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WATER-RESOURCES INVESTIGATIONS REPORT 02-4280
Water quality in the Rancocas Creek study area--SHEET 4 OF 5
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WATER QUALITY

Results of chemical analyses of samples from 25 ground-water and 29 surface-water sites, presented in tables 4-1 and 4-2, respectively, were used to document the quality of ground water and surface water in the Rancocas Creek study area. All water-quality data presented on this sheet are results of analyses conducted by the USGS. Analyses of water samples were selected from the WATSTORE (National Water Data Storage and Retrieval System) database, which is maintained by the USGS. Water has the capacity, through various chemical processes, to dissolve and transport at least small amounts of almost all substances that it contacts (Heath, 1987, p. 64). Because samples are intended to represent ambient water-quality conditions, samples from wells or surface-water sites located near, or at, landfills and hazardous-waste sites or thought to be affected by contamination were not included in this report.

Ground-water samples were collected according to the methods described in Wood (1976) and Claassen (1982). Surface-water samples were collected at streamflow-gaging stations with the equal-discharge-increment method described in Ward and Harr (1990). Ground-water and surface-water samples were analyzed for major ions, nutrients, and trace elements; surface-water samples also were analyzed for bacteria. Water samples were analyzed according to the methods described by Fishman and Friedman (1989) and Wershaw and others (1987). The results of analyses of ground-water and surface-water samples are presented in tables 4-1 and 4-2, respectively.

Stiff diagrams for the 25 ground-water and 29 surface-water samples are plotted in figure 4-1. These diagrams show the relative concentrations, in milliequivalents per liter, of the major cations to the left of the vertical axis and of the major anions to the right of the vertical axis. Differences in the ionic composition of the samples can be evaluated by comparing the shapes of the figures. A value of zero was used for dissolved iron in 20 of the 29 surface-water Stiff diagrams because data for this constituent were unavailable. The nearly equal number of milliequivalents on the cation (+) and anion (-) sides of the diagrams, despite the absence of data for dissolved iron, indicates that iron is a minor constituent in surface water. Stiff diagrams that include values for dissolved iron support this conclusion. Concentrations of total nitrate plus nitrite were substituted for concentrations of dissolved nitrate plus nitrite in 23 of the 29 surface-water Stiff diagrams because data for the dissolved constituents were unavailable. Concentrations of dissolved nitrate were substituted for concentrations of dissolved nitrate plus nitrite in 2 of the 25 ground-water Stiff diagrams because data for dissolved and total nitrate plus nitrite were unavailable. These substitutions are justifiable for two reasons: (1) Nitrite generally is unstable in the natural waters of the study area and, thus, any nitrogen species is likely to be present only as nitrate; and (2) because nitrate is highly soluble in water, nearly all nitrate that is present is likely to be in the dissolved state, and the total-nitrate concentration is nearly equal to the dissolved-nitrate concentration. A value of zero was used for nitrate plus nitrite in five surface-water and two ground-water Stiff diagrams because neither total nor dissolved nitrate plus nitrite or nitrate data were available.

Results of ground-water analyses in table 4-1 were compared with U.S. Environmental Protection Agency (USEPA) drinking-water regulations established in accordance with the Safe Drinking Water Act (PL 93-523). Only one of the 23 ground-water samples analyzed for cadmium contained concentrations that exceeded 5.0 µg/L (micrograms per liter), which is the USEPA maximum contaminant level (MCL)[3] (U.S. Environmental Protection Agency, 1990a; U.S. Environmental Protection Agency, 1990b). No other constituents were present in the ground water in concentrations that exceeded USEPA's primary drinking-water regulations; however, concentrations of four constituents exceeded the USEPA secondary maximum contaminant level (SMCL)[4] (U.S. Environmental Protection Agency, 1990c). The SMCLs of 300 µg/L for iron and 50 µg/L for manganese were exceeded in samples from 7 and 6 of the 25 wells, respectively. The SMCL of 200 µg/L for aluminum was exceeded in samples from 4 of 16 wells. pH was lower than the SMCL range of 6.5 to 8.5 in 16 of the 25 ground-water samples.

USEPA drinking-water regulations do not apply to untreated surface water. Instead, the State of New Jersey has developed surface-water standards that vary with the use of a surface-water body or stream segment (New Jersey Department of Environmental Protection, 1994b). Because these standards vary across the Rancocas Creek study area, they are not used in this report as an index with which to compare surface-water quality.

Ground-Water

The chemical characteristics of ground water are controlled by temperature, pressure, duration of contact and geochemical reactions with lithologic materials, and human activities that introduce contaminants into the water. The quality of water in an unconfined aquifer system typically varies more than that in a confined aquifer system because of the water table's proximity to land surface and the absence of an overlying regional confining unit, which can impede the downward movement of surface-related constituents. Analyses of ground-water samples collected since 1980 from 25 wells and analyzed for major ions, nutrients, trace elements and bacteria were selected from the WATSTORE database. Ground-water sites were selected to represent the quality of water in the entire study area, although most of the wells are in three distinct areas: (1) in the outcrop of the Potomac-Raritan-Magothy aquifer system adjacent to the Delaware River and the Fall Line, (2) in the unconfined Kirkwood-Cohansey aquifer system in the southeastern part of the study area, and (3) north of the Fall Line in the northwestern part of study area. Water-quality data for the central part of the study area are limited because few wells there are screened in unconfined aquifers.

Ground-water-quality data can be related to the land use that surrounds the well, the well's location within the regional flow system, and the mineralogy of the local aquifer. Three land-use regions are found in the study area. The southeastern part, where the Kirkwood Formation and Cohansey Sand crop out, is forested with little agricultural or urban land (fig. 1-4). The central part, extending from northeast to southwest, includes the outcrops of several Coastal Plain hydrogeologic units and is primarily agricultural with some urban and forested areas. The northern and western parts of the study area, bordering the Delaware River and the Fall Line, are predominantly urban. This region includes the outcrops of the Potomac-Raritan-Magothy aquifers and several fractured-rock aquifers north of the Fall Line.

Despite the variations in their shapes, the Stiff diagrams indicate that calcium is the predominant cation in 12 of the 25 ground-water samples collected in the Rancocas Creek study area, and sodium plus potassium are the predominant cations in 10 of the 25 samples. The Stiff diagrams also indicate that sulfate is the predominant anion in 9 of the 25 ground-water samples, and bicarbonate is the predominant anion in 8 of the 25 samples. Of the constituents measured, the relative equivalent mass in most ground-water samples was lowest for dissolved iron, magnesium, chloride, and nitrate plus nitrite.

The Kirkwood-Cohansey aquifer system contains dilute, well-oxygenated, acidic waters that have little buffering capacity and therefore are susceptible to chemical input from human activities. The major-ion composition of water from wells in the southeastern part of the study area is similar to that of precipitation. The ionic composition of precipitation in southern New Jersey is dominated by sodium, chloride, and sulfate (Lord and others, 1990). The water samples from the Kirkwood-Cohansey aquifer system in forested areas contain predominantly sodium cations balanced with chloride anions. Concentrations of all constituents were slightly higher in water from well 5-1092 than in water from the other wells, possibly because land use near the well is highly urban. Water samples from the Kirkwood-Cohansey aquifer system have the lowest relative equivalent mass of dissolved ions in the study area. All wells in this area are in regional recharge areas, and would be expected to contain low concentrations of all constituents analyzed for because the water has been in contact with the aquifer material only a short time.

Water-quality data for the central part of the study area are extremely limited. Analysis of a water sample from one well that taps the unconfined part of the Englishtown aquifer system shows that the predominant cation is calcium; the predominant anions are nitrate and chloride. Much of the land in the central part of the study area is used for agriculture; therefore, the concentrations of most constituents--especially the inorganic constituents calcium, nitrate, and magnesium--in this area are likely to be greater than those in samples from wells in the forested outcrop area of the Kirkwood-Cohansey aquifer system. This is probably a result of the dissolution of liming agents and nitrogen-based fertilizers that are applied in agricultural areas. Because the soils in the outcrop areas are well-drained and naturally low in nutrients, fertilizer and lime are applied to increase crop yields. The low moisture capacity of these soils necessitates irrigation, which promotes the leaching of inorganic constituents that are applied. Constituents added to the soil in agricultural areas in limestone and dolomite (liming agents) are barium, calcium, inorganic carbon, magnesium, and strontium; application of fertilizer typically adds chloride, nitrogen, potassium, sodium, and sulfur. The relatively low pH of precipitation in the study area enhances the dissolution of calcium carbonate from limestone applied to the soil. The generally low pH of the ground water in the study area causes the carbonate ions to be present in the form of carbonic acid (H_2CO_3), so that concentrations of bicarbonate and carbonate in the ground water commonly are low. The concentration of dissolved nitrate can vary greatly with such factors as the use of fertilizers and the presence of septic systems or feedlots.

Most of the area adjacent to the Delaware River in the study area is urban. All wells in the Coastal Plain near the river are screened in the Potomac-Raritan-Magothy aquifers. North of the Fall Line, wells are open to either the Stockton or Lockatong Formation. The predominant cation in water from wells in the Potomac-Raritan-Magothy aquifers is either sodium or calcium, and the predominant anion is sulfate or bicarbonate. The predominant ions in water from wells north of the Fall Line are calcium and bicarbonate. Samples from wells in this region contain the highest relative equivalent mass of all samples collected from the study area. Urban land use commonly is responsible for contributing high concentrations of major ions to the shallow ground water. Moreover, because much of this area is a regional discharge area, the ground water has been exposed to the aquifer material (unconsolidated sediments and marine deposits) for a long time, providing an opportunity for particle dissolution.

The pH of water from 15 of the 25 sampled wells in the study area was less than 5.5. The solubilities of many trace elements, such as cadmium, copper, lead, strontium, and zinc, increase with decreasing pH; therefore, these trace elements would be expected to be detected more frequently in acidic ground water with a pH less than 5.5 than in more basic ground water. Copper and zinc concentrations tended to be greatest in the samples with a low pH. High concentrations of strontium and cadmium also were detected, however, in samples with a pH greater than 5.5, possibly as a result of the proximity of urban or agricultural land. Other trace elements, such as beryllium, cobalt, molybdenum, and vanadium, are relatively insoluble in acidic water or are relatively rare in aquifer material, and generally are not detected in ground-water samples from the study area.

Surface Water

The Rancocas Creek study area is divided into six principal drainage basins (fig. 1-3). Samples from selected surface-water sites are used to represent the water-quality conditions in each of these drainage basins. Surface-water sites were selected to provide an even distribution of sites along the length of the streams in the study area. The surface-water samples selected from the WATSTORE database were limited to 29 sites at which samples had been collected at base-flow conditions, so that the analysis results would reflect ambient water quality.

The Stiff diagrams illustrate the quality of the surface water in the Rancocas Creek study area (fig. 4-1). The diagrams indicate that calcium is the predominant cation in 17 of the 29 surface-water samples, and sodium plus potassium is the predominant cation in 12 of the 29 samples. The diagrams also indicate that sulfate is the predominant anion in 14 of the 29 surface-water samples, and chloride is the predominant anion in 8 of the 29 samples. Of the constituents measured, the relative mass equivalent in most surface-water samples was lowest for dissolved iron, magnesium, and nitrate plus nitrite.

The ionic composition of the surface-water samples largely reflects the chemistry of the ground water that discharges to the streams and that of precipitation. The chemical quality of surface water also is related strongly to characteristics of the drainage basin. Basin characteristics that can affect the quality of surface water include land use, effluent discharge, population, stream discharge, atmospheric deposition, and climate. Most of the streams in the study area flow from east to west, through agricultural areas at their headwaters, then through urban areas, before discharging into the Delaware River along the western edge of the study area. The headwaters of the Rancocas Creek, in the southeastern part of the study area, however, are primarily forested.

Urban and agricultural land use probably accounts for the elevated concentrations of sodium and chloride found in surface-water samples from the study area. Elevated concentrations of these constituents most likely are a result of human activities, such as road deicing, the disposal of septic and industrial waste, and the application of fertilizers to lawns and agricultural land. The pH of most surface-water samples from the study area generally was higher than that of the ground-water samples, possibly as a result of discharges from wastewater-treatment facilities, which are more alkaline than the receiving waters and are more likely to contain elevated concentrations of dissolved constituents.

The Stiff diagrams that show the chemistry of surface-water samples from individual basins are similar when land use remains constant. The Stiff diagrams for samples from three sites in the Rancocas Creek Basin, 01466500, 01465970, and 395216074294000 (fig. 4-1), show the chemical composition of water from small, primarily forested drainage basins; these samples are the least affected by human activities of all surface-water samples from the study area. The diagrams show that the water is relatively dilute (contains low concentrations of all major ions) and is closer in composition to precipitation than to the other samples. Additionally, the dissolved-ion concentration generally increases downstream.

Samples from surface-water sites for which sufficient data were available were tested for trends in the concentrations of selected constituents. A seasonal Kendall test (Hirsch and others, 1982) was used to determine trends in the concentrations of 12 constituents at 6 surface-water sites (table 4-3). This test can be used to determine whether constituent concentrations have increased, decreased, or remained the same during the period of the test. The test was conducted on sample-analysis results for periods during which at least four samples were collected per year. Data for quarterly or monthly samples for a minimum of 10 years were available for all six sites selected. A seasonal test was used because the concentrations of many surface-water constituents depend on the time of year the sample was collected. Because many of the samples were collected quarterly, a four-season test was used. The test is used to compare constituent concentrations to concentrations in other samples collected during the same season. The results for all four seasons then are combined.

Two versions of the Seasonal Kendall test--one for uncensored data and one for censored data--were used (Schertz and others, 1991). For uncensored data, the concentrations of constituents were adjusted to account for variations caused by changes in streamflow. In general, if the input of a particular constituent to a stream remains constant, dilution will cause the concentration of that constituent to decrease as streamflow increases. In some cases, however, the concentration of the constituent increases because constituents are added from precipitation, ground-water discharge, or overland runoff. Other constituents may exhibit a combination of both effects. The Lowess smooth method of flow adjustment, a regression technique (Cleveland, 1979), was used to describe the relation between constituent concentration and streamflow. This technique makes use of a weighting function to minimize the influence of outliers; smaller weights are assigned to values of the constituent that are farther from the estimated value. For censored data when more than 5 percent of the analytical results for a constituent are below the method reporting level, the flow adjustment is not used.

Results of the trend tests for the six sites are presented in table 4-3. The table shows the period of data used for the test, the number of samples analyzed for each constituent, the trend in the concentration of each constituent, the magnitude of the change, and the level of significance of the test, or p-value. The p-value, a number between 0 and 1, represents the probability that an apparent association between two variables could have resulted solely by chance arrangement of the data rather than through probable association between the two variables. Thus, the lower the p-value, the higher the probability that a trend exists. Summary statistics for the six sites for the period of record are presented in table 4-4.

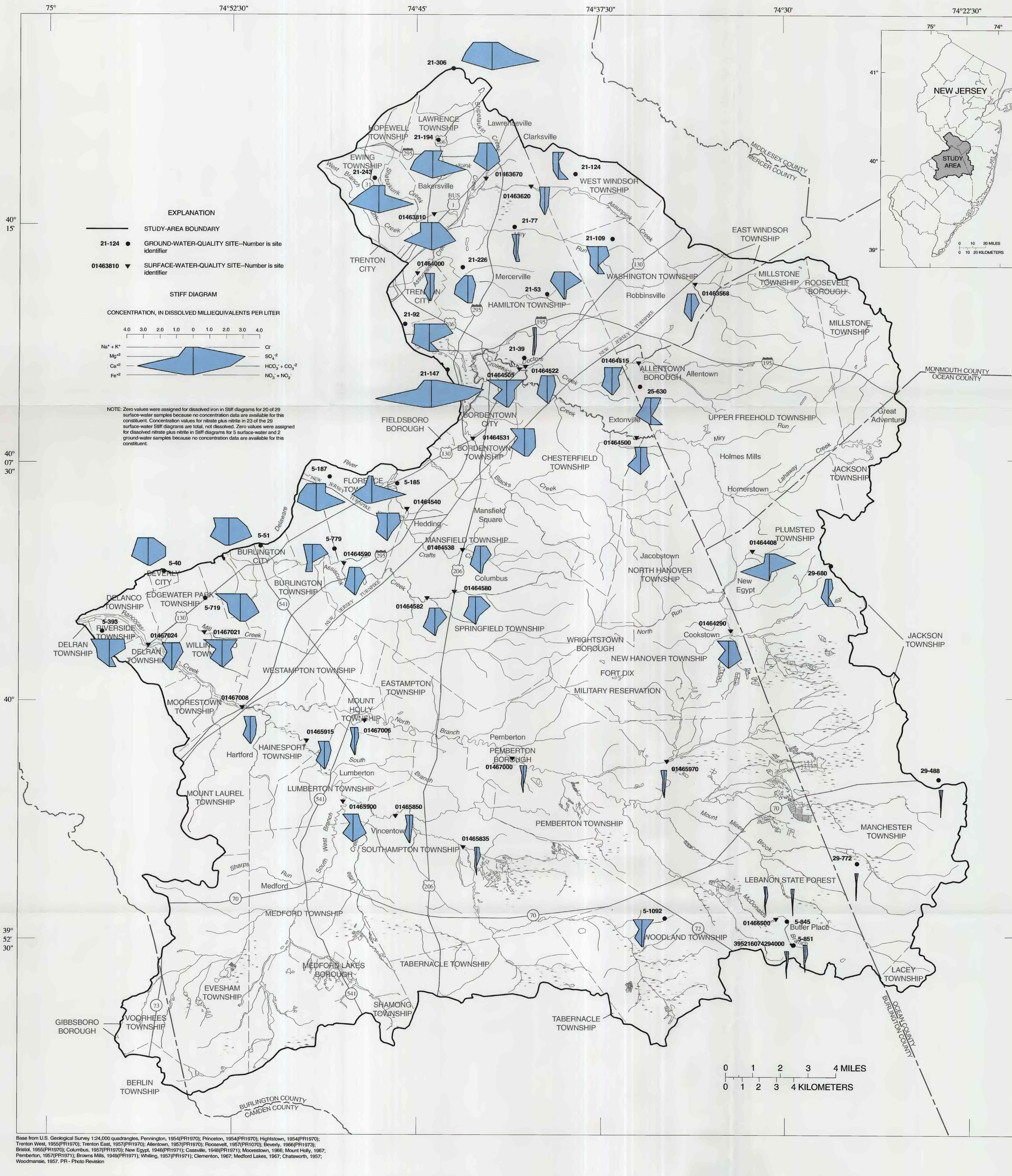
Results of the trend analyses indicate that concentrations of several major ions in surface water increased over the period for which the data were tested. The concentration of dissolved chloride increased at all six sites. The concentrations of sodium increased at five of the sites and remained unchanged at one. Trends in surface-water-quality are associated strongly with the dominant land use in the immediate vicinity of the stream site. Results of previous investigations have indicated that upward trends in concentrations were found at more sites and were statistically stronger when the dominant land use near the sites, rather than land use for the entire basin, was considered (Robinson and others, 1996). The increase in concentrations of sodium and chloride in this study may indicate an increase in the use of road-deicing salts in the Rancocas Creek study area over the test period. Robinson and others (1996) showed a statistically significant relation between the rate of application of salt and concentrations of both sodium and chloride in surface water.

The results of the trend tests also indicate that concentrations of all nutrients tested, except those for nitrate plus nitrite, decreased over the test period. Concentrations of ammonium plus organic nitrogen decreased at four of the six sites, and remained unchanged at two. Ammonium concentrations decreased at two of the sites, and remained unchanged at four. Phosphorus concentrations decreased at two of the sites, and remained unchanged at four. Concentrations of nitrate plus nitrite decreased at two sites, increased at two sites, remained unchanged at one site, and was untested at one site because of insufficient data. The decrease in the concentrations of nutrients in the study area may be the result of improvements in municipal-waste treatment that took place in the 1970s and 1980s. Other observed trends in constituent concentrations include a decrease in sulfate concentrations at three of the six sites and an increase in calcium concentrations at one site. No statistically significant trends were found for magnesium or dissolved solids at any of the six sites tested.

The concentrations of selected constituents at the streamflow-gaging station Crosswicks Creek at Extonville, N.J. (01464500), are plotted in figure 4-2. This graph displays upward and downward trends in order to visually associate the statistical parameters in table 4-3 with concentration data from the corresponding site. Concentrations of chloride and sodium increased over the period of record, whereas concentrations of the three nitrogen-containing constituents and phosphorus decreased.

[3]A maximum contaminant level (MCL) is the highest concentration, amount, or level of a specific contaminant allowed in water distributed by a public water supplier. MCLs are set by Federal and State agencies to protect the public health, and are enforceable under the authority of the Safe Drinking Water Act (U.S. Environmental Protection Agency, 1990a and 1990b).

[4]A secondary maximum contaminant level (SMCL) is the limit for the concentration, amount, or level of a contaminant that affects the aesthetic quality of drinking water, such as taste, odor, and color. SMCLs are intended for use as guidelines and are not enforceable (U.S. Environmental Protection Agency, 1990c).



Base from U.S. Geological Survey 1:24,000 quadrangles, Pennington, 1954(PR1970); Princeton, 1954(PR1970); Hightstown, 1954(PR1970); Trenton West, 1955(PR1970); Trenton East, 1957(PR1970); Allentown, 1957(PR1970); Roosevelt, 1957(PR1070); Beverly, 1966(PR1973); Bristol, 1955(PR1970); Columbus, 1957(PR1970); New Egypt, 1946(PR1971); Cassville, 1948(PR1971); Moorestown, 1966; Mount Holly, 1967; Pemberton, 1957(PR1971); Browns Mills, 1949(PR1971); Whiting, 1957(PR1971); Clementon, 1967; Medford Lakes, 1967; Chatsworth, 1957; Woodmansie, 1957. PR - Photo Revision

Figure 4-1. Locations of water-quality stations, and Stiff diagrams showing the ionic composition of water samples from the Rancocas Creek study area, New Jersey.

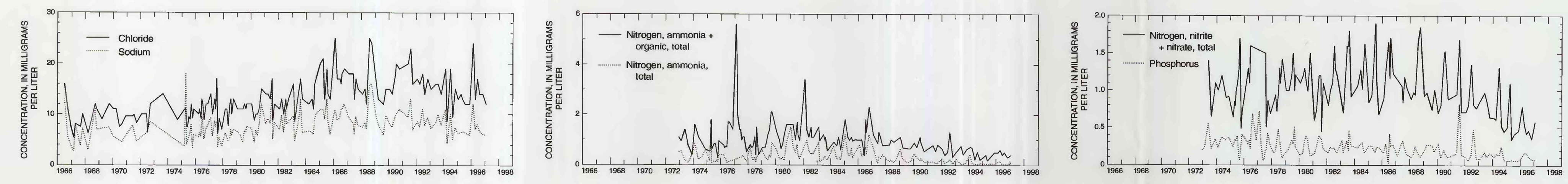


Figure 4-2. Concentrations of selected constituents in water from the Crosswicks Creek at Extonville, N.J. (01464500), surface-water site in the Rancocas Creek study area, New Jersey.

Table 4-1. Selected results of water-quality analyses of ground-water samples from 25 sites, Rancocas Creek study area, New Jersey

[Site locations are shown in fig. 4-1; sea level, National Geodetic Vertical Datum of 1929; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; --, no reported value; constituents not detected in a sample are reported as the value of the method reporting level for that analysis preceded by a "less-than" symbol (<); number in parentheses is parameter code used to identify the constituent, property, or characteristic in the U.S. Geological Survey water-quality database (NWIS)]

U.S. Geological Survey well number	New Jersey permit number	Latitude[1]	Longitude[1]	Aquifer code[2]	Date sampled	Depth of well (feet below land surface) (72008)	Altitude of land-surface datum (feet above sea level) (72000)	Specific conductance, field (µS/cm) (00095)	pH, field (standard units) (00400)	Temperature, water (deg C) (00010)	Oxygen, dissolved (mg/L) (00300)
5- 40	27-01528	400405	0745517	MRPAM	08-14-85	51	18	242	6.3	16.5	2.2
5- 51	27-00119	400453	0745121	MRPAM	06-12-80	85	9	317	6.3	14.5	--
5- 185	27-02366	400650	0744547	MRPAM	06-06-80	121	15	219	6.7	13.5	--
5- 187	27-00023	400703	0744832	MRPAM	07-02-85	134	30	244	6.5	14.5	1.2
5- 393	--	400212	0745748	MRPAM	08-16-85	67	15	278	5.2	16.5	3.9
5- 719	27-03590	400314	0745336	MRPAU	06-16-80	61	40	301	7.2	20.0	--
5- 779	27-05651	400447	0744820	MRPAU	06-11-80	50	41	192	5.3	14.0	--
5- 845	32-10467	395302	0742953	CNSY	02-24-86	36.5	133	19	5.0	11.5	5.4
5- 851	32-10473	395217	0742937	CKKD	02-25-86	29.9	139	33	4.8	11.0	7.9
5-1092	32-08688	395308	0743453	CKKD	07-10-90	85	123	126	4.7	13.0	6.2
21- 39	28-09807	401048	0744036	MRPAM	06-04-80	199	55	39	5.4	13.0	--
21- 53	28-02789	401248	0743940	MRPAU	03-12-85	79.5	85	227	5.3	13.5	3.5
21- 77	28-01621	401455	0744100	MRPAU	03-14-85	83	65	60	5.1	13.5	7.1
21- 92	28-04078	401152	0744528	MRPAM	02-13-85	80	27	350	4.6	14.5	4.4
21- 109	28-00861	401432	0743700	MRPAU	07-16-86	74	105	190	4.7	15.0	8.6
21- 124	28-02879	401635	0743831	MRPAM	07-16-86	62	80	114	[3]5.4	13.0	10.3
21- 147	28-09524	401026	0744344	MRPAM	06-09-80	63	10	566	6.6	14.5	--
21- 194	--	401740	0744407	SCKN	07-17-85	110	120	310	6.9	13.0	6.9
21- 226	28-05565	401339	0744307	MRPAM	03-11-85	51	50	174	6.4	11.5	5.7
21- 243	27-00471	401628	0744643	SCKN	06-17-85	67	120	334	7.5	14.0	4.9
21- 306	28-05616	401955	0744330	LCKG	08-04-88	98	190	455	8.0	13.5	.1
25- 630	28-06419	400953	0743554	EGLS	06-26-86	45	100	215	5.0	13.0	9.2
29- 488	28-06885	395729	0742343	CKKD	07-13-90	143	150	34	4.7	13.0	.1
29- 680	28-01388	400413	0742805	CKKD	05-20-82	66	180	134	5.0	14.0	--
29- 772	32-08640.1	395451	0742702	CKKD	09-11-84	41.5	135	23	4.5	13.0	.1

U.S. Geological Survey well number	Calcium, dissolved (mg/L as Ca) (00915)	Magnesium, dissolved (mg/L as Mg) (00925)	Sodium, dissolved (mg/L as Na) (00930)	Potassium, dissolved (mg/L as K) (00935)	Alkalinity, field[4] (mg/L as $CaCO_3$) (00410)	Sulfate, dissolved (mg/L as SO_4) (00945)	Chloride, dissolved (mg/L as Cl) (00940)	Fluoride, dissolved (mg/L as F) (00950)	Silica, dissolved (mg/L as SiO_2) (00955)	Solids, residue at 180 deg C, dissolved (mg/L) (70300)	Nitrogen, nitrite, dissolved (mg/L as N) (00613)
5- 40	20	9.5	12	3.9	53	50	12	<0.10	8.3	144	<0.010
5- 51	22	9.5	16	9.2	69	53	18	--	11	196	--
5- 185	24	4.7	3.2	2.9	102	8.3	2.7	--	18	125	--
5- 187	23	12	11	2.7	88	27	20	<.10	8.2	182	<.010
5- 393	14	9.3	23	4.3	6	47	32	<.10	7.1	187	<.010
5- 719	13	9.7	32	3.0	57	40	14	--	11	193	--
5- 779	5.7	4.8	11	1.3	--	47	17	--	12	96	--
5- 845	.30	.40	1.7	.32	[5]<.5	1.7	3.0	.01	4.0	--	--
5- 851	1.6	.90	2.1	.40	[5]<.5	8.1	3.8	.04	3.8	--	--
5-1092	8.5	1.7	11	2.0	[5]6.7	12	25	<.10	4.7	--	<.010
21- 39	1.2	.45	1.8	.50	6	6.3	2.8	--	8.2	30	--
21- 53	7.1	10	5.4	14	6	51	14	--	12	171	<.010
21- 77	2.7	1.1	4.7	1.8	5	6.6	6.4	--	7.4	53	<.010
21- 92	21	11	19	3.5	[5]3	68	35	--	10	214	<.010
21- 109	9.8	5.8	14	3.0	[5]2.0	33	18	<.10	9.2	115	<.010
21- 124	6.0	4.2	6.2	2.5	[5]4.0	<.20	13	<.10	11	80	<.010
21- 147	67	11	7.3	4.6	116	150	10	--	14	379	--
21- 194	27	13	11	.90	100	16	20	--	29	--	--
21- 226	16	8.3	3.4	1.1	18	22	9.5	--	5.1	112	<.010
21- 243	36	14	9.1	.90	104	18	14	--	26	--	--
21- 306	36	19	24	2.5	141	60	13	.20	12	256	<.010
25- 630	18	6.1	5.1	4.0	3	20	21	<.10	11	163	<.010
29- 488	.24	.24	2.0	.70	[5]1.5	3.4	4.5	.20	8.4	--	<.010
29- 680	8.3	3.1	1.6	2.7	2	14	7.0	--	--	87	<.010
29- 772	.33	.15	1.6	.30	[5]2.0	2.1	4.4	<.10	6.1	16	<.010

U.S. Geological Survey well number	Nitrogen, NO_2+NO_3, dissolved (mg/L as N) (00631)	Nitrogen, ammonia, dissolved (mg/L as N) (00608)	Nitrogen, ammonia + organic, dissolved (mg/L as N) (00623)	Phosphorus, ortho, dissolved (mg/L as P) (00671)	Carbon, organic, dissolved (mg/L as C) (00681)	Aluminum, dissolved (µg/L as Al) (01106)	Arsenic, dissolved (µg/L as As) (01000)	Barium, dissolved (µg/L as Ba) (01005)	Beryllium, dissolved (µg/L as Be) (01010)	Cadmium, dissolved (µg/L as Cd) (01025)	Chromium, dissolved (µg/L as Cr) (01030)
5- 40	2.20	<0.010	0.10	0.060	1.7	10	<1	67	<0.5	<1.0	<10
5- 51	.860	--	--	.020	4.5	--	--	100	<1	4.0	--
5- 185	<.100	--	--	.230	3.9	--	--	90	<1	1.0	--
5- 187	2.10	1.30	2.1	<.010	1.3	100	<1	57	<.5	<1.0	<10
5- 393	5.60	<.010	.30	<.010	.70	<10	<1	91	.5	<1.0	<10
5- 719	4.60	--	--	.100	7.2	--	--	90	<1	<1.0	--
5- 779	.010	--	--	<.010	2.0	--	--	60	3	<1.0	--
5- 845	[6].030	.014	--	--	1.4	40	--	--	--	--	--
5- 851	[6].020	.017	--	.001	1.8	150	--	--	--	--	--
5-1092	1.20	<.010	<.20	.010	1.0	220	<1	49	<.5	<1.0	<5
21- 39	.020	--	--	.010	.40	--	--	40	2	3.0	--
21- 53	1.40	.030	.60	<.010	.80	220	--	120	<.5	<1.0	<10
21- 77	3.00	<.010	.10	<.010	.30	<10	--	72	.5	<1.0	<10
21- 92	8.10	<.010	.20	.010	.90	520	--	48	2	<1.0	10
21- 109	5.80	.030	.30	<.010	.80	250	<1	71	<.5	<1.0	<10
21- 124	8.20	.020	.30	<.010	.30	10	<1	200	<.5	<1.0	<10
21- 147	.060	--	--	--	6.8	--	--	230	3	9.0	--
21- 194	--	--	--	--	--	--	--	160	<.5	<1.0	--
21- 226	3.80	<.010	.20	.010	.30	<10	--	57	<.5	<1.0	10
21- 243	--	--	--	--	--	--	--	250	<.5	<1.0	--
21- 306	<.100	.050	<.20	.030	.90	20	5	44	<.5	<1.0	<5
25- 630	9.80	.010	.70	<.010	.30	40	<1	220	<.5	<1.0	<10
29- 488	<.100	.020	<.20	<.010	.40	100	<1	20	.6	<1.0	<5
29- 680	5.50	<.050	<.05	<.010	--	--	--	<100	<5	<5.0	<50
29- 772	<.100	.040	.20	--	.50	<10	<1	--	--	<1.0	<1

U.S. Geological Survey well number	Cobalt, dissolved (µg/L as Co) (01035)	Copper, dissolved (µg/L as Cu) (01040)	Iron, dissolved (µg/L as Fe) (01046)	Lead, dissolved (µg/L as Pb)[7] (01049)	Lithium, dissolved (µg/L as Li) (01130)	Manganese, dissolved (µg/L as Mn) (01056)	Mercury, dissolved (µg/L as Hg) (71890)	Molybdenum, dissolved (µg/L as Mo) (01060)	Strontium, dissolved (µg/L as Sr) (01080)	Vanadium, dissolved (µg/L as V) (01085)	Zinc, dissolved (µg/L as Zn) (01090)
5- 40	<3	<10	<3	<30	<4	30	--	<10	95	<6	10
5- 51	<3	<10	6,200	--	12	780	--	<10	220	<6	8
5- 185	<3	<10	9,700	<30	27	96	--	<10	180	7	18
5- 187	<3	<10	21	<30	4	22	--	<10	150	<6	4
5- 393	<3	<10	13	<30	10	46	--	<10	68	<6	89
5- 719	<3	77	9	--	<4	3	--	27	93	<6	10
5- 779	<3	<10	11,000	<30	11	190	--	<10	52	<6	5
5- 845	--	--	<2	<30	--	2	--	--	--	--	--
5- 851	--	--	<2	--	--	61	--	--	--	--	--
5-1092	<3	10	18	<30	<4	18	--	<10	39	<6	11
21- 39	<3	<10	2,800	<30	13	44	--	<10	19	<6	13
21- 53	7	320	420	<30	16	97	--	<10	63	<6	36
21- 77	<3	90	27	<30	12	6	--	<10	30	<6	15
21- 92	9	320	98	<30	12	370	--	<10	100	<6	210
21- 109	5	260	110	<30	7	140	<0.1	<10	62	<6	25
21- 124	<3	150	7	<30	5	13	<.1	<10	100	<6	26
21- 147	<3	<10	12,000	--	4	3,000	--	22	560	<6	<4
21- 194	<3	<10	<3	<30	7	<1	--	<10	160	<6	3
21- 226	<3	30	39	<30	6	5	--	<10	36	<6	9
21- 243	<3	<10	6	<30	5	<1	--	<10	170	<6	12
21- 306	<3	<10	9	<30	11	6	<.1	10	1,100	<6	4
25- 630	30	10	41	<30	7	26	<.1	<10	170	<6	40
29- 488	<3	<10	280	<30	<4	8	--	<10	5	<6	6
29- 680	--	190	140	<100	--	22	--	--	--	--	1,200
29- 772	--	<1	1,300	<30	--	5	<.1	--	--	--	15

[1]Latitude and longitude are referenced to North American Datum of 1927.
[2]The aquifer codes are MRPAM, Middle Potomac-Raritan-Magothy aquifer; MRPAU, Upper Potomac-Raritan-Magothy aquifer; EGLS, Englishtown aquifer system; CNSY, Cohansey Sand; CKKD, Kirkwood-Cohansey aquifer system; SCKN, Stockton Formation; LCKG, Lockatong Formation.
[3]Value listed represents laboratory pH (standard units).
[4]Analysis done by whole-water total fixed-endpoint titration.
[5]Value listed represents laboratory alkalinity (mg/L as $CaCO_3$).
[6]Value listed represents nitrogen, nitrate, dissolved (mg/L as N).
[7]The detection limit for lead in samples analyzed before 1994 is 30 µg/L (John Garbarino, U.S. Geological Survey, written comm., 1994).

Table 4-2. Selected results of water-quality analyses of surface-water samples from 29 sites, Rancocas Creek study area, New Jersey

[Site locations are shown in fig. 4-1: trib, tributary; st, street; mi², square miles; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; E, estimated value; MPN, most probable number; >, greater than; constituents not detected in a sample are reported as the value of the method reporting level for that analysis preceded by a "less-than" symbol (<); number in parentheses is parameter code used to identify the constituent, property, or characteristic in the U.S. Geological Survey water-quality database (NWIS)]

U.S. Geological Survey surface-water site number	U.S. Geological Survey surface-water site name	Date sampled	Drainage area (mi²)	Specific conductance, field (µS/cm) (00095)	pH, field (standard units) (00400)	Temperature, water (deg C) (00010)	Oxygen, dissolved (mg/L) (00300)
01463568	Assunpink Creek at Carsons Mills, N.J.	06-01-82	12.5	114	7.2	20.0	8.3
01463620	Assunpink Creek near Clarksville, N.J.	11-06-96	34.3	--	7.0	11.5	10.2
01463670	Shipetaukin Creek at Bakersville, N.J.	05-26-76	8.97	203	7.2	12.5	8.9
01463810	Shabakunk Creek near Lawrenceville, N.J.	10-12-76	11.7	333	7.2	9.0	9.4
01464000	Assunpink Creek at Trenton, N.J.	06-13-96	90.6	98	6.9	20.0	6.5
01464290	Crosswicks Creek at Hockamik Road near Cookstown, N.J.	10-12-76	23.5	210	7.1	12.0	7.1
01464408	Crosswicks Creek trib number 2 trib at New Egypt, N.J.	11-05-81	--	240	5.2	10.0	9.3
01464500	Crosswicks Creek at Extonville, N.J.	10-31-96	81.5	151	7.4	12.0	8.6
01464505	Crosswicks Creek at Groveville, N.J.	09-29-82	98.2	262	7.2	18.0	7.2
01464515	Doctors Creek at Allentown, N.J.	11-07-96	17.4	[1]179	7.3	10.5	9.9
01464522	Doctors Creek at Route 130 at Yardville, N.J.	05-31-83	25.8	157	[2]7.0	17.5	9.2
01464531	Blacks Creek at Bordentown, N.J.	06-08-81	22.6	243	7.1	21.0	7.0
01464538	Crafts Creek at Columbus, N.J.	05-27-82	5.38	160	6.8	19.5	9.5
01464540	Crafts Creek at Hedding, N.J.	09-08-76	10.6	228	7.2	20.0	9.0
01464580	Assiscunk Creek at Columbus, N.J.	10-02-80	8.28	187	6.4	16.5	6.0
01464582	Assiscunk Creek near Columbus, N.J.	05-27-82	10.9	170	6.5	19.5	6.9
01464590	Assiscunk Creek near Burlington, N.J.	05-31-83	37.4	149	--	17.5	7.7
01465835	South Branch Rancocas Creek at Retreat	06-07-82	44.1	57	4.4	18.5	6.3
01465850	South Branch Rancocas Creek at Vincentown, N.J.	11-14-96	64.5	80	6.3	5.5	10.3
01465900	Southwest Branch Rancocas Creek at Eayerstown, N.J.	09-09-76	76.0	177	6.9	20.0	6.0
01465915	South Branch Rancocas Creek at Hainesport, N.J.	09-26-78	155	119	6.5	17.0	7.2
01465970	North Branch Rancocas Creek at Browns Mills, N.J.	10-18-90	--	44	5.7	19.5	8.3
01466500	McDonalds Branch in Lebanon State Forest, N.J.	04-11-84	2.35	68	3.9	7.5	7.5
01467000	North Branch Rancocas Creek at Pemberton, N.J.	11-14-96	118	54	5.3	6.5	10.1
01467006	North Branch Rancocas Creek at Pine St at Mount Holly, N.J.	10-05-78	134	73	6.4	15.5	9.2
01467008	Rancocas Creek at Centerton, N.J.	09-26-78	304	115	6.5	16.5	7.9
01467021	Mill Creek at Levitt Parkway at Willingboro, N.J.	09-10-76	9.12	254	6.7	21.0	6.6
01467024	Rancocas Creek at Bridgeboro, N.J.	11-14-80	343	178	6.9	8.0	--
3952160 74294000	McDonalds Branch 1100 feet upstream of gage in Lebanon State Forest, N.J.	04-04-84	--	72	3.9	9.5	3.1

U.S. Geological Survey surface-water site number	Oxygen demand, biochemical 5-day[3] (mg/L) (00310)	Fecal streptococci (MPN[4]) (31677)	Fecal coliform, EC broth[5] (MPN[4]) (31615)	Calcium, dissolved (mg/L as Ca) (00915)	Magnesium, dissolved (mg/L as Mg) (00925)	Sodium, dissolved (mg/L as Na) (00930)	Potassium, dissolved (mg/L as K) (00935)	Alkalinity, field[6] (mg/L as $CaCO_3$) (00410)	Sulfate, dissolved (mg/L as SO_4) (00945)	Chloride, dissolved (mg/L as Cl) (00940)
01463568	2.3	79	130	8.2	4.2	3.6	1.8	[7]9.0	24	8.2
01463620	E1.2	--	110	5.9	2.9	5.5	3.0	[7]11	12	11
01463670	1.6	--	>2,400	16	6.5	9.6	2.0	39	31	10
01463810	1.8	490	790	33	8.0	13	3.7	72	48	16
01464000	5.2	--	>24,000	7.1	1.8	5.9	3.2	[7]13	11	9.1
01464290	5.8	49	23	12	2.2	13	4.0	40	29	14
01464408	--	--	--	34	4.0	4.0	2.1	4	76	13
01464500	<1.0	--	330	15	2.8	6.1	3.0	[7]27	19	14
01464505	16	700	1,100	16	3.2	25	4.4	[7]24	23	35
01464515	E1.9	--	790	12	5.0	7.9	3.8	[7]23	18	20
01464522	3.9	1,100	1,300	12	5.9	6.7	2.5	[7]18	25	15
01464531	16	240	33	17	5.0	16	5.2	[7]34	31	20
01464538	<1	27	330	12	5.5	4.4	3.2	[7]10	31	12
01464540	<1	240	33	13	6.1	11	5.4	17	39	25
01464580	2.1	1,100	200	14	5.0	5.5	5.8	11	43	12
01464582	<1.0	350	1,600	14	4.9	4.8	4.3	[7]10	35	12
01464590	3.9	2,300	1,300	12	5.5	5.0	3.2	[7]15	31	12
01465835	3.2	94	23	1.9	.90	2.3	.80	[7]<1.0	11	4.9
01465850	<1.0	--	130	5.7	1.6	4.5	1.6	[7]5.7	9.7	8.3
01465900	4.5	2,200	9,200	12	1.9	12	3.6	40	24	12
01465915	3.2	220	5,400	9.8	2.4	7.0	2.5	12	20	10
01465970	<1	33	11	2.0	.80	3.3	1.0	[7]3.3	5.7	4.7
01466500	--	--	--	.68	.26	1.6	.12	[7]<1.0	6.7	3.0
01467000	<1.0	--	<2	2.1	.86	4.4	.90	[7]1.4	7.6	6.8
01467006	1.2	540	350	4.6	1.5	4.8	1.3	4	12	7.4
01467008	2.9	110	230	8.3	2.3	7.5	2.3	16	19	11
01467021	11	--	--	14	4.4	23	4.7	33	25	33
01467024	--	--	--	11	3.3	12	3.6	16	33	17
3952160 74294000	--	--	--	.62	.22	2.4	.48	[7]<1.0	4.5	4.1

U.S. Geological Survey surface-water site number	Fluoride, dissolved (mg/L as F) (00950)	Silica, dissolved (mg/L as SiO_2) (00955)	Solids, residue at 180 deg C, dissolved (mg/L) (70300)	Nitrogen, nitrite, total (mg/L as N) (00615)	Nitrogen, NO_2+NO_3, total (mg/L as N) (00630)	Nitrogen, ammonia, total, (mg/L as N) (00610)	Nitrogen, ammonia + organic, total (mg/L as N) (00625)	Phosphorus, total (mg/L as P) (00665)	Carbon, organic, total (mg/L as C) (00680)	Arsenic, total (µg/L as As) (01002)
01463568	0.20	3.8	80	0.010	0.600	0.110	0.70	--	4.8	1
01463620	.10	5.5	66	--	--	.220	.60	0.040	--	<1
01463670	.10	--	140	.050	1.90	.150	.53	.100	4.7	<1
01463810	--	13	186	--	1.00	.150	.60	.080	5.1	2
01464000	<.10	2.5	68	--	--	.210	1.4	.350	--	2
01464290	--	8.7	108	--	--	--	4.8	1.10	9.1	1
01464408	--	--	162	--	[8]<.010	--	--	--	--	--
01464500	.20	11	94	--	--	<.030	.30	.080	--	<1
01464505	.40	10	163	.120	1.50	E1.10	2.0	--	7.1	2
01464515	.20	11	106	--	--	.470	.70	.070	--	<1
01464522	.20	6.5	130	.030	1.60	.050	.74	--	6.4	2
01464531	.20	14	162	--	3.10	.900	2.6	--	18	0
01464538	.20	12	119	.020	1.20	.110	E.35	--	3.9	1
01464540	--	3.9	138	--	--	--	1.1	.160	4.0	1
01464580	.40	17	118	--	.4	.070	.54	--	3.0	2
01464582	.30	16	126	.030	.700	.300	E.70	--	5.0	2
01464590	.20	12	127	.020	1.00	.130	.80	--	9.0	1
01465835	<.10	4.6	44	<.010	.1	.130	.86	--	12	1
01465850	<.10	6.7	58	--	--	.050	.50	.080	--	<1
01465900	--	7.9	96	--	--	--	2.0	2.50	7.7	2
01465915	.10	7.6	86	--	.700	.300	--	--	7.4	1
01465970	.20	4.4	26	.01	.110	.060	.34	<.020	7.8	<1
01466500	.04	2.0	--	--	--	--	--	--	8.3	--
01467000	<.10	5.2	38	--	--	.040	.30	.020	--	<1
01467006	.10	5.9	55	--	<1.00	.300	1.5	--	7.3	1
01467008	.10	7.1	83	.010	.600	.300	2.6	.350	8.0	2
01467021	--	--	153	--	--	--	--	.270	13	2
01467024	--	7.7	107	--	--	--	--	--	--	--
3952160 74294000	.1	1.8	--	--	--	--	--	--	21	--

U.S. Geological Survey surface-water site number	Boron, total recoverable (µg/L as B) (01022)	Cadmium, total recoverable (µg/L as Cd) (01027)	Chromium, total recoverable (µg/L as Cr) (01034)	Copper, total recoverable (µg/L as Cu) (01042)	Iron, total recoverable (µg/L as Fe) (01045)	Lead, total recoverable (µg/L as Pb) (01051)	Manganese, total recoverable (µg/L as Mn) (01055)	Mercury, total recoverable (µg/L as Hg) (71900)	Nickel, total recoverable (µg/L as Ni) (01067)	Zinc, total recoverable (µg/L as Zn) (01092)
01463568	20	1	10	5	1,400	4	140	<0.10	7	10
01463620	20	<1	<1	2	860	<1	180	<.10	2	<10
01463670	<20	<1	--	<20	990	4	120	<.50	<2	<20
01463810	--	<1	--	<20	740	14	150	<.50	4	60
01464000	20	<1	4	12	5,600	23	140	<.10	5	60
01464290	--	<1	--	<20	2,700	6	100	<.50	4	50
01464408	--	--	--	--	3,700	--	87	--	--	--
01464500	30	<1	<1	1	2,500	1	60	<.10	3	<10
01464505	60	1	10	5	2,200	3	40	.10	4	10
01464515	30	<1	<1	1	1,100	<1	120	<.10	3	<10
01464522	60	1	10	8	1,900	16	90	<.10	7	30
01464531	70	1	<10	9	2,300	4	150	<.10	7	30
01464538	10	1	10	4	1,800	4	260	.20	7	10
01464540	--	<1	--	<20	740	4	70	<.50	5	20
01464580	30	3	30	3	14,000	29	290	<.10	5	30
01464582	20	1	10	3	4,600	6	260	1.8	4	20
01464590	70	1	10	6	3,700	12	120	.10	7	30
01465835	60	1	10	5	2,300	10	30	.30	6	20
01465850	30	<1	<1	1	1,300	2	30	<.10	2	10
01465900	--	<1	--	<20	1,900	7	30	<.50	3	<20
01465915	--	--	<20	6	3,600	--	60	<.50	7	30
01465970	10	<1	<1	4	2,400	10	40	<.10	1	<10
01466500	--	--	--	--	200	--	--	--	--	--
01467000	20	<1	2	1	1,500	4	30	<.10	1	10
01467006	--	--	<20	6	2,800	--	30	<.50	10	100
01467008	--	--	<20	6	4,100	--	80	<.50	4	50
01467021	--	--	--	--	7,500	200	120	--	--	40
01467024	--	--	--	--	--	--	--	--	--	--
3952160 74294000	--	--	--	--	460	--	--	--	--	--

[1]Value listed represents laboratory specific conductance.
[2]Value listed represents laboratory pH (standard units).
[3]A measure of the quantity of dissolved oxygen necessary for the decomposition of organic matter by microorganisms over 5 days at 20 degrees Celsius.
[4]In the most-probable-number (MPN) method to determine fecal streptococci and fecal coliform, bacteria are grown from the sample in a nutrient solution and the most probable number of organisms is calculated from the amount of gas produced.
[5]EC broth refers to a specific mixture of nutrients that is used for growing bacteria by the MPN method.
[6]Analysis done by whole-water total fixed-endpoint titration.
[7]Value listed represents laboratory alkalinity (mg/L as $CaCO_3$).
[8]Value listed represents nitrogen, NO_2+NO_3, dissolved (mg/L as N).

Table 4-3. Results of seasonal Kendall tests for trends in the concentrations of selected constituents in surface water in the Rancocas Creek study area, New Jersey

[Site locations are shown in fig. 4-1; deg C, degrees Celsius; mg/L, milligrams per liter; up, upward trend in concentration of constituent; down, downward trend in concentration of constituent; none, no significant trend; change is flow-adjusted change in concentration, in milligrams per liter per year; p-value represents the probability that an apparent association between two variables could have resulted solely from chance arrangement of the data rather than through probable association between the two variables; p-values equal to or less than 0.05 are considered to represent a significant trend; --, insufficient data to conduct seasonal Kendall test]

Constituent	Site 01463620 Assunpink Creek near Clarksville, N.J. 1/79 to 12/96: Number of samples	Trend	Change	p-value	Site 01464000 Assunpink Creek at Trenton, N.J. 8/62 to 12/96: Number of samples	Trend	Change	p-value	Site 01464500 Crosswicks Creek at Extonville, N.J. 8/62 to 12/96: Number of samples	Trend	Change	p-value
Nitrogen, ammonia, total, mg/L as N	97	none[1]	0.00	0.016	58	down[1]	-0.04	0.001	72	down[2]	-0.01	0.001
Nitrogen, ammonia + organic, total, mg/L as N	60	none	.00	.981	30	down[2]	-.06	.021	76	down[2]	-.03	.000
Nitrogen, nitrite + nitrate, total, mg/L as N	61	down	-.02	.022	26	up[2]	.12	.030	72	down[2]	-.01	.040
Phosphorus, total, mg/L as P	70	none	.00	.016	28	none[2]	-.01	.459	75	down[2]	-.01	.000
Calcium, dissolved, mg/L as Ca	61	none	-.01	.889	59	none	-.03	.361	101	up	.13	.000
Magnesium, dissolved, mg/L as Mg	61	none	-.03	.148	59	none	-.03	.902	101	none	.01	.085
Sodium, dissolved, mg/L as Na	61	up	.19	.001	53	none	.09	.342	97	up	.11	.000
Potassium, dissolved, mg/L as K	60	none	.01	.144	53	none	.00	.795	97	none	-.01	.448
Chloride, dissolved, mg/L as Cl	60	up	.35	.001	61	up	.36	.002	103	up	.28	.000
Sulfate, dissolved, mg/L as SO_4	59	none	-.18	.476	61	down	-.83	.000	108	none	.01	.795
Silica, dissolved, mg/L as SiO_2	60	none	.04	.250	40	down	-.11	.006	86	none	.02	.363
Solids, residue at 180 deg C, dissolved, mg/L	58	none	.08	.842	54	none	-.57	.256	96	none	.27	.170

Constituent	Site 01464515 Doctors Creek at Allentown, N.J. 7/75 to 12/96: Number of samples	Trend	Change	p-value	Site 01465850 South Branch Rancocas Creek at Vincentown, N.J. 7/75 to 12/96: Number of samples	Trend	Change	p-value	Site 01467000 North Branch Rancocas Creek at Pemberton, N.J. 8/62 to 12/96: Number of samples	Trend	Change	p-value
Nitrogen, ammonia, total, mg/L as N	67	none	-0.01	0.074	114	none[1]	0.00	0.106	114	none[1]	0.00	0.003
Nitrogen, ammonia + organic, total, mg/L as N	72	down	-.02	.020	71	none	-.01	.082	76	down[2]	-.02	.002
Nitrogen, nitrite + nitrate, total, mg/L as N	68	none	.01	.335	68	up	.01	.001	--	--	--	--
Phosphorus, total, mg/L as P	59	down	-.01	.007	57	none	.00	.937	96	none[1]	.00	.166
Calcium, dissolved, mg/L as Ca	73	none	.01	.899	72	none	.00	.814	97	none	-.01	.241
Magnesium, dissolved, mg/L as Mg	73	none	-.04	.070	72	none	.01	.074	97	none	.00	.781
Sodium, dissolved, mg/L as Na	72	up	.16	.005	72	up	.08	.000	94	up	.05	.000
Potassium, dissolved, mg/L as K	73	up	.03	.026	71	none	.01	.121	94	none	.00	.621
Chloride, dissolved, mg/L as Cl	73	up	.31	.004	71	up	.20	.000	98	up	.10	.000
Sulfate, dissolved, mg/L as SO_4	73	down	-.21	.034	72	down	-.20	.020	98	none	-.05	.144
Silica, dissolved, mg/L as SiO_2	64	up	.11	.020	63	none	-.04	.177	82	none	.01	.298
Solids, residue at 180 deg C, dissolved, mg/L	73	none	-.03	.928	72	none	.03	.928	93	none	.02	.644

[1]Seasonal Kendall test for censored data conducted because more than 5 percent of constituent values were below the method detection limit; Lowess smooth flow adjustment not used.
[2]Seasonal Kendall test conducted for the period 7/75 to 12/96 because of insufficient data for this constituent outside this time period.

Table 4-4. Summary of water-quality data for selected surface-water sites in the Rancocas Creek study area, New Jersey

[Site locations are shown in fig. 4-1; deg C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; *, mean value is estimated by use of a log-probability regression to predict values below the reporting level; constituents not detected in a sample are reported as the value of the detection limit for that analysis preceded by a "less-than" symbol (<)]

Constituent	Site 01463620 Assunpink Creek near Clarksville, N.J. 6/63 to 1/97: Number of samples	Maximum	Mean	Minimum	Site 01464000 Assunpink Creek at Trenton, N.J. 8/23 to 8/96: Number of samples	Maximum	Mean	Minimum	Site 01464500 Crosswicks Creek at Extonville, N.J. 7/08 to 1/97: Number of samples	Maximum	Mean	Minimum
Temperature, water, deg C	120	30.0	15.5	0.0	216	34.0	15.5	0.0	254	25.5	14.0	0.0
Specific conductance at 25 deg C, field, µS/cm	96	168	127	71	108	523	302	98	175	325	158	80
Oxygen, dissolved, mg/L	98	15.7	9.8	4.6	88	14.2	8.2	2.0	155	14.2	8.2	2.4
[1]Oxygen demand biochemical, 5-day, mg/L	97	8.9	2.8*	<.10	85	20	5.5	1.0	154	8.4	3.2*	<1.0
pH, field, standard units	98	7.8	6.9	5.7	106	8.1	7.0	5.7	169	8.9	7.0	5.5
[2]Alkalinity, field, mg/L as $CaCO_3$	22	24	12	1.0	68	80	36	8.0	80	57	21	1.0
Nitrogen, ammonia, total, mg/L as N	97	.900	.113*	<.030	58	3.60	.860*	<.030	124	1.80	0.345	.030
Nitrogen, nitrite, total, mg/L as N	66	.040	.014	.003	41	.346	.082	.010	90	.240	.056	.009
Nitrogen, ammonia + organic, total, mg/L as N	96	2.3	.78	.03	66	8.1	1.9	.40	132	5.6	.99	.18
Nitrogen, nitrite + nitrate, total, mg/L as N	98	2.50	.842	.050	56	5.77	2.44	.39	124	1.90	1.02	.340
Phosphorus, total, mg/L as P	69	.554	.089	.020	63	2.50	.638	.070	131	34.0	.494	.030
Organic carbon, total, mg/L as C	68	13	5.6	1.6	42	26	8.9	2.2	109	14	6.6	1.1
Calcium, dissolved, mg/L as Ca	98	11	8.1	4.1	91	26	18	7.1	153	22	15	7.4
Magnesium, dissolved, mg/L as Mg	98	5.3	4.1	1.9	91	14	6.8	1.8	153	4.9	2.7	1.0
Sodium, dissolved, mg/L as Na	98	11	6.2	3.1	79	60	24	5.9	146	18	7.8	2.7
Potassium, dissolved, mg/L as K	98	13	2.8	1.8	79	8.4	4.1	2.1	146	9.1	3.0	1.3
Chloride, dissolved, mg/L as Cl	98	29	13	6.9	97	100	29	5.8	156	25	13	4.0
Sulfate, dissolved, mg/L as SO_4	96	36	19	9.6	97	85	41	11	156	37	23	13
Fluoride, dissolved, mg/L as F	98	.30	.14*	<.10	49	1.6	.38*	<.10	116	.50	.25	.0
Silica, dissolved, mg/L as SiO_2	97	7.4	4.1	.70	55	14	8.5	2.5	119	13	9.4	4.5
Iron, total recoverable, µg/L as Fe	21	1,800	852	370	17	5,600	1,260	110	26	7,800	2,650	40
Manganese, total recoverable, µg/L as Mn	21	190	102	50.0	16	230	131*	<10.0	30	150	71.3	10.0
[3,4]Fecal coliform, EC broth, MPN	95	3,500	157*	<2.0	56	160,000	6,270*	<2.0	120	9,200	513*	<2.0
[4]Fecal streptococci, MPN	67	1,600	157*	<2.0	18	16,000	1,590*	<2.0	83	24,000	1,370	11
Solids, residue at 180 deg C, dissolved, mg/L	94	113	79.5	36.0	84	313	175	68.0	143	169	105	66.0

Constituent	Site 01464515 Doctors Creek at Allentown, N.J. 11/75 to 1/97: Number of samples	Maximum	Mean	Minimum	Site 01465850 South Branch Rancocas Creek at Vincentown, N.J. 12/24 to 1/97: Number of samples	Maximum	Mean	Minimum	Site 01467000 North Branch Rancocas Creek at Pemberton, N.J. 9/23 to 1/97: Number of samples	Maximum	Mean	Minimum
Temperature, water, deg C	118	26.0	15.5	0.0	201	27.0	14.5	0.0	207	27.0	14.0	-0.5
Specific conductance field, µS/cm	116	242	166	116	129	163	78	52	152	82	52	35
Oxygen, dissolved, mg/L	116	14.4	8.8	3.8	121	14.0	8.4	1.2	130	13.5	8.8	4.4
[1]Oxygen demand biochemical, 5-day, mg/L	115	9.6	2.8	.3	115	6.9	1.6*	<1.0	119	3.8	1.1*	<.9
pH, field, standard units	116	8.4	7.2	6.7	127	6.8	5.9	4.4	149	6.4	4.8	3.7
[2]Alkalinity, field, mg/L as $CaCO_3$	39	53	26	8.0	46	14	3.8	1.0	70	4.0	0.9*	<1.0
Nitrogen, ammonia, total, mg/L as N	106	2.30	.530	.030	112	.700	.124*	<.010	113	.500	.079*	<.010
Nitrogen, nitrite, total, mg/L as N	77	.260	.044	.010	86	.038	.011*	<.010	87	.032	.007*	<.001
Nitrogen, ammonia + organic, total, mg/L as N	116	3.0	1.1	.29	121	2.2	.79	.24	123	2.0	.52	.11
Nitrogen, nitrite + nitrate, total, mg/L as N	108	2.66	.992	.200	115	1.00	.461	.010	116	1.40	.117*	<.050
Phosphorus, total, mg/L as P	90	.730	.201	.040	94	.560	.147	.020	95	.500	.055*	<.010
Organic carbon, total, mg/L as C	86	10	4.7	1.3	94	43	12	2.0	98	32	9.4	3.0
Calcium, dissolved, mg/L as Ca	117	19	12	7.9	124	10	5.6	2.0	150	4.7	2.0	.50
Magnesium, dissolved, mg/L as Mg	117	6.7	4.9	2.7	124	4.3	1.5	.5	150	1.4	.84	.20
Sodium, dissolved, mg/L as Na	117	18	7.1	4.1	123	6.8	4.2	1.6	142	5.6	3.0	.50
Potassium, dissolved, mg/L as K	117	5.5	3.5	2.2	122	3.2	1.6	.7	142	1.8	.83	.20
Chloride, dissolved, mg/L as Cl	117	28	16	10	128	22	7.2	1.0	155	8.6	5.1	2.2
Sulfate, dissolved, mg/L as SO_4	117	40	21	12	128	36	15	7.1	155	24	10	5.0
Fluoride, dissolved, mg/L as F	96	.40	.23	.10	100	.30	.09*	<.10	117	.40	.08*	<.10
Silica, dissolved, mg/L as SiO_2	98	11	7.5	3.2	102	9.0	5.2	2.4	121	6.3	4.2	2.3
Iron, total recoverable, µg/L as Fe	21	2,400	1,35[illegible]	530	20	3,200	1,930	980	22	2,900	1,720	750
Manganese, total recoverable, µg/L as Mn	23	230	10[illegible]	40.0	21	50.0	31.0	20.0	24	50.0	31.2	10.0
[3,4]Fecal coliform, EC broth, MPN	113	9,200	97[illegible]	<2.0	119	16,000	550*	<2.0	122	3,500	144*	<2.0
[4]Fecal streptococci, MPN	82	9,200	67[illegible]	<2.0	83	7,900	651	2.0	88	5,400	578	2.0
Solids, residue at 180 deg C, dissolved, mg/L	116	145	99.9	70.0	124	100	61.7	32.0	147	80.0	36.4	14.0

[1]A measure of the quantity of dissolved oxygen necessary for the decomposition of organic matter by microorganisms over 5 days at 20 degrees Celsius.
[2]Analysis done by whole-water total fixed-endpoint titration.
[3]EC broth refers to a specific mixture of nutrients that is used for growing bacteria by the MPN method.
[4]In the most-probable-number (MPN) method to determine fecal streptococci and fecal coliform, bacteria are grown from the sample in a nutrient solution and the most probable number of organisms is calculated from the amount of gas produced.

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