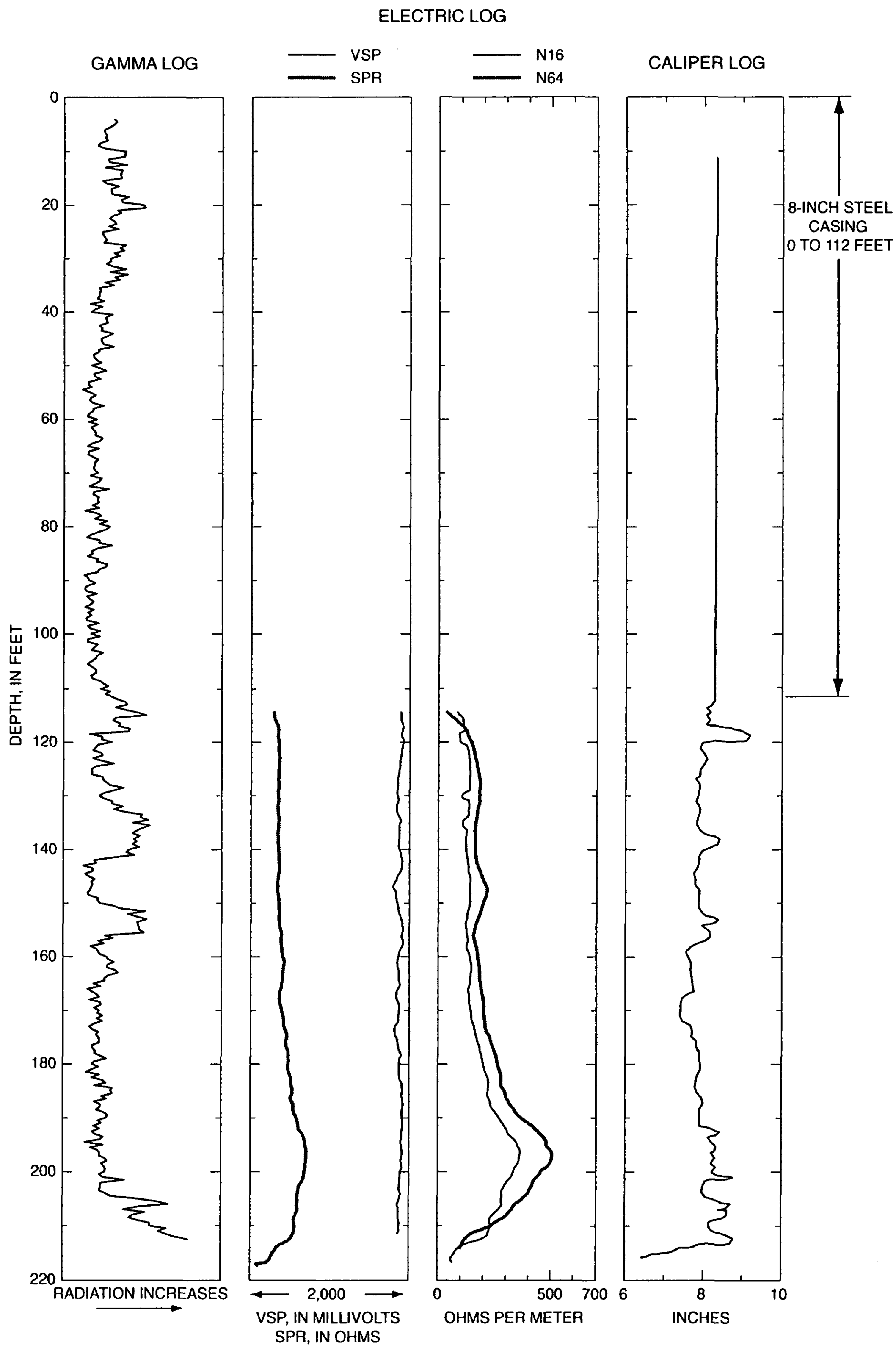


Figure 1-7. Geophysical logs for Puchack MW-7D (well number 070921)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-8D (WELL NUMBER 070924)

Depth, in feet below land surface	
0- 2	Fill, dark cinders over sand, brown, medium-grained
15- 17*	Sand and gravel, white and brown, very fine- to coarse-grained sand and very coarse-grained gravel, friable cemented sandstone
28- 30*	Sand, brown (10YR 5/3), medium- to coarse-grained, clean, saturated, trace gravel
30- 40	Cuttings: Clay, vary pale orange (10YR 8/2), quartz sand lenses
43- 45*	Sand, very light gray (N8), fine- to coarse-grained, trace silt
43- 51	Cuttings: Sand, very coarse-grained and coarse-grained gravel
51- 58	Clay with sand lenses indicated by drilling at 51 to 58 ft
58- 60*	Clay, pale yellowish-brown (10YR 6/2), little iron-stained laminations, very stiff, medium plasticity
64-	Clay becoming sandy, indicated by drilling at 64 ft
73- 75*	Sand, pale yellowish-brown (10YR 6/2), clean, medium- to coarse-grained, quartz
73- 84	Cuttings: Sand and gravel, trace clay
84- 87	Cuttings: Clay
88- 90*	Sand, pale yellowish-brown (10YR 6/2), medium-grained, trace coarse- grained; over light gray (N7) silty clay
88-103	Cuttings: Clay, yellowish-gray (5Y 7/2), containing sand and gravel, increasing biotite, trace mica
103-105*	Sand, light brownish-gray (5YR 6/1), medium-grained, little biotite
103-113	Cuttings: Sand, gravel, some clay
113-115	Cuttings: Clay
115-118	Cuttings: Sand, coarse- to very coarse-grained, little mica, little biotite
118-120*	Clay, yellowish-gray (5Y 8/1); sandy, fine- to medium-grained; silty, little gravel, little mica, little biotite
133-135*	Sand, yellowish-gray (5Y 7/2), medium- to coarse-grained
138-146	Cuttings: Gravel, very coarse-grained, some clay, drilling becomes hard at 146 ft
148-168	Cuttings: Gravel, very coarse-grained, cobbles
171-172	Cuttings: Clay, pale yellowish-orange (10YR 8/6), contains sand and gravel
175-	Very hard, smooth drilling
177-	Cuttings: Sand, very coarse-grained; gravel, abundant biotite chips, some mica, grading to a hard biotite schist, very slow drilling

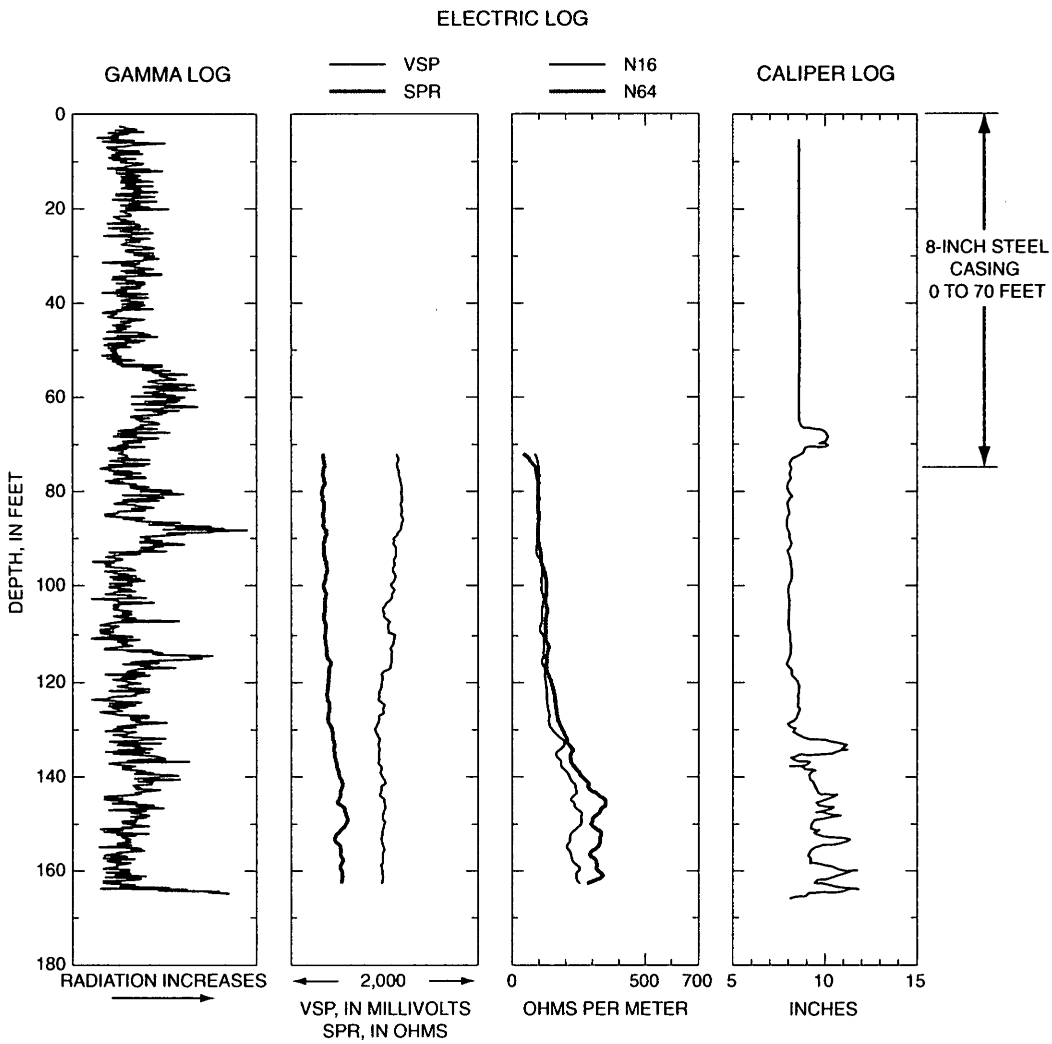


Figure 1-8. Geophysical logs for Puchack MW-8D (well number 070924)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-9D (WELL NUMBER 070927)

Depth, in feet below land surface	
0- 2*	Sand, moderate brown (5YR 4/4), fine- to medium-grained, loamy
2- 14	Cuttings: Sand and gravel, some iron-cemented layers
14- 17	Cuttings: Clay, dark yellowish-orange
17- 30	Cuttings: Sand, gravel, little clay
30- 39	Cuttings: Clay, very pale orange
39-	Sand indicated by drilling at 39 ft
43- 45*	Sand, dark yellowish-orange (10YR 6/6), fine- to medium-grained, quartz, trace gravel
50-	Cuttings: Clay, pinkish-gray, indicated by drilling at 50 ft
58- 60*	Clay, yellowish-gray (5Y 7/2), bedded with layers of fine- to medium-grained sand
60- 73	Sand and clay layers indicated by drilling
73- 75*	Sand, grayish-orange (10YR 7/4), fine- to medium-grained, trace clay
88- 96	Cuttings: Sand, medium- to coarse-grained, fine-grained gravel
96-100	Cuttings: Clay, very pale orange
100-103	Cuttings: Sand and gravel
103-105*	Sand, very pale orange (10YR 8/2), medium- to coarse-grained, some iron staining
104-106	Clay indicated by drilling at 104 ft
106-110	Sand indicated by drilling at 106 to 110 ft
110-	Cuttings: Clay, brownish-gray, heavy lignite, hard drilling
118-120*	Clay, brownish-gray (5YR 4/1), silty, stiff, low plasticity, organic
120-125	Cuttings: Clay and lignite
125-133	Cuttings: Sand and clay lenses grading to sand and gravel
133-135*	Sand, pinkish-gray (5YR 8/1), medium- to coarse-grained, quartz, trace clay, trace gravel
140-148	Sand and gravel with clay layers indicated by drilling from 140 to 148 ft
148-150*	Sand, pinkish-gray (5YR 8/1), medium-grained, silty
150-158	Cuttings: Gravel, very coarse-grained, angular, increasing mica
158-163	Cuttings: Sand, very coarse-grained, and fine gravel
163-183	Cuttings: Gravel, angular rock chips, quartz, little sandstone; heavy mud loss, very hard drilling
183-185	Clay, light gray, smooth drilling
185-191	Cuttings: Gravel, very coarse-grained, angular, quartz, sandstone, black opaques, trace mica
191-193	Weathered rock indicated by drilling at 191 ft, cuttings are clay
193-195*	Weathered rock, pale greenish-yellow (10Y 8/2), dry, highly weathered muscovite, talc-like with mica sheen, sandy, fine-grained, quartz

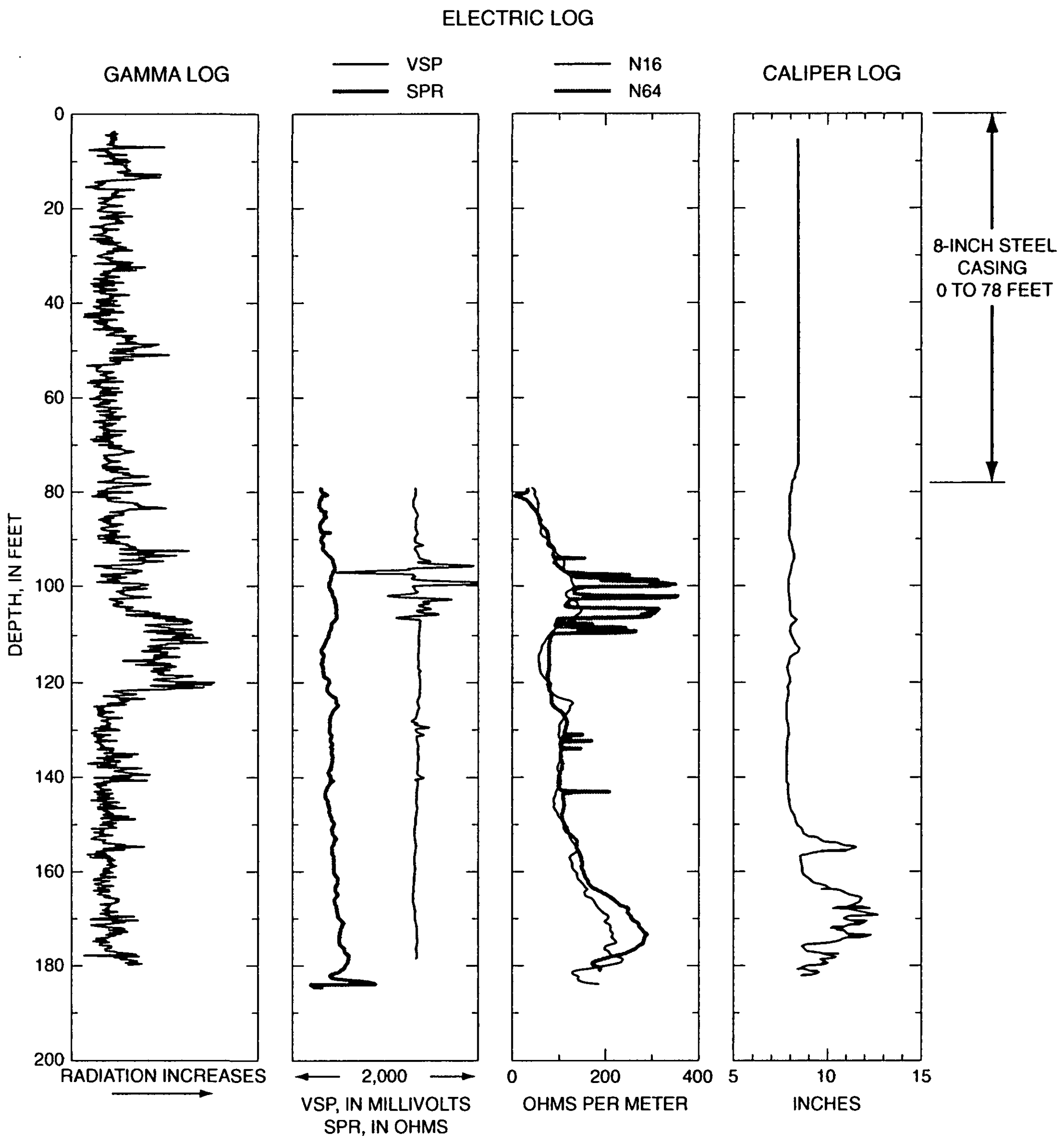


Figure 1-9. Geophysical logs for Puchack MW-9D (well number 070927)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-10D (WELL NUMBER 070929)

Depth, in feet below land surface	
0- 2*	Soil, moderate brown, (5YR 4/4), fine-grained, sandy, loam
12-	Clay indicated by drilling at 12 ft
13- 15*	Clay, olive-gray (5Y 4/1), soft, organic, little plant fiber, high plasticity, moist
23-	Sand indicated by drilling at 23 ft
28- 30*	Sand, light brown (5YR 5/6), medium- to very coarse-grained, poorly sorted, some very coarse gravel
30- 43	Gravel, very coarse-grained, indicated by drilling and cuttings
43- 45*	Sand, very pale orange (10YR 8/2), fine- to very coarse-grained, some gravel, fine- to very coarse-grained, (< 2.0 cm (0.8 in.)), poorly sorted, trace white clay
54-	Clay indicated by drilling at 54 ft
58- 60*	Clay, very pale orange (10YR 8/2), mottled dark yellowish-orange (10YR 6/6), silty, stiff, medium to low plasticity
70- 72*	Clay, pinkish-gray (5YR 8/1), silty, sandy, fine-grained, stiff, low plasticity, some iron staining
70- 88	Sand, some clay layers, indicated by drilling and cuttings
88- 90*	Sand, yellowish-gray (5Y 7/2), fine- to very coarse-grained, sand layers with little clay
90-102	Cuttings: Clay, very pale orange (10YR 8/2), sand at 102 ft
103-105*	Sand, light gray (N7), medium- to coarse-grained
105-118	Cuttings: sand and gravel, coarse-grained
118-120*	Clay, pinkish-gray (5YR 8/1), silty, low plasticity, trace mica, trace gravel
122-133	Cuttings: Sand and gravel, very coarse-grained, little mica, trace black opaques, drilling indicates clay at 125 ft and 133 ft
133-135*	Clay, pinkish-gray (5YR 8/1), silty; contains sand and gravel, coarse- to very coarse-grained
133-148	Sand and gravel indicated by drilling from 133 to 148 ft
148-150*	Sand, pinkish-gray (5YR 8/1), medium-grained, quartz
150-163	Cuttings: Gravel, fine- to very coarse-grained, trace clay
163-165*	Sand, yellowish-gray (5Y 7/2), fine- to very coarse-grained, little gravel, fine to very coarse-grained
165-173	Sand, with some clay lenses indicated by drilling and cuttings
173-	Gravel and cobble zone indicated by drilling
173-178	Cuttings: Sand and gravel, coarse-grained, 0.1-0.3 cm (0.04-0.1 in.), drilling suggests coarser material
178-180*	Sand and gravel, yellowish-gray (5Y 7/2), fine- to very coarse-grained, gravel < 2 cm (<0.8 in.), poorly sorted
183-	Cuttings: Clay, white, with gravel
183-233	Gravel indicated by cuttings and drilling, drilling becomes smooth and hard at 230 ft, may be rock
233-235*	Weathered rock; clay, dark yellowish-orange (10YR 6/6), iron-stained; quartz sand, very coarse-grained, foliation visible

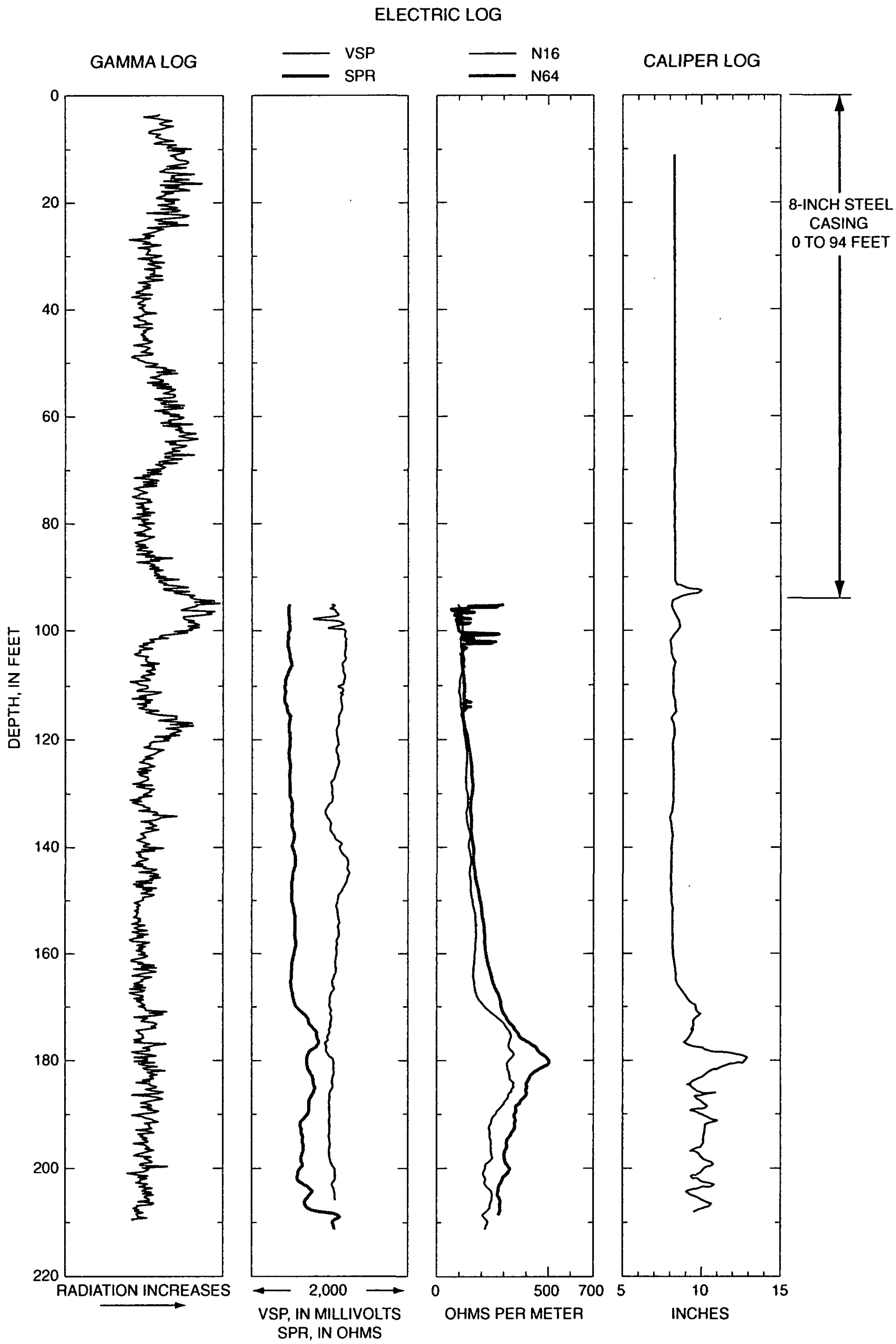


Figure 1-10. Geophysical logs for Puchack MW-10D (well number 070929)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-12M (WELL NUMBER 070930)

Depth, in feet below land surface	
0- 2*	Sand, moderate brown, (5YR 4/4), fine- to medium-grained, trace gravel
10-	Iron-cemented sand indicated by drilling and cuttings
13- 15*	Sand, light brown (5YR 5/6), medium-grained, trace iron cement
16- 28	Sand and gravel indicated by drilling and cuttings from 16 to 28 ft, very hard at 16 ft, drill bit jammed
28- 30*	Sand and gravel, light brown (5YR 5/6), medium- to coarse-grained, iron-stained, gravel < 1.0 cm (0.4 in.)
30- 43	Cuttings: Sand and gravel, very coarse-grained
43- 45*	Sand and silt, very pale orange (10YR 8/2) with orange mottling, very fine- grained, clayey
45- 58	Clay indicated by drilling at 45 to 58 ft, becomes harder at 48 ft
58- 60*	Clay, very light gray (N8), moist, medium plasticity; some layers of sand, grayish-orange (10YR 7/4), very fine- to fine-grained
62- 70	Sand and gravel layer at 62 ft, clay 62 to 69 ft, then soft drilling to 70 ft
73- 75*	Sand, very pale orange (10YR 8/2), medium- to very coarse-grained; trace gravel, fine-grained, thin clay lenses, very light gray (N8)
75- 88	Cuttings: Sand, very coarse-grained, little gravel, trace clay
88- 90*	Sand, yellowish-gray (5Y 8/1), medium- to very coarse-grained, clayey, little gravel
103-105*	Sand, grayish-orange (10YR 7/4), medium-grained
114-	Clay, red and white mottled, indicated by drilling and cuttings
118-120*	Clay, pale red (10R 6/2), mottled, stiff, high plasticity
124-128	Cuttings: Lignite and clay, dark purple
133-135*	Sand, pale yellowish-brown (10YR 6/2), medium-grained, lignite
142-144	Cuttings: Heavy lignite at 142 ft; clay, light brownish-gray (5YR 6/1), contains lignite at 144 ft
148-150*	Clay, light brownish-gray (5YR 6/1), mottled brownish-gray (5YR 4/1), silty, organic, hard, low plasticity
157-	Sand, with clay lenses indicated by drilling and cuttings at 157 ft
163-165*	Sand and gravel, very coarse-grained sand, quartz, trace clay
173-178	Sand with thin clay lenses indicated by drilling; cuttings contain sand, coarse- to very coarse-grained, quartz, little mica
178-180*	Sand, grayish-orange (10YR 7/4), fine- to medium-grained; trace gravel, coarse-grained, little iron-cemented sand
180-193	Clay and sand lenses, lignite, brownish-gray clay, and very coarse quartz sand indicated by drilling and cuttings
193-208	Cuttings: Sand and clay lenses, very pale orange (10YR 8/2)
208-210*	Sand, very pale orange (10YR 8/2), medium- to coarse-grained, little gravel (0.2-0.5 cm (0.08-0.2 in.))
210-217	Cuttings: Sand, gravel with clay lenses
223-225*	Sand and gravel, very pale orange (10YR 8/2), medium- to coarse-grained, interbedded with clay layers, very pale orange, (10YR 8/2), stiff, low to medium plasticity
238-240*	Sand and gravel, yellowish-gray (5Y 7/2), fine- to very coarse-grained
240-250	Cuttings: Sand and gravel with clay lenses

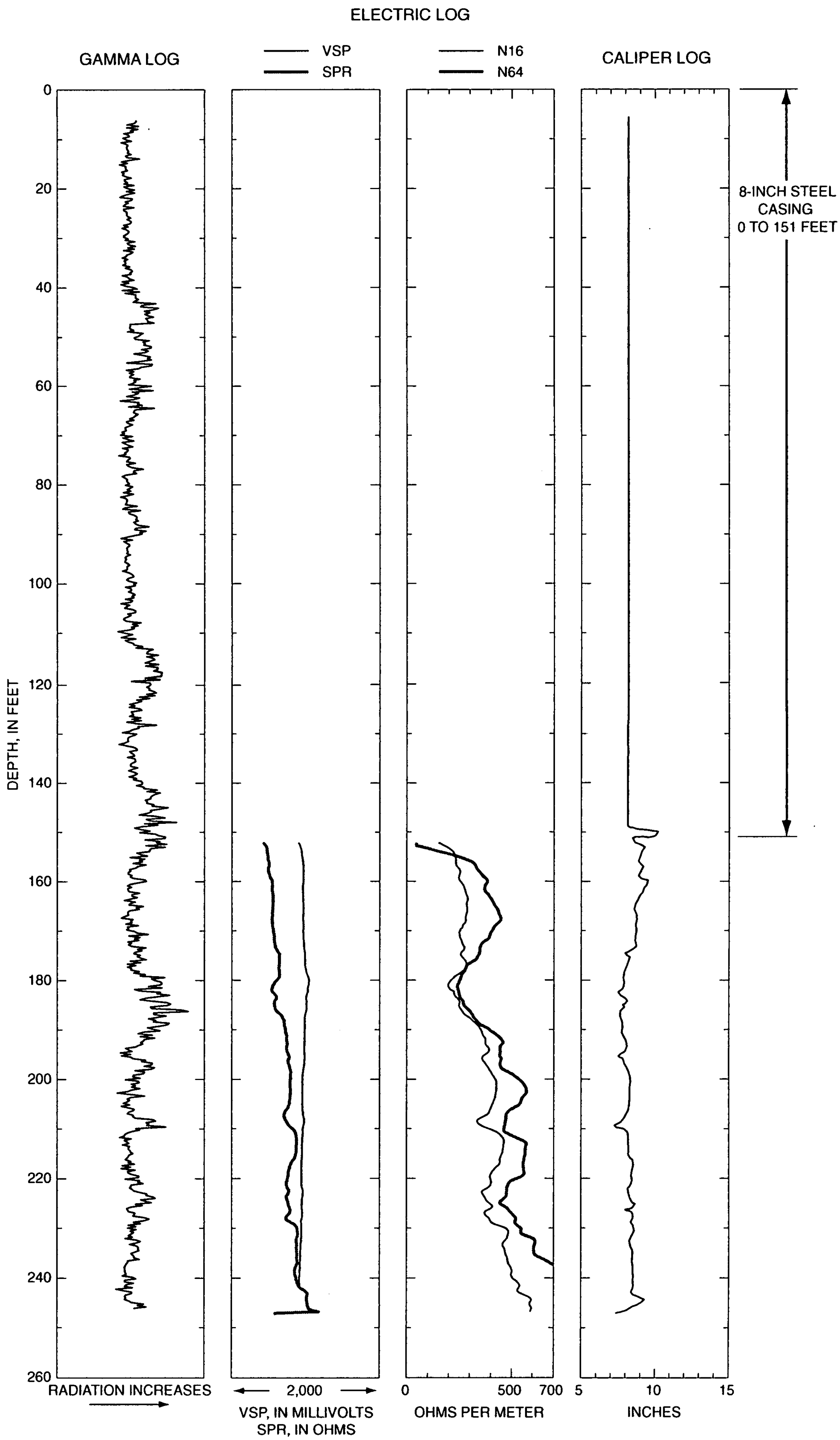


Figure 1-11. Geophysical logs for Puchack MW-12M (well number 070930)

LITHOLOGIC DESCRIPTION FOR PUCHACK MW-14 (WELL NUMBER 070931)

Depth, in feet below land surface	
0- 2*	Fill soil, brown, grading to sand, dark yellowish-orange (10YR 6/6), fine- grained
13- 15*	Sand, very pale orange (10YR 8/2), medium-grained, trace gravel, fine- grained
28- 30*	Sand, pale yellowish-brown (10YR 6/2), fine- to very coarse-grained, trace gravel; lenses of clay, very pale orange (10YR 8/2), stiff, medium plasticity
28- 43	Cuttings: Gravel, very coarse-grained, iron-cemented sand, tan and white clay
43- 58	Cuttings: Clay, gravel, sand, cobbles and angular chips of quartz gravel
60- 67	Clay indicated by drilling from 60 to 67 ft, clay cuttings are dark yellowish-orange (10YR 6/6)
67- 73	Cuttings: Sand grading to gravel, very coarse, some clay
73- 75*	Clay, yellowish-gray (5Y 8/1), mottled dark yellowish-orange (10YR 6/6), silty, stiff; grades to sand, dark yellowish-orange (10YR 6/6), fine- to very coarse-grained, little gravel
86- 88	Clay indicated by drilling at 86 ft, clay cuttings are pinkish-gray (5YR 8/1), sandy
88- 90*	Clay, brownish-gray (5YR 4/1), silty, firm, low plasticity, trace lignite
94-	Sand indicated by drilling at 94 ft
103-105*	Sand and gravel, fine- to very coarse-grained; clay, very pale orange (10YR 8/2)
106-110	Clay indicated by drilling at 106 ft, clay cuttings are very pale orange (10YR 8/2)
110-115	Sand indicated by drilling at 110 ft, grading to coarse at 115 ft
115-130	Sand with clay lenses indicated by drilling at 115 ft to 130 ft, sand cuttings are very coarse-grained with little mica, trace clay
133-135*	Clay, very pale orange (10YR 8/2), mottled pale yellowish-orange (10YR 8/6) grading to moderate reddish-brown (10R 4/6), firm, medium plasticity
135-145	Cuttings: Clay, reddish brown

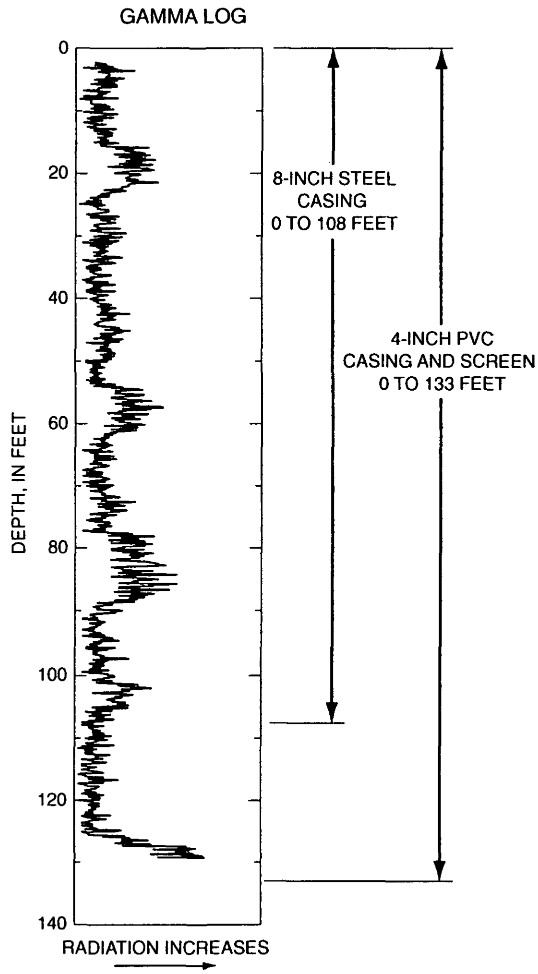


Figure 1-12. Geophysical logs for Puchack MW-14 (well number 070931)

APPENDIX 2. Structure-contour maps of tops of hydrostratigraphic units in the Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers, Pennsauken Township and vicinity, Camden County, New Jersey

This appendix contains a structure-contour map for each of the 12 hydrostratigraphic layers in the study area. These maps were developed from previously published hydrostratigraphic interpretations, previously available data, and the new data collected during this study. First, a conceptual lithologic model based on all available information was developed for the vicinity of the Puchack well field within the framework of previous interpretations. Locally, the data indicated a more detailed breakdown of the commonly recognized Upper, Middle, and Lower Potomac-Raritan-Magothy aquifers. A comparison of the conceptual model with previously published hydrostratigraphic interpretations for the study area indicated that the conceptual model could be extended to the limits of the study area.

Altitudes of the top of each of the 12 hydrostratigraphic layers at each available data-point location were estimated using all available data. Because these data showed wide ranges in type, quality, age, and source, considerable subjective evaluation was required. Where available, borehole geophysical logs, principally gamma logs, were the most useful data for correlating the stratigraphic layers and determining altitudes of the structural tops. Once the initial interpretations were made, drafts of the structure contours for each layer were prepared by hand, using logical contouring methods. In some areas, the results of this process indicated either considerable stratigraphic variability and (or) possible problems with the data or interpretations. Accordingly, the data were re-examined in an effort to determine the cause of the observed variations. In some cases, data of known or suspected poor quality were removed from the data set. In a few local areas, altitudes of the tops of units at data points could neither be reconciled with altitudes at surrounding data points nor reasonably be excluded. Therefore, these data points were assumed to indicate actual stratigraphic variability that could not be described in detail with the limited number of data points available.

Because of this stratigraphic variability and the scarcity of data in some areas, an effort was made to retain all reasonable data if they could not be excluded or qualified in some way. Also, the data were retained whenever possible as an indication of the degree of precision associated with the structure-contour positions.

After the logical contouring was refined, a digital model of the top of each of the 12 hydrostratigraphic layers was prepared. Beginning at the top of the basal confining unit (typically bedrock), contours for each layer were compared with the contours for the overlying layer. Anomalies occurred when layers appeared to have a zero or negative thickness. This situation was most common in areas where data were sparse. Once an anomaly was identified, the structure-contour positions were corrected to reflect an appropriate thickness for the given layer while maintaining a reasonable relation with nearby data points both in the layer and in adjacent layers.

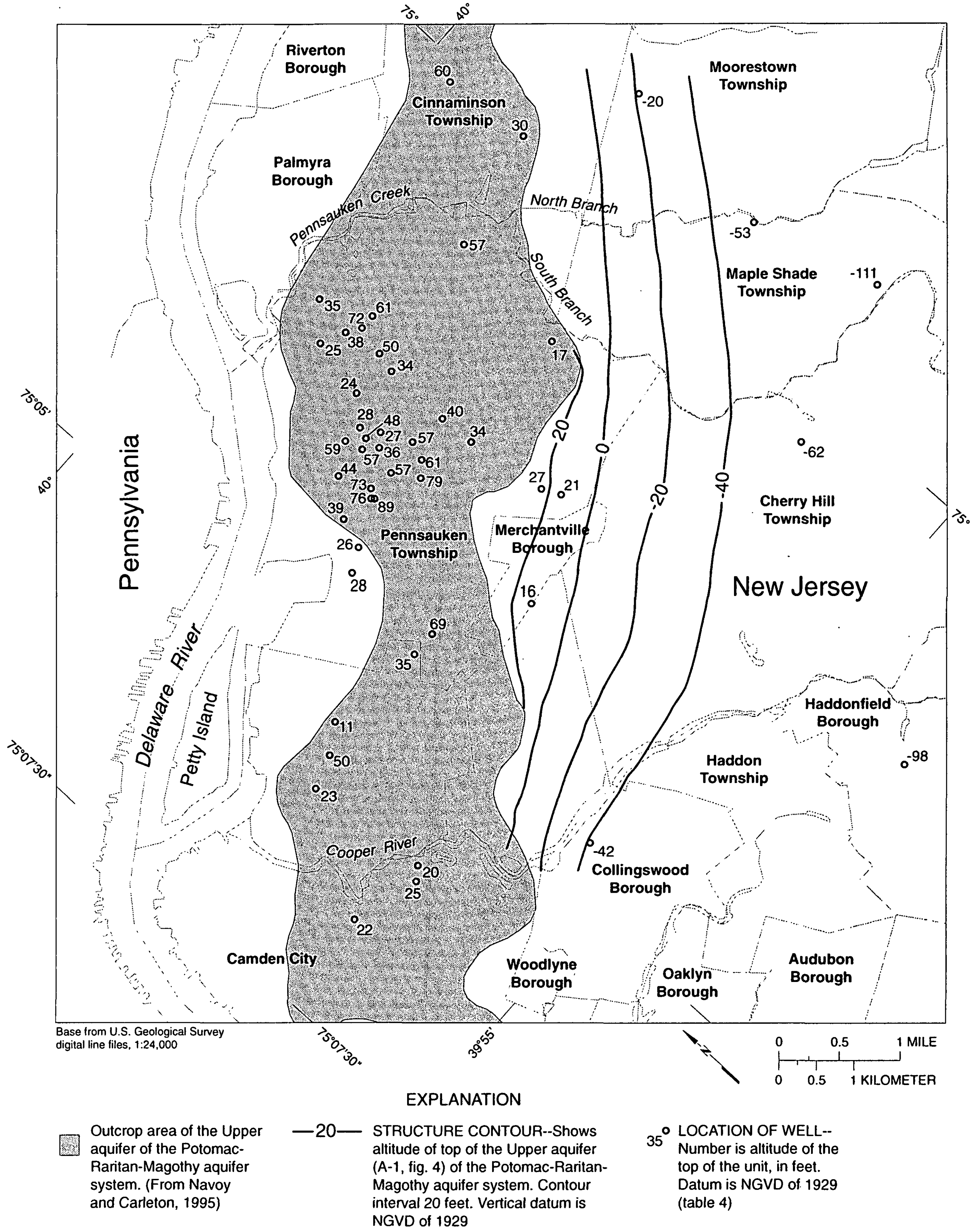


Figure 2-1. Structure-contour map of the top in the Upper aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden, New Jersey.

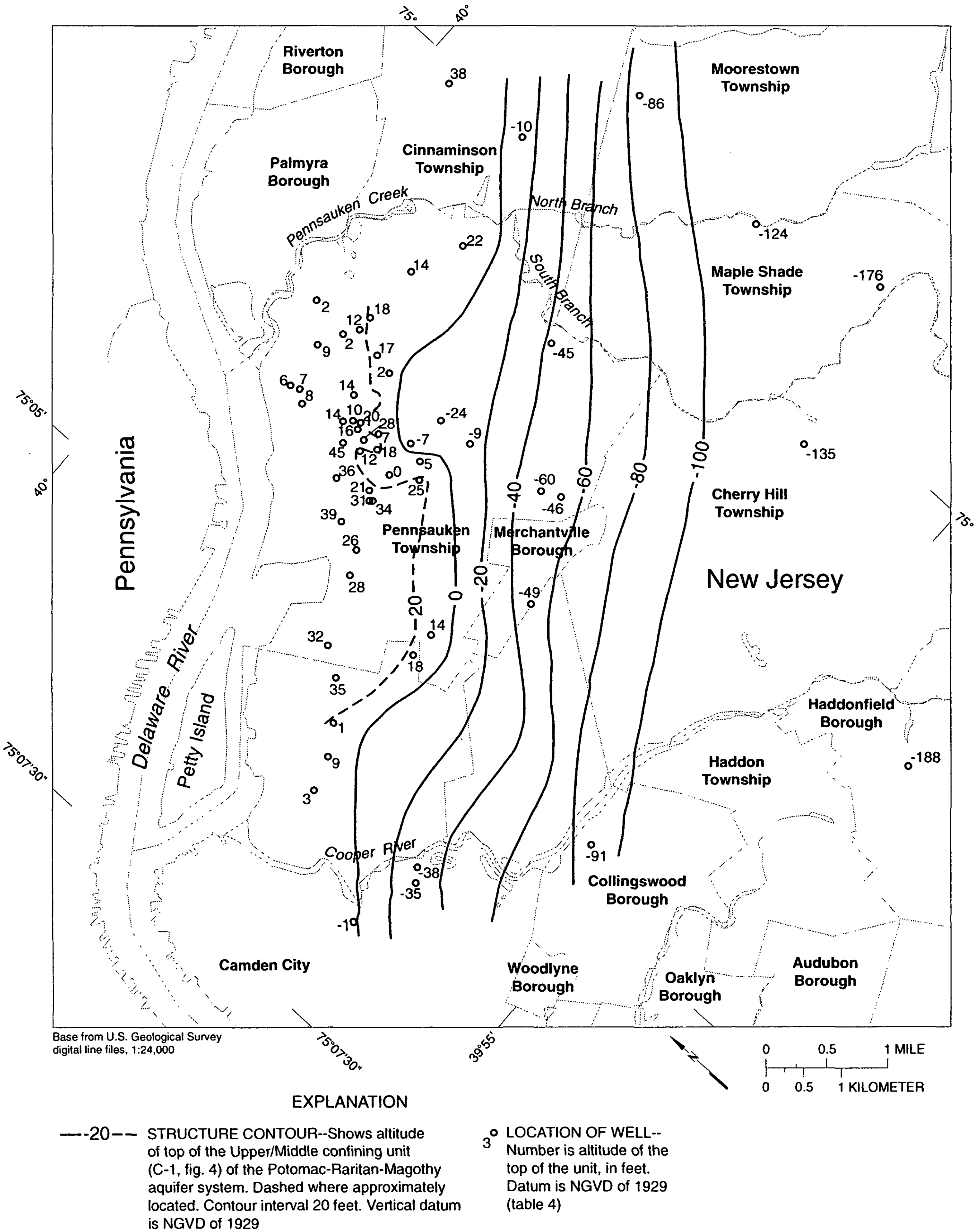
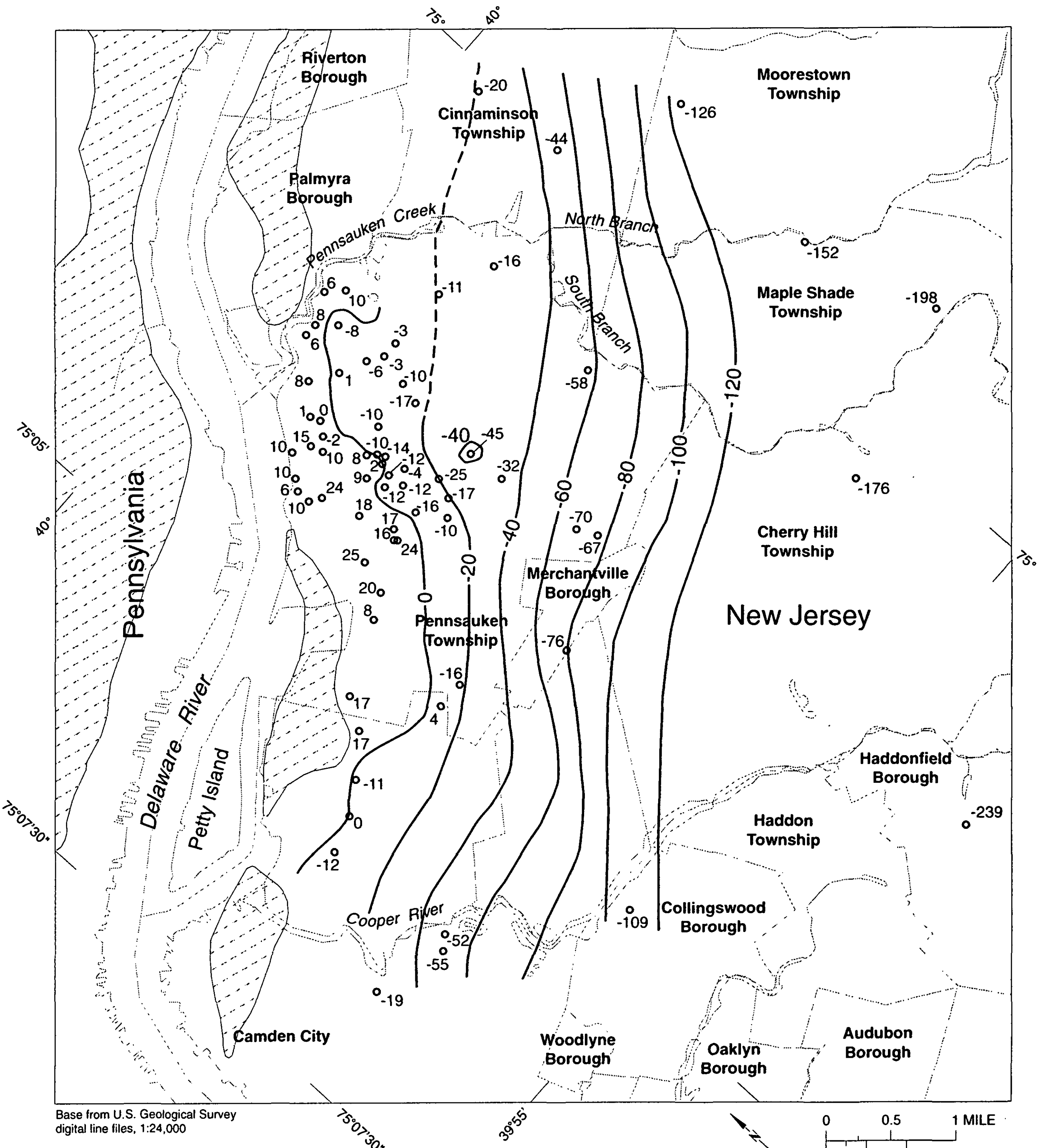


Figure 2-2. Structure-contour map of the top of the Upper/Middle confining unit of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.



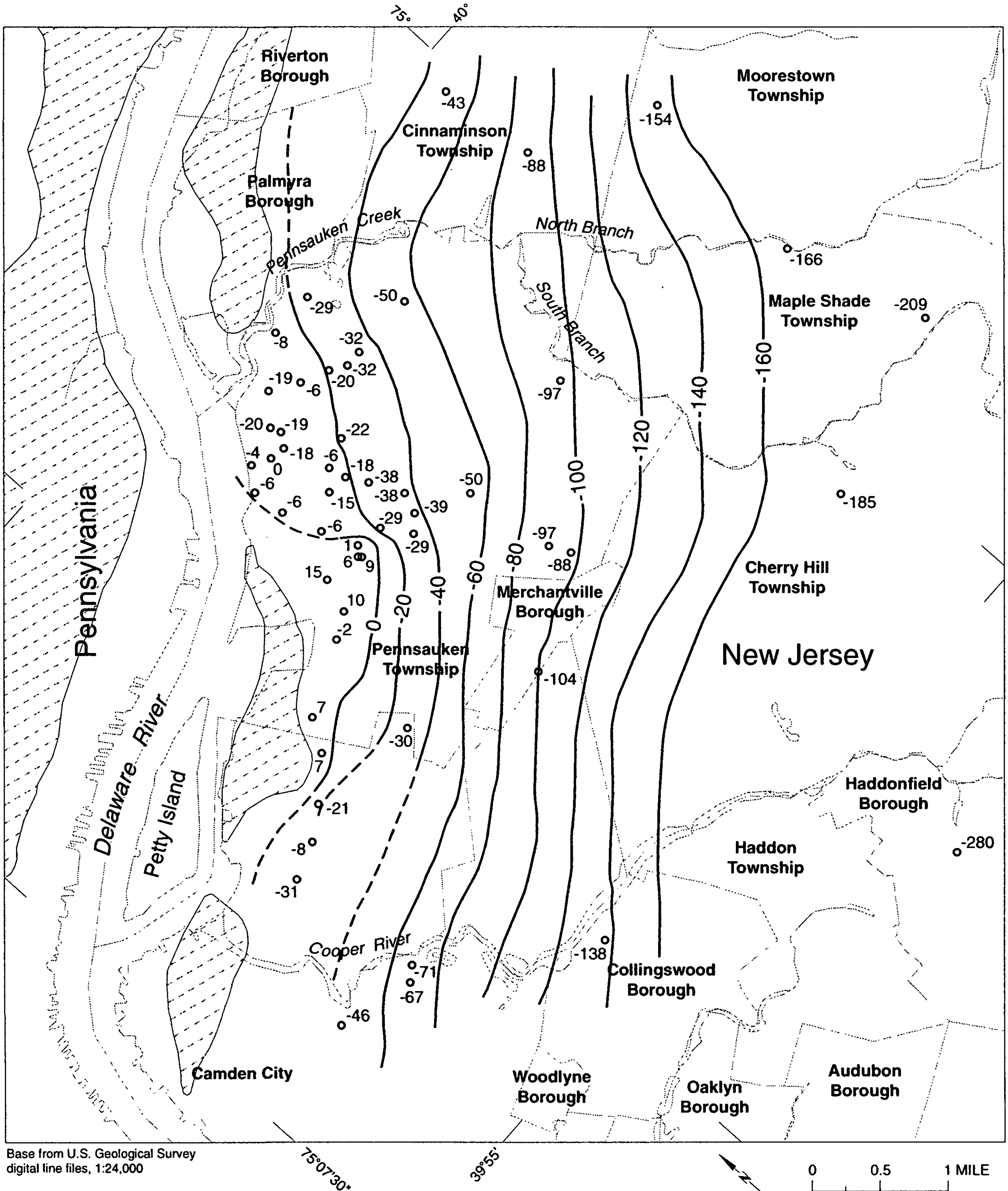
EXPLANATION

Outcrop area of the Middle aquifer of the Potomac-Raritan-Magothy aquifer system. (From Navoy and Carleton, 1995)

—-20— — STRUCTURE CONTOUR--Shows altitude of top of the upper sand layer in the Middle aquifer (A-2a, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

o 10 LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-3. Structure-contour map of the top of the upper sand layer in the Middle aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.



EXPLANATION

Outcrop area of the Middle aquifer of the Potomac-Raritan-Magothy aquifer system. (From Navoy and Carleton, 1995)

—-20— — STRUCTURE CONTOUR--Shows altitude of top of the interbedded confining unit in the Middle aquifer (A-2C1, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

o -31 LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-4. Structure-contour map of the top of the interbedded confining unit in the Middle aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.

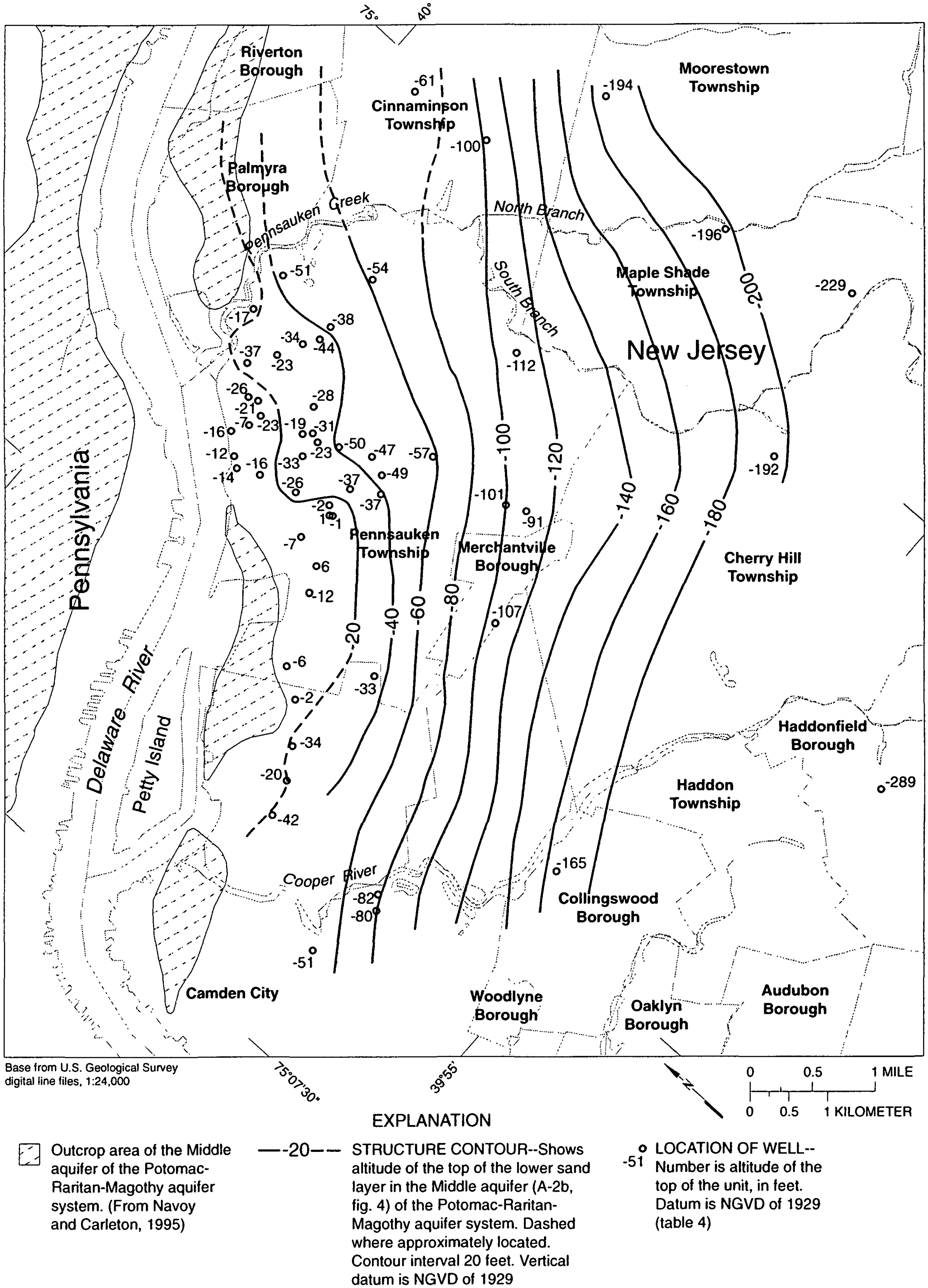
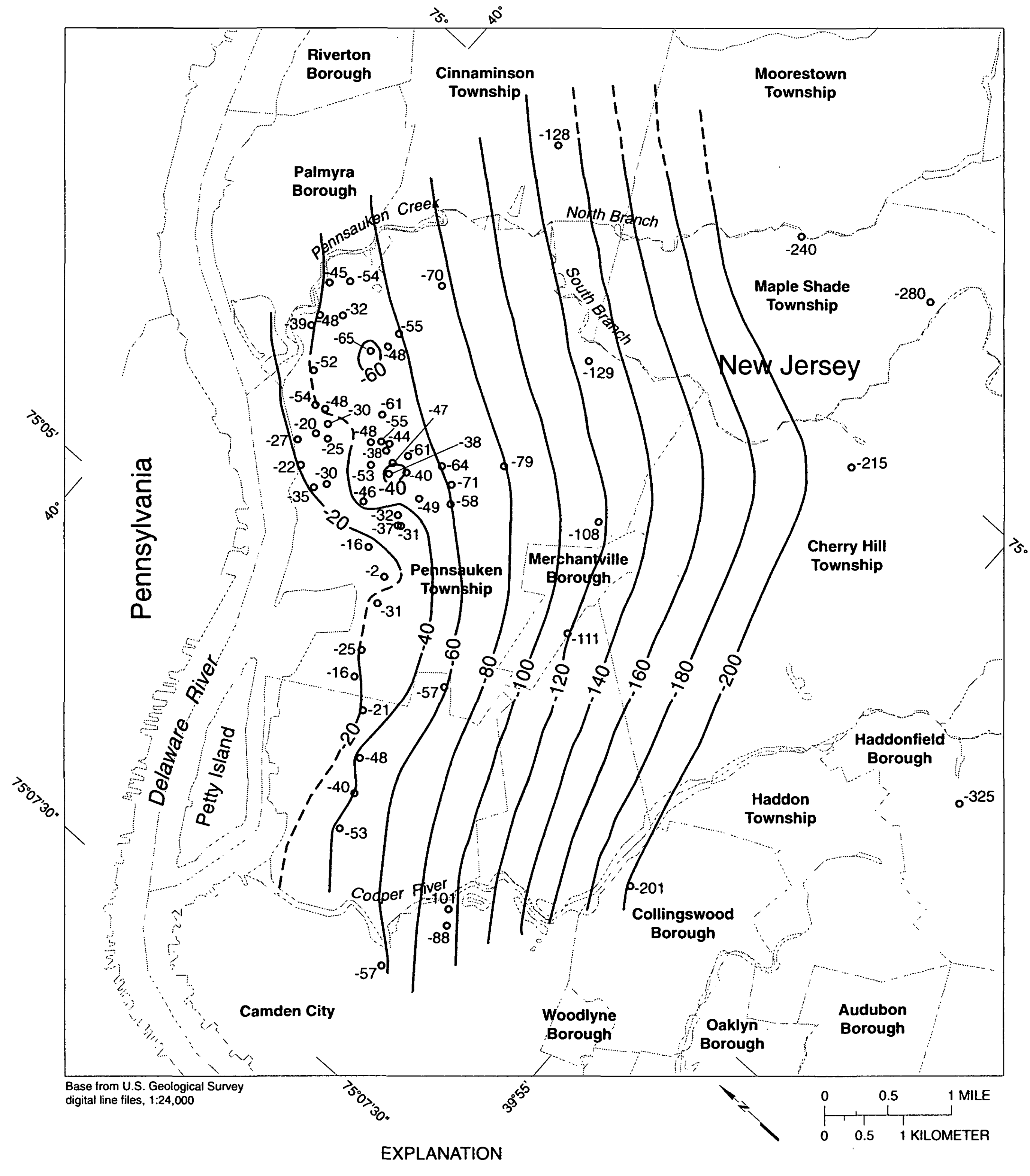


Figure 2-5. Structure-contour map of the top of the lower sand layer in the Middle aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.

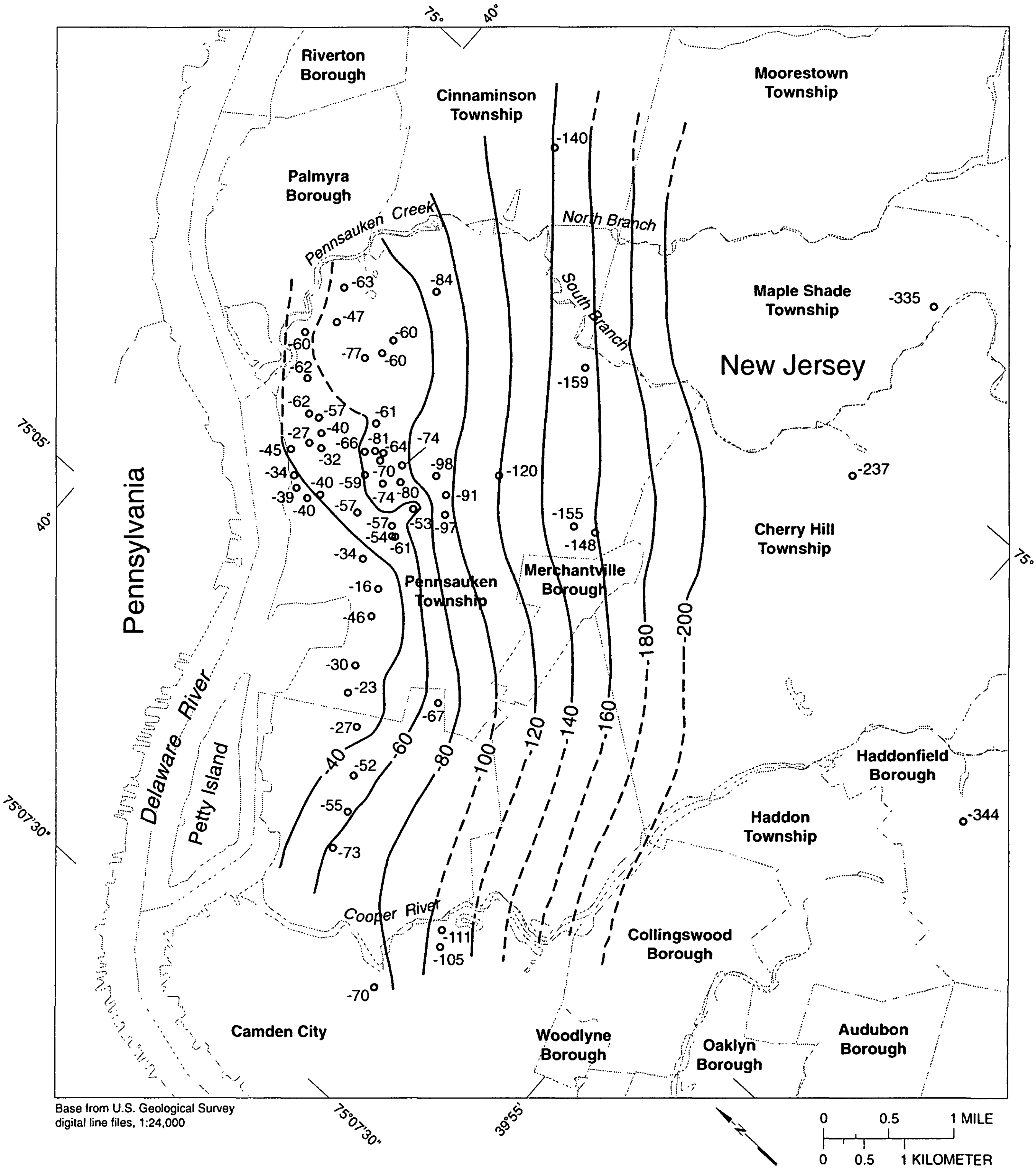


EXPLANATION

—-20— — STRUCTURE CONTOUR--Shows altitude of top of the upper confining unit in the Middle/Lower confining unit (C-2a, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

-57 o LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-6. Structure-contour map of the top of the upper confining unit in the Middle/Lower confining unit of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.

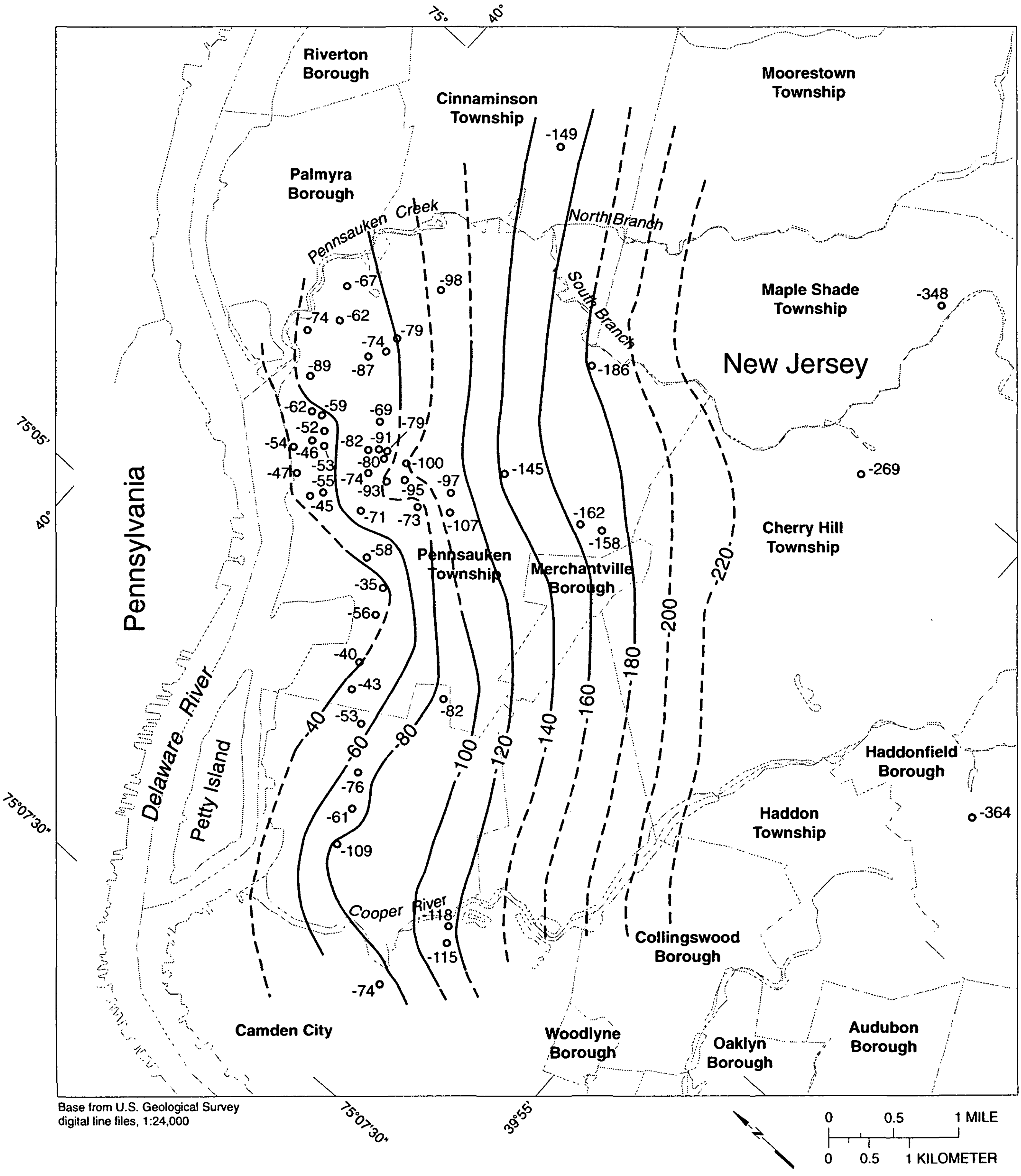


EXPLANATION

—-40— — STRUCTURE CONTOUR--Shows altitude of top of the Intermediate Sand in the Middle/Lower confining unit (C-2A1, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

-70 o LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-7. Structure-contour map of the top of the Intermediate Sand in the Middle/Lower confining unit of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.

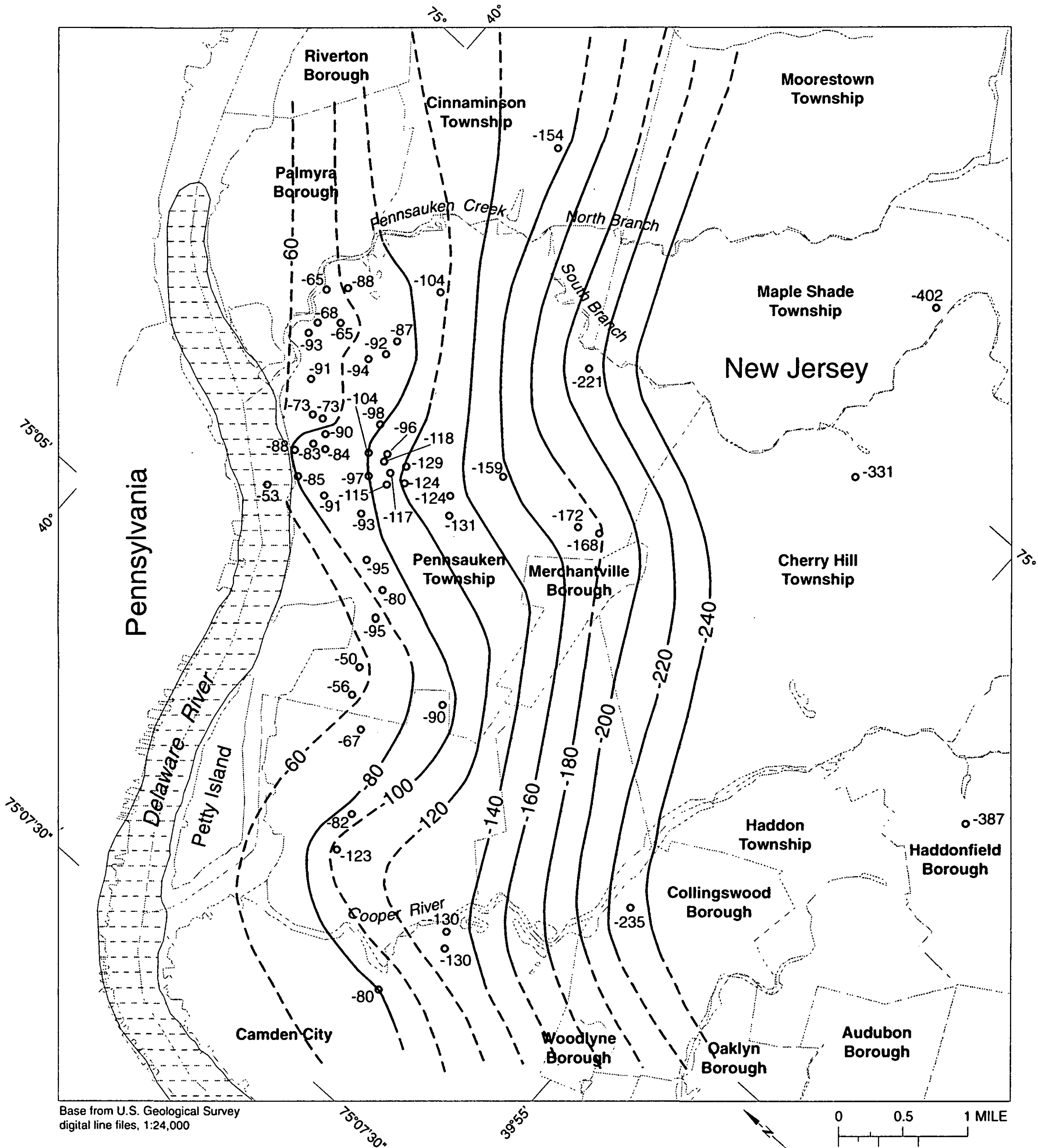


EXPLANATION

—-40— — STRUCTURE CONTOUR--Shows altitude of top of the lower confining unit in the Middle/Lower confining unit (C-2b, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

-74 o LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-8. Structure-contour map of the top of the lower confining unit in the Middle/Lower confining unit of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.



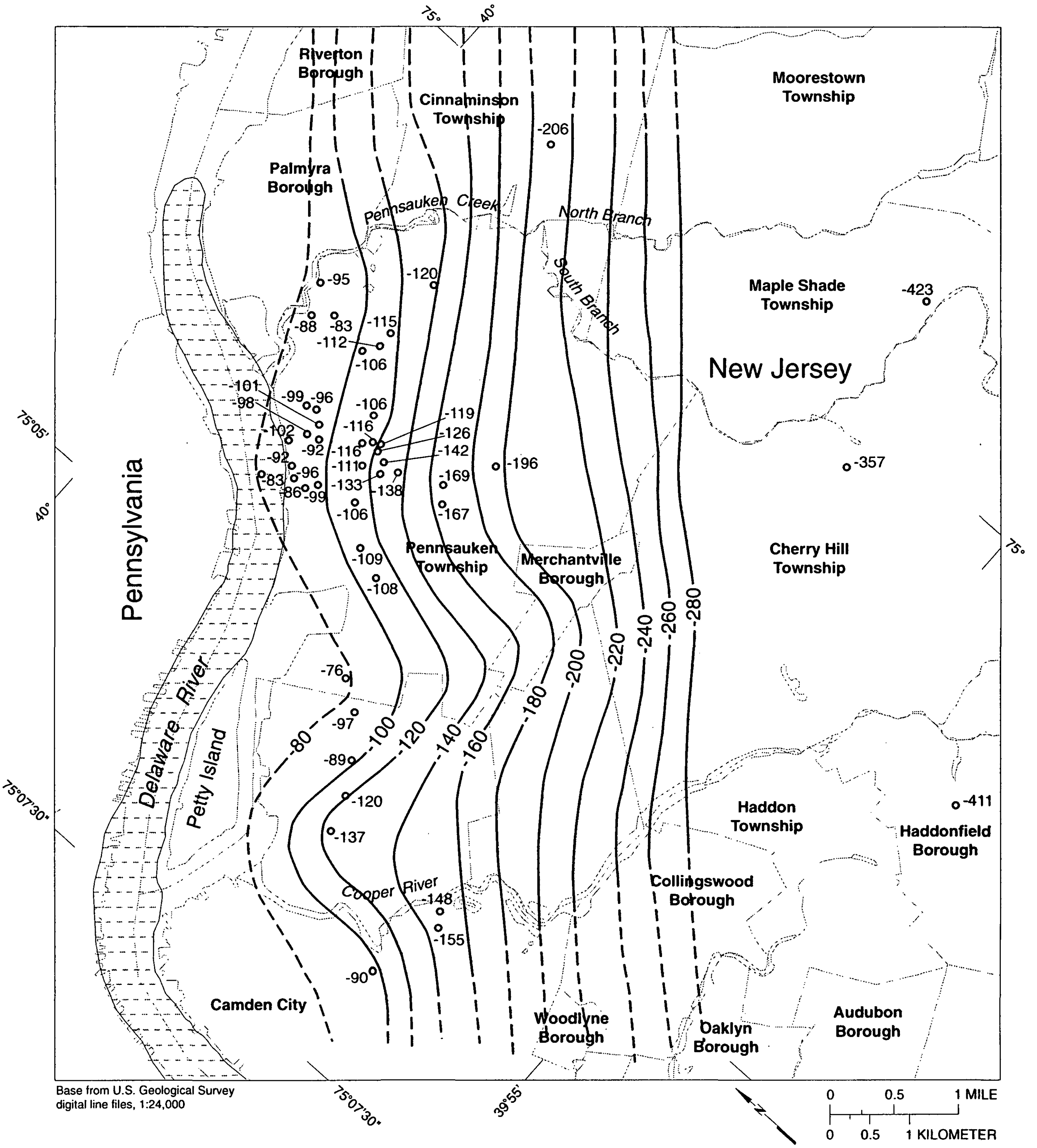
EXPLANATION

Outcrop area of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. (From Navoy and Carleton, 1995)

—-40— — STRUCTURE CONTOUR--Shows altitude of top of the upper zone of the Lower aquifer (A-3a, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

-80 o LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-9. Structure-contour map of the top of the upper zone of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.



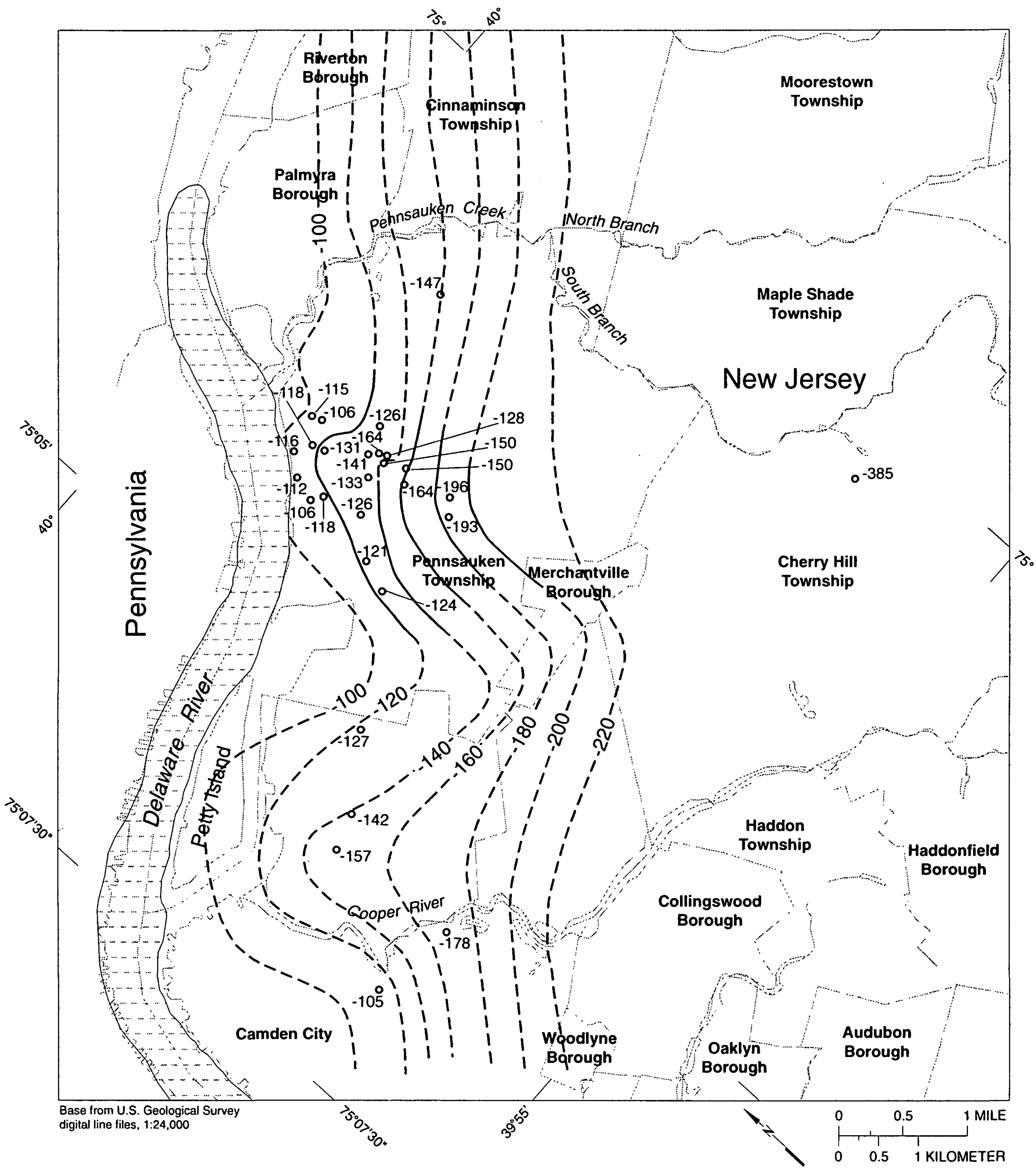
EXPLANATION

Outcrop area of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. (From Navoy and Carleton, 1995)

—-80—— STRUCTURE CONTOUR--Shows altitude of top of the middle zone of the Lower aquifer (A-3b, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

-90o LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-10. Structure-contour map of the top of the middle zone of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.



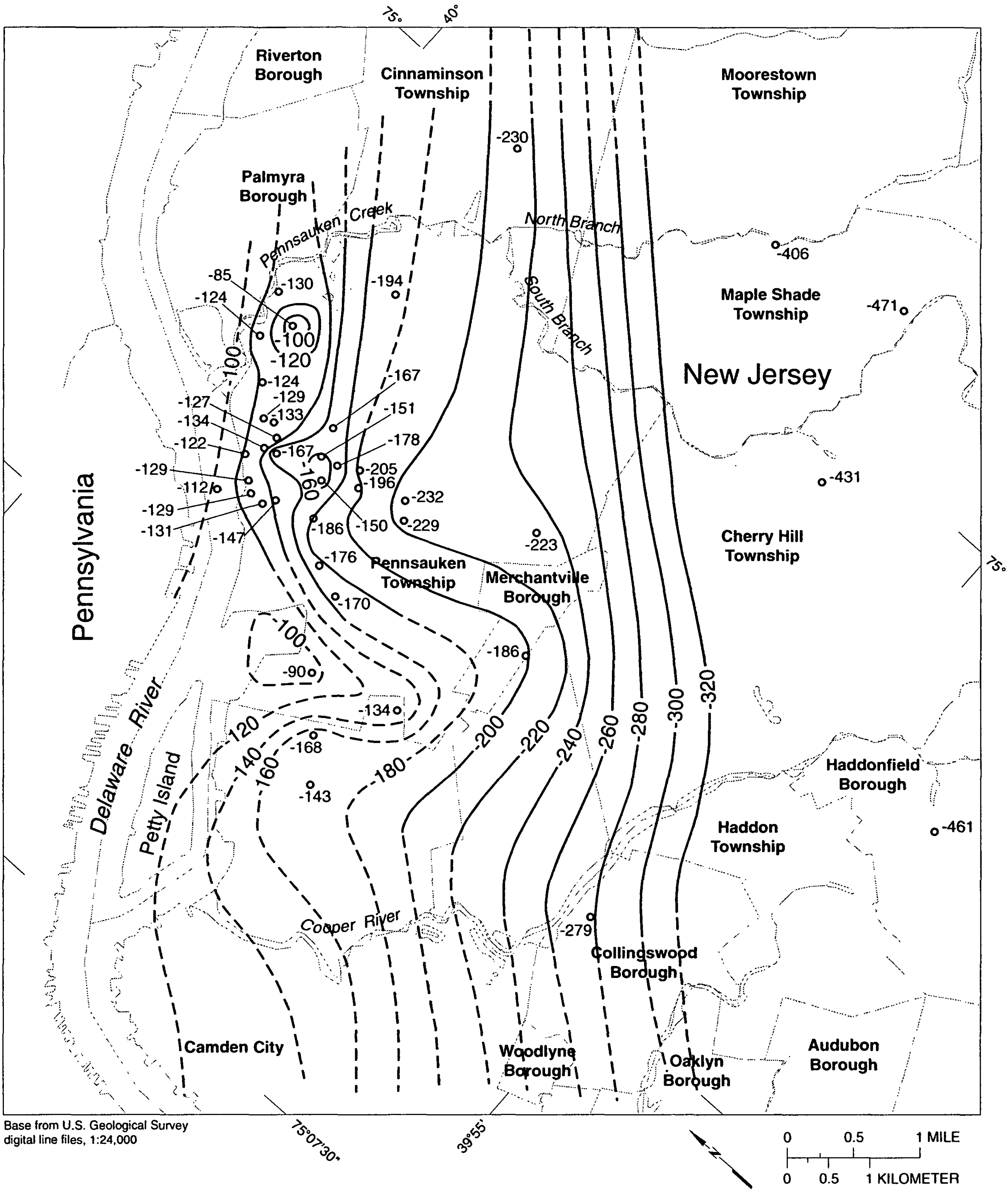
EXPLANATION

Outcrop area of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system. (From Navoy and Carleton, 1995)

—-100— — STRUCTURE CONTOUR--Shows altitude of top of the lower zone of the Lower aquifer (A-3c, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

o -105 LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-11. Structure-contour map of the top of the lower zone of the Lower aquifer of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.



EXPLANATION

—-100— — STRUCTURE CONTOUR--Shows altitude of top of the basal confining unit (C-3, fig. 4) of the Potomac-Raritan-Magothy aquifer system. Dashed where approximately located. Contour interval 20 feet. Vertical datum is NGVD of 1929

o -279 LOCATION OF WELL--Number is altitude of the top of the unit, in feet. Datum is NGVD of 1929 (table 4)

Figure 2-12. Structure-contour map of the top of the basal confining unit of the Potomac-Raritan-Magothy aquifer system, Pennsauken Township and vicinity, Camden County, New Jersey.

APPENDIX 3. Laboratory analytical results for field quality-assurance samples and ground-water environmental samples, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998

Table 3-1. Geochemical analysis of field-blank samples collected in Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998

[USGS, U.S. Geological Survey; µg/L, micrograms per liter; mg/L, milligrams per liter; --, data unavailable; constituents not detected in a sample are reported as the value of the detection limit for that analysis preceded by a "less-than" symbol (<); analyses of blank samples by USGS National Water Quality Laboratory, Denver, Colo.]

Station number	Field-blank collection site	Date	Time	Aluminum, dissolved (µg/L as Al)	Antimony, dissolved (µg/L as Sb	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)
395845075031201	PUCHACK 1	12-11-97	1320	3.27	<0.20	<0.20	<0.20	5.58	<0.30
400000074000097	USGS LAB, OCALA FL	02-04-98	1630	2.7	<0.20	<0.20	<0.20	11.93	<0.30
		02-04-98	1550	2.9	<0.20	<0.20	<0.20	10.61	<0.30
395842075023101	GSM MW-1	02-10-98	1150	<0.30	<0.20	<0.20	<0.20	1.36	<0.30
395828075031601	CAMDEN CITY MW-4A	03-30-98	1200	3.61	<0.20	<0.20	<0.20	8.52	<0.30
		03-30-98	1300	3.07	<0.20	0.23	<0.20	6.7	<0.30
395806075025803	PUCHACK MW-4D	04-07-98	1000	3.02	<0.20	0.26	<0.20	4.94	<0.30
395801075030602	PUCHACK MW-3D	04-14-98	1220	2.77	<0.20	0.27	<0.20	8.72	<0.30
395846075025501	PUCHACK MW-9S	04-21-98	1415	3.22	<0.20	0.35	<0.20	10.35	<0.30
395827075030201	PUCHACK MW-6M	04-22-98	1230	4.03	<0.20	0.33	<0.20	10.96	<0.30
395836075031901	PUCHACK MW-7D	04-28-98	1145	3.58	<0.20	0.25	<0.20	7.33	<0.30
395828075033601	PUCHACK MW-10M	04-29-98	1230	5.00	<0.20	0.32	<0.20	8.55	<0.30

Station number	Date	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Manganese, dissolved (µg/L as Mn)	Mercury, dissolved (µg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)
395845075031201	12-11-97	<0.20	<0.20	<0.20	<3.00	<0.30	<0.10	--	<0.20	<0.50
400000074000097	02-04-98	<0.20	0.24	<0.20	<3.00	<0.30	0.26	--	<0.20	<0.50
	02-04-98	<0.20	<0.20	<0.20	<3.00	<0.30	<0.10	--	<0.20	<0.50
395842075023101	02-10-98	<0.20	<0.20	<0.20	<3.00	<0.30	<0.10	--	<0.20	<0.50
395828075031601	03-30-98	<0.20	<0.20	<0.20	<3.00	<0.30	<0.10	--	<0.20	<0.50
	03-30-98	<0.20	0.58	0.20	<3.00	<0.30	1.5	<0.1	<0.20	<0.50
395806075025803	04-07-98	<0.20	<0.20	0.55	<3.00	<0.30	<0.10	<0.1	<0.20	<0.50
395801075030602	04-14-98	<0.20	<0.20	1.3	<3.00	<0.30	<0.10	<0.1	<0.20	<0.50
395846075025501	04-21-98	<0.20	<0.20	1.68	<3.00	<0.30	<0.10	<0.1	<0.20	<0.50
395827075030201	04-22-98	<0.20	0.30	2.79	<3.00	<0.30	0.19	<0.1	<0.20	0.55
395836075031901	04-28-98	<0.20	<0.20	1.31	<3.00	<0.30	0.13	<0.1	<0.20	<0.50
395828075033601	04-29-98	<0.20	<0.20	1.34	<3.00	<0.30	<0.10	<0.1	<0.20	<0.50

Table 3-1. Geochemical analysis of field-blank samples collected in Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

Station number	Date	Silica, dissolved (mg/L as SiO_2)	Silver, dissolved (μg/L as Ag)	Strontium, dissolved (μg/L as Sr)	Thallium, dissolved (μg/L as Tl)	Uranium, natural, dissolved (μg/L as U)	Zinc, dissolved (μg/L as Zn)	Calcium, dissolved (mg/L as Ca)	Magnes-ium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
395845075031201	12-11-97	<0.000	<0.20	<0.10	<0.10	<0.20	<0.50	0.006	0.001	0.031
400000074000097	02-04-98	<0.020	<0.20	0.10	<0.10	<0.20	0.98	0.007	<0.001	0.025
	02-04-98	<0.020	<0.20	<0.10	<0.10	<0.20	<0.50	0.002	<0.001	0.028
395842075023101	02-10-98	<0.020	<0.20	<0.10	<0.10	<0.20	6.65	0.004	0.001	<0.025
395828075031601	03-30-98	<0.000	<0.20	<0.10	<0.10	<0.20	<0.50	0.003	0.001	<0.025
	03-30-98	<0.020	<0.20	0.64	<0.10	<0.20	5.31	0.013	0.001	<0.025
395806075025803	04-07-98	<0.020	<0.20	<0.10	<0.10	<0.20	4.77	0.010	0.002	<0.025
395801075030602	04-14-98	<0.000	<0.20	<0.10	<0.10	<0.20	5.9	0.011	0.001	0.026
395846075025501	04-21-98	<0.020	<0.20	<0.10	<0.10	<0.20	10.15	0.007	0.001	0.025
395827075030201	04-22-98	<0.020	<0.20	0.10	<0.10	<0.20	7.38	0.010	0.001	0.029
395836075031901	04-28-98	<0.020	<0.20	<0.10	<0.10	<0.20	4.59	0.005	<0.001	<0.025
395828075033601	04-29-98	<0.020	<0.20	<0.10	<0.10	<0.20	2.14	0.006	<0.001	0.032

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998

[USGS, U.S. Geological Survey; constituent list 1 contains two forms of chromium and a limited number of other constituents; constituent list 2 contains all major ions, two forms of chromium, nine other trace elements, and organic compounds; µg/L, micrograms per liter; mg/L, milligrams per liter; --, data unavailable; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; NTU, nephelometric turbidity units; ANC, acid-neutralizing capacity; Fet, field electrometric titration; recover, recoverable; constituents not detected in a sample are reported as the value of the detection limit for that analysis preceded by a "less than" symbol (<); E, estimated; K, less than; D, diluted; analyses of environmental samples by New Jersey Department of Health laboratory, Trenton, New Jersey]

USGS well number	Latitude	Longitude	Site name	Constituent list	Date	Time	ANC, unfiltered (mg/L)	Oxygen, dissolved, (mg/L)
070358	395830	0750310	PUCHACK 4R/6-70	1	05-13-98	1240	--	0.2
070359	395835	0750308	PUCHACK 5/5A	1	05-14-98	1410	--	0.11
070363	395842	0750310	PUCHACK 2	1	05-11-98	1630	--	0.21
070366	395844	0750316	PUCHACK 1	2	12-11-97	1500	49	0.3
070367	395839	0750307	PUCHACK 3/3A	1	05-11-98	1445	--	0.17
070368	395847	0750348	DELAIR 1	2	12-01-97	1245	62	0.14
070372	395853	0750208	NATIONAL HWY 1	1	12-30-97	1045	--	0.2
070373	395900	0750318	MORRIS 6	1	12-30-97	1305	--	0.06
070375	395911	0750307	MORRIS 8	1	12-12-97	1205	--	0.1
070528	395836	0750304	PUCHACK 6-75/7	1	05-11-98	1805	--	0.25
070570	395903	0750217	PSLF 3	1	02-23-98	1435	--	0.07
070571	395912	0750248	LANDFILL 4	1	03-02-98	1510	--	3.86
070851	395814	0750329	CAMDEN CITY MW-1A	1	02-25-98	1605	--	0.44
070852	395814	0750329	CAMDEN CITY MW-1B	1	02-03-98	1255	--	0.22
070853	395814	0750254	CAMDEN CITY MW-2A	1	02-26-98	1205	--	1.99
070854	395814	0750254	CAMDEN CITY MW-2B	1	02-09-98	1400	--	9.01
070855	395828	0750316	CAMDEN CITY MW-4A	1	03-30-98	1310	--	0.27
070856	395828	0750316	CAMDEN CITY MW-4B	1	03-31-98	1455	--	9.1
070906	395814	0750352	PUCHACK MW-1D	1	05-07-98	1420	--	0
070907	395814	0750352	PUCHACK MW-1S	1	05-07-98	1215	--	0.6
070908	395814	0750352	PUCHACK MW-1M	1	05-07-98	1310	--	1.7
070909	395801	0750358	PUCHACK MW-2M	1	04-08-98	1305	--	0.11
070910	395801	0750358	PUCHACK MW-2D	1	04-08-98	1550	--	0.11
070911	395801	0750306	PUCHACK MW-3M	1	04-14-98	1505	--	5.38
070912	395801	0750306	PUCHACK MW-3D	1	04-14-98	1350	--	0.1
070913	395806	0750258	PUCHACK MW-4M	1	04-07-98	1450	--	4.88
070914	395806	0750258	PUCHACK MW-4I	1	04-07-98	1710	--	3.4
070915	395806	0750258	PUCHACK MW-4D	1	04-07-98	1325	--	0.09
070916	395823	0750309	PUCHACK MW-5M	2	04-30-98	1505	<0.1	8.19
070917	395823	0750309	PUCHACK MW-5I	2	05-06-98	1315	<0.1	1
070918	395823	0750309	PUCHACK MW-5D	2	04-30-98	1520	<0.1	0.07
070919	395827	0750302	PUCHACK MW-6M	2	04-22-98	1540	3	5.59
070920	395827	0750302	PUCHACK MW-6D	2	04-22-98	1415	23	0.19
070921	395836	0750319	PUCHACK MW-7D	2	04-28-98	1310	73	0.05
070922	395836	0750319	PUCHACK MW-7M	2	04-28-98	1515	7	1.98
070923	395844	0750342	PUCHACK MW-8M	1	03-11-98	1615	--	0.63
070924	395844	0750342	PUCHACK MW-8D	1	03-25-98	1205	--	0.14
070925	395846	0750255	PUCHACK MW-9S	2	04-21-98	1705	1	8.18
070926	395846	0750255	PUCHACK MW-9M	2	04-21-98	1250	4	7.3
070927	395846	0750255	PUCHACK MW-9D	2	04-21-98	1510	104	0.05
070928	395828	0750336	PUCHACK MW-10M	2	04-29-98	1515	235	0.08
070929	395828	0750336	PUCHACK MW-10D	2	04-29-98	1315	85	0.06
070930	395755	0750232	PUCHACK MW-12M	1	04-13-98	1325	--	5.8
070931	395812	0750315	PUCHACK MW-14	1	03-25-98	1630	--	1.41
070940	395808	0750248	SUPER TIRE MW-2D	1	04-01-98	1455	--	3.44
070942	395811	0750333	KING ARTHUR MW-3	1	03-11-98	0945	--	0.35
070943	395814	0750338	KING ARTHUR MW-5S	1	03-11-98	1320	--	8.56
070946	395815	0750354	SGL CHROME MW-3	1	02-25-98	1217	--	0.27
070947	395825	0750336	APS-4	1	03-04-98	1150	--	7.49
070949	395842	0750231	GSM MW-1	1	02-10-98	1515	--	6.94
070957	395903	0750217	PSLF MW-3D	1	02-23-98	1225	--	0.06
070958	395903	0750226	PSLF MW-5	1	02-18-98	1640	--	0.43
070959	395903	0750226	PSLF MW-5D	1	02-18-98	1341	--	0.13
070960	395907	0750234	PSLF MW-6	1	03-02-98	1223	--	0.6
070961	395907	0750234	PSLF MW-6D	1	02-17-98	1405	--	0.07

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	pH, field (standard units)	Specific conductance, unfiltered (µS/cm)	Temperature, water (°C)	Turbidity, field (NTU)	Calcium, filtered (mg/L)	Magnesium, filtered (mg/L)	Sodium, filtered (mg/L)	Potassium, filtered (mg/L)
070358	6.27	220	13.71	0.72	--	--	--	--
070359	6.34	240	13.89	0.64	--	--	--	--
070363	6.62	247	13.87	0.54	--	--	--	--
070366	5.95	265	14.4	0.5	14.9	7.4	17.4	3.4
070367	6.64	251	13.39	2.58	--	--	--	--
070368	6.44	247	15.4	0.09	16.1	5.5	13.6	2.2
070372	4.84	175	13.2	0.42	--	--	--	--
070373	4.84	245	14.6	0.24	--	--	--	--
070375	6.58	449	15.4	3.21	--	--	--	--
070528	6.47	227	13.33	0.69	--	--	--	--
070570	6.01	496	20.1	0.69	--	--	--	--
070571	4.68	203	16.97	0.03	--	--	--	--
070851	5.62	313	14.96	7.59	--	--	--	--
070852	6.69	396	17.3	3.68	--	--	--	--
070853	4.63	206	14.22	0.41	--	--	--	--
070854	4.97	--	15.1	0.26	--	--	--	--
070855	6.29	252	15.3	0.05	--	--	--	--
070856	5.28	158	15.4	3.36	--	--	--	--
070906	6.66	277	16.2	0.1	--	--	--	--
070907	5.24	570	16.4	1.57	--	--	--	--
070908	6.45	295	15.7	0.19	--	--	--	--
070909	6.43	305	15.2	0.29	--	--	--	--
070910	6.48	257	14.8	1.23	--	--	--	--
070911	5.17	132	15.3	0.51	--	--	--	--
070912	6.09	206	14.1	2.11	--	--	--	--
070913	5.91	153	15.5	0.81	--	--	--	--
070914	5.32	159	14.6	1.87	--	--	--	--
070915	5.41	159	13.8	0.16	--	--	--	--
070916	4.81	196	14.1	0.12	12	5.2	9.5	2.9
070917	4.91	165	13.6	0.81	9.2	5.4	9.1	3.4
070918	6.55	257	14.2	0.55	18.9	9.2	11.9	4.3
070919	5.11	195	14.8	0.09	11	5.4	10.4	4.5
070920	5.67	187	14.4	0.42	11.5	4.9	11.6	4.2
070921	6.7	262	14.6	0.31	17.2	8.4	12.7	3
070922	5.32	349	14.2	0.26	14.5	6.9	31.1	5.9
070923	6.31	285	15.6	1.24	--	--	--	--
070924	6.71	270	15	1.71	--	--	--	--
070925	4.98	153	15.7	0.15	9.6	5.2	6.4	2.4
070926	5	375	15.4	0.08	18.4	7.7	31.9	4.2
070927	5.89	493	14.4	0.1	30.4	12.1	38.4	6.4
070928	6.62	677	16.3	0.21	33.6	12.6	18	2.9
070929	6.86	268	14.9	0.14	19.3	7.9	12	2.7
070930	7.29	171	15.1	0.43	--	--	--	--
070931	5.3	148	15.4	2.06	--	--	--	--
070940	6.4	490	19.4	3.74	--	--	--	--
070942	6.24	252	15.4	0.1	--	--	--	--
070943	5.14	134	14	0.38	--	--	--	--
070946	6.42	323	14.9	0.07	--	--	--	--
070947	7.74	327	16.06	0.27	--	--	--	--
070949	5.51	386	16.4	8.14	--	--	--	--
070957	6.13	754	16.9	0.13	--	--	--	--
070958	5.83	669	21	46.3	--	--	--	--
070959	6.13	602	19.3	0.99	--	--	--	--
070960	4.68	213	17.98	0.16	--	--	--	--
070961	5.41	344	17	0.11	--	--	--	--

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Chloride, filtered (mg/L)	Sulfate, unfiltered (mg/L)	Ammonia, filtered (mg/L)	Ammonia + organic nitrogen, filtered (mg/L)	Nitrite, filtered (mg/L)	Nitrite + nitrate, filtered (mg/L)	Ortho-phosphate, filtered (mg/L)	Phosphorus, filtered (mg/L)	Carbon, organic, filtered (mg/L)
070358	--	--	--	--	--	--	--	--	--
070359	--	--	--	--	--	--	--	--	--
070363	--	--	--	--	--	--	--	--	--
070366	27	17.9	1.31	1.51	0.009	1.06	<0.02	--	1.2
070367	--	--	--	--	--	--	--	--	--
070368	20	17.1	1.39	1.55	0.007	0.17	0.04	--	1.1
070372	--	--	--	--	--	--	--	--	--
070373	--	--	--	--	--	--	--	--	--
070375	--	--	--	--	--	--	--	--	--
070528	--	--	--	--	--	--	--	--	--
070570	--	--	--	--	--	--	--	--	--
070571	--	--	--	--	--	--	--	--	--
070851	--	--	--	--	--	--	--	--	--
070852	--	--	--	--	--	--	--	--	--
070853	--	--	--	--	--	--	--	--	--
070854	--	--	--	--	--	--	--	--	--
070855	--	--	--	--	--	--	--	--	--
070856	--	--	--	--	--	--	--	--	--
070906	--	--	--	--	--	--	--	--	--
070907	--	--	--	--	--	--	--	--	--
070908	--	--	--	--	--	--	--	--	--
070909	--	--	--	--	--	--	--	--	--
070910	--	--	--	--	--	--	--	--	--
070911	--	--	--	--	--	--	--	--	--
070912	--	--	--	--	--	--	--	--	--
070913	--	--	--	--	--	--	--	--	--
070914	--	--	--	--	--	--	--	--	--
070915	--	--	--	--	--	--	--	--	--
070916	15.7	33.9	<0.03	--	0.008	3.19	E0.02	<0.03	<1
070917	11.1	37.3	0.54	--	0.008	1.4	<0.02	<0.03	1.1
070918	57.9	5.38	1.41	--	0.01	0.21	E0.02	<0.03	<1
070919	10.2	40.8	<0.03	<0.03	<0.003	3.04	<0.02	--	1.01
070920	15.3	22.3	0.34	0.4	0.004	0.33	<0.02	--	<1
070921	19.6	9.88	3.49	2.97	0.006	0.04	<0.02	--	<1
070922	62.6	24.6	<0.03	0.08	0.014	3.18	0.03	--	<1
070923	--	--	--	--	--	--	--	--	--
070924	--	--	--	--	--	--	--	--	--
070925	15.2	21.3	<0.03	<0.03	<0.003	2.99	<0.02	--	<1
070926	71.2	30.2	<0.03	<0.03	<0.003	3.62	<0.02	--	<1
070927	53.4	31.8	1.34	1.3	0.003	0.03	<0.02	--	2.7
070928	E43.9	1.65	0.59	--	0.042	<0.02	E0.06	<0.03	4.25
070929	19.9	3.8	3.86	--	E0.008	0.13	E0.03	<0.03	<1
070930	--	--	--	--	--	--	--	--	--
070931	--	--	--	--	--	--	--	--	--
070940	--	--	--	--	--	--	--	--	--
070942	--	--	--	--	--	--	--	--	--
070943	--	--	--	--	--	--	--	--	--
070946	--	--	--	--	--	--	--	--	--
070947	--	--	--	--	--	--	--	--	--
070949	--	--	--	--	--	--	--	--	--
070957	--	--	--	--	--	--	--	--	--
070958	--	--	--	--	--	--	--	--	--
070959	--	--	--	--	--	--	--	--	--
070960	--	--	--	--	--	--	--	--	--
070961	--	--	--	--	--	--	--	--	--

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Aluminum, filtered (μg/L)	Cadmium, filtered (μg/L)	Chromium, filtered (μg/L)	Chromium, hexavalent, filtered (μg/L)	Cobalt, filtered (μg/L)	Copper, filtered (μg/L)	Iron, filtered (μg/L)	Manganese, filtered (μg/L)	Mercury, filtered (μg/L)
070358	--	--	248	142	--	--	310	35.2	E0.04
070359	--	--	25.9	<5	--	--	1,280	112	E0.04
070363	--	--	180	176	--	--	52.6	92.5	E0.1
070366	11.4	<1	52.4	33.7	113	6.3	--	1,890	E0.06
070367	--	--	146	97.4	--	--	350	94	E0.04
070368	26	<1	<1	<5	105	<3	5,112	1,827	E0.04
070372	--	--	<1	<5	--	--	173	256	<0.04
070373	--	--	<1	<5	--	--	176	2,790	<0.04
070375	--	--	<1	<5	--	--	10,600	2,310	<0.04
070528	--	--	788	774	--	--	44.1	29.1	E0.13
070570	--	--	<1	6.2	--	--	31,900	3,440	<0.04
070571	--	--	341	311	--	--	5.8	510	0.07
070851	--	--	4,130	4,278	--	--	8	410	0.07
070852	--	--	<1	<5	--	--	59,200	4,230	<0.04
070853	--	--	9,070	9,606	--	--	3.7	121	0.91
070854	--	--	<1	<5	--	--	13.8	167	<0.04
070855	--	--	3.6	5.4	--	--	10.3	21.6	<0.04
070856	--	--	<1	<5	--	--	5.1	99.7	<0.04
070906	--	--	<1	<5	--	--	125	828	<0.04
070907	--	--	9,720	11,540	--	--	9.3	759	0.37
070908	--	--	<1	<5	--	--	5,540	4,060	<0.04
070909	--	--	<1	<5	--	--	7,030	1,080	<0.04
070910	--	--	<1	<5	--	--	8.5	102	<0.04
070911	--	--	<1	<5	--	--	215	272	0.65
070912	--	--	<1	<5	--	--	864	42.8	<0.04
070913	--	--	<1	<5	--	--	72	312	<0.04
070914	--	--	2	<5	--	--	33.9	212	1.4
070915	--	--	<1	<5	--	--	804	53.5	0.45
070916	112	2.4	1.4	<5	29.2	13	11.1	339	<0.04
070917	70	<1	8,100	8,090	22.4	8.6	4.6	83.9	0.17
070918	11.4	<1	904	735	1.6	<1	3.5	38.1	0.09
070919	62.7	<1	1.2	<5	20.8	4.9	13.4	317	<0.04
070920	35.1	<1	3,320	3,465	17.1	4.5	3.5	81.4	0.24
070921	13.3	<1	<1	<5	11	<1	422	618	<0.04
070922	28.4	<1	<1	<5	34	2.5	90.1	800	<0.04
070923	--	--	1.5	<5	--	--	6,950	1,790	<0.04
070924	--	--	<1	<5	--	--	3,802	5,104	<0.04
070925	34.4	<1	<1	<5	11.6	1.4	4.5	317	<0.04
070926	48	<1	1.3	<5	7.5	4.4	6.5	431	0.04
070927	14.8	<1	<1	<5	55.9	1.1	2,170	2,060	<0.04
070928	29.7	18.7	<1	<5	19.7	<1	100,000	6,560	<0.04
070929	16.1	<1	<1	<5	9.2	<1	343	116	<0.04
070930	--	--	1.1	<5	--	--	2.6	38.5	<0.04
070931	--	--	<1	<5	--	--	46.3	308	2.52
070940	--	--	1	<5	--	--	14.2	36	<0.04
070942	--	--	2,340	1,820	--	--	2.8	719	<0.04
070943	--	--	<1	<5	--	--	19.4	49.9	<0.04
070946	--	--	1.7	<5	--	--	29	5,120	<0.04
070947	--	--	1.1	<5	--	--	28.6	61.7	0.05
070949	--	--	1.7	<5	--	--	16.7	701	<0.04
070957	--	--	<1	<5	--	--	35,300	1,490	<0.04
070958	--	--	<1	<5	--	--	39,600	1,900	<0.04
070959	--	--	<1	<5	--	--	35,400	1,580	<0.04
070960	--	--	114	81.1	--	--	3.3	1,740	<0.04
070961	--	--	<1	<5	--	--	274	1,310	<0.04

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Nickel, filtered (μg/L)	Zinc, filtered (μg/L)	Silica, filtered (mg/L)	Acetone, unfiltered (μg/L)	Acrylonitrile, unfiltered (μg/L)	Benzene, unfiltered (μg/L)	Bromo-benzene, unfiltered (μg/L)	Bromo-chloro-methane, unfiltered (μg/L)	Bromo-dichloro-methane, unfiltered (μg/L)
070358	--	--	--	1	<0.6	<0.4	<0.3	<0.2	<0.2
070359	--	--	--	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070363	--	--	--	1	<0.6	<0.4	<0.3	<0.2	<0.2
070366	15.9	16.9	5.7	<0.85	<0.78	<0.23	<0.31	<0.54	<0.55
070367	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070368	93	28.1	6.5	2.8	<0.78	<0.23	<0.31	<0.54	<0.55
070372	--	--	--	<0.9	<0.6	E0.1	<0.3	<0.2	<0.2
070373	--	--	--	3	<0.6	<0.4	<0.3	<0.2	<0.2
070375	--	--	--	2	<0.6	<0.4	<0.3	<0.2	<0.2
070528	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070570	--	--	--	<0.9	<0.6	2	<0.3	<0.2	<0.2
070571	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070851	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070852	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070853	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070854	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070855	--	--	--	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070856	--	--	--	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070906	--	--	--	17	<0.6	<0.4	<0.3	<0.2	<0.2
070907	--	--	--	3	<0.6	E0.3	<0.3	<0.2	<0.2
070908	--	--	--	2	<0.6	<0.4	<0.3	<0.2	<0.2
070909	--	--	--	2	<0.6	<0.4	<0.3	<0.2	<0.2
070910	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070911	--	--	--	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070912	--	--	--	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070913	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070914	--	--	--	2	<0.6	<0.4	<0.3	<0.2	<0.2
070915	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070916	18.8	163	7.4	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070917	31	41.1	6	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070918	4.4	6.6	4.9	K1.3	<0.35	<0.13	<0.21	<0.26	<0.21
070919	8.2	43.2	6.9	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070920	23.8	29.7	4.1	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070921	6.2	5	6.8	E2	<0.6	<0.4	<0.3	<0.2	<0.2
070922	25.7	38.7	7.9	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070923	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070924	--	--	--	3	<0.6	<0.4	<0.3	<0.2	<0.2
070925	4.8	19.5	8	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070926	6.7	16	6.9	1	<0.6	<0.4	<0.3	<0.2	<0.2
070927	52.1	30.3	6.2	<0.9	<0.6	1	<0.3	<0.2	<0.2
070928	6.8	8.9	4.6	<0.9	<0.6	E1,200	<0.3	<0.2	<0.2
070929	2	4.4	6.6	E7	<0.6	1	<0.3	<0.2	<0.2
070930	--	--	--	<0.73	<0.35	<0.13	<0.21	<0.26	<0.21
070931	--	--	--	E6	<0.6	<0.4	<0.3	<0.2	<0.2
070940	--	--	--	<0.73	<0.35	1.8	<0.21	<0.26	<0.21
070942	--	--	--	K2	<0.6	<0.4	<0.3	<0.2	<0.2
070943	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070946	--	--	--	3	<0.6	<0.4	<0.3	<0.2	<0.2
070947	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070949	--	--	--	<0.9	<0.6	<0.4	<0.3	<0.2	<0.2
070957	--	--	--	<0.9	<0.6	2	<0.3	<0.2	<0.2
070958	--	--	--	<0.9	<0.6	10	<0.3	<0.2	<0.2
070959	--	--	--	<0.9	<0.6	2	<0.3	<0.2	<0.2
070960	--	--	--	<0.9	<0.6	1	<0.3	<0.2	<0.2
070961	--	--	--	<0.9	<0.6	E0.2	<0.3	<0.2	<0.2

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Bromoform, unfiltered (μg/L)	tert-Butyl alcohol, unfiltered (μg/L)	Butyl chloride, unfiltered (μg/L)	n-Butyl-benzene, unfiltered (μg/L)	sec-Butyl-benzene, unfiltered (μg/L)	tert-Butyl-benzene, unfiltered (μg/L)	Carbon disulfide, unfiltered (μg/L)	Carbon tetra-chloride, unfiltered (μg/L)	Chloro-acetonitrile, unfiltered (μg/L)
070358	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070359	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070363	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070366	<0.62	<0.63	<0.5	<0.34	<0.34	<0.37	<0.26	<0.41	<0.87
070367	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070368	<0.62	<0.63	<0.5	<0.34	<0.34	<0.37	<0.26	<0.41	<0.87
070372	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	1	<0.5
070373	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070375	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070528	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070570	<0.2	<0.3	<0.4	<0.5	<0.5	E0.1	<0.4	<0.5	<0.5
070571	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070851	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070852	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070853	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070854	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070855	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070856	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070906	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070907	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070908	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070909	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070910	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070911	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	1.5	<0.34
070912	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070913	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070914	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070915	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070916	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070917	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070918	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070919	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070920	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070921	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070922	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070923	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070924	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070925	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070926	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070927	<0.2	<0.3	<0.4	<0.5	E0.5	E0.1	<0.4	<0.5	<0.5
070928	<0.2	<0.3	E50	<0.5	E17	<0.4	<0.4	<0.5	<0.5
070929	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070930	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070931	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070940	<0.41	<0.99	<0.23	<0.09	<0.08	<0.12	<0.09	<0.13	<0.34
070942	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070943	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070946	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070947	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070949	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070957	<0.2	11	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070958	<0.2	18	<0.4	0.7	1	<0.4	<0.4	<0.5	<0.5
070959	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070960	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5
070961	<0.2	<0.3	<0.4	<0.5	<0.5	<0.4	<0.4	<0.5	<0.5

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Chloro-benzene, unfiltered (μg/L)	Chloro-dibromo-methane, unfiltered (μg/L)	Chloro-ethane, unfiltered (μg/L)	Chloro-form, unfiltered (μg/L)	3-Chloro-propylene, unfiltered (μg/L)	o-Chloro-toluene, unfiltered (μg/L)	p-Chloro-toluene, unfiltered (μg/L)	Dibromo-chloro-propane, unfiltered (μg/L)	1,2-Dibromo-ethane, unfiltered (μg/L)
070358	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070359	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070363	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070366	<0.37	<0.59	<0.57	<0.42	<0.25	<0.25	<0.69	<0.88	<0.66
070367	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070368	<0.37	<0.59	<0.57	<0.42	<0.25	<0.25	<0.69	<0.88	<0.66
070372	0.4	<0.2	<2	2	<1	<0.6	<0.4	<0.3	<0.1
070373	0.6	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070375	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070528	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070570	9	<0.2	<1.6	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070571	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070851	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070852	<0.3	<0.2	<1.6	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070853	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070854	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070855	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070856	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070906	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070907	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070908	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070909	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070910	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070911	<0.14	<0.33	<0.45	0.33	<0.1	<0.12	<0.1	<0.76	<0.44
070912	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070913	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070914	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070915	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070916	<0.14	<0.33	<0.45	0.59	<0.1	<0.12	<0.1	<0.76	<0.44
070917	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070918	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070919	<0.3	<0.2	<2	0.7	<1	<0.6	<0.4	<0.3	<0.1
070920	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070921	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070922	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070923	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070924	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070925	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070926	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070927	14	<0.2	<2	<0.3	<1	<0.6	E0.03	<0.3	<0.1
070928	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070929	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070930	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070931	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070940	<0.14	<0.33	<0.45	<0.14	<0.1	<0.12	<0.1	<0.76	<0.44
070942	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070943	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070946	<0.3	<0.2	<1.6	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070947	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070949	<0.3	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070957	6	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070958	E28	<0.2	<1.6	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070959	9	<0.2	<1.6	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070960	0.4	<0.2	<2	<0.3	<1	<0.6	<0.4	<0.3	<0.1
070961	3	<0.2	E0.2	<0.3	<1	<0.6	<0.4	<0.3	<0.1

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Dibromo-methane, unfiltered (μg/L)	o-Dichloro-benzene, unfiltered (μg/L)	1,3-Dichloro-benzene, unfiltered (μg/L)	1,4-Dichloro-benzene, unfiltered (μg/L)	trans-1,4-Dichloro-2-butene, unfiltered (μg/L)	1,1-Dichloro-ethane, unfiltered (μg/L)	1,2-Dichloro-ethane, unfiltered (μg/L)	cis-1,2-Dichloro-ethylene, unfiltered (μg/L)	trans-1,2-Dichloro-ethylene, unfiltered (μg/L)
070358	<0.2	<0.2	<0.4	<0.3	<0.6	2	<0.2	2	<0.4
070359	<0.31	<0.24	<0.16	<0.21	<0.73	0.66	<0.29	0.79	<0.16
070363	<0.2	<0.2	<0.4	<0.3	<0.6	0.6	<0.2	<0.4	<0.4
070366	<0.73	<0.36	<0.28	<0.24	<0.49	<0.36	<0.45	<0.55	<0.25
070367	<0.2	<0.2	<0.4	<0.3	<0.6	0.8	<0.2	1	<0.4
070368	<0.73	<0.36	<0.28	<0.24	<0.49	<0.36	<0.45	<0.55	<0.25
070372	<0.2	<0.2	<0.4	<0.3	<0.6	2	1	8	<0.4
070373	<0.2	<0.2	<0.4	0.3	<0.6	E0.4	<0.2	0.9	<0.4
070375	<0.2	<0.2	<0.4	<0.3	<0.6	E0.6	<0.2	<0.4	<0.4
070528	<0.2	<0.2	<0.4	<0.3	<0.6	0.6	<0.2	0.9	<0.4
070570	<0.2	4	<0.7	<16	<0.6	2	<0.2	10	<0.4
070571	<0.2	<0.2	<0.4	<0.3	<0.6	E0.07	<0.2	E0.2	<0.4
070851	<0.2	<0.2	<0.4	<0.3	<0.6	2	<0.2	2	<0.4
070852	<0.2	<0.2	<0.4	<0.3	<0.6	4	<0.2	6	<0.4
070853	<0.2	<0.2	<0.4	<0.3	<0.6	1	0.4	2	<0.4
070854	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070855	K0.24	<0.24	<0.16	<0.21	<0.73	2.6	<0.29	<0.1	<0.16
070856	K0.31	<0.24	<0.16	<0.21	<0.73	<0.09	<0.29	<0.1	<0.16
070906	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070907	<0.2	<0.2	<0.4	<0.3	<0.6	0.9	<0.2	8	<0.4
070908	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070909	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070910	<0.2	<0.2	<0.4	<0.3	<0.6	3	<0.2	<0.4	<0.4
070911	<0.31	<0.24	<0.16	<0.21	<0.73	<0.09	<0.29	<0.1	<0.16
070912	<0.31	<0.24	<0.16	<0.21	<0.73	<0.09	<0.29	<0.1	<0.16
070913	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070914	<0.2	<0.2	<0.4	<0.3	<0.6	E0.08	<0.2	4	<0.4
070915	<0.2	<0.2	<0.4	<0.3	<0.6	E0.3	0.4	E0.3	<0.4
070916	<0.31	<0.24	<0.16	<0.21	<0.73	<0.09	<0.29	<0.1	<0.16
070917	<0.2	<0.2	<0.4	<0.3	<0.6	3	0.4	5	<0.4
070918	<0.31	<0.24	<0.16	<0.21	<0.73	<0.09	<0.29	<0.1	<0.16
070919	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070920	<0.2	<0.2	<0.4	<0.3	<0.6	0.9	0.3	<0.4	<0.4
070921	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070922	<0.2	<0.2	<0.4	<0.3	<0.6	E0.04	<0.2	<0.4	<0.4
070923	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070924	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070925	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070926	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070927	<0.2	3	E0.3	10	<0.6	6	2	19	0.8
070928	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	E22	<0.4
070929	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070930	K0.33	<0.24	<0.16	<0.21	<0.73	<0.09	<0.29	<0.1	<0.16
070931	<0.2	<0.2	<0.4	<0.3	<0.6	0.5	0.5	0.9	<0.4
070940	<0.31	<0.24	<0.16	<0.21	<0.73	E22	<0.29	<0.1	<0.16
070942	<0.2	<0.2	<0.4	<0.3	<0.6	E0.1	<0.2	E0.2	<0.4
070943	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	E0.03	<0.4
070946	<0.2	<0.2	<0.4	<0.3	<0.6	<0.4	<0.2	<0.4	<0.4
070947	<0.2	<0.2	<0.4	<0.3	<0.6	0.6	<0.2	15	<0.4
070949	<0.2	<0.2	<0.4	<0.3	<0.6	E0.2	<0.2	3	<0.4
070957	<0.2	2	E0.3	5	<0.6	0.5	0.7	1	<0.4
070958	<0.2	11	2	E31	<0.6	0.4	<0.2	9	<0.4
070959	<0.2	<0.2	E0.2	6	<0.6	1	0.6	1	<0.4
070960	<0.2	<0.2	<0.4	0.6	<0.6	12	0.7	E23	0.6
070961	<0.2	<0.2	<0.4	1	<0.6	2	0.5	2	<0.4

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	1,1-Dichloro-ethylene, unfiltered (μg/L)	Dichloro-difluoro-methane, unfiltered (μg/L)	1,2-Dichloro-propane, unfiltered (μg/L)	1,3-Dichloro-propane, unfiltered (μg/L)	2,2-Dichloro-propane, unfiltered (μg/L)	1,1-Dichloro-2-propanone, unfiltered (μg/L)	1,1-Dichloro-propylene, unfiltered (μg/L)	cis-1,3-Dichloro-propylene, unfiltered (μg/L)	trans-1,3-Dichloro-propylene, unfiltered (μg/L)
070358	1	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070359	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070363	0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070366	<0.33	<0.53	<0.49	<0.54	<0.45	<0.94	<0.41	<0.51	<0.59
070367	0.6	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070368	<0.33	<0.53	<0.49	<0.54	<0.45	<0.94	<0.41	<0.51	<0.59
070372	0.8	<0.8	1	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070373	<0.5	E0.2	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070375	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070528	1	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070570	<0.5	<0.8	0.5	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070571	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070851	2	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070852	1	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070853	5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070854	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070855	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070856	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070906	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070907	9	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070908	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070909	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070910	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070911	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070912	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070913	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070914	<0.4	<0.8	0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070915	1	<0.8	0.4	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070916	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070917	10	<0.8	0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070918	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070919	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070920	3	<0.8	0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070921	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070922	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070923	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070924	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070925	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070926	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070927	2	<0.8	2	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070928	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070929	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070930	<0.12	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070931	E10	<0.8	0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070940	E3,580	<0.3	<0.17	<0.39	<0.25	<0.39	<0.19	<0.26	<0.31
070942	1	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070943	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070946	<0.5	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070947	12	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070949	4	<0.8	<0.3	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070957	<0.5	<0.8	1	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070958	<0.5	<0.8	0.4	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070959	<0.5	<0.8	0.6	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070960	E0.3	7	<2	<0.2	<0.5	<1	<0.6	<0.2	<0.2
070961	<0.5	<0.8	E0.2	<0.2	<0.5	<1	<0.6	<0.2	<0.2

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Ethyl-benzene, unfiltered (μg/L)	Ethylether, unfiltered (μg/L)	Ethyl meth-acrylate, unfiltered (μg/L)	Hexa-chloro-butadiene, unfiltered (μg/L)	Hexa-chloro-ethane, unfiltered (μg/L)	2-Hexanone, unfiltered (μg/L)	Isopropyl-benzene, unfiltered (μg/L)	p-Isopropyl-toluene, unfiltered (μg/L)	Methacrylo-nitrile, unfiltered (μg/L)
070358	<0.5	E0.09	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070359	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070363	<0.5	E0.1	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070366	<0.3	0.89	<0.64	<0.52	<0.46	<1.26	<0.33	<0.37	<0.63
070367	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070368	<0.3	<0.44	<0.64	<0.52	<0.46	<1.26	<0.33	<0.37	<0.63
070372	<0.5	E0.1	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070373	<0.5	0.8	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070375	<0.5	E0.07	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070528	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070570	E0.3	<7	<0.5	<0.5	<0.3	<0.5	0.6	<0.5	<0.5
070571	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070851	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070852	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070853	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070854	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070855	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070856	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070906	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070907	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070908	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070909	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070910	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070911	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070912	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070913	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070914	<0.5	<0.1	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070915	<0.5	E0.3	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070916	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070917	<0.5	E0.09	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070918	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070919	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070920	<0.5	E0.1	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070921	<0.5	E0.1	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070922	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070923	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070924	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070925	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070926	<0.5	<0.6	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070927	<0.5	E24	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070928	E1,000	<0.5	<0.5	<0.5	<0.3	4	E190	E40	<0.5
070929	3	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070930	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070931	<0.5	E0.2	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070940	<0.11	<0.32	<0.55	<0.12	<0.14	<0.53	<0.08	<0.11	<0.88
070942	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070943	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070946	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070947	<0.5	<0.5	0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070949	<0.5	<0.5	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070957	<0.5	7	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070958	E52	11	<0.5	<0.5	<0.3	8	6	E0.5	<0.5
070959	<0.5	17	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070960	<0.5	2	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5
070961	<0.5	2	<0.5	<0.5	<0.3	<0.5	<0.6	<0.5	<0.5

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Methyl acrylate, unfiltered (μg/L)	Methyl bromide, unfiltered (μg/L)	Methyl tert-butyl ether (MTBE), unfiltered (μg/L)	Methyl chloride, unfiltered (μg/L)	Methylene chloride, unfiltered (μg/L)	Methyl ethyl ketone, unfiltered (μg/L)	Methyl iodide, unfiltered (μg/L)	Methyl isobutyl ketone, unfiltered (μg/L)	Methyl meth-acrylate, unfiltered (μg/L)
070358	<0.5	<0.6	0.6	<0.7	<0.4	K0.6	<0.6	<1	<0.5
070359	<0.45	<0.57	0.86	<0.67	<0.28	<0.55	<0.34	<0.49	<0.47
070363	<0.5	<0.6	0.8	<0.7	<0.4	0.7	<0.6	<1	<0.5
070366	<0.39	<0.33	2.7	<1.04	<0.44	0.79	<0.45	<0.93	<0.63
070367	<0.5	<0.6	0.7	<0.7	<0.4	2	<0.6	<1	<0.5
070368	<0.39	<0.33	0.71	<1.04	<0.44	<0.48	<0.45	<0.93	<0.63
070372	<0.5	<0.6	19	<0.7	<0.4	0.9	<0.6	<1	<0.5
070373	<0.5	<0.6	0.7	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070375	<0.5	<0.6	0.8	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070528	<0.5	<0.6	E0.5	<0.7	<0.4	1	<0.6	<1	<0.5
070570	<0.5	<0.6	0.7	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070571	<0.5	<0.6	<0.5	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070851	<0.5	<0.6	3	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070852	<0.5	<0.6	5	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070853	<0.5	<0.6	<0.5	<0.7	<0.4	K0.9	<0.6	<1	<0.5
070854	<0.5	<0.6	E0.3	<0.7	<0.4	K0.8	<0.6	<1	<0.5
070855	<0.45	<0.57	0.85	<0.67	<0.28	<0.55	<0.34	<0.49	<0.47
070856	<0.45	<0.57	<0.52	<0.67	<0.28	K0.56	<0.34	<0.49	<0.47
070906	<0.5	<0.6	E0.5	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070907	<0.5	<0.6	6	<0.7	<0.4	K0.7	<0.6	<1	<0.5
070908	<0.5	<0.6	2	<0.7	<0.4	K0.6	<0.6	<1	<0.5
070909	<0.5	<0.6	<0.5	<0.7	<0.4	0.6	<0.6	<1	<0.5
070910	<0.5	<0.6	0.8	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070911	<0.45	<0.57	<0.52	<0.67	<0.28	1.3	<0.34	<0.49	<0.47
070912	<0.45	<0.57	1	<0.67	<0.28	<0.55	<0.34	<0.49	<0.47
070913	<0.5	<0.6	E0.4	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070914	<0.5	<0.6	<0.5	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070915	<0.5	<0.6	E0.2	<1	<0.4	1	<0.6	<1	<0.5
070916	<0.45	<0.57	<0.52	<0.67	<0.28	K1.1	<0.34	<0.49	<0.47
070917	<0.5	<0.6	E0.2	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070918	<0.45	<0.57	<0.52	<0.67	<0.28	<0.55	<0.34	<0.49	<0.47
070919	<0.5	<0.6	E0.3	<0.7	0.4	<0.5	<0.6	<1	<0.5
070920	<0.5	<0.6	E0.2	<0.7	0.4	K0.6	<0.6	<1	<0.5
070921	<0.5	<0.6	0.8	<0.7	<0.4	K0.6	<0.6	<1	<0.5
070922	<0.5	<0.6	E0.3	<0.7	<0.4	K0.5	<0.6	<1	<0.5
070923	<0.5	<0.6	2	E0.1	<0.4	<0.5	<0.6	<1	<0.5
070924	<0.5	<0.6	2	1	<0.4	1	<0.6	<1	<0.5
070925	<0.5	<0.6	2	<0.7	<0.4	K0.6	<0.6	<1	<0.5
070926	<0.5	<0.6	0.9	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070927	<0.5	<0.6	E0.3	<0.7	0.5	K0.5	<0.6	<1	<0.5
070928	<0.5	<0.6	<0.5	<0.7	<0.4	K6	<0.6	<1	<0.5
070929	<0.5	<0.6	0.8	<0.7	<0.4	K0.8	<0.6	<1	<0.5
070930	<0.45	<0.57	<0.52	<0.67	<0.28	<0.55	<0.34	<0.49	<0.47
070931	<0.5	<0.6	E0.3	1	<0.4	<0.5	<0.6	<1	<0.5
070940	<0.45	<0.57	4	<0.67	<0.28	0.62	<0.34	<0.49	<0.47
070942	<0.5	<0.6	E0.3	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070943	<0.5	<0.6	<0.5	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070946	<0.5	<0.6	0.6	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070947	<0.5	<0.6	E0.5	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070949	<0.5	<0.6	0.6	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070957	<0.5	<0.6	3	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070958	<0.5	<0.6	0.9	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070959	<0.5	<0.6	1	<0.7	<0.4	<0.5	<0.6	<1	<0.5
070960	<0.5	<0.6	1	<0.7	4	<0.5	<0.6	<1	<0.5
070961	<0.5	<0.6	1	E0.5	<0.4	<0.5	<0.6	<1	<0.5

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Naphthalene, unfiltered (μg/L)	Nitrobenzene, unfiltered (μg/L)	2-Nitropropane, unfiltered (μg/L)	Pentachloroethane, unfiltered (μg/L)	Propionitrile, unfiltered (μg/L)	n-Propylbenzene, unfiltered (μg/L)	Styrene, unfiltered (μg/L)	1,1,1,2-Tetrachloroethane, unfiltered (μg/L)	1,1,2,2-Tetrachloroethane, unfiltered (μg/L)
070358	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070359	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070363	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070366	<0.52	<1.54	<0.88	<0.71	<0.64	<0.92	<0.23	<0.48	<0.73
070367	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070368	<0.52	<1.54	<0.88	<0.71	<0.64	<0.92	<0.23	<0.48	<0.73
070372	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.2	<0.2
070373	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070375	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070528	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070570	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070571	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070851	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070852	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070853	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070854	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070855	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070856	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070906	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070907	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070908	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070909	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070910	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070911	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070912	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070913	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070914	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070915	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070916	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070917	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070918	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070919	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070920	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070921	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070922	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070923	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070924	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070925	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070926	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070927	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070928	E390	<1	<0.4	<0.3	<0.8	E500	<0.3	<0.3	<0.2
070929	<4	<1	<0.4	<0.3	<0.8	E0.4	<0.3	<0.3	<0.2
070930	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070931	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070940	<0.48	<1.19	<0.68	<0.12	<0.63	<0.08	<0.15	<0.22	<0.56
070942	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070943	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070946	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070947	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070949	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070957	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070958	E12	<1.1	<0.4	<0.3	<0.8	4	<0.3	<0.3	<0.2
070959	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070960	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2
070961	<0.2	<1	<0.4	<0.3	<0.8	<0.5	<0.3	<0.3	<0.2

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	Tetra-chloro-ethylene (PCE), unfiltered (μg/L)	Tetra-hydrofuran, unfiltered (μg/L)	Toluene, unfiltered (μg/L)	1,2,3-Trichloro-benzene, unfiltered (μg/L)	1,2,4-Trichloro-benzene, unfiltered (μg/L)	1,1,1-Trichloro-ethane, unfiltered (μg/L)	1,1,2-Trichloro-ethane, unfiltered (μg/L)	Trichloro-ethylene (TCE), unfiltered (μg/L)	Trichloro-fluoro-methane, unfiltered (μg/L)
070358	<0.5	<0.7	<0.4	<0.3	<0.4	2	<0.2	10	<0.6
070359	<0.45	<0.37	<0.1	<0.35	<0.28	0.99	<0.36	2.7	<0.1
070363	<0.5	<0.7	<0.4	<0.3	<0.4	0.8	<0.2	4	<0.6
070366	0.95	<0.82	<0.21	<0.43	<0.35	<0.44	<0.48	12	<0.84
070367	<0.5	<0.7	<0.4	<0.3	<0.4	1	<0.2	4	<0.6
070368	<0.37	<0.82	<0.21	<0.43	<0.35	<0.44	<0.48	<0.29	<0.84
070372	E32	<0.7	<0.4	<0.3	<0.4	0.8	<0.2	E29	E0.2
070373	1	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	5	E0.2
070375	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070528	<0.5	<0.7	<0.4	<0.3	<0.4	1	<0.2	6	<0.6
070570	E0.5	2	<0.4	<0.3	0.4	<0.5	<0.2	2	<0.6
070571	4	<0.7	<0.4	<0.3	<0.4	E0.2	<0.2	E0.2	<0.6
070851	2	<0.7	<0.4	<0.3	<0.4	6	<0.2	16	<0.6
070852	0.6	<0.7	<0.4	<0.3	<0.4	2	<0.2	E35	<0.6
070853	5	<0.7	<0.4	<0.3	<0.4	8	0.3	E51	<0.6
070854	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070855	<0.45	<0.37	<0.1	<0.35	<0.28	13	<0.36	12	<0.1
070856	<0.45	<0.37	<0.1	<0.35	<0.28	<0.07	<0.36	<0.14	<0.1
070906	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070907	E280	<0.7	<0.4	<0.3	<0.4	6	<0.2	E76	<0.6
070908	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070909	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070910	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070911	<0.45	<0.37	<0.1	<0.35	<0.28	2.4	<0.36	1.3	<0.1
070912	<0.45	<0.37	<0.1	<0.35	<0.28	<0.07	<0.36	3	<0.1
070913	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	0.5	<0.6
070914	<0.5	<0.7	<0.4	<0.3	<0.4	E0.4	<0.2	E140	<0.6
070915	1	<0.7	<0.4	<0.3	<0.4	1	<0.2	18	<0.6
070916	<0.45	<0.37	<0.1	<0.35	<0.28	<0.07	<0.36	<0.14	<0.1
070917	3	<0.7	<0.4	<0.3	<0.4	11	0.2	E48	<0.6
070918	<0.45	<0.37	<0.1	<0.35	<0.28	<0.07	<0.36	0.91	<0.1
070919	E0.4	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	E0.1	<0.6
070920	1	<0.7	<0.4	<0.3	<0.4	3	<0.2	17	<0.6
070921	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070922	3	<0.7	<0.4	<0.3	<0.4	E0.1	<0.2	E0.4	<0.6
070923	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070924	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070925	<0.5	<0.7	<0.4	<0.3	<0.4	E0.1	<0.2	<0.4	<0.6
070926	E0.3	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	E0.1	<0.6
070927	11	13	<0.4	<0.3	E0.2	0.7	<0.2	E130	<0.6
070928	<0.5	<0.7	E1,500	<0.3	<0.4	<0.5	<0.2	E24	<0.6
070929	<0.5	<0.7	3	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070930	E0.28	<0.37	<0.1	<0.35	<0.28	0.76	<0.36	16	<0.1
070931	4	<0.7	<0.4	<0.3	<0.4	9	<0.2	E93	<0.6
070940	7.8	<0.37	<0.1	<0.35	<0.28	E12,500	4.4	20	<0.1
070942	2	<0.7	<0.4	<0.3	<0.4	2	<0.2	11	<0.6
070943	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	9	<0.6
070946	<0.5	<0.7	<0.4	<0.3	<0.4	<0.5	<0.2	<0.4	<0.6
070947	<0.5	<0.7	<0.4	<0.3	<0.4	E52	<0.2	E20	<0.6
070949	<0.5	<0.7	<0.4	<0.3	<0.4	17	<0.2	E310	E0.5
070957	E0.5	<4	<0.4	<0.3	<0.4	<0.5	<0.2	0.5	<0.6
070958	<0.5	E40	2	0.3	0.8	<0.5	<0.2	1	<0.6
070959	E0.5	4	<0.4	<0.3	<0.4	<0.5	<0.2	0.8	<0.6
070960	15	<0.7	<0.4	<0.3	<0.4	E0.4	<0.2	18	<0.6
070961	0.6	1	<0.4	<0.3	<0.4	<0.5	<0.2	0.9	<0.6

Table 3-2. Analyses of ground-water samples collected from selected wells, Pennsauken Township and vicinity, Camden County, New Jersey, December 1, 1997-May 14, 1998--Continued

USGS well number	1,2,3-Trichloro-propane, unfiltered (μg/L)	1,2,4-Trimethyl-benzene, unfiltered (μg/L)	1,3,5-Trimethyl-benzene, unfiltered (μg/L)	Vinyl chloride, unfiltered (μg/L)	1,3-Xylene + 1,4-Xylene, unfiltered (μg/L)	o-Xylene, unfiltered (μg/L)
070358	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070359	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070363	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070366	<0.68	<0.25	<0.17	<0.46	<0.29	<0.34
070367	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070368	<0.68	<0.25	<0.17	<0.46	<0.29	<0.34
070372	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070373	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070375	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070528	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070570	<0.3	<0.4	<0.5	<0.6	<0.9	0.5
070571	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070851	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070852	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070853	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070854	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070855	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070856	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070906	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070907	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070908	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070909	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070910	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070911	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070912	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070913	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070914	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070915	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070916	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070917	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070918	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070919	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070920	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070921	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070922	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070923	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070924	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070925	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070926	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070927	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070928	<0.3	E1,300	E660	<0.6	E2,100	E1,700
070929	<0.3	4	0.6	<0.6	7	5
070930	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070931	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070940	<0.44	<0.11	<0.09	<0.21	<0.2	<0.09
070942	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070943	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070946	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070947	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070949	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070957	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070958	<0.3	13	1	<0.6	E37	10
070959	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4
070960	<0.3	<0.4	<0.5	4	<0.9	<0.4
070961	<0.3	<0.4	<0.5	<0.6	<0.9	<0.4

APPENDIX 4. Ground-water withdrawals in Pennsauken Township and vicinity, Camden County, New Jersey, 1956-96

[USGS, U.S. Geological Survey; all values in million gallons; --, well removed from service; ---, well not installed]

USGS well number	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
050123	---	---	---	---	---	---	---	---	---	---	---	---	---	---	15.511	50.11	25.02	23.96	74.93	88.75
050124	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.852	6.63	15.48	11.44	15.83	14.54
050125	---	---	---	---	116.6	116.6	143.4	173.05	191.35	145.13	61.65	77.71	74.6	42.37	48.55	69.25	116.05	114.38	152.17	131.6
050126	---	---	---	---	---	116.6	143.4	173.05	191.35	145.13	61.65	77.71	74.6	42.37	48.55	69.25	116.05	114.38	152.1	131.6
050130	---	---	---	---	---	---	---	---	148.06	294.9	224.06	288.1	275.9	333.9	322.4	324.8	298.9	268.1	224	262
050131	---	---	---	---	---	---	---	---	---	---	37.19	107.48	174	203.97	201.2	84.79	101.4	158.86	150.41	66.12
050231	---	---	---	---	---	27.89	114.98	126.67	141.06	138.96	117.49	122.47	132.62	0	190.74	94.608	199	133.9	253.1	33.74
050232	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0	129.2
050233	115.02	146.83	146.31	170.3	175.6	161.4	115	126.68	141.06	139.26	117.38	122.47	132.72	220.1	190.2	307.6	275.9	222.5	277.7	146
050350	---	---	---	---	---	217.8	311.4	329.1	195.38	58.43	76.07	36.12	14.75	16.81	17.41	10.72	14..01	26.20	0	0
050729	124.57	147.13	146.31	170.3	175.5	161.3	108.87	126.68	141.06	139.56	117.37	122.37	132.62	110.17	151.43	64.12	67.75	135.3	105.08	82.08
050746	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070061	336.4	378.4	374.4	351.3	304.5	329.3	258.1	262.7	270.6	328.1	372.4	362.2	408.5	435.6	348.6	376.5	336.5	0	0	0
070064	320.6	342.6	404.9	485.9	548.5	558.3	517.7	453.9	511.2	437	455.3	512.4	516.4	483.1	523.7	511.9	482.5	514.9	514.9	463
070068	334.2	339	503	699.8	723.9	664.3	599.9	484.3	517.3	477	438.2	518.7	503	497.3	486.1	522.5	524.5	509.3	509.2	378.3
070070	356.2	382	388.8	260.8	243.3	279.2	122.8	143.5	182.3	199.5	158.5	93.3	83.3	137.7	78.1	105.5	137.1	160.8	160.8	17.3
070078	206.0	353	220.3	300.7	245.9	191.1	102.8	159.2	215.1	321	324.4	352	365.7	345.3	400.5	361.6	376.9	299	299	227.8
070083	321.8	321.7	297.8	225.1	210.3	150.7	210.8	216.9	192.5	186.4	167.8	101.7	181.9	283.6	272.9	226.2	166.8	296.9	296.9	226.4
070090	324.4	167.7	284.2	271.1	310.4	302.9	156.2	185.2	140.4	228.3	269.2	317.8	269.1	293.7	344.5	356.6	0	18.96	18.96	74.33
070094	300.9	330	318	342.6	332	315.4	190.2	139.7	178.5	193.8	196.1	273.7	266.7	320.3	340.9	404	412	388.4	388.4	225.8
070097	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070098	---	---	---	---	---	---	---	---	---	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070104	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070106	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070107	---	---	---	---	---	---	---	---	---	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070108	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070109	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070110	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070111	---	---	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070112	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27

Appendix 4. Ground-water withdrawals in Pennsauken Township and vicinity, Camden County, New Jersey, 1956-96--Continued

USGS well number	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
070113	160.3	202.38	153.86	172.28	160.42	154.2	156.57	168.44	165.96	119.95	121.5	116.28	120.02	42.56	117.18	126.16	122.64	129.64	143.91	140.27
070157	---	---	---	---	---	---	---	---	---	---	---	9.18	61.68	57.24	56.88	54.24	29.52	43.8	42.48	53.4
070162	---	---	---	---	---	2.80	7.2	8.4	26.04	15	5.58	7.15	0	5.45	113.04	0.17	0	0	1.12	0
070163	---	---	---	---	0.14	11.20	28.68	33.48	1035.6	60	92.76	28.32	126	110.40	113.04	189.6	226.8	139.2	44.64	9.72
070175	219.67	20.6	251.4	269.43	146.34	146.86	155.62	169.8	204.56	106	108.92	106.94	112.96	108.5	93.36	113.7	124.82	105.84	100.82	105.24
070176	---	---	---	---	146.34	146.86	155.62	169.8	204.56	106	108.92	106.94	112.96	108.5	93.36	113.7	124.82	105.84	100.82	105.24
070177	219.67	20.6	251.4	269.43	146.34	146.86	155.62	169.8	204.56	106	108.92	106.94	112.96	108.5	93.36	113.7	124.82	105.84	100.82	105.24
070178	---	---	---	---	146.34	146.86	155.62	169.8	204.56	106	108.92	106.94	112.96	108.5	93.36	113.7	124.82	105.84	100.82	105.24
070179	219.67	20.6	251.4	269.43	146.34	146.86	155.62	169.8	204.56	106	108.92	106.94	112.96	108.5	93.36	113.7	124.82	105.84	100.82	105.24
070288	88.3	100.8	99.4	118.4	127.47	125.57	122.43	124.97	132.63	111.8	107.73	117.47	119.2	128.67	107.57	83.88	25.70	33.57	90.43	27.78
070289	88.3	100.8	99.4	118.4	127.47	125.57	122.43	124.97	132.63	111.8	107.73	117.47	119.2	128.67	107.57	83.88	25.70	33.57	90.43	27.78
070290	88.3	100.8	99.4	118.4	127.47	125.57	122.43	124.97	132.63	111.8	107.73	117.47	---	---	---	---	---	---	---	---
070291	---	---	---	---	---	---	---	---	---	---	---	---	119.2	128.67	107.57	83.88	25.70	33.57	90.43	27.78
070292	---	---	---	---	---	---	---	---	---	0	0	0.411	16.44	32.72	51.64	252.9	445.7	501.4	481.3	478.20
070319	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	141.25	309.3	296.05	238.3	259.2
070325	---	---	---	0	0	52.09	82.65	83.99	69.75	--	--	--	--	--	--	--	--	--	--	--
070326	---	---	---	0	0	52.09	82.65	83.99	69.75	52.44	133.85	185.9	182.5	197.25	150.15	--	--	--	--	--
070329	---	---	---	---	---	---	---	---	---	52.44	133.85	185.9	182.5	197.25	150.15	141.25	309.3	296.05	238.3	259.2
070329	---	---	---	---	---	---	---	---	---	52.44	133.85	185.9	182.5	197.25	150.15	141.25	309.3	296.05	238.3	259.2
070332	---	---	---	---	---	---	---	172.6	188	192.75	160.50	146.8	187.3	198.8	248.75	217.65	123.65	169.65	169.75	140.4
070335	---	123.3	290.2	333.2	277.2	273.8	328.2	172.6	188	192.75	160.50	146.8	187.3	198.8	248.75	217.65	123.65	169.65	169.75	140.4
070341	258.85	337.3	235.2	227.7	299.5	308.4	346.2	453.5	477.5	542.1	576.8	556.6	237.95	264.85	313.05	276.6	258.8	269.6	252.1	210.75
070341	258.85	337.3	235.2	227.7	299.5	308.4	346.2	453.5	488.5	542.1	576.8	556.6	237.95	264.85	313.05	276.6	258.8	269.6	252.1	210.75
070342	---	---	---	---	---	---	---	---	---	---	---	---	237.95	264.85	313.05	276.6	258.8	269.6	252.1	210.75
070345	144.2	153.26	133.76	154.86	168.24	171.38	191.32	196.98	186.84	191.08	199.42	168.38	183.52	165.6	183.56	192.5	144.82	105.02	114.88	90.86
070346	144.2	153.26	133.76	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070347	144.2	153.26	133.76	154.86	168.24	171.38	191.32	196.98	186.84	191.08	199.42	168.38	183.52	165.6	183.56	192.5	144.82	105.02	114.88	90.86
070348	---	---	---	154.86	168.24	171.38	191.32	196.98	186.84	191.08	199.42	168.38	183.52	165.6	183.56	192.5	144.82	105.02	114.88	90.86
070349	144.2	153.26	133.76	154.86	168.24	171.38	191.32	196.98	186.84	191.08	199.42	168.38	183.52	165.6	183.56	192.5	144.82	105.02	114.88	90.86
070350	144.2	153.26	133.76	154.86	168.24	171.38	191.32	196.98	186.84	191.08	199.42	168.38	183.52	165.6	183.56	192.5	144.82	105.02	114.88	90.86

Appendix 4. Ground-water withdrawals in Pennsauken Township and vicinity, Camden County, New Jersey, 1956-96--Continued

USGS well number	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
070358	---	---	---	---	---	---	---	---	---	---	---	---	---	---	347.8	425.6	474.8	401	401	0
070359	331	315.42	295.78	288.94	316.7	365.26	415.8	426.16	444.4	431.4	443	437.2	435	411.2	347.8	425.6	474.8	401	401	478
070361	331	315.42	295.78	288.94	316.7	365.26	415.8	426.16	444.4	431.4	443	437.2	435	411.2	347.8	--	--	--	--	--
070363	331	315.42	295.78	288.94	316.7	365.26	415.8	426.16	444.4	431.4	443	437.2	435	411.2	347.8	425.6	474.8	401	401	478
070366	331	315.42	295.78	288.94	316.7	365.26	415.8	426.16	444.4	431.4	443	437.2	435	411.2	347.8	425.6	474.8	401	401	478
070367	331	315.42	295.78	288.94	316.7	365.26	415.8	426.16	444.4	431.4	443	437.2	435	411.2	347.8	425.6	474.8	401	401	478
070367	331	315.42	295.78	288.94	316.7	365.26	415.8	426.16	444.4	431.4	443	437.2	435	411.2	347.8	425.6	474.8	401	401	478
070368	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070369	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070370	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070372	---	---	---	---	---	---	---	---	---	---	---	56	314.8	327.7	307.8	291.2	284.6	359.1	351.5	353.5
070373	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070374	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070375	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070377	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070379	---	---	---	---	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070382	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070386	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070387	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	--
070388	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070390	182.4	149.2	142.8	137.9	85.23	122.5	195.6	233.7	226	203	224.4	235.2	233.9	255.1	269.1	318.4	287.3	292.3	292.3	369.3
070527	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070528	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	478
070530	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070545	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070547	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070586	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070587	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070597	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070602	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070674	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070723	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
070724	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Appendix 4. Ground-water withdrawals in Pennsauken Township and vicinity, Camden County, New Jersey, 1956-96--Continued

USGS well number	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
050123	98.26	62.04	34.49	33.35	70.78	53.79	38.81	69.16	20.37	87.50	168.16	57.53	84.67	116.53	97.19	72.14	187.88	273.57	232.38	270.87	204.87
050124	21.07	19.51	21.35	8.10	22.07	7.29	10.58	187.51	0	205.03	135.1	28.59	24.46	2.50	68.53	49.06	193.99	179.71	436.01	402.80	174.21
050125	94.45	129.36	90.86	143.29	92.26	50.81	91.56	122.37	110.23	114.17	135.18	51.03	71.21	3.08	8.24	9.65	41.74	104.61	162.30	51.82	19.62
050126	94.45	129.36	90.86	143.29	92.26	50.81	91.56	122.37	110.23	114.17	135.18	51.03	71.21	3.08	8.24	9.65	53.22	17.8	2.02	6.01	15.65
050130	235.1	214.6	209	221.5	215.91	277.12	241.9	66.11	11.42	0	32.84	70.50	117.15	191.02	37.88	90.95	93.62	64.48	65.19	115.17	188.49
050131	231.79	92.71	49.73	61.02	165.17	110.32	48.9	0.91	19.87	0	7.82	288.24	421.15	336.43	327.7	319.60	325.72	274.31	270.18	262.28	291.36
050231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
050232	236.43	208.94	119.49	0	0	286.63	281.62	288.70	294.80	268.85	313.73	207.25	259.52	225.65	219.89	243.95	115.79	237.38	140.41	62.38	201.44
050233	0	86.42	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--	--	--	--	--
050350	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
050729	37.66	33.11	20	0	0	0	0	0	0	0	0	29.505	7.5	0.322	7.85	0.002	0.022	39.62	33.30	11.58	9.58
050746	---	---	140.21	258.90	256.10	286.63	281.62	288.70	294.80	437.03	438.40	427.62	310.95	255.05	274.87	321.11	402.97	146.51	201.22	366.62	347.00
070061	0	77.5	145.8	224.3	291	63.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
070064	469	251	152.8	375.3	436.7	466.5	466.7	434	857.6	844.6	530.1	511.1	465.0	413.3	342.8	297.2	288.3	256.0	147.4	122	0
070068	363.1	314.7	373.6	341.3	242.5	388.7	7.99	224.6	415.8	380.6	219.0	190.2	151.8	114.0	75.1	46.2	24.4	13.1	43.0	0	0
070070	217.2	5.14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070078	376.9	323.6	217.3	267.7	273.7	130.3	293.0	83	0	0	0	0	0	0	0	0	0	0	0	0	0
070083	314.8	209.5	18.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
070090	136.1	217.4	59.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070094	52.8	45.0	185.4	11.24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
070097	129.45	129.55	133.36	148.73	152.73	140.45	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--
070098	129.45	129.55	133.36	148.73	152.73	140.45	462.34	190.97	316.31	256.03	320.53	315.08	316.51	193.34	10	51.46	46.24	235.74	325.46	260.43	204.04
070104	129.45	129.55	133.36	148.73	152.73	140.45	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--
070106	129.45	129.55	133.36	148.73	152.73	140.45	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070107	129.45	129.55	133.36	148.73	152.73	140.45	549.68	209.76	77.79	85.33	196.70	210.05	222.94	245.54	40.31	26.51	0.42	26.38	1.68	0	0
070108	129.45	129.55	133.36	148.73	152.73	140.45	0	0	0	0	0	0	0	--	--	--	--	--	--	--	--
070109	129.45	129.55	133.36	148.73	152.73	140.45	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070110	129.45	129.55	133.36	148.73	152.73	140.45	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070111	129.45	129.55	133.36	148.73	152.73	140.45	0	6.93	1.58	0	0	0	0	168.38	23.50	0	0	0	0	0	0
070112	129.45	129.55	133.36	148.73	152.73	140.45	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Appendix 4. Ground-water withdrawals in Pennsauken Township and vicinity, Camden County, New Jersey ,1956-96--Continued

USGS well number	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
																					0
070162	0	0	0	0	0	0	0	122.45	0	0	0	0	0	0	0	0	0	0	0	0	0
070163	27.6	38.04	0	1.68	18.6	0	20.15	47.21	0.482	0.462	48.81	34.59	78.57	2.43	22.30	32.21	28.54	43.64	27.05	25.44	0
070175	114.38	123.53	132.67	141.82	150.96	159.48	159.30	172.61	165.97	0	0	0	0	0	8.14	325.28	13.17	196.40	16.63	3.23	1.095
070176	114.38	123.53	132.67	141.82	150.96	159.48	159.30	172.61	165.97	70.65	12.79	45.05	9.47	13.95	8.14	27.98	13.17	0	1.96	3.23	0
070177	114.38	123.53	132.67	141.82	150.96	159.48	159.30	172.61	165.97	207.92	82.36	198.67	148.06	42.54	64.13	80.39	0.03	99.03	285.28	126.83	24.08
070178	114.38	123.53	132.67	141.82	150.96	159.48	159.30	172.61	165.97	103.88	418.65	313.13	200.92	214.06	237.63	275.76	197.93	351.73	1.96	271.97	306.33
070179	114.38	123.53	132.67	141.82	150.96	159.48	159.30	172.61	165.97	428.43	359.87	331.69	410.63	400.46	339.04	0	313.25	0	305.67	260.87	295.69
070288	54.24	65.06	55.48	97.26	114.4	71.42	124.00	215.90	232.37	237.97	141.11	40.48	66.67	75.71	82.62	0	0	0	--	--	--
070289	54.24	65.06	55.48	97.26	114.4	69.58	98.48	85.72	129.80	145.91	75.68	109.16	94.42	106	117.06	0	0	0	--	--	--
070290	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070291	54.24	65.06	55.48	97.26	114.4	169.04	177.75	89.11	59.92	9.67	142.95	179.77	179.37	206.95	228.55	178.85	157.31	118.173	211.36	273.33	274.73
070292	449.90	401.90	421.33	181.17	190.86	158.85	107.04	146.31	0	80.72	136.57	99.95	102.05	116.09	128.21	127.57	63.23	135.21	77.74	65.52	40.82
070319	247.65	176.95	188.5	163.6	137.35	7.60	0	122.29	206.50	260.53	78.21	268.62	364.29	327.45	335.3	284.64	237.21	305.80	221.07	91.46	277.87
070325	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070326	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070329	247.65	176.95	188.5	163.6	137.35	284.95	318.9	253.06	231.96	260.53	357.06	268.62	338.50	327.45	335.3	349.77	270.218	240.96	227.65	227.8	0
070329	247.65	176.95	188.5	163.6	137.35	284.95	318.9	253.06	231.96	260.53	357.06	268.62	338.50	327.45	335.3	349.77	270.21	240.96	227.65	227.8	0
070332	177.7	223.65	170.1	175.4	207.1	270.44	230.55	146.24	149.33	254.18	164.39	225.68	381.80	196.47	129.80	22.26	106.725	104.17	110.19	348.15	303.94
070335	177.7	223.65	170.1	175.4	207.1	169.98	234.48	298.98	288.70	254.18	268.23	225.68	141.486	196.47	129.80	72.901	277.42	316.04	280.89	115.76	139.93
070341	248.45	177.03	206.55	210.99	135.8	41.89	15.08	70.93	85.06	88.96	67.15	42.99	20.77	10.91	10.82	0	0	0	0	0	0
070341	248.45	177.03	206.55	210.99	135.8	41.89	15.08	70.93	85.06	88.96	67.15	42.99	20.77	10.91	10.82	0	0	0	0	0	0
070342	248.45	177.03	206.55	210.99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
070345	117.4	123.96	198.18	154.04	182.18	132.39	149.29	162.38	146.54	188.09	164.95	144.00	134.77	133.16	153.59	162.78	111.38	114.13	125.70	127.38	151.68
070346	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070347	117.4	123.96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070348	117.4	123.96	198.18	154.04	182.18	132.39	149.29	162.38	146.54	188.09	164.95	144.00	134.77	133.16	153.59	162.78	111.38	114.13	125.70	127.38	151.68
070349	117.4	123.96	198.18	154.04	182.18	132.39	149.29	162.38	146.54	188.09	164.95	144.00	134.77	133.16	153.59	162.78	111.38	114.13	125.70	127.38	151.68
070350	117.4	123.96	198.18	154.04	182.18	132.39	149.29	162.38	146.54	188.09	164.95	144.00	134.77	133.16	153.59	162.78	111.38	114.13	0	0	0

Appendix 4. Ground-water withdrawals in Pennsauken Township and vicinity, Camden County, New Jersey, 1956-96--Continued

USGS well number	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
																					0
070358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
070359	475	404.3	399.4	411.2	418.2	390.99	313.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
070361	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070363	475	404.3	399.4	411.2	418.2	390.99	313.53	470.5	388.3	343.9	252.2	280	281.3	0	0	0	0	0	0	8.82	0
070366	475	404.3	399.4	411.2	418.2	390.99	313.53	470.5	388.3	343.9	252.2	280	281.3	599.53	679.25	674.895	681.408	683.28	636.64	605.71	603.88
070367	475	404.3	399.4	411.2	418.2	390.99	313.53	470.5	388.3	343.9	252.2	280	281.3	0	0	0	0	0	0	0	0
070367	475	404.3	399.4	411.2	418.2	390.99	313.53	470.5	388.3	343.9	252.2	280	281.3	0	0	0	0	0	0	0	0
070368	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	254.505	260.67	265.11	562.52	333.88
070369	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	249.537	251.82	390.8	376.66	333.88
070370	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	147.226	296.40	310.57	302.19	333.88
070372	350.8	351.4	319.9	320.6	326.2	461.5	433.09	471.99	138.27	241.47	34.53	198.82	0	229.22	227.14	323.6	309.83	355.02	266.85	175.23	0.271
070373	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	0	0	0	102.72	333.88
070374	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	238.23	329.28	287.55	231.16	333.88
070375	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	218.88	260.406	207.15	108.32	333.88
070377	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	513.293	527.37	507.53	486.88	333.88
070379	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	430.35	431.43	323.25	444.91	333.88
070382	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	31.59	121.88	62.1	324.66	333.88
070386	429.4	418.6	392.5	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	271.11	245.43	129.22	356.2	333.88
070387	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070388	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
070390	429.4	418.6	392.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	385.6	333.88
070527	0	0	509	483.6	455	311.0	344.0	352.5	747.9	797	541.8	566.6	559.9	541.5	490.0	464.5	499.3	525.8	615.49	564.7	201.8
070528	475	404.3	399.4	411.2	418.2	390.99	313.53	0	0	0	0	0	0	0	0	0	92.736	0	0	0	0
070530	---	---	---	154.04	182.18	132.39	149.29	162.38	146.54	188.09	164.95	144.00	134.77	133.16	153.59	162.78	111.38	114.13	125.70	127.38	151.68
070545	---	---	---	418.1	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	506.584	206.89	448.98	348.93	333.88
070547	---	---	---	---	---	---	0	485.48	400.82	470.66	398.95	341.33	278.24	272.10	308.71	242.12	201.68	215.28	97.87	130.67	154.66
070586	---	---	---	---	---	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	625.572	628.20	357.12	283.8	333.88
070587	---	---	---	---	427.4	322.33	366.10	422.25	412..52	424.83	279.40	283.01	271.11	254.48	223.64	303.18	626.616	622.512	625.6	622.71	333.88
070597	---	---	---	---	---	---	0	0	82.74	15.11	21.29	13.13	17.36	7.28	2.75	1.09	9.48	20.66	0.13	3.58	5.50
070602	---	---	---	---	---	---	0	36.74	323.77	241.47	327.86	198.82	483.03	229.22	227.14	115.542	113.473	51.99	215.31	329.363	306.04
070674	---	---	---	---	---	---	---	---	---	---	---	---	0	-0	-0	126.77	206.19	189.33	197.01	134.85	55.16
070723	---	---	---	---	---	---	---	---	---	---	---	---	0	0	0	122.99	152.87	111.99	45.48	67.84	143.63
070724	---	---	---	---	---	---	243.82	478.21	425.81	411.74	364.97	433.23	465.07	395.67	364.37	366.46	307.19	95.03	214.91	83.73	120.40

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