HYDROLOGIC DATA FOR THE BIG SPRING BASIN, CLAYTON COUNTY, IOWA, WATER YEAR 1989

By Stephen J. Kalkhoff and Ronald L. Kuzniar

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CONVERSION FACTORS

For readers who prefer to use metric (International System) units, conversion factors for inch-pound units used in this report are listed below:

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
acre	4,047.0	square meter
acre	0.4047	hectare
square foot (ft^2)	929.0	square centimeter
	Mass	
pound (lb)	.454	kilogram
ton, short	.907	megagram
tons per day (t/d)	.907	megagrams per day

Water Year: A water year is a 12-month period, from October 1 through September 30, designated by the calendar year in which it ends. Years are water years in this report unless otherwise stated

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ABSTRACT

Hydrologic data were collected in the Big Spring Basin located in Clayton County, Iowa, during the 1989 water year. The data were collected in cooperation with the Iowa Department of Natural Resources, Geological Survey Bureau, to provide information on variation and movement of agricultural chemicals in the hydrologic cycle in the Big Spring Basin. Precipitation, stream, and ground-water data were collected.

Total rainfall in the basin ranged from 20.0 to 24.4 inches. The greatest monthly rainfall was in August. Calcium and sulfate were the predominant ions in the rain and the median nitrate and ammonia concentrations as nitrogen were 0.40 and 0.63 mg/L (milligrams per liter), respectively.

Stream discharge, water temperature, specific conductance, and pH were monitored continuously, and monthly water-quality samples were collected at three sites in the basin. The predominant ions in Roberts Creek, at the site where it leaves the basin, were calcium, magnesium, and bicarbonate. Nitrate plus nitrite as nitrogen concentrations ranged from 0.2 to 6.2 mg/L. Pesticide concentrations in 23 samples ranged from less than 0.10 μg/L (micrograms per liter) to 4.4 μg/L. Atrazine was detected in 100 percent of the samples, cyanazine and metolachlor in 43 percent of the samples and alachlor in 35 percent of the samples.

At Big Spring, the ground-water discharge point, the daily mean water temperature ranged from 5.1 to 10.6 degrees Celsius, the daily mean specific conductance ranged from 271 to 793 microsiemens per centimeter at 25 degrees Celsius, and the daily median pH ranged from 6.5 to 7.1. Calcium, magnesium, and bicarbonate were the predominant ions in solution. Nitrate plus nitrite as nitrogen concentrations ranged from 2.0 to 7.4 mg/L. Atrazine was detected in 95 percent of the samples, cyanazine was detected in 26 percent of the samples, and metolachlor and alachlor were detected in 16 percent of the samples. The maximum atrazine concentration was 3.3 μg/L.

Water levels in the unconsolidated aquifers and the Galena aquifer were highest in the spring after snowmelt and in September after the greatest monthly rainfall. Water levels in the Saint Peter aquifer declined by approximately 0.5 to 3.0 feet.

During a baseflow seepage study, August 16 and 17, the measured discharge lost by streams in the basin was 2.82 cubic feet per second, the measured dissolved nitrogen load lost was 80 pounds per day, and the measured atrazine load lost was 0.002 pound per day. The total measured discharge and total dissolved nitrogen load leaving the basin in streams was 0.07 cubic feet per second and less than 20 pounds per day, respectively.

INTRODUCTION

There is concern nationally, as well as within the State of Iowa, to understand, quantify, and minimize the occurrence of agricultural chemicals in surface and ground water. In response to this concern, the Big Spring basin in Clayton County, Iowa, has been studied since 1980 and has become a nationally known demonstration area for improving ground-water quality through the modification of agricultural practices. Numerous multidisciplinary studies that deal with agronomy, geology, hydrology, biology, and socioeconomics of the basin currently are being conducted.

The unique ground-water-flow system in the Big Spring basin aids in studying the movement of agricultural chemicals in ground water. Much of the ground water in the basin is intercepted by a karst system within the Galena aquifer and is discharged at Big Spring. The extent of the ground-water drainage basin has been defined by dye tracing, potentiometric-surface mapping, and other hydrologic analyses. Nearly all land in the basin is farmed and a clear link between agricultural chemicals and ground-water contamination has been established (Hallberg and others, 1983, 1984; Libra and others, 1986).

Beginning in October 1987, the U.S. Geological Survey, in cooperation with the Iowa Department of Natural Resources, Geological Survey Bureau, has collected water quality and quantity data in the Big Spring Basin. These data are needed to refine the understanding of the hydrologic cycle in the basin and the agricultural-chemical transport processes in the system. The dynamic nature of the surface- and ground-water flow in the basin requires some facets of water quality and quantity be monitored continuously. The data collected in the study aids in interpretion of the flow system.

This report is the second in a series of reports that present the data collected by the U.S. Geological Survey in the Big Spring Basin. Hydrologic data collected in the first year of this study, water year 1988, are published in a previous report (Kalkhoff, 1989).

Purpose and Scope

This report presents the hydrologic data collected in the Big Spring Basin during the 1989 water year by the U.S. Geological Survey. These data include information on the quantity and quality of precipitation, ground, and surface water. The scope of this work includes measuring the input (precipitation) and the outputs (stream discharge and spring discharge) from the system. Also included is continuous monitoring of selected water-quality constituents (water temperature, specific conductance, and pH) of the water leaving the system and of a small stream flowing into the Galena aquifer through a sinkhole complex. Suspended-sediment load leaving the basin is determined. Precipitation and stream discharge are recorded at three sites. Chemical quality of surface water and ground water is monitored by storm event and monthly sampling at three sites. Ground-water discharge from the basin via springflow is measured at a monitoring site at Big Spring. Precipitation-quality data are included from the NADP/NTN (National Atmospheric Deposition Program/National Trends Network) site at Big Spring.

In addition to the monitoring activities in the basin, two studies to define the processes affecting surface-water quality were conducted. During a period of low streamflow after an extended period without rain, discharge measurements were made at numerous sites on streams in the study area to define areas where seepage from surface water was contributing to the ground-water flow system. During the seepage study, samples were collected for the analysis of nutrients and selected herbicides. Also, hydrologic data were collected in the Deer Creek subbasin to study ground water-surface water relations in a small drainage basin.

Hydrologic data in this report are divided into four main sections: precipitation, surface-water, ground water, and the seepage study. The precipitation section includes rainfall amounts at three sites and precipitation quality at the NADP/NTN site. The surface-water section includes discharge data for four sites and water-quality information for three sites. The ground-water section includes water-level data and water-quality information for three important ground-water systems, the unconsolidated aquifers, the Galena aquifer, and the Saint Peter aquifer. The last section includes data describing the results of a basin-wide study of discharge and water quality of streams during a period of low base-flow.

The hydrologic data are presented in two formats to aid the reader in interpretion. Data are summarized and presented graphically in the text and are tabled in the hydrologic data section in the back of the report.

Additional water discharge and chemistry data are collected by State, Federal, and University researchers through ongoing studies. The data presented in this report do not include the additional data. Reports detailing other studies in the Big Spring Basin were released in water year 1989 by the Iowa Department of Natural Resources, Geological Survey Bureau (Hallberg and others, 1989), the University of Iowa Hygienic laboratory (Kennedy and others, 1988), and Iowa State University researchers (Hersh and Crumpton, 1989).

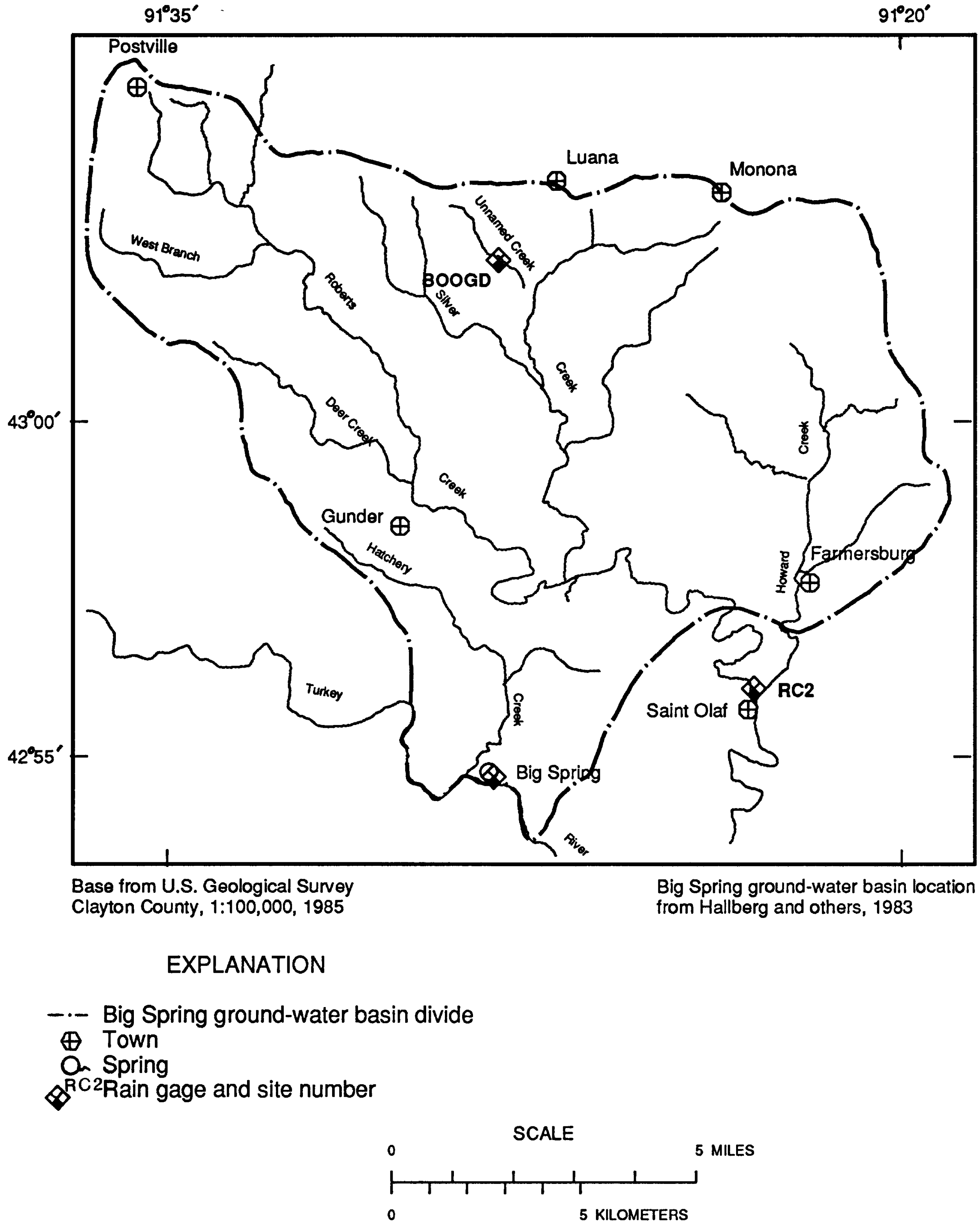

Figure 1.--Location of the Big Spring study area and rain gages.

Study area

The study area (fig. 1), located in Clayton County in northeastern Iowa is the 103 mi^2 (square miles) ground-water basin that drains through Big Spring (Hallberg and others, 1983). Streams in the study area include Roberts Creek and its major tributary, Silver Creek, which together drain approximately 69 percent (70.7 mi^2) of the area overlying the ground-water basin. The remaining area is drained by Howard Creek (approximately 18 mi^2), and Hatchery Creek (8.8 mi^2), and several small intermittent streams.

Methodology

Precipitation was measured using standard tipping bucket rain gages at three monitoring sites (fig. 1). At two sites, RC2 and BOOGD, precipitation was recorded digitally every 15 minutes. At Big Spring precipitation was recorded continuously with a weighing bucket gage

Precipitation-quality samples obtained at Big Spring were collected automatically with an Aerochem Metrics Wet/Dry Precipitation Collector[1]. During periods of precipitation, a bucket was exposed to catch the rain. Between rain events the bucket was covered to avoid the collection of particulate matter. Buckets were removed and the contents analyzed weekly. Site operations are described in detail in the National Atmospheric Deposition Program/National Trends Network instruction manual (1988).

Water quality was continuously monitored in Roberts Creek above Saint Olaf (RC2), the primary surface-water discharge point, and at Big Spring, the primary ground-water discharge point (fig. 2). Water samples for chemical analyses were collected monthly at these two sites, in Unnammed Creek near Luana (BOOGD), and in Deer Creek near Postville (DC5). Stream and spring stage were also continuously recorded for later calculation of discharge. Additional samples were collected during hydrologic events, snowmelt and heavy rains. Pertinent data for the water-quality monitoring sites are shown in table 1.

The water-quality constituents continuously monitored in Roberts Creek and Big Spring are water temperature, specific conductance, and pH. These constituents are measured using a multiple parameter meter and recorded digitally at 15 minute intervals. The data are retrieved weekly by computer through a phone modem in the U.S. Geological Survey's office in Iowa City. Stage was recorded continuously at stream sites DC5, RC2, L23S, and BOOGD with bubble-gage sensors and digital recorders (Rantz and others, 1982a, p 32-39). Stream discharge was calculated from stage using stage-discharge relations(Kennedy, 1983, p. 30-32) or by using the theoretical-discharge equation for V-notch weirs (Rantz and others, 1982b, p. 305). From the 15-minute observations, daily mean values were calculated and permanently stored in the U.S. Geological Survey National Water Data Storage and Retrieval System (WATSTORE) data base. Values determined by the multiple parameter field meter were calibrated weekly against pH buffer and conductance reference solutions. Temperature values were calibrated with a mercury thermometer. Stage measurements were calibrated by comparison to permanent reference marks.

Measurement of unstable water-quality constituents and stream discharge were made at the time of sample collection. Water temperatures and dissolved-oxygen concentrations were measured in the stream or spring pool. Water temperatures were measured with a standard mercury or alcohol thermometer that had been checked against a laboratory grade thermometer for accuracy. Dissolved-oxygen concentrations were measured with a dissolved-oxygen meter. Water to be analyzed was collected from a flowing section of the stream or the surface of the spring pool. Immediately after sample collection, the pH and specific conductance of the water were measured. Stream discharge normally was measured by current-meter methods (Buchanan and Somers, 1969). Because of low-flow conditions with shallow stream depths during most of the 1989 water year, the 0.6-depth method generally was used. Where the channel was extremely narrow and the discharge small, less than 0.50 ft^3/s (cubic foot per second), a portable Parshall flume was used to measure the flow (Kilpatrick and Schneider, 1983, p 13-15).

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

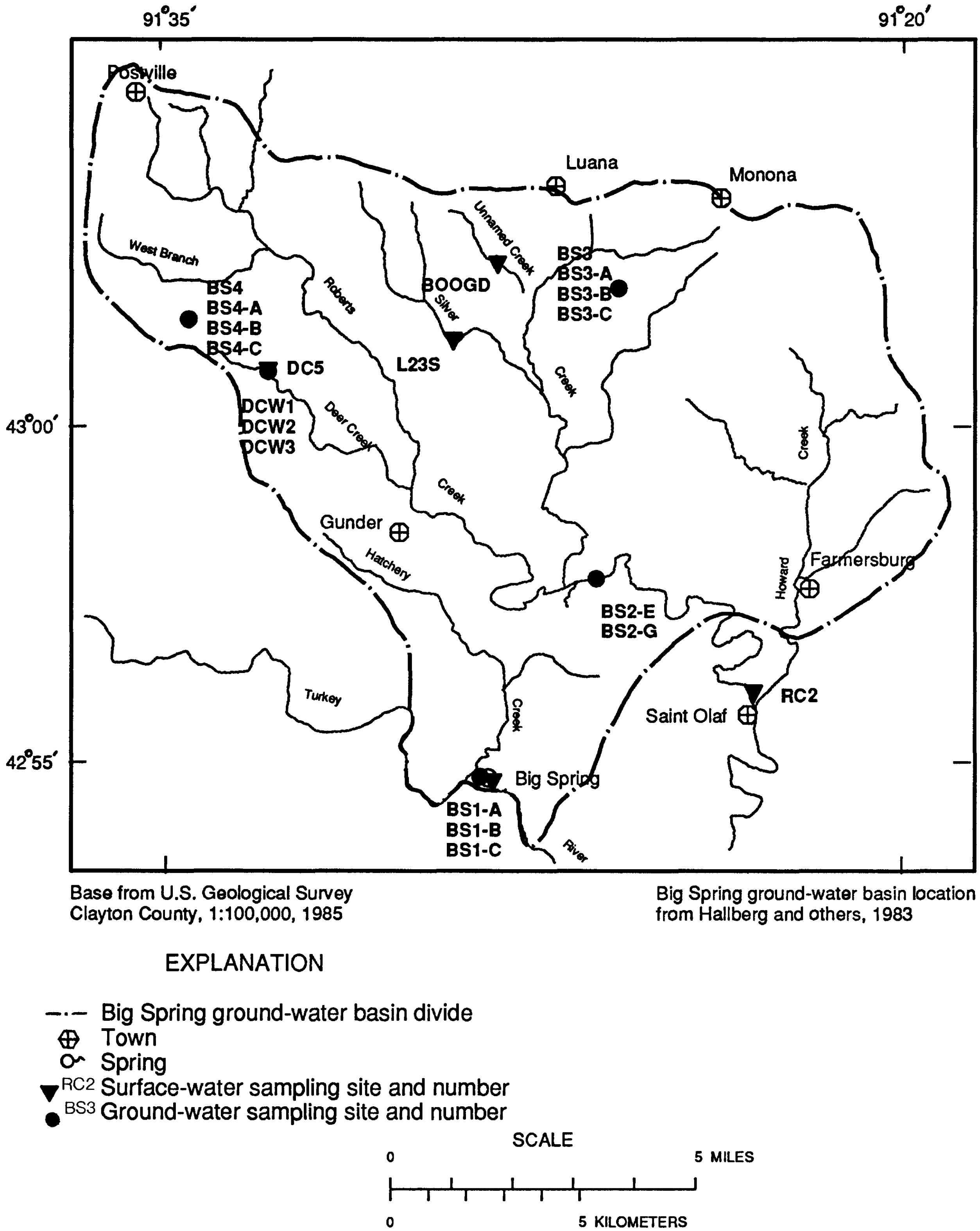

Figure 2.--Location of surface- and ground-water quality monitoring sites.

Suspended-sediment samples were collected periodically by local observers, technicians, and by automatic samplers during storms. The observers collected depth-integrated samples at one vertical using techniques described by Guy and Norman (1970). Samples were collected three times per week at Roberts Creek above Saint Olaf (RC2), intermittently at Unnamed Creek near Luana (BOOGD), and weekly at Big Spring.

Water levels in the principal water-supply aquifers in the basin were recorded at four well nests (table 2). At each well nest, water levels were recorded for the unconsolidated aquifers, the Galena aquifer, and the Saint Peter aquifer. Water levels were sensed by a float and then recorded hourly for subsequent storage in the WATSTORE database. Additional wells (DCW1, DCW2, and DCW3) were used to monitor the relation between water levels in the unconsolidated aquifer and flow in Deer Creek.

A seepage study was conducted during stable-flow conditions on August 16 and 17, 1989. Discharge measurements were made and water samples were collected using techniques described previously for routine sampling. The location and drainage areas of the seepage study sites are given in table 3.

Samples for chemical analyses were prepared as described in table 4 for shipment to the laboratory. Analyses of water samples by the University of Iowa Hygienics Laboratories in Iowa City and Des Moines, Iowa, followed the analytical methods listed in table 4. The U.S. Environmental Protection Agency's (1983) method 81.40 for the analyses of pesticides was modified to use dual capillary columns.

Suspended-sediment concentrations were determined by the U.S. Geological Survey Sediment Laboratory in Iowa City, Iowa, using standard filtration and evaporation methods (Guy, 1969).

In this report, a shorthand terminology is used in describing the results of the chemical analyses of nitrogen species and herbicides. 'Nitrate-N' is used to report nitrate plus nitrite as nitrogen, 'ammonia-N' is used to report ammonia as nitrogen, and 'organic-N' is used to report organic nitrogen. Reported herbicide concentrations reflect the total recoverable concentrations and are not adjusted for recovery rates.

Acknowledgments

This project was supported, in part, by the Iowa Department of Natural Resources, Geological Survey Bureau, through the Big Spring Basin Demonstration Project, with funds provided from the Iowa Groundwater Protection Act. George Hallberg, Coordinator of the Big Spring Basin Demonstration Project, and other members of the Iowa Department of Natural Resources, Geological Survey Bureau, Bob Libra, John Littke, Deb Quade, and Bob Rowden provided technical advice and field support. Darwin Evans, of the Geological Survey Bureau, drilled and installed the monitoring wells. Jerry Spykerman, manager of the Big Spring Fish Hatchery, provided support for data collection at the spring and collected NADP/NTN precipitation samples. Roger Koster, the Big Spring Project Coordinator for the Iowa State University Cooperative Extension Service, located landowners willing to cooperate in the small-basin study. Leon Dibble allowed installation of equipment on his property. Leann Hilgerson, Karen and Eugene Voss, and Jerry Koonze collected sediment samples. These people contributed significantly in collection of hydrologc data for the project.

HYDROLOGIC DATA SUMMARY

Precipitation

Total rainfall at Big Spring for water year 1989 was 24.1 inches which was 9.3 inches less than the average for the area (National Oceanic and Atmospheric Administration, 1988, p. 3). The median weekly rainfall was 0.24 inch(table 5). Measurable precipitation of 0.01 inch or more fell during 44 of 52 weeks.

Precipitation at Unnamed Creek near Luana (BOOGD) and at Roberts Creek above Saint Olaf (RC2) are listed in table 6. The total rainfall measured for the 1989 water year was 20.0 inches (13.3 inches below average) at BOOGD and 24.4 inches (8.98 inches below average) at site RC2. The greatest monthly rainfall occurred in August when 7.15 and 6.62 inches fell at sites BOOGD and RC2, respectively. The greatest daily rainfall fell at site BOOGD on August 22, 1989 (1.81 inches) and at site RC2 on July 18, 1989 (2.29 inches).

Quality

Weekly precipitation samples were collected when measurable rainfall occurred at Big Spring. Results of chemical analyses of these samples are summarized in table 5 . The median concentration of the predominant cation, calcium, was 0.50 mg/L (milligrams per liter) and the median concentration of the predominant anion, sulfate, was 2.3 mg/L. The median concentrations of nitrate and ammonia were 0.40 and 0.63 mg/L as nitrogen, respectively. Maximum concentrations of all major ions except sulfate were less than 10 mg/L.

Surface water

Deer Creek

Discharge and water-quality data were collected at site DC5 on Deer Creek near Postville (fig. 2) as part of a study to determine the relations between ground- and surface-water in a small drainage basin.

Discharge

Stream discharge was continuously recorded in part of November and December, 1988, and from mid-May to the end of the water year (table 7). Daily mean discharge recorded at site DC5 ranged from 0.14 ft^3/s on July 28 to an estimated 4.2 ft^3/s on August 22 after the greatest daily rainfall in the basin. Median monthly discharge was approximately 0.30 ft^3/s in November and December 1988 and decreased through the summer from 0.27 ft^3/s in May to 0.17 ft^3/s in August. Median discharge then increased slightly in September to 0.26 ft^3/s.

Water quality

Chemical analyses of dissolved constituents in samples collected from site DC5 on Deer Creek show that calcium and magnesium are the predominant cations in solution (table 8). Calcium and magnesium concentrations ranged from 10 and 3.3 mg/L, respectively, during snowmelt on March 11, to 87 and 28 mg/L, respectively, on September 7. Sodium concentrations were less than 10 mg/L and potassium concentrations were less than 20 mg/L. The predominant anion in solution was bicarbonate. Bicarbonate concentrations ranged from 54 mg/L during snowmelt on March 10 to 415 mg/L just before snowmelt on March 7. Sulfate concentrations ranged from less than 0.1 mg/L during snowmelt in March to 43 mg/L on December 1. Except during snowmelt, dissolved nitrate-N is the predominant nitrogen species in solution (table 9). Dissolved nitrate-N concentrations ranged from 1.1 to 4.9 mg/L. During snowmelt, March 10-12, ammonia-N and organic-N are the predominant nitrogen species; at that time, concentrations of ammonia-N ranged from 2.1 to 4.9 mg/L. At other times of the year, ammonia-N concentrations generally were less than 0.5 mg/l. Organic-N concentrations ranged from 2.9 to 11 mg/L during snowmelt.

Four herbicides, atrazine, cyanazine, metolachlor, and alachlor were detected in 25 samples collected at site DC5 on Deer Creek (fig. 3 and table 10). Atrazine was detected in 72 percent of the samples in concentrations ranging from less than 0.1 to 11 µg/L (micrograms per liter). Cyanazine was detected in 24 percent of the samples in concentrations ranging from less than 0.1 to 0.30 µg/L. Metolachlor was detected in 40 percent of the samples ranging from less than 0.1 to 3.4 µg/L. Alachlor was detected in 12 percent of the samples in concentrations ranging from less than 0.1 to 0.53 µg/L. Metribuzin, butylate, and trifluralin were not detected.

Silver Creek

Daily mean discharge at site L23S on Silver Creek ranged from 0.00 ft^3/s on August 21 to 83 ft^3/s on March 11 during snowmelt (fig. 4). Mean discharge for the 1989 water year was 0.76 ft^3/s. Daily mean discharge at site L23S is shown in table 11 and the flow distribution is shown in figure 5. Discharge exceeded 1.0 ft^3/s approximately 5 percent of the year and exceeded 0.1 ft^3/s approximately 76 percent of the year.

Unnamed Creek

Discharge

Flow in Unnamed Creek near Luana (BOOGD) was recorded on only 29 days during water year 1989 (table 12). Measurable discharge was recorded in March, July, August, and September. The maximum daily mean discharge at site BOOGD was 7.0 ft^3/s on March 10, during spring snowmelt.

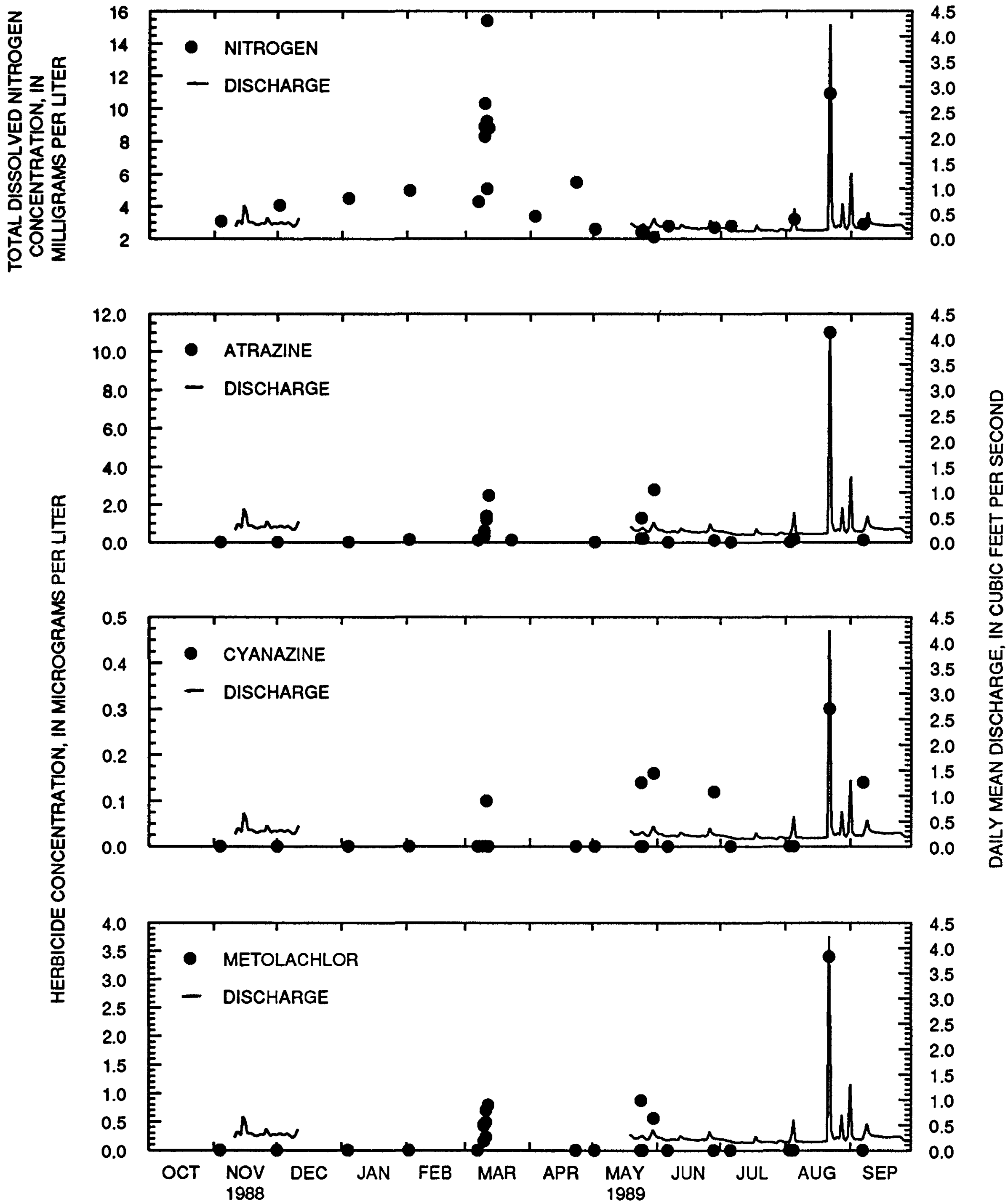

Figure 3.--Selected chemical constituents and stream discharge at site DC5, Deer Creek near Postville, Iowa.

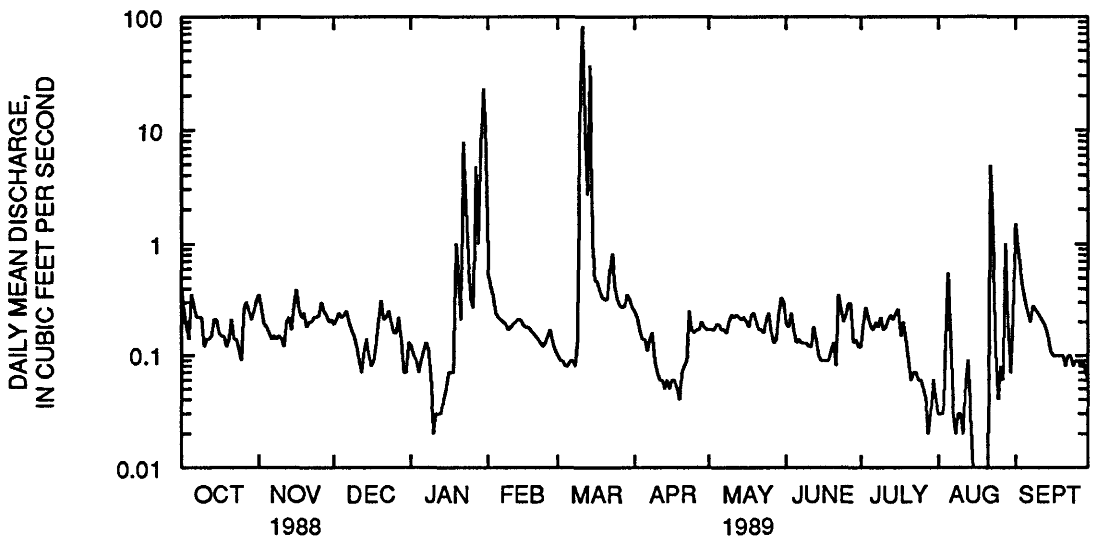

Figure 4.--Daily mean discharge at site L23S, Silver Creek near Luana, Iowa.

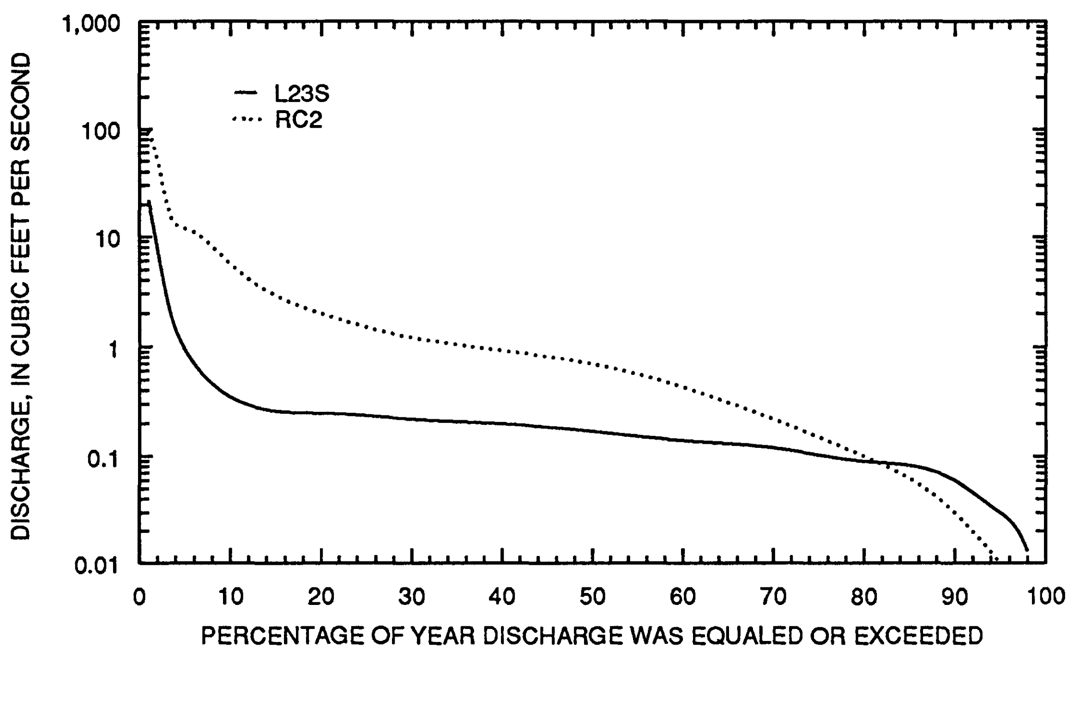

Figure 5.--Flow duration at site L23S, Silver Creek near Postville, and at site RC2, Roberts Creek above Saint Olaf, in the Big Spring Basin.

Water quality

Collection of water-quality data was limited at Unnamed Creek near Luana (BOOGD) due to lack of streamflow caused by less than normal rainfall in water year 1989. water-quality samples were collected only during spring snowmelt on March 10-12, 1989. Concentrations of three nitrogen species and orthophosphorous were generally higher than 1.0 mg/L in five samples during spring snowmelt (table 9). Organic-N was the predominant nitrogen species present in concentrations that ranged from 3.9 to 5.8 mg/L. Dissolved nitrate-N concentrations ranged from 1.8 to 2.9 mg/L. Ammonia-N concentrations ranged from 2.0 to 3.4 mg/L. Concentrations of all dissolved nitrogen species as nitrogen ranged from 8.5 to 11 mg/L.

Four pesticides were detected in samples from site BOOGD (table 10). Atrazine was detected in all samples, cyanazine and metolachlor were detected in three of five samples, and alachlor was detected in one sample. Atrazine concentrations ranged from 1.5 to 3.5 μg/L, cyanazine concentrations ranged from less than 0.1 to 0.25 μg/L, metolachlor concentrations ranged from less than 0.1 to 0.63 μg/L, and alachlor concentrations ranged from less than 0.1 μg/L to 0.14 μg/L.

Roberts Creek

Discharge

Daily mean discharge at Roberts Creek above Saint Olaf (RC2) is listed in table 13 and illustrated in figure 6. The median discharge at site RC2 for the 1989 water year was 0.70 ft^3/s. Maximum daily mean discharge (290 ft^3/s) occurred on March 11 during spring snowmelt. Daily mean discharge then decreased through the rest of the spring and summer. There was no recorded discharge from July 25 through August 1 and from August 8 to August 22. Flow distribution is shown in figure 5. Discharge exceeded 0.1 ft^3/s approximately 80 per cent of the year, exceeded 1.0 ft^3/s approximately 35 percent of the year, and exceeded 10 ft^3/s approximately 7 percent of the year.

Water quality

The maximum daily mean specific conductance of 740 μS/cm (microsiemens per centimeter at 25 degrees Celsius) was recorded in Roberts Creek above Saint Olaf (RC2) on the last day of monitor operation (November 21, 1988) before instrumentation was removed for winter (table 13). The minimum daily mean specific conductance (344 μS/cm) was recorded on August 24. The daily mean water temperature varied from 0.9 degrees Celsius on April 1 to 27.0 degrees Celsius on August 4. Daily median pH varied from 7.12 on August 25 to 8.87 on April 29 (table 14).

Analyses of water-quality samples from site RC2 showed that calcium and magnesium generally were the predominant cations and bicarbonate was the predominant anion in solution (table 8). Sodium and potassium concentrations usually were 20 mg/L or less. During snowmelt, sulfate concentrations ranged from 2.3 mg/L to 61 mg/L and chloride concentrations ranged from 16 to 110 mg/L. Silica concentrations were 14 mg/L or less. Dissolved nitrate-N concentrations (table 9) ranged from 0.2 to 6.2 mg/L. Ammonia-N nitrogen was detected in 12 of 22 samples. Dissolved ammonia-N concentrations ranged from 1.0 to 4.2 mg/L from February 1 to April 4 and were less than 0.5 mg/L the rest of the year. Organic-N was the major nitrogen species during much of the water year. Dissolved organic-N concentrations ranged from 0.4 to 7.2 mg/L from February 1 to April 4 and concentrations ranged from 0.4 to 3.1 mg/L the rest of the year.

Four of seven analyzed herbicides were detected (concentration greater than 0.1 μg/L) in Roberts Creek above Saint Olaf (RC2). Atrazine was detected in all samples, cyanazine was detected in 10 of 23 samples, metolachlor was detected in 10 of 23 samples, and alachlor was detected in 8 of 23 samples (table 10). Metribuzin, butylate, and trifluralin were not detected. Atrazine concentrations ranged from 0.11 to 4.4 μg/L. Cyanazine concentrations ranged from less than 0.1 to 0.78 μg/L. Metolachlor concentrations ranged from less than 0.1 to 0.83 μg/L and alachlor concentrations ranged from less than 0.1 to 0.77 μg/L.

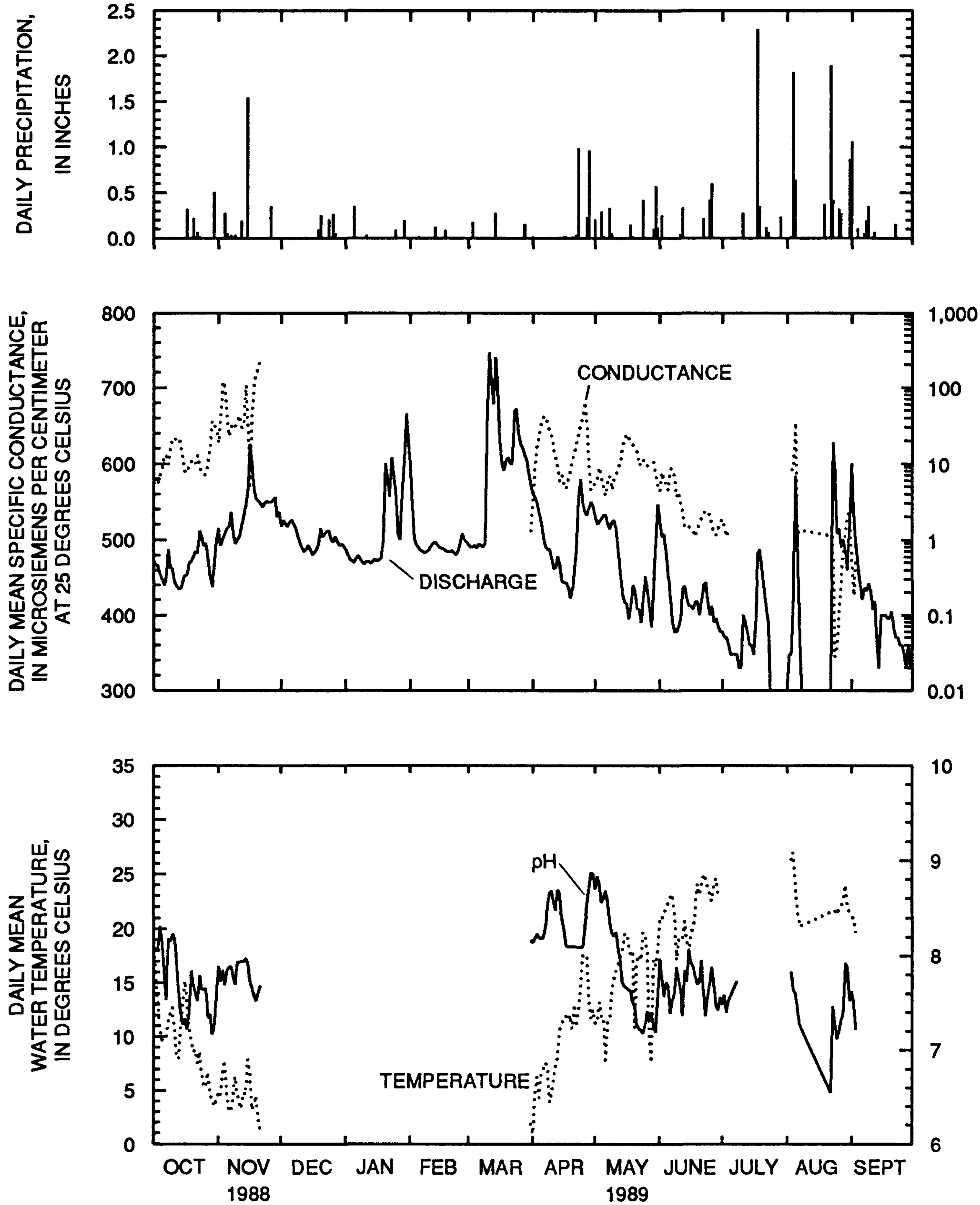

Figure 6.--Daily precipitation, daily mean specific conductance, discharge, water temperature, and daily median pH at site RC2, Roberts Creek above Saint Olaf, Iowa.

The daily mean suspended-sediment loads at site RC2 ranged from 0.0 tons per day on days of no streamflow to 220 tons per day on March 14 (table 15). The greatest monthly sediment loads were in January (82 tons) and March (490 tons) when snow- and ice-melt occurred.

Ground Water

Unconsolidated aquifers

Water levels are continuously recorded at five wells screened in unconsolidated material in the Big Spring Basin (fig. 2). Well BS1-A is screened in alluvial material in the Turkey River Valley, well BS3-C is in weathered limestone and loess, wells BS4-B and BS4-C are in sands deposited by glacial action, and well DCW-1 is in Deer Creek alluvial material.

The highest water level in well BS1-A (fig. 7 and table 16) was recorded in March (9.84 feet below land surface) and the lowest water level was recorded in August (14.87 feet below land surface). The highest water level in well BS3-C was recorded in September, the month following the greatest monthly rainfall in water year 1989 and the lowest level was in April. Water levels were recorded for only one month in wells BS4-B and BS4-C, which is an insufficient period to define a yearly range in water levels. Water levels in well DCW-1 varied from a low of 6.88 feet below land surface on August 4 to a high of 4.68 feet below land surface on September 1. More than 6.0 inches of rain fell in the Big Spring Basin during the period August 4 to September.

As part of an investigation to study the relation between shallow ground water and surface water, samples were collected for chemical analyses from two wells (DCW2 and DCW3) and four lysimeters (DCLA, DCLB, DCLC, and DCLD) completed in unconsolidated material in the Deer Creek sub-basin. The physical data for the wells and lysimeters are given in table 2.

The results of chemical analyses of samples from wells DCW2 and DCW3 indicate calcium and magnesium are the predominant cations in solution (table 17). Calcium concentrations ranged from 92 to 120 mg/L and magnesium concentrations ranged from 26 to 38 mg/L. Sodium and potassium concentrations were less than 10 mg/L. Bicarbonate is the predominant anion. The bicarbonate concentration ranged from 342 to 509 mg/L. Sulfate concentrations ranged from 17 to 110 mg/L and chloride concentrations ranged from 1.0 to 28 mg/L. Organic-N was the major nitrogen species present (table 18). Concentrations of organic-N ranged from less than 0.1 mg/L to 0.9 mg/L. Nitrate-N was detected in 5 of 19 samples from wells DCW2 and DCW3 in concentrations ranging from less than 0.1 to 0.9 mg/L. Ammonia-N was detected in seven of 19 samples in concentrations ranging from less than 0.1 mg/L to 0.2 mg/L. Of the seven analyzed herbicides, only metolachlor was present in one sample in concentrations greater than the detection limit (table 19).

The four lysimeters were used to collect water from the water table or unsaturated zone depending on the water level. Lysimeters DCLA and DCLB were always in the saturated zone and lysimeter DCLD was always in the unsaturated zone. Lysimeter DCLC was in the water table in April and May and part of September and in the unsaturated zone in June through August and the last half of September. Nitrate-N and ammonia-N concentrations in the deepest lysimeters, DCLA and DCLB, were less than the detection limit in all samples (table 18). Organic-N concentrations in samples from these lysimeters ranged from less than 0.1 to 0.4 mg/L. Samples from DCLC had nitrate-N concentrations that ranged from less than 0.1 to 0.5 mg/L, ammonia-N concentrations 0.1 mg/L or less, and organic-N concentrations that ranged from less than 0.1 to 0.8 mg/L. Samples from DCLD had nitrate-N concentrations that ranged from 4.5 to 13 mg/L, ammonia-N concentrations less than 0.1 mg/L, and organic-N concentrations that ranged from 0.1 to 0.8 mg/L. Total nitrogen concentrations (nitrate-N, ammonia-N, and organic-N) in samples from the lysimeters and the water level from well DCW-1 are shown in figure 8.

Cyanazine and alachlor were the only pesticides detected in the lysimeter (DCLA) installed 8.5 feet below land surface (table 19). Each herbicide was detected once in 15 samples. In lysimeter DCLB, which was installed at 7 feet below land surface, atrazine was detected in 1 of 15 samples and cyanazine and alachlor each were detected in 2 of 15 samples. In samples from the lysimeter installed at 5.5 feet below land surface, DCLC, atrazine was detected in 14 of 15 samples in concentrations ranging from less than 0.1 μg/L to

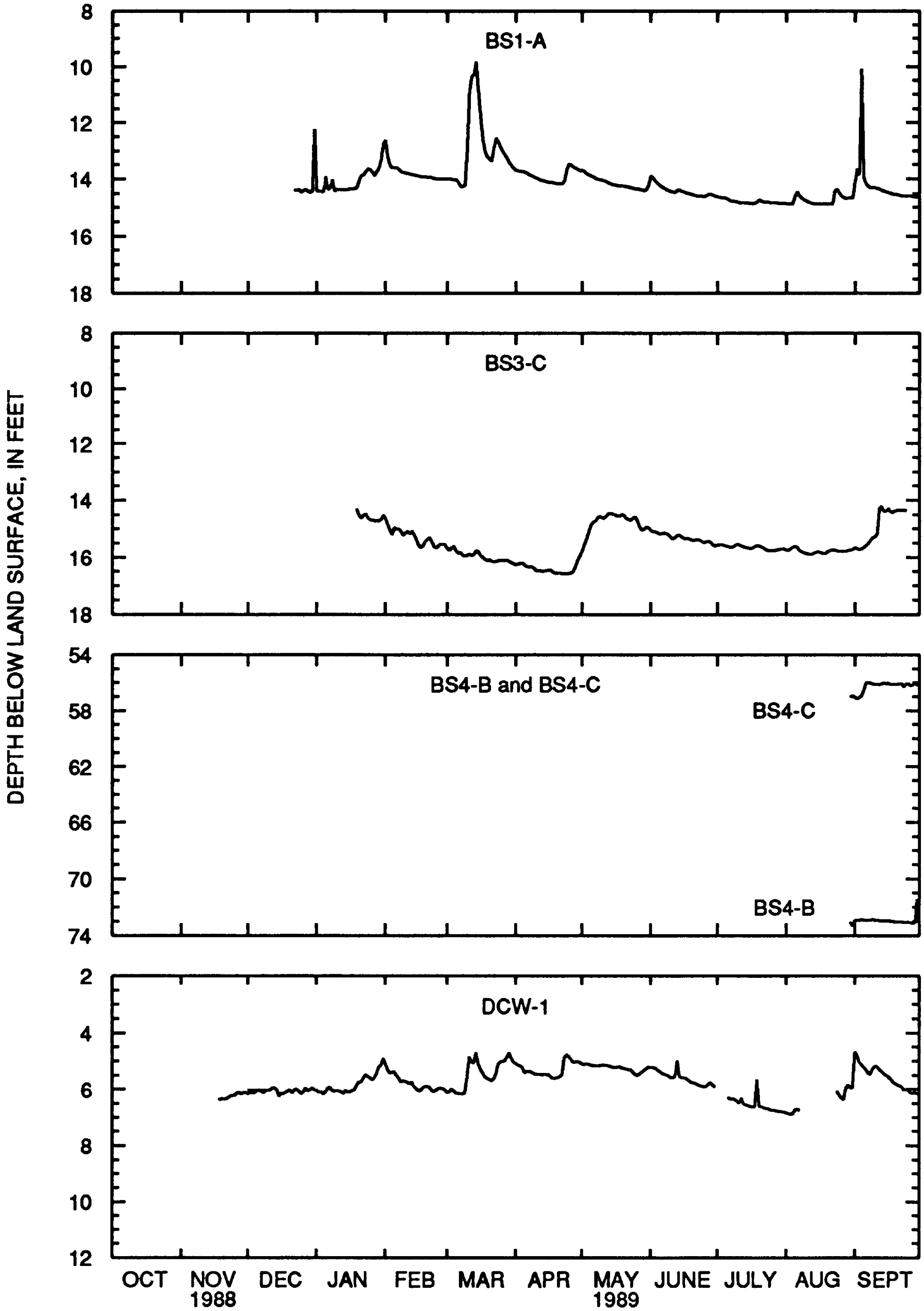

Figure 7.--Daily mean water levels in unconsolidated aquifers in the Big Spring Basin.

0.96 µg/L, cyanazine was detected in two of 15 samples in concentrations from less than 0.1 ug.L to 1.4 µg/L, metolachlor was detected in 5 of 14 samples in concentrations from less than 0.1 to 0.5 µg/L. Alachlor was detected in one sample at a concentration of 0.35 µg/L. In samples from lysimeter DCLD, installed at 4.0 feet, below land surface, atrazine was detected in all 12 samples in concentrations ranging from 0.44 µg/L to 0.66 µg/L, cyanazine was detected in 2 of 12 samples in concentrations from less than 0.1 ug.L to 0.23 µg/L, metolachlor was detected in two of 12 samples in concentrations from less than 0.1 to 0.24 µg/L. Alachlor was detected in two samples in concentrations from less than 0.1 to 0.6 µg/L. Atrazine and metolachlor concentrations in lysimeter water samples and the water level in well DCW-1 are shown in figures 9 and 10.

Galena Aquifer

Water-quality data for the Galena aquifer were collected at the discharge point, Big Spring, and water levels in the aquifer were recorded at four monitoring wells (BS1-B, BS2-E, BS3-A, and BS4-A) in water year 1989 (table 20). Daily water levels are shown in figure 11.

Water levels

Two wells ,BS1-B and BS2-E, located in the southern and central part of the basin had the greatest range of water levels in the Galena aquifer. Water levels in BS1-B ranged from 5.29 feet below land surface on March 15 to 10.38 feet below land surface on July 20. Mean daily water levels in BS2-E ranged from 148.92 feet below land surface on March 10 to 154.89 feet below land surface on July 28. The water level in well BS4-A gradually decreased from 214.94 feet below land surface on January 29 to 219.99 feet below land surface on September 27.

Big Spring

Continuous water-quality data collected at Big Spring are shown as daily mean and median values in figure 12 and are listed in tables 21 and 22. Daily mean specific conductance values ranged from 271 µS/cm on March 12 during snowmelt to 793 µS/cm on December 1, 1988. Daily mean water temperatures ranged from 5.1 °C on March 12 during snowmelt to 10.6 °C during 8 days in September. The maximum daily median pH was 7.06 on December 12 and the minimum daily median pH was on 6.54 on February 1. Daily mean suspended-sediment concentrations ranged from 1 mg/L on numerous days in February and March to 840 mg/L on March 11 during snowmelt.

The predominant cations in solution at Big Spring were calcium and magnesium (table 17). Calcium concentrations ranged from 24 to 90 mg/L and magnesium concentrations ranged from 9.0 to 38 mg/L. Sodium and potassium concentrations were 25 mg/L or less. The predominant anion, bicarbonate, was present in concentrations that ranged from 115 to 382 mg/L. Sulfate concentrations ranged from less than 0.1 mg/L during snowmelt to 48 mg/L and chloride concentrations ranged from 8.5 to 38 mg/L. Silica concentrations were 15 mg/L or less. Dissolved nitrate-N generally was the predominant nitrogen species in solution (table 18). Nitrate-N concentrations ranged from 2.0 to 7.4 mg/L. Ammonia-N concentrations exceeded the detection limits in five samples collected during snowmelt. Dissolved ammonia-N concentrations in these samples ranged from 0.1 to 3.6 mg/L. Organic-N concentrations ranged from less than 0.1 to 3.5 mg/L, but were 2.0 mg/L or greater in four of five samples collected during the snowmelt period, February 1 to March 16. During the remainder of the year organic-N concentrations were 1.2 mg/L or less.

Four of seven analyzed herbicides were detected (concentration greater than 0.1 µg/L) in samples from Big Spring (table 19). Atrazine was detected in 18 of 19 samples, cyanazine was detected in 5 of 19 samples, and metolachlor and alachlor were detected in 3 of 19 samples. Metribuzin, butylate, and trifluralin were not detected. Atrazine concentrations ranged from less than 0.1 on November 16 to 3.3 µg/L in a sample collected on March 16. Cyanazine concentrations ranged from less than 0.1 to 0.34 µg/L. Metolachlor concentrations ranged from less than 0.1 to 0.22 µg/L. Alachlor concentrations ranged from less than 0.1 to 0.17 µg/L.

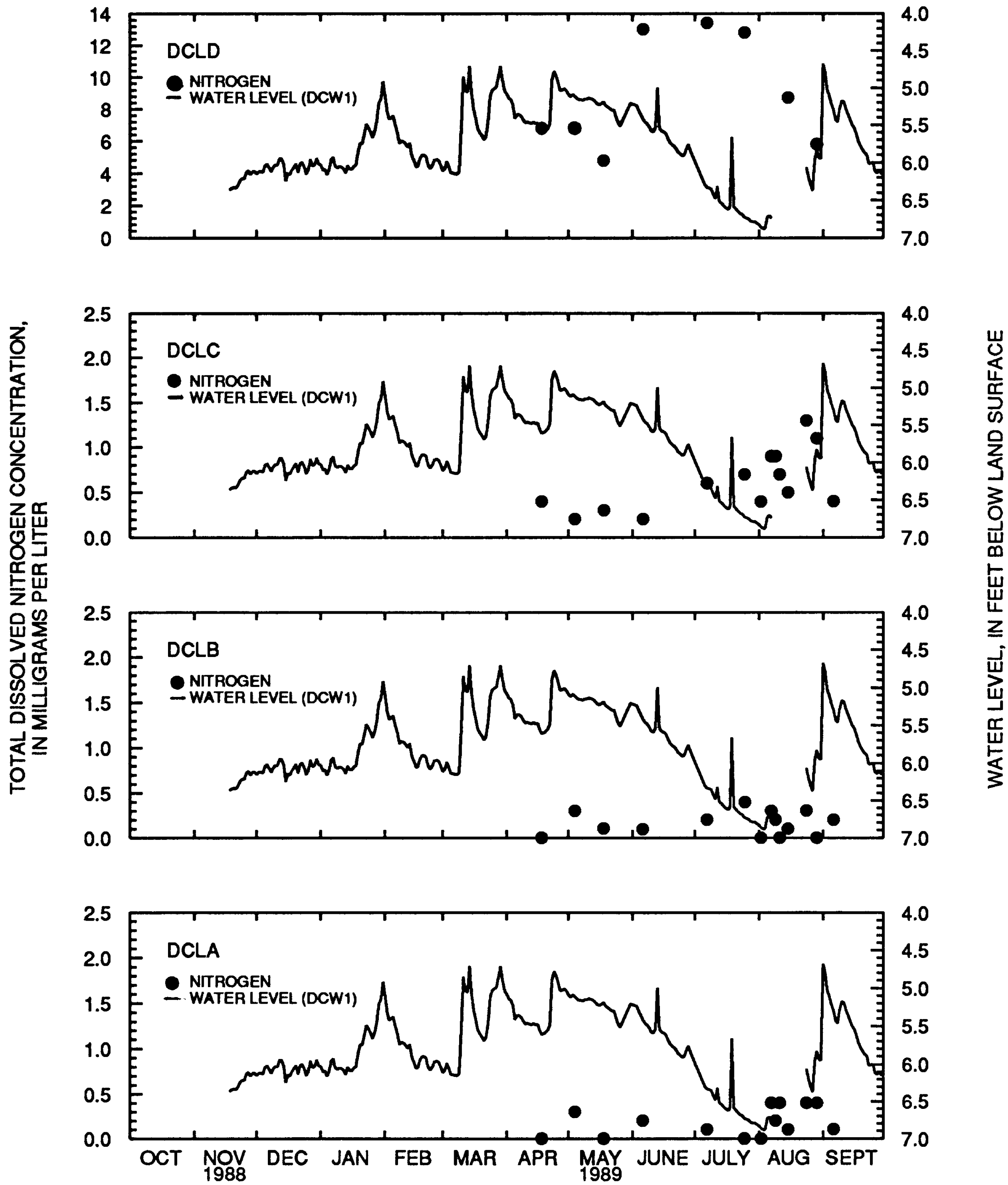

Figure 8.--Total dissolved nitrogen and the water level in unconsolidated aquifers in the Deer Creek subbasin

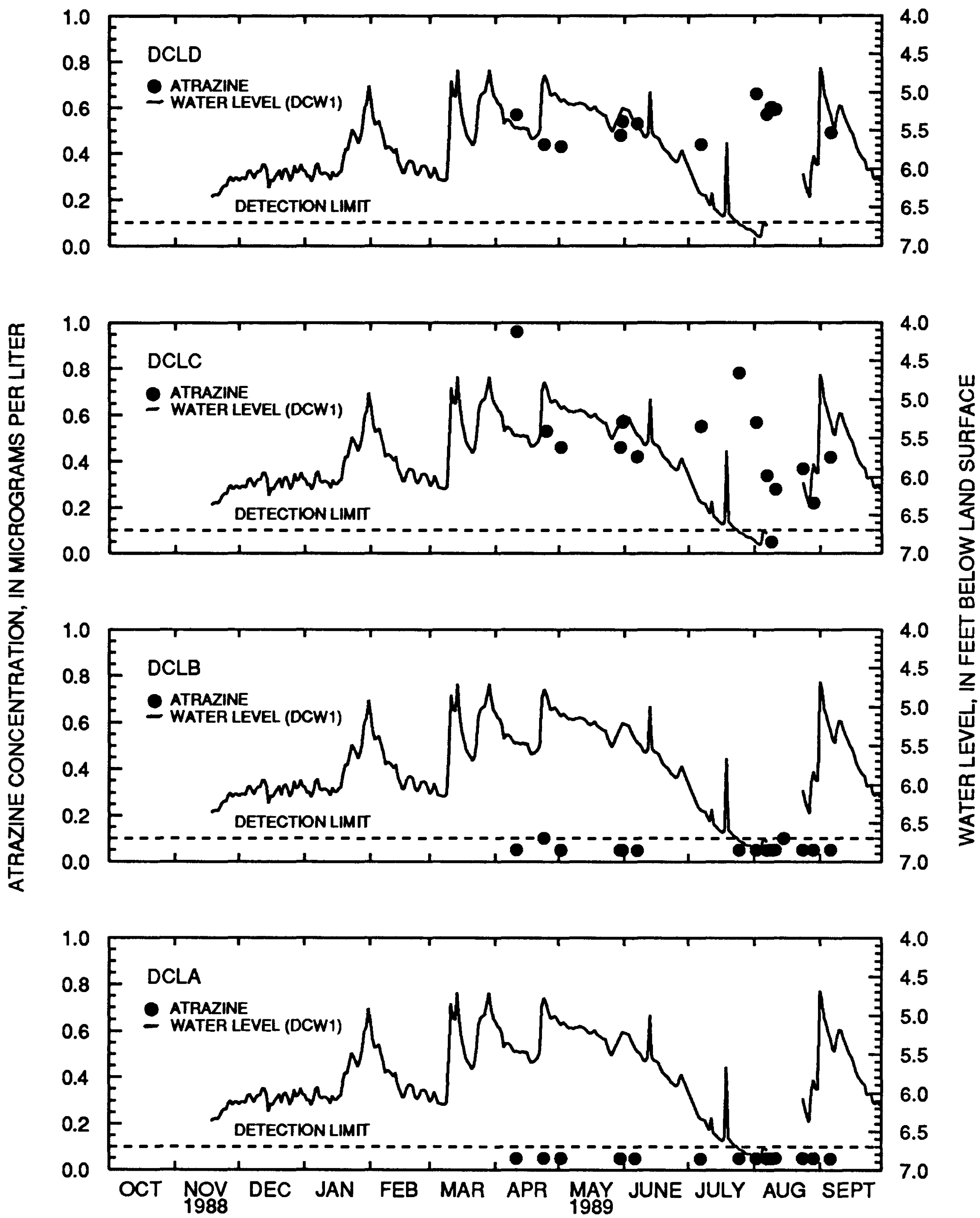

Figure 9.--Total recoverable atrazine and water levels in unconsolidated material in the Deer Creek subbasin.

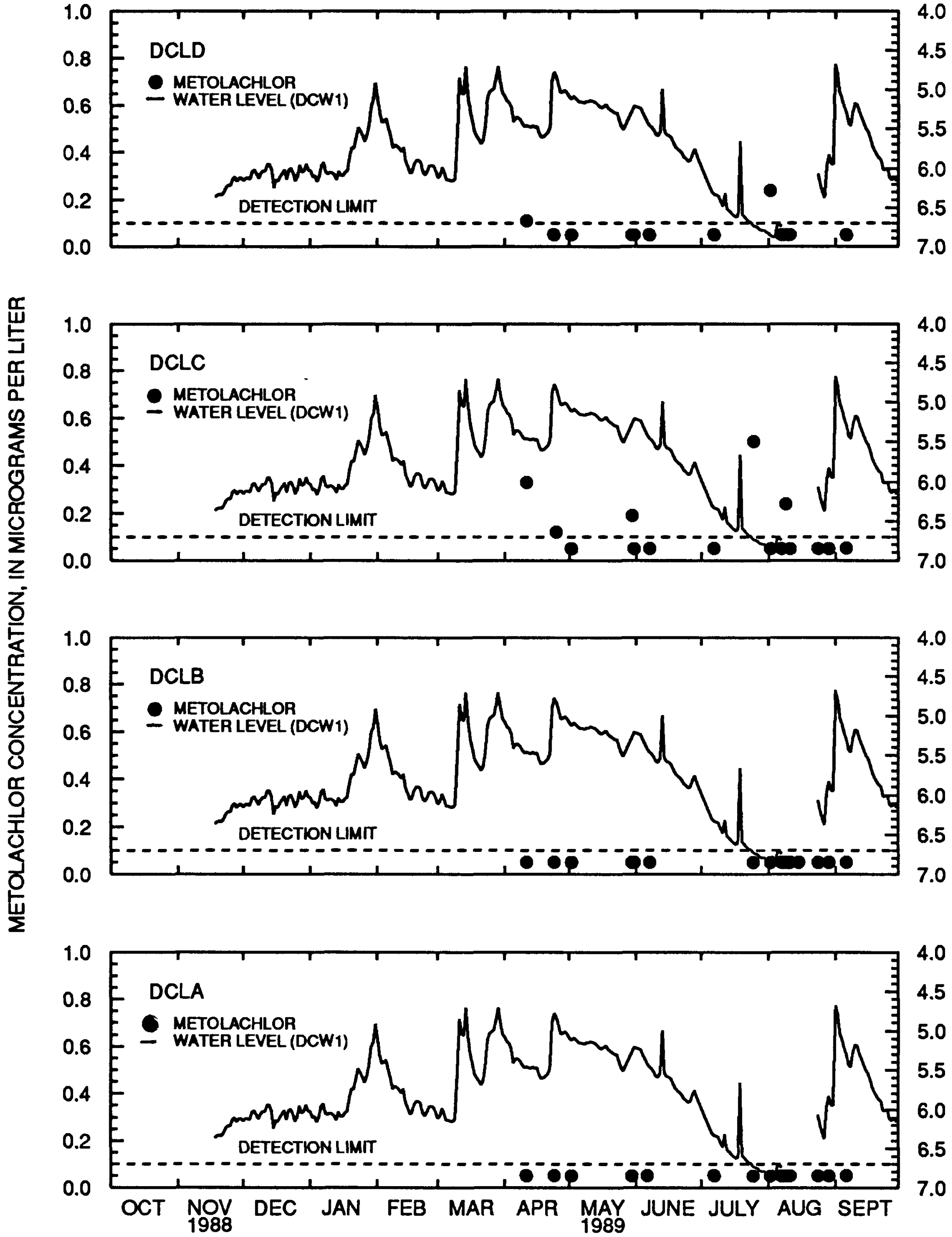

Figure 10.--Total recoverable metolachlor and water levels in unconsolidated material in the Deer Creek subbasin.

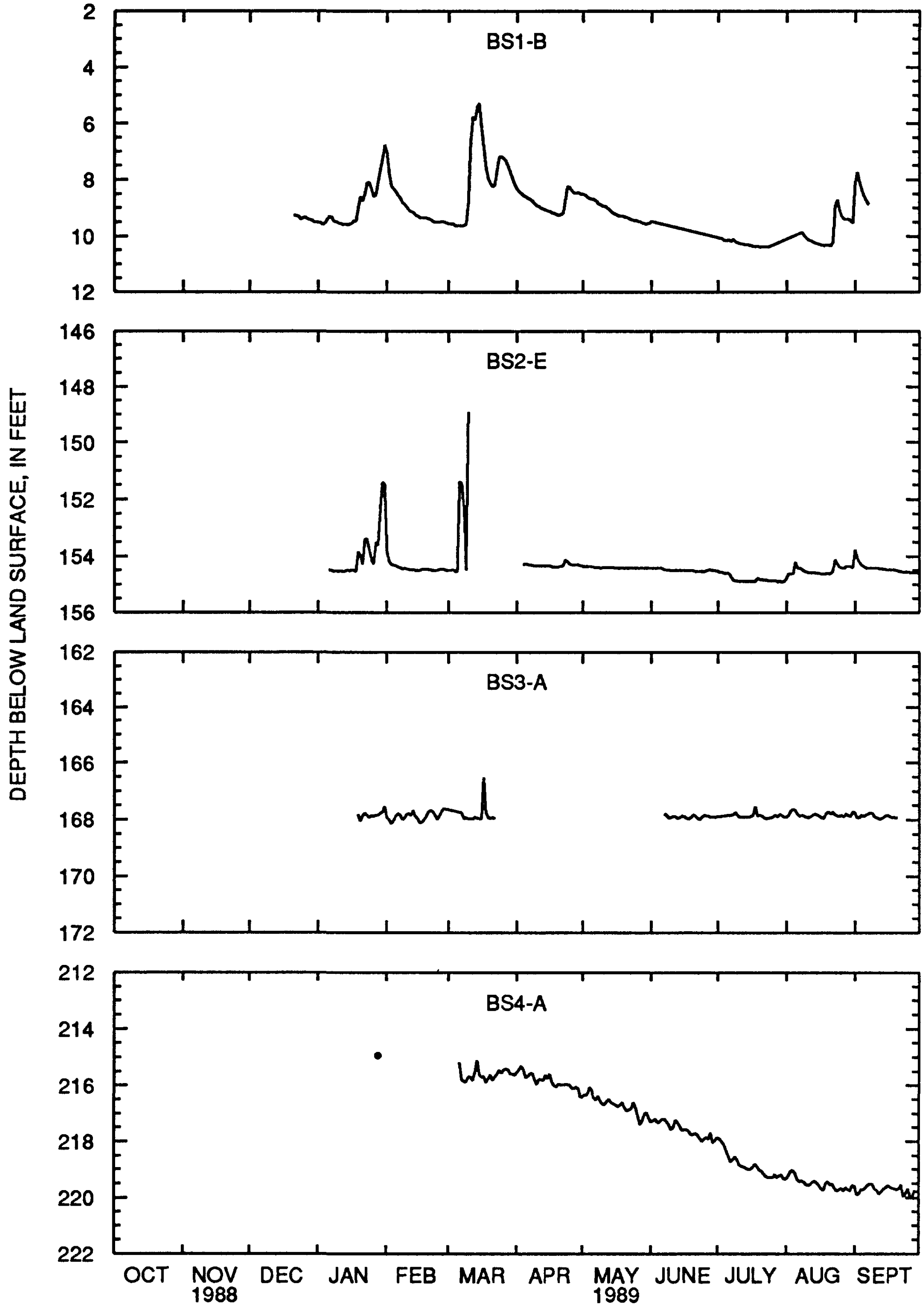

Figure 11.--Daily mean water levels in the Galena aquifer in the Big Spring Basin.

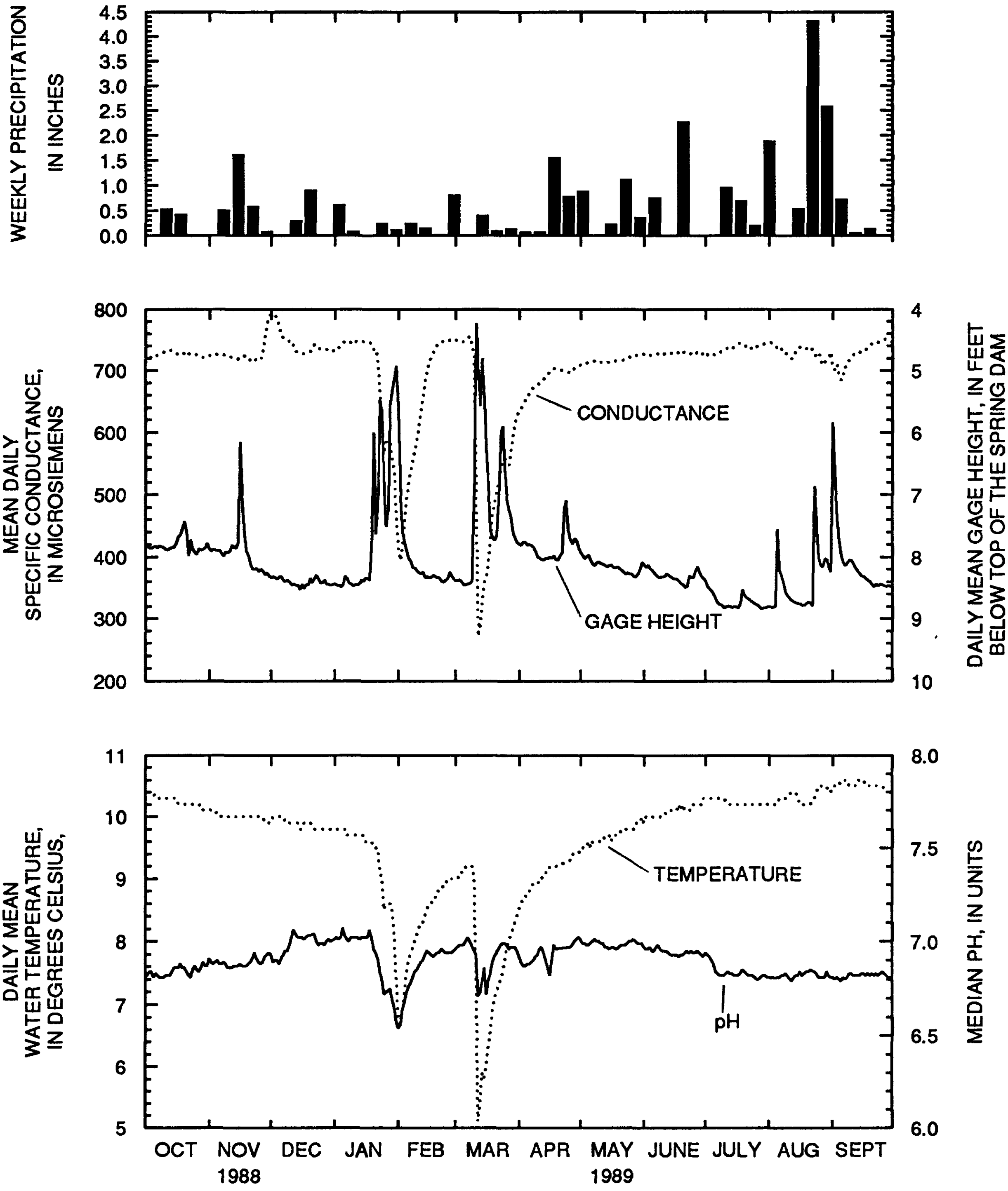

Figure 12.--Weekly precipitation, daily mean specific conductance, gage height, water temperature, and daily median pH at Big Spring, Clayton County, Iowa.

Saint Peter Aquifer

Water levels in the Saint Peter aquifer were monitored at three sites (BS2-G, BS3, and BS4) in the Big Spring Basin in water year 1989 (fig. 2). Water levels decreased at all three sites (fig. 13 and table 23). The greatest decrease, approximately 3.0 feet, was in well BS4 in which the water level declined from 366.97 on February 2 to 370.06 feet below land surface on September 30. The water level dropped 1.53 feet in well BS2-G and 0.33 feet in well BS3.

Seepage Study

Stream discharge was measured at 38 sites (fig. 14) on August 16 and 17 after an extended period without rain to determine areas where streamflow was being lost to the ground-water system through seepage and areas where water was flowing into the streams from shallow aquifers. Water samples were collected concurrently to document nutrient and herbicide inflow from ground water and outflow into the underlying aquifer. The results of the data collection are presented in tables 24 and 25. Discussion and interpretation of the results are beyond the scope of this report.

Discharge

Discharge increased in Roberts Creek from 0.01 ft^3/s at site RC13, the most upstream site, to 1.22 ft^3/s at F45 approximately 11 miles downstream. Streamflow in this reach originated partially from two tributaries, West Branch Roberts Creek and Deer Creek, and from industrial discharge in the headwaters. West Branch Roberts Creek (RC21) contributed 0.31 ft^3/s, Deer Creek(DC2) contributed approximately 0.08 ft^3/s, and industrial discharge (RC26) contributed 0.56 ft^3/s.

Discharge decreased downstream from 1.22 ft^3/s at site F45 to 0.0 ft^3/s at site RC2. Silver Creek joins Roberts Creek in this 15-mile reach of site, but during the seepage study it was dry.

Determination of seepage in Roberts Creek and Silver Creek is complicated by non-uniform point-source discharges in the headwaters of the streams. A municipal wastewater treatment plant discharges upstream of site SC10 and a creamery discharges wastewater upstream of site SC13. Discharges were 0.08 and 1.03 ft^3/s at sites SC10 and SC13, respectively. Discharge at site L23S on the main stem of Silver Creek was 0.05 ft^3/s. Downstream there was no flow at site SC1. During the seepage study Silver Creek did not contribute flow to Roberts Creek. The total measured discharge lost in the Silver Creek sub-basin was approximately 1.16 ft^3/s. In addition, approximately 0.18 ft^3/s and 0.07 ft^3/s were lost from Hatchery and Howard Creek, respectively. The total measured discharge lost in the Big Spring Basin during the two day seepage study was 2.82 ft^3/s and the total measured stream discharge leaving the basin in streams was 0.07 ft^3/s.

Water Quality

Total dissolved nitrogen concentrations (nitrate-N, ammonia-N, and organic-N) were generally less than 2.0 mg/L at sites on Roberts Creek upstream of site RC18 (fig 15). The predominant nitrogen species was nitrate. Organic nitrogen was the predominant nitrogen species at sampling sites downstream of site RC18.

Total dissolved nitrogen loads at sites on the main stem of Roberts Creek were 0.003 tons per day or less except at sites RC16 and RC18 (fig. 15). During the two-day seepage study, the measured total dissolved nitrogen load lost from Roberts Creek was 0.01 t/d (tons per day). No nitrogen left the basin through Roberts Creek streamflow because there was no flow at site RC2.

Total dissolved nitrogen concentrations, almost entirely as nitrate-N, were 33 mg/L at site SC10. Total nitrogen concentration decreased to 7.9 mg/l at site SC3 on the east fork of Silver Creek, and was composed nearly equally of nitrate, ammonia, and organic nitrogen. Total dissolved nitrogen concentration at site L23S was 8.6 mg/L. The total dissolved nitrogen load was 0.02 tons per day at site SC3 and was 0.001 tons per day at site L23S. Combined total dissolved nitrogen loads as nitrogen at sites L23S and SC3 was 0.02 tons per day. There was no streamflow downstream of these two sites.

The nitrogen load also decreased from Hatchery and Howard Creeks. The total measured nitrogen load decreased 0.003 tons per day in Hatchery Creek and decreased approximately 0.0002 tons per day in Howard Creek. The total measured dissolved nitrogen load lost in the study area was approximately 0.03 tons per day and the dissolved nitrogen load leaving the Big Spring Basin in streams was less than 0.0004 tons per day.

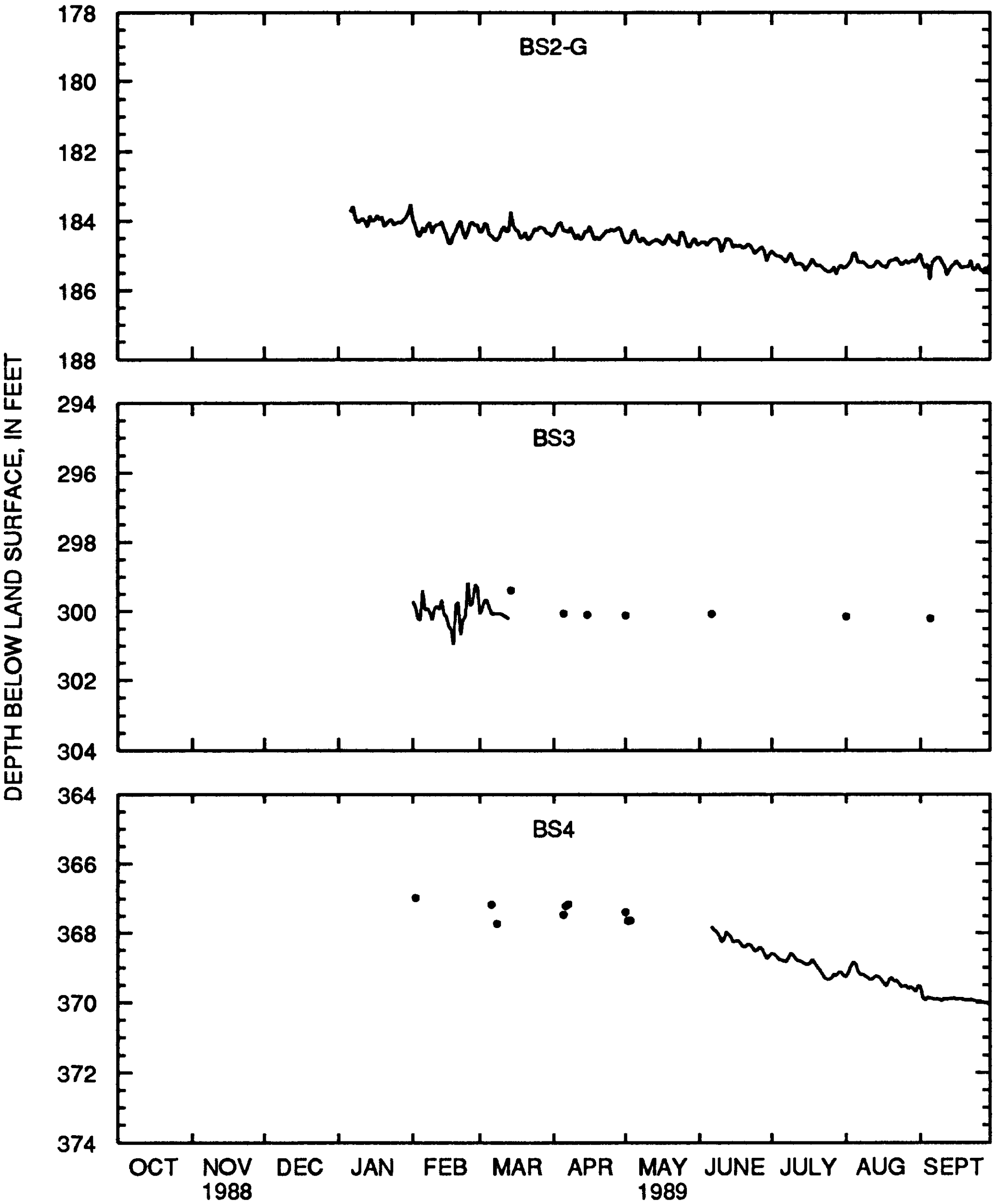

Figure 13.--Daily mean water levels in the Saint Peter aquifer in the Big Spring basin.

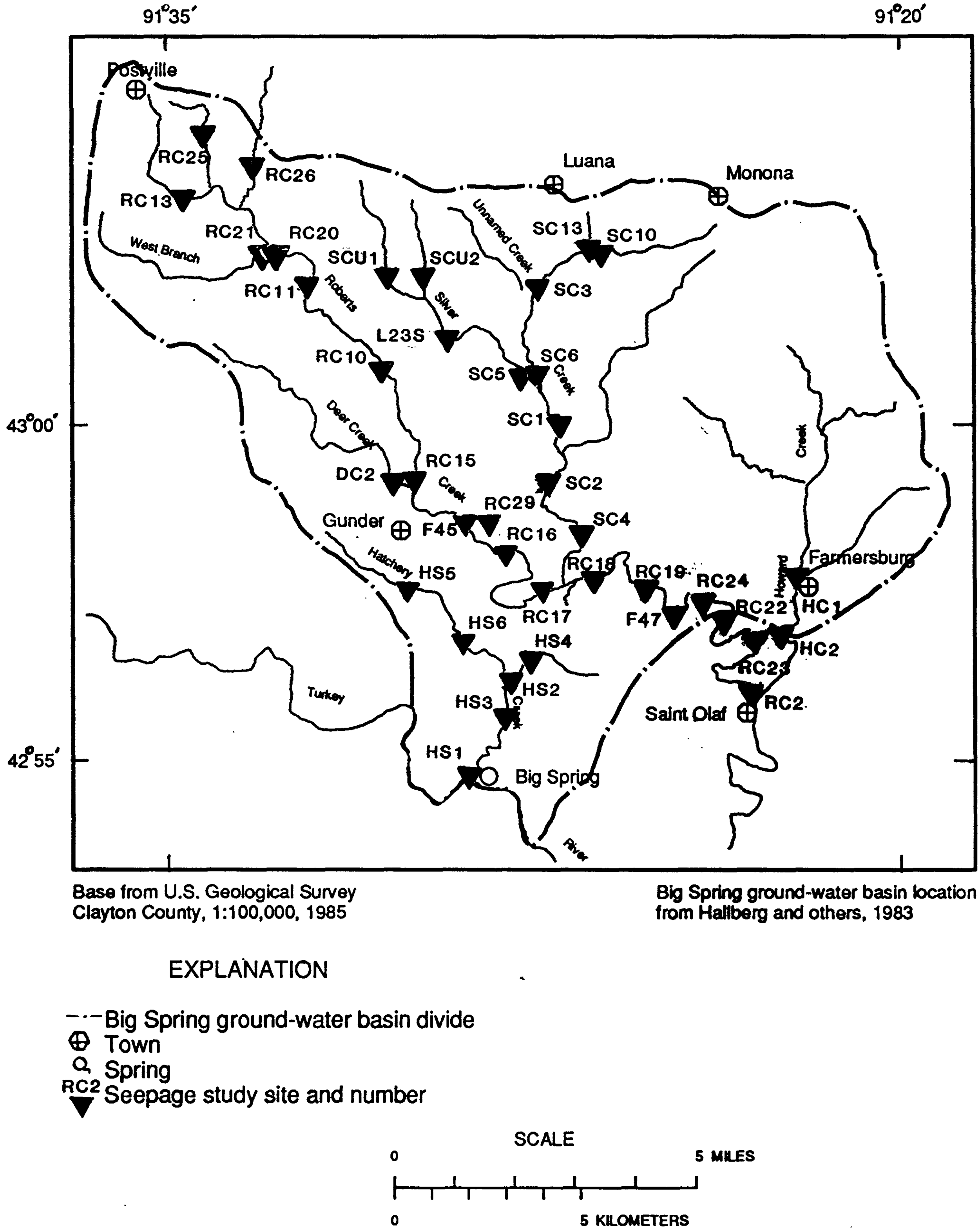

Figure 14.--Location of the seepage-study sampling sites.

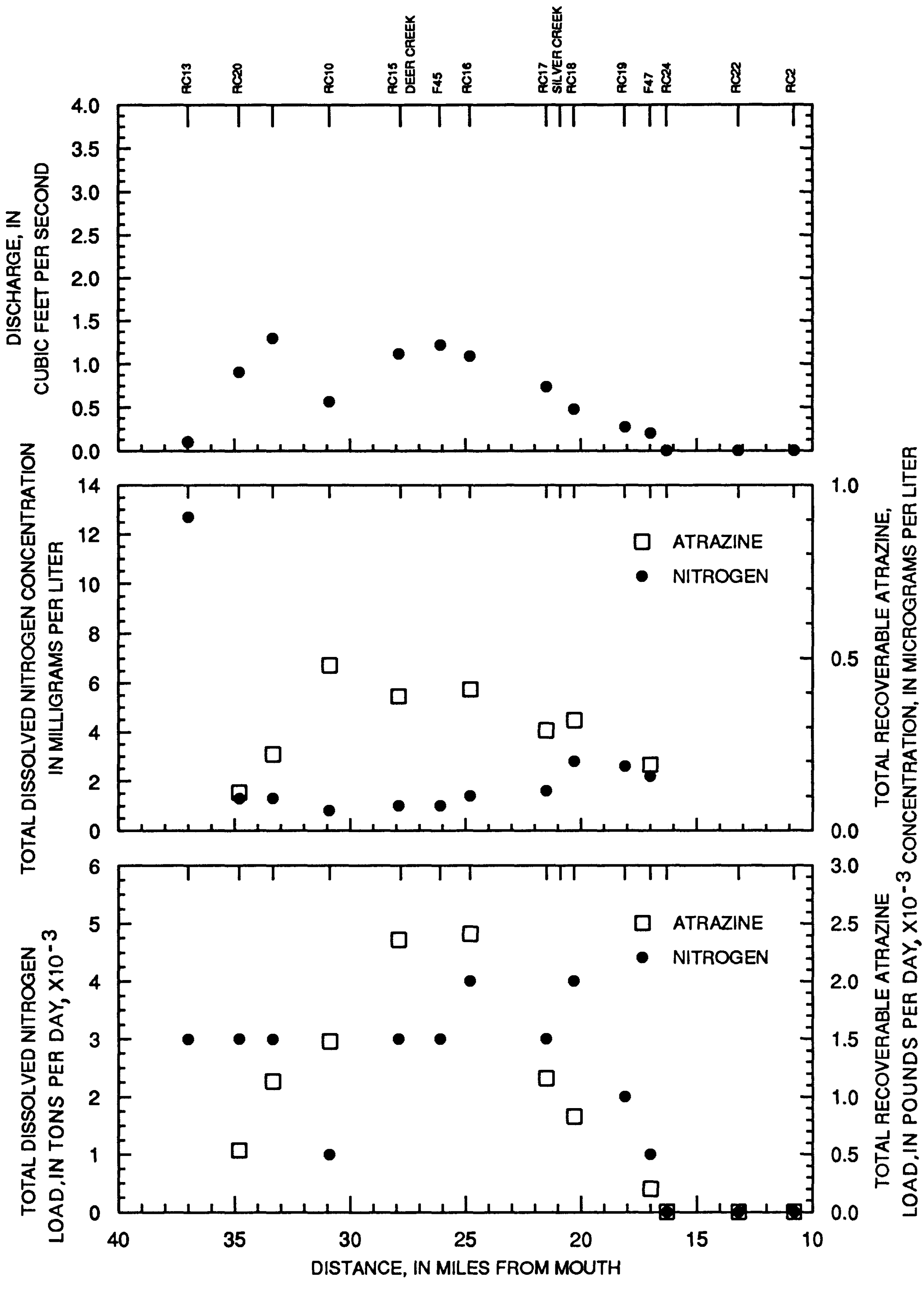

Figure 15.--Stream discharge, total dissolved nitrogen, and total recoverable atrazine concentrations and load in Roberts Creek, August 16-17, 1989.

During the seepage study samples were collected at 19 sites for the analyses of selected herbicides (table 25). Atrazine was detected in 14 of the 19 samples in concentrations from less than 0.1 to 0.48 µg/L. Cyanazine was detected in only one sample. Metolachlor, alachlor, metribuzin, butylate, and trifluralin were not detected. Proceeding downstream on Roberts Creek, atrazine concentrations increased from 0.11 µg/L at site RC20 to 0.48 µg/L at site RC10 and then decreased to 0.19 µg/L at site RC19 (fig. 15), the last site where flow was observed. The measured atrazine load also increased from 0.0005 lb/d (pounds per day) at site RC20 to 0.002 lb/d at site RC16 and then decreased to 0.0002 lb/d at site RC19. The measured atrazine load lost from Roberts Creek during the seepage study was about 0.002 lb/d. The total measured loss in the basin, including 0.0001 lb/d from Hatchery Creek, was about 0.002 lb/d.

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HYDROLOGIC DATA

page 29 follows

Table 1.--Records of monitoring sites in the Big Spring Basin, Clayton County, Iowa

[Lat., Latitude; Long., Longitude; mi^2, square miles]

Station number	Site identi-cation number	Station name	Location Lat.	Location Long.	Drainage area(mi^2)
DC5	430040091325401	Deer Creek near Postville	430400	0913254	1.1
BOOGD	05412060	Unnamed Creek near Luana	430224	0912807	1.15
L23S	05412070	Silver Creek near Luana	430119	0912921	4.39
RC2	05412100	Roberts Creek above Saint Olaf	425549	0912303	70.7
	425433091280101	Big Spring near Elkader	425433	0912801	1/103

1/ Ground-water drainage

Table 2.--Records of selected monitoring wells, lysimeters, and tile lines in the Big Spring Basin, Clayton County, Iowa

[Sec., section: T., township: R., range: well construction data from Iowa Department of Natural Resources, Geological Survey Bureau]

Number	Station identification number	Location Sec.	T.	R.	Altitude (feet)	Well depth (feet)	Open interval (feet)	Aquifer
				Well nest BS1				
BS1-A	425433091285001	NWSE31	94N	05W	855	36	33-36	Unconsolidated
BS1-B	425433091285002	NWSE31	94N	05W	855	85	61-85	Galena
BS1-D	425433091285004	NWSE31	94N	05W	855	215	173-215	Saint Peter
				Well nest BS2				
BS2-E	425736091260302	SENW16	94N	05W	950	180	165-180	Galena
BS2-G	425736091260303	SENW16	94N	05W	950	335	300-335	Saint Peter
				Well nest BS3				
BS3	430145091253001	SWNW22	95N	05W	1,080	397	351-397	Saint Peter
BS3-A	430145091253002	SWNW22	95N	05W	1,080	185	165-185	Galena
BS3-B	430145091253003	SWNW22	95N	05W	1,080	60		Galena
BS3-C	430145091253004	SWNW22	95N	05W	1,080	26	11-26	Unconsolidated
				Well nest BS4				
BS4	430133091344801	NWSE20	95N	06W	1,160	580	550-580	Saint Peter
BS4-A	430133091344802	NWSE20	95N	06W	1,160	361	261-361	Galena
BS4-B	430133091344803	NWSE20	95N	06W	1,160	139	130-139	Unconsolidated
BS4-C	430133091344804	NWSE20	95N	06W	1,160	61	50-61	Unconsolidated
				Single wells				
DCW1	430040091325402	SESE28	95N	06W	1,070	13	11-13	Unconsolidated
DCW2	430040091325403	SESE28	95N	06W	1,070	11	8-11	Unconsolidated
DCW3	430040091325410	SESE28	95N	06W	1,100	15	13-15	Unconsolidated
				Lysimeters				
DCLA	430040091325404	SESE28	95N	06W	1,070	8.5		Unconsolidated
DCLB	430040091325405	SESE28	95N	06W	1,070	7.0		Unconsolidated
DCLC	430040091325406	SESE28	95N	06W	1,070	5.5		Unconsolidated
DCLD	430040091325407	SESE28	95N	06W	1,070	4.0		Unconsolidated
				Tile line				
DCT2	430040091325408	SESE28	95N	06W	1,070			

Table 3.--Location and drainage area of seepage study sampling sites

[Lat., latitude; Long., longitude; mi^2, square miles]
[nr, near; SE, southeast; N, north; SW, southwest; NW, northwest; W, west; E, east; NE, northeast; S, south; trib, tributary; Cr, Creek]

Station number	Site identi-cation number	Site name	Location Lat.	Location Long.	Drainage area(mi^2)
HS5		Hatchery Creek nr Gunder	425734	0913012	1.28
HS6		Hatchery Creek SE of Gunder	425647	0912859	2.84
HS4		Hatchery Cr trib N of Big Spring	425629	0912737	1.36
HS2		Hatchery Cr trib nr Big Spring	425606	0912806	1.85
HS3		Hatchery Creek nr Big Spring	425536	0912806	7.02
HS1		Hatchery Creek at Big Spring	425446	0912853	8.80
RC25		Roberts Creek at Postville	430419	0913413	
RC13		Roberts Creek trib nr Postville	430327	0913440	2.28
RC26		Roberts Creek trib at Hwy 52	430409	0913312	
RC21		West Branch Roberts Cr at mouth	430244	0913300	4.14
RC20		Roberts Creek nr Postville	430240	0913253	11.1
RC11		Roberts Creek SE of Postville	430211	0913216	13.2
RC10		Roberts Creek nr Luana	430057	0913042	15.9
RC15		Roberts Creek at Gunder	425908	0913002	18.2
DC2		Deer Creek at Gunder	425908	0913025	5.56
F45		Roberts Creek E of Gunder	425830	0912858	26.0
RC29		Roberts Creek trib 2 East of Gunder	425830	0912837	
RC16		Roberts Creek north of Big Spring	425806	0912805	28.8
RC17		Roberts Creek near Big Spring	425735	0912722	30.4
SC10		East Fork Silver Cr nr Monona	430240	0912620	3.05
SC13		E Fork Silver Cr trib nr Monona	430240	0912606	.28
SC3		E Fork Silver Cr nr Luana	430203	0912730	4.28
SC6		E Fork Silver Creek S of Luana	430054	0912730	9.46
SCU1		Silver Creek SW of Luana	430210	0913033	1.36
SCU2		Silver Creek trib SW of Luana	430201	0912949	.70
L23S	05412070	Silver Creek nr Luana	430119	0912921	4.39
SC5		Silver Creek South of Luana	430049	0912744	5.59
SC1		Silver Creek NE of Gunder	430002	0912653	17.3
SC14		Silver Creek trib nr Monona	430140	0912510	1.13
SC2		Silver Creek nr Gunder	425916	0912712	25.2

Table 3.--Location and drainage area of seepage study sampling sites --Continued

Station number	Site identi-cation number	Site name	Location Lat.	Long.	Drainage area(mi^2)
SC4		Silver Creek East of Gunder	425824	0912630	28.8
RC18		Roberts Creek NE of Big Spring	425736	0912603	61.8
RC19		Roberts Creek NW of Saint Olaf	425733	0912510	63.6
F47		Roberts Creek W of Farmersburg	425706	0912434	64.3
RC24		Roberts Creek nr Farmersburg	425724	0912358	65.2
RC22		Roberts Creek SW of Farmersburg	425641	0912226	66.6
RC2	05412100	Roberts Creek above Saint Olaf	425549	0912303	70.7
HC1		Howard Creek at Farmersburg	425744	0912209	13.8
HC2		Howard Creek nr Farmersburg	425648	0912223	17.8

Table 4.--Sample preparation and chemical analysis procedures

[EPA methods from U.S. Environmental Protection Agency, 1983]
[um, micrometer; C, Carbon; N, nitrogen; P, phosporus; mg/L, milligram per liter; µg/L, microgrem per liter]

Sample preparation method	Chemical constituent
Filtration through a 0.45um membrane	Calcium, magnesium, sodium, potassium sulfate, chloride, dissolved solids, silica, aluminum, iron, nitrate plus nitrite, organic nitrogen, ammonia
Acidification with nitric acid	Calcium, magnesium, sodium, potassium, iron, aluminum
Chill	Organic carbon, nitrate plus nitrite, ammonia, organic nitrogen, orthophosphate, atrazine, cyanazine, metolachlor, alachlor, metribuzin, butylate, trifluralin
Acidification with sulfuric acid	Nitrate plus nitrite, ammonia, orthophosphate

Constituent	Analytical method	Quantitation or detection limit
Field Measurements		
Stream discharge	Buchanan and Somers, 1969	
Water temperature	Wood, 1976	
Specific conductance	Wood, 1976	
pH	Wood, 1976	
Oxygen, dissolved	Wood, 1976	
Alkalinity	Incremental titration	
Bicarbonate, dissolved	Incremental titration	
Carbonate, dissoved	Incremental titration	
Inorganic compounds, dissolved		
Calcium	EPA 215.2	
Magnesium	EPA 200.7	
Sodium	EPA 273.1	
Potassium	EPA 258.1	
Chloride	EPA 325.3	
Sulfate	EPA 275.4	
Silica	EPA 370.1	
Nutrients, total and dissolved		
Nitrate plus nitrite as N	EPA 353.2	0.1 mg/L
Ammonia as N	EPA 350.1	.1 mg/L
Organic nitrogen as N	EPA 415.1	.1 mg/L
Carbon, total organic as C	EPA 415.1	
Orthophosphate as P	EPA 365.1	.1 mg/L
Pesticides, total recoverable		
Atrazine	1/EPA 81.41	.1 µg/L
Cyanazine	1/EPA 81.41	.1 µg/L
Metolachlor	1/EPA 81.41	.1 µg/L
Alachlor	1/EPA 81.41	.1 µg/L
Metribuzin	1/EPA 81.41	.1 µg/L
Butylate	1/EPA 81.41	.1 µg/L
Trifluralin	1/EPA 81.41	.1 µg/L

1/ Modified for use of dual-capillary columns

Table 5.--Statistical summary of precipitation quantity and quality at Big Spring water year 1989

[Chemical constituents in milligrams per liter]

[μS/cm, microsiemens per centimeter at 25 degrees Celsius]

[N, nitrogen; <, less than detection limit indicated]

Constituent	Number of weekly samples	Precipitation weighted mean	Median	Minimum	Maximum
Precipitation (inches)	52	--	0.24	0.00	4.32
Lab pH (units)	44	5.72	6.09	3.94	7.53
Lab conductance (μS/cm)	44	16	18	2.6	112
Calcium	44	.62	.50	.01	6.1
Magnesium	44	.10	.08	<.01	1.0
Sodium	44	.07	.09	.01	.86
Potassium	44	.10	.04	<.01	3.4
Sulfate	44	2.1	2.3	.03	18
Chloride	44	.12	.14	.03	1.4
Nitrate as N	44	.40	.40	<.02	3.1
Ammonia as N	44	.62	.63	<.01	4.6

Table 6.--Accumulated daily rainfall, water year 1989

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Unnamed Creek at Luana (BOOGD)						
1	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.00	0.00	0.00	0.48
2	.00	.00	.00	.00	.00	.00	.00	.00	.27	.00	.00	.00
3	.00	.00	.00	.00	.00	.06	.02	.00	.00	.00	.06	.00
4	.00	.22	.00	.00	.00	.00	.00	.23	.00	.00	1.67	.11
5	.00	.04	.00	.19	.00	.00	.00	.00	.00	.00	.20	.00
6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7	.00	.02	.00	.02	.00	.00	.00	.00	.00	.00	.00	.06
8	.00	.12	.00	.00	.00	.00	.01	.19	.00	.00	.00	.32
9	.00	.04	.00	.00	.00	.00	.00	.05	.00	.00	.00	.37
10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
11	.00	.00	.00	.02	.00	.00	.00	.00	.15	.12	.00	.00
12	.00	.14	.00	.00	.00	.00	.00	.00	.17	.00	.00	.00
13	.00	.00	.00	.00	.10	.00	.00	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00	.27	.00	.00	.00	.00	.00	.01
15	.00	1.04	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	.16	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00
17	.27	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
18	.02	.00	.00	.00	.00	.00	.00	.16	.00	1.15	.00	.00
19	.00	.00	.02	.00	.00	.01	.00	.03	.00	.06	.40	.00
20	.26	.00	.14	.00	.00	.00	.24	.01	.00	.00	.00	.00
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
22	.02	.00	.00	.00	.00	.00	.49	.00	.58	.08	1.81	.14
23	.00	.00	.01	.00	.00	.00	.52	.00	.00	.00	.34	.00
24	.00	.00	.09	.00	.00	.00	.00	.37	.00	.00	.00	.00
25	.00	.00	.00	.05	.00	.00	.01	.00	.24	.00	.00	.00
26	.00	.27	.14	.00	.00	.00	.07	.00	.47	.00	.53	.00
27	.00	.00	.06	.00	.00	.00	.11	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00	.14	.31	.00	.00	.00	.85	.00
29	.00	.09	.00	.08		.00	.01	.61	.00	.28	.00	.00
30	.00	.00	.00	.00		.00	.00	.11	.00	.00	.01	.00
31	.00		.00	.00		.00		.03		.00	1.28	
Total	0.73	1.98	0.46	0.36	0.10	0.49	1.86	1.80	1.88	1.70	7.15	1.49
						Roberts Creek above Saint Olaf (RC2)						
1	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.20	0.00	0.00	0.00	1.06
2	.00	.00	.00	.00	.00	.00	.00	.00	.25	.00	.00	.00
3	.00	.00	.00	.00	.00	.17	.00	.00	.01	.00	.02	.00
4	.00	.27	.00	.00	.00	.00	.00	.29	.00	.00	1.82	.10
5	.00	.05	.00	.35	.01	.00	.00	.02	.00	.00	.64	.00
6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05
8	.00	.00	.00	.00	.00	.00	.00	.33	.00	.00	.00	.19
9	.00	.05	.00	.00	.00	.00	.00	.05	.00	.00	.00	.35
10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
11	.00	.00	.00	.03	.00	.00	.00	.00	.04	.27	.00	.00
12	.00	.19	.00	.00	.00	.00	.00	.00	.33	.00	.00	.01
13	.00	.00	.00	.00	.12	.00	.00	.00	.00	.00	.00	.06
14	.00	.00	.00	.00	.00	.27	.00	.00	.01	.00	.00	.00
15	.00	1.54	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	.17	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
17	.32	.00	.00	.00	.00	.08	.01	.00	.00	.00	.00	.00
18	.00	.00	.00	.00	.01	.00	.00	.14	.00	2.29	.00	.00
19	.00	.00	.09	.00	.00	.00	.00	.02	.00	.35	.37	.00
20	.22	.00	.24	.00	.00	.00	.01	.00	.00	.00	.00	.00
21	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
22	.06	.00	.00	.00	.00	.00	.03	.00	.21	.11	1.89	.15
23	.02	.00	.00	.00	.00	.00	.98	.00	.00	.06	.42	.00
24	.00	.00	.20	.00	.00	.00	.00	.42	.00	.00	.00	.00
25	.00	.00	.00	.08	.00	.00	.00	.01	.42	.00	.00	.00
26	.00	.35	.26	.00	.00	.00	.00	.00	.60	.00	.32	.00
27	.00	.00	.05	.00	.00	.00	.23	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00	.15	.96	.00	.00	.00	.27	.00
29	.00	.00	.00	.19		.00	.00	.10	.00	.23	.00	.00
30	.50	.00	.00	.00		.00	.00	.57	.00	.00	.00	.00
31	.00		.00	.00		.00		.11		.00	.87	
Total	1.30	2.48	.84	0.65	0.14	0.67	2.24	2.26	1.87	3.31	6.62	1.97

Table 7.--Daily mean discharge at site DC5, Deer Creek near Postville, Iowa, water year 1989

[Discharge in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
1	---	---	0.30	---	---	---	---	---	0.26	0.22	0.16	1.3
2	---	---	.32	---	---	---	---	---	.25	.22	.17	.29
3	---	---	.33	---	---	---	---	---	.25	.21	.15	.22
4	---	---	.30	---	---	---	---	---	.22	.20	.27	.22
5	---	---	.31	---	---	---	---	---	.21	.19	.59	.22
6	---	---	.33	---	---	---	---	---	.21	.19	.18	.21
7	---	---	.30	---	---	---	---	---	.21	.16	.18	.22
8	---	---	.26	---	---	---	---	---	.22	.16	.18	.35
9	---	---	.25	---	---	---	---	---	.22	.15	.17	.52
10	---	---	.30	---	---	---	---	---	.21	.15	.17	.35
11	---	.25	.41	---	---	---	---	---	.21	.16	.17	.30
12	---	.36	---	---	---	---	---	---	.28	.16	.17	.29
13	---	.35	---	---	---	---	---	---	.26	.15	.17	.28
14	---	.29	---	---	---	---	---	---	.23	.15	.17	.28
15	---	.66	---	---	---	---	---	---	.23	.15	.17	.27
16	---	.58	---	---	---	---	---	---	.22	.15	.17	.27
17	---	.34	---	---	---	---	---	---	.21	.15	.16	.26
18	---	.33	---	---	---	---	---	---	.21	.27	.16	.26
19	---	.33	---	---	---	---	---	.31	.21	.20	.17	.26
20	---	.30	---	---	---	---	---	.28	.20	.18	.18	.26
21	---	.28	---	---	---	---	---	.24	.20	.16	.17	.26
22	---	.28	---	---	---	---	---	.24	.21	.17	4.2	.27
23	---	.31	---	---	---	---	---	.24	.22	.17	.40	.27
24	---	.31	---	---	---	---	---	.27	.20	.17	.25	.27
25	---	.30	---	---	---	---	---	.29	.23	.16	.22	.27
26	---	.42	---	---	---	---	---	.24	.37	.16	.27	.23
27	---	.35	---	---	---	---	---	.22	.27	.15	.23	.19
28	---	.28	---	---	---	---	---	.22	.24	.14	.69	.19
29	---	.31	---	---		---	---	.31	.23	.18	.23	.19
30	---	.31	---	---		---	---	.40	.23	.19	.19	.19
31	---		---	---		---		.30		.17	.28	

Table 8.--Concentrations of major ions at selected surface-water sites in the Big Spring Basin
[Dissolved constituents are in milligrams per liter;
[--, data not collected; <, less than detection limit indicated]

Date	Time	Calcium	Magne-sium	So-dium	Pot-tas-sium	Bi-carbo-nate	Car-bo-nate	Sul-fate	Chlo-ride	Silica
				Deer Creek near Postville (DC5)						
12-01-88	1200	79	26	4.1	0.6	332	0	43	12	15
1-04-89	1300	80	27	4.4	< .1	--	--	28	8.5	23
2-02-89	0900	83	28	5.4	4.0	--	--	42	12	--
3-07-89	0930	80	27	4.6	< .1	415	0	28	9.5	21
3-10-89	1800	11	3.6	2.5	19	54	0	<0.1	9.5	8.2
3-11-89	1500	10	3.3	1.3	17	55	0	< .1	9.5	8.2
3-12-89	1300	25	7.6	2.0	13	100	0	< .1	16	11
4-03-89	1330	78	26	5.2	2.1	--	--	40	14	18
5-02-89	1000	76	27	5.1	.7	283	12	34	10	--
5-24-89	1845	77	27	5.3	.7	338	0	25	8.5	--
6-06-89	0945	86	28	4.5	.5	342	0	29	8.5	--
7-06-89	0815	74	25	5.9	.5	--	--	28	8.5	25
8-03-89	1000	79	26	4.9	.8	351	0	28	9.5	--
8-22-89	2000	24	7.9	2.8	17	--	--	1.0	12	9.2
9-07-89	0910	87	28	4.1	1.4	356	0	28	10	26
				Unnamed Creek near Luana (BOOGD)						
3-11-89	1510	12	4.0	3.5	14	--	--	< .1	12	7.0
				Roberts Creek above Saint Olaf (RC2)						
10-03-88	1400	65	27	10	18	249	10	61	29	--
11-04-88	1330	68	33	20	9.1	351	0	44	32	--
12-01-88	1000	81	34	68	16	323	24	51	110	3.1
2-01-89	1230	25	9.8	5.4	21	114	0	2.3	16	--
3-06-89	1030	92	37	15	5.0	404	0	39	24	14
3-16-89	1130	31	10	5.5	20	134	0	9.6	18	10
8-23-89	1640	29	16	6.4	15	--	--	9.7	19	5.1

Table 9.--Selected nitrogen, phosphorus and carbon species at surface-water sampling sites in the Big Spring Basin

[Dissolved constituents in milligrams per liter; N, nitrogen; P, phosphorus; C, carbon; --, data not collected; <, less than detection limit indicated]

Date	Time	Nitrate plus nitrite, total (as N)	Nitrate plus nitrite, dissolved (as N)	Ammonia, total (as N)	Ammonia, dissolved (as N)	Organic nitrogen, total (as N)	Organic nitrogen, dissolved (as N)	Ortho-phos-phorus, total (as P)	Ortho-phos-phorus, dissolved (as P)	Organic carbon, total (as C)
				Deer Creek near Postville (DC5)						
11-04-88	1210	--	2.4	--	<0.1	--	0.7	--	<0.1	--
12-01-88	1200	--	3.6	<0.1	< .1	0.5	.5	--	< .1	2.8
1-04-89	1300	4.0	4.0	< .1	< .1	.6	.5	0.1	.1	1.2
2-02-89	0900	4.1	4.1	.2	.3	.4	.6	--	.1	3.4
3-07-89	0930	4.0	4.0	< .1	< .1	.3	.3	--	< .1	1.5
3-10-89	1440	--	2.8	--	2.4	--	3.7	--	.5	--
3-10-89	1615	--	1.7	--	3.2	--	3.4	--	.8	--
3-10-89	1800	--	1.6	--	4.9	--	3.8	--	.8	37
3-11-89	1310	--	1.6	--	3.8	--	3.8	--	.8	--
3-11-89	1500	--	1.2	--	3.2	--	11.0	--	.8	48
3-11-89	1730	--	1.1	--	2.1	--	2.9	--	.8	--
3-12-89	1300	--	1.7	--	3.4	--	3.7	--	.6	30
4-03-89	1330	--	2.7	--	.2	--	.5	--	--	4.4
4-23-89	0930	--	4.0	--	.1	--	1.4	--	< .1	--
5-02-89	1000	--	2.6	--	< .1	--	< .1	--	< .1	3.8
5-24-89	1845	--	1.9	--	.1	--	.5	--	.2	3.0
5-24-89	2300	--	1.9	--	.2	--	.5	--	.2	4.6
5-25-89	0900	--	2.0	--	< .1	--	.4	--	.2	4.3
5-30-89	1030	--	1.3	--	.1	--	.8	--	.1	8.6
6-06-89	0945	2.7	2.6	< .1	< .1	.2	.2	--	< .1	2.3
6-28-89	1000	--	2.7	--	.1	--	.1	--	--	--
7-06-89	0845	--	2.8	--	< .1	--	.1	--	--	1.5
8-03-89	1000	2.0	1.9	< .1	< .1	1.0	.1	< .1	< .1	2.7
8-05-89	1330	--	1.9	--	.1	--	1.2	--	.2	7.2
8-22-89	2000	4.6	4.9	.4	.5	5.0	5.5	1.4	1.0	29
9-07-89	0910	--	2.6	--	< .1	--	.3	--	.1	5.9
				Unnamed Creek near Luana (BOOGD)						
3-10-89	1200	--	2.9	--	2.9	--	5.4	--	1.0	--
3-10-89	1740	--	2.0	--	2.8	--	5.8	--	1.0	--
3-11-89	1045	2.9	2.9	3.2	3.4	3.4	5.1	1.0	1.0	--
3-11-89	1510	--	1.8	--	2.6	--	5.5	--	.8	--
3-12-89	1315	--	2.6	--	2.0	--	3.9	--	1.2	--
				Roberts Creek above Saint Olaf (RC2)						
10-03-88	1400	--	1.6	--	< .1	--	1.4	--	.3	9.5
11-04-88	1330	1.0	1.1	1.0	< .1	1.0	.6	.2	.2	6.4
11-16-88	0430	--	1.5	--	< .1	--	3.1	--	.6	--
12-01-88	0850	3.5	3.4	< .1	< .1	.8	.8	--	.6	3.9
1-04-89	0930	1.0	1.0	< .1	< .1	1.0	1.0	.6	.6	3.7
2-01-89	1230	1.2	1.1	7.1	3.4	1.1	3.2	1.3	1.3	45
3-06-89	1030	4.0	4.0	1.2	1.2	.4	.4	--	.5	2.8
3-11-89	0845	--	2.2	--	3.8	--	7.2	--	1.5	--
3-11-89	1400	--	2.4	--	4.2	--	5.8	--	1.2	--
3-11-89	1800	--	1.8	--	2.8	--	5.7	--	1.5	--
3-12-89	1230	--	1.7	--	4.1	--	5.7	--	1.4	--
3-16-89	1130	--	3.7	--	3.8	--	3.4	--	.6	40
4-04-89	1600	--	2.4	--	1.0	--	.6	--	--	--
4-23-89	1040	--	0.2	--	< .1	--	1.1	--	.2	--
5-01-89	1000	0.3	.3	.2	< .1	.9	.4	--	.2	6.6
6-07-89	1100	--	.4	--	.2	--	.6	--	.2	4.9
8-05-89	1240	--	6.2	--	< .1	--	.6	--	1.1	18
8-23-89	0030	--	1.0	--	.4	--	2.9	--	.5	26
8-23-89	1600	--	.4	--	.2	--	1.3	--	.3	28
8-23-89	1640	.5	.5	.2	.1	3.0	2.7	.8	.5	19
8-23-89	1800	--	.4	--	< .1	--	1.8	--	.4	16
9-06-89	1000	1.0	1.0	< .1	< .1	.9	.8	.4	.4	10

Table 10 .--Selected herbicides at surface-water sites in the Big Spring Basin

[Total recoverable constituents in micrograms per liter; <, less than detection limit indicated; --, data not collected]

Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
Deer Creek near Postville (DC5)								
11-04-88	1000	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
12-01-88	1200	< .1	< .1	< .1	< .1	< .1	< .1	< .1
1-04-89	1300	< .1	< .1	< .1	< .1	< .1	< .1	< .1
2-02-89	0900	.13	< .1	< .1	< .1	< .1	< .1	< .1
3-07-89	0930	.1	< .1	< .1	< .1	< .1	< .1	< .1
3-10-89	1440	.29	< .1	.16	< .1	< .1	< .1	< .1
3-10-89	1615	.48	< .1	.45	< .1	< .1	< .1	< .1
3-10-89	1800	.60	< .1	.43	< .1	< .1	< .1	< .1
3-11-89	1300	1.2	.10	.70	< .1	< .1	< .1	< .1
3-11-89	1500	1.3	< .1	.49	< .1	< .1	< .1	< .1
3-11-89	1730	1.4	< .1	.23	< .1	< .1	< .1	< .1
3-12-89	1300	2.5	< .1	.79	< .1	< .1	< .1	< .1
4-23-89	0930	.11	< .1	< .1	< .1	< .1	--	< .1
5-02-89	1000	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-24-89	1845	.2	< .1	< .1	.13	< .1	< .1	< .1
5-24-89	2300	1.3	.14	.87	.53	< .1	--	< .1
5-25-89	0900	.20	< .1	< .1	< .1	< .1	--	< .1
5-30-89	1030	2.8	.16	.56	.20	< .1	--	< .1
6-06-89	0945	< .1	< .1	< .1	< .1	< .1	< .1	< .1
6-28-89	1000	.10	.12	< .1	< .1	< .1	< .1	< .1
7-06-89	1500	< .1	< .1	< .1	< .1	< .1	--	< .1
8-03-89	1000	< .1	< .1	< .1	< .1	< .1	--	< .1
8-05-89	1330	.15	< .1	< .1	< .1	< .1	--	< .1
8-22-89	2000	11	.30	3.4	< .1	< .1	< .1	< .1
9-07-89	0910	.11	.14	< .1	< .1	< .1	< .1	< .1
Unnamed Creek near Luana (BOOGD)								
3-10-89	1200	1.5	.15	< .1	< .1	< .1	< .1	< .1
3-10-89	1740	2.4	.25	< .1	< .1	< .1	< .1	< .1
3-11-89	1045	2.5	.14	.24	< .1	< .1	< .1	< .1
3-11-89	1510	2.4	< .1	.30	< .1	< .1	< .1	< .1
3-12-89	1315	3.5	< .1	.63	.14	< .1	< .1	< .1

Table 10.--Selected herbicides at monthly monitoring sites in the Big Spring Basin--Continued

Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
				Roberts Creek above Saint Olaf (RC2)				
10-03-88	1400	2.9	0.74	0.26	0.69	<0.1	<0.1	<0.1
11-04-88	1330	.16	< .1	< .1	< .1	< .1	< .1	< .1
11-16-88	0430	.26	< .1	< .1	< .1	< .1	< .1	< .1
12-01-88	1000	.14	< .1	< .1	< .1	< .1	< .1	< .1
1-04-89	0930	.16	< .1	< .1	< .1	< .1	< .1	< .1
2-01-89	1230	2.9	.11	.3	.12	< .1	< .1	< .1
3-06-89	1030	.11	< .1	< .1	< .1	< .1	< .1	< .1
3-11-89	0845	1.7	.25	.35	< .1	< .1	< .1	< .1
3-11-89	1400	1.9	< .1	.33	< .1	< .1	< .1	< .1
3-11-89	1800	2.3	< .1	.25	.17	< .1	< .1	< .1
3-12-89	1230	2.5	.16	.52	.13	< .1	< .1	< .1
3-16-89	1130	4.4	.30	.83	.36	< .1	< .1	< .1
4-04-89	1600	.41	< .1	< .1	< .1	< .1	< .1	< .1
4-04-89	1605	.46	< .1	< .1	< .1	< .1	< .1	< .1
4-23-89	0100	.33	< .1	< .1	< .1	< .1	< .1	< .1
5-01-89	1000	.32	< .1	< .1	< .1	< .1	< .1	< .1
6-07-89	1100	1.1	.24	< .1	< .1	< .1	< .1	< .1
8-05-89	1240	.14	< .1	< .1	< .1	< .1	< .1	< .1
8-23-89	0030	.19	< .1	< .1	< .1	< .1	< .1	< .1
8-23-89	1600	1.0	.50	.45	.19	< .1	< .1	< .1
8-23-89	1640	1.3	.76	.18	.69	< .1	< .1	< .1
8-23-89	1800	1.4	.78	< .1	.77	< .1	< .1	< .1
9-06-89	1000	1.9	.25	.14	< .1	< .1	< .1	< .1

Table 11.--Daily mean discharge at site L23S, Silver Creek near Luana, Iowa, water year 1989

[Discharge in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
1	0.41	0.35	0.19	0.12	0.54	0.10	0.25	0.17	0.19	0.12	0.03	1.5
2	.26	.27	.21	.10	.42	.09	.22	.17	.18	.19	.03	.90
3	.18	.19	.24	.09	.34	.09	.17	.17	.24	.27	.03	.60
4	.14	.18	.22	.07	.24	.08	.14	.19	.17	.22	.15	.40
5	.35	.16	.23	.09	.22	.08	.14	.19	.13	.18	.55	.30
6	.28	.14	.25	.11	.21	.09	.11	.17	.14	.17	.14	.24
7	.22	.15	.20	.13	.20	.09	.14	.17	.13	.20	.03	.20
8	.22	.14	.17	.11	.19	.08	.16	.16	.13	.18	.02	.28
9	.22	.15	.15	.06	.17	.14	.09	.20	.13	.22	.03	.26
10	.12	.14	.12	.02	.18	21	.07	.23	.12	.17	.03	.24
11	.14	.12	.09	.03	.19	83	.06	.22	.12	.18	.02	.22
12	.14	.20	.07	.03	.20	9.2	.06	.23	.18	.21	.06	.20
13	.15	.22	.11	.03	.21	2.7	.05	.22	.14	.23	.09	.18
14	.21	.17	.14	.04	.21	37	.06	.21	.10	.21	.03	.15
15	.21	.29	.10	.05	.19	.97	.05	.22	.09	.24	.01	.11
16	.16	.39	.08	.07	.18	.47	.06	.20	.09	.26	.01	.10
17	.15	.26	.09	.07	.18	.46	.06	.18	.09	.15	.01	.10
18	.15	.22	.13	.07	.17	.38	.05	.23	.09	.20	.01	.10
19	.12	.24	.21	1.0	.16	.33	.04	.24	.11	.14	.01	.10
20	.14	.18	.31	.50	.15	.32	.07	.20	.13	.09	.01	.10
21	.21	.20	.21	.21	.14	.32	.08	.17	.08	.06	.00	.08
22	.14	.20	.22	7.9	.13	.59	.09	.17	.35	.07	4.9	.10
23	.14	.22	.25	2.4	.12	.81	.25	.16	.27	.07	1.3	.10
24	.11	.22	.20	.66	.13	.42	.17	.21	.20	.06	.12	.08
25	.09	.23	.16	.32	.15	.32	.16	.24	.23	.06	.04	.09
26	.26	.30	.16	.27	.17	.28	.17	.16	.29	.05	.08	.09
27	.30	.25	.22	4.8	.13	.27	.17	.13	.29	.04	.06	.08
28	.25	.23	.14	1.0	.11	.28	.20	.14	.13	.02	1.0	.09
29	.21	.20	.07	6.9		.35	.18	.24	.14	.03	.20	.07
30	.25	.21	.07	23		.32	.17	.33	.12	.06	.07	.06
31	.31		.13	8.3		.27		.30		.04	.20	

Table 12.--Daily mean discharge at site BOOGD, Unnamed Creek near Luana, Iowa, water year 1989

[Discharge in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.5
2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.13	.01
5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.14	.00
6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.16
9	.00	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.70
10	.00	.00	.00	.00	.00	7.0	.00	.00	.00	.00	.00	.02
11	.00	.00	.00	.00	.00	6.9	.00	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.00	2.5	.00	.00	.00	.00	.00	.00
13	.00	.00	.00	.00	.00	.24	.00	.00	.00	.00	.00	.00
14	.00	.00	.00	.00	.00	5.1	.00	.00	.00	.00	.00	.00
15	.00	.00	.00	.00	.00	.18	.00	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00
17	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
18	.00	.00	.00	.00	.00	.00	.00	.00	.00	.06	.00	.00
19	.00	.00	.00	.00	.00	.00	.00	.00	.00	.08	.00	.00
20	.00	.00	.00	.00	.00	.27	.00	.00	.00	.01	.00	.00
21	.00	.00	.00	.00	.00	.23	.00	.00	.00	.00	.00	.00
22	.00	.00	.00	.00	.00	.82	.00	.00	.00	.00	.34	.00
23	.00	.00	.00	.00	.00	.70	.00	.00	.00	.00	.07	.00
24	.00	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00	.00
25	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
26	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00
27	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.4	.00
29	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00
30	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00	.00
31	.00		.00	.00		.00		.00		.00	.09	

Table 13.--Daily mean discharge and specific conductance at site RC2, Roberts Creek above Saint Olaf, Iowa, water year 1989

[---, data not available to calculate mean values; Water-quality instrumentation was removed from November 20 to March 30]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Daily mean discharge, in cubic feet per second						
1	0.54	1.4	1.5	0.74	9.0	0.86	4.0	2.0	1.9	0.06	0.00	10
2	.47	.84	1.8	.64	2.5	.80	3.6	1.6	1.1	.05	.03	2.0
3	.46	1.0	1.6	.56	1.0	.80	3.0	1.7	1.2	.05	.03	.90
4	.36	1.2	1.5	.52	.85	.84	2.2	1.9	.72	.04	.22	.50
5	.30	1.4	1.7	.50	.78	.78	1.7	2.1	.37	.03	6.9	.25
6	.25	1.5	1.8	.58	.72	.88	1.1	2.1	.17	.03	1.1	.16
7	.32	2.3	1.6	.62	.70	.84	.81	1.6	.08	.03	.05	.23
8	.74	1.2	1.4	.56	.68	.80	.75	1.4	.06	.03	.00	.21
9	.44	.89	1.1	.50	.70	.90	.75	1.7	.06	.02	.00	.26
10	.41	1.0	.90	.48	.74	50	.58	1.8	.07	.02	.00	.21
11	.27	1.1	.78	.52	.82	290	.42	1.4	.09	.10	.00	.12
12	.24	1.5	.70	.52	.90	110	.43	.76	.23	.08	.00	.15
13	.22	2.0	.74	.49	.94	60	.60	.40	.24	.06	.00	.04
14	.23	2.8	.84	.52	.86	250	.48	.19	.16	.04	.00	.02
15	.29	4.3	.75	.56	.80	90	.28	.15	.13	.04	.00	.10
16	.34	18	.64	.52	.77	20	.27	.14	.13	.03	.00	.10
17	.34	10	.68	.54	.76	10	.27	.09	.12	.08	.00	.10
18	.49	4.6	.74	.58	.72	8.1	.23	.13	.15	.66	.00	.09
19	.52	3.4	1.0	1.0	.70	11	.17	.25	.15	.74	.00	.09
20	.60	3.2	1.4	10	.70	12	.23	.21	.10	.42	.00	.11
21	.70	3.0	1.1	6.3	.72	10	.37	.12	.15	.21	.00	.07
22	.67	2.7	1.2	3.7	.68	10	.79	.12	.25	.12	.00	.05
23	1.3	3.0	1.3	12	.64	49	3.7	.08	.27	.08	19	.05
24	1.1	3.2	1.3	7.0	.70	52	6.2	.17	.15	.01	8.0	.04
25	.82	3.1	1.0	4.0	.91	25	3.1	.33	.10	.00	1.2	.04
26	.90	3.1	.94	1.2	1.2	18	2.3	.21	.13	.00	1.4	.03
27	.57	3.3	1.1	1.0	1.0	16	2.1	.12	.08	.00	.80	.02
28	.33	3.6	.95	4.0	.94	13	2.6	.07	.09	.00	1.0	.04
29	.24	2.0	.84	10		11	3.1	.23	.07	.00	.70	.02
30	.46	2.3	.88	45		7.3	2.7	.81	.06	.00	.40	.04
31	1.0		.82	20		5.2		2.9		.00	1.6	
				Daily mean specific conductance, in microsiemens per centimeter at 25 degrees Celsius								
1	575	627	---	---	---	---	551	573	564	527	---	481
2	571	665	---	---	---	---	598	581	589	517	---	426
3	573	708	---	---	---	---	624	595	575	504	592	474
4	585	701	---	---	---	---	638	582	575	513	592	---
5	594	660	---	---	---	---	652	568	565	---	654	---
6	611	636	---	---	---	---	661	558	593	---	504	---
7	610	648	---	---	---	---	662	577	593	---	513	---
8	599	653	---	---	---	---	650	584	583	---	---	---
9	623	649	---	---	---	---	642	566	557	---	---	---
10	633	656	---	---	---	---	636	579	563	---	---	---
11	631	663	---	---	---	---	620	585	548	---	---	---
12	634	647	---	---	---	---	607	596	535	---	---	---
13	634	650	---	---	---	---	593	600	515	---	---	---
14	624	703	---	---	---	---	577	622	---	---	---	---
15	606	647	---	---	---	---	585	631	517	---	---	---
16	588	567	---	---	---	---	572	639	515	---	---	---
17	589	668	---	---	---	---	567	---	512	---	---	---
18	600	707	---	---	---	---	---	629	504	---	---	---
19	603	720	---	---	---	---	---	625	513	---	---	---
20	605	725	---	---	---	---	---	619	522	---	---	---
21	600	740	---	---	---	---	---	616	528	---	---	---
22	611	---	---	---	---	---	---	598	533	---	---	---
23	595	---	---	---	---	---	---	600	538	---	505	---
24	588	---	---	---	---	---	---	606	533	---	344	---
25	585	---	---	---	---	---	663	598	533	---	356	---
26	586	---	---	---	---	---	681	597	519	---	409	---
27	604	---	---	---	---	---	652	600	509	---	450	---
28	621	---	---	---	---	---	595	601	506	---	482	---
29	656	---	---	---		---	565	602	514	---	509	---
30	650	---	---	---		---	572	586	522	---	532	---
31	646		---	---		511		571		---	538	

Table 14 .--Daily mean water temperature and median pH at site RC2, Roberts Creek above Saint Olaf, Iowa, water year 1989

[---, data not available to calculate mean or median values; Water-quality instrumentation was removed from November 20 to March 30]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Daily mean water temperature, in degrees Celsius						
1	19.5	4.7	---	---	---	---	.9	11.3	21.1	---	---	21.1
2	16.0	4.4	---	---	---	---	4.8	11.2	21.0	---	---	20.9
3	13.5	6.7	---	---	---	---	6.3	13.2	21.2	---	26.3	19.7
4	10.9	7.8	---	---	---	---	4.3	11.9	22.2	---	27.0	---
5	9.7	5.0	---	---	---	---	6.5	11.9	22.3	---	23.8	---
6	9.6	3.3	---	---	---	---	7.0	7.5	22.8	---	21.9	---
7	9.9	3.0	---	---	---	---	7.6	11.3	23.2	---	20.2	---
8	11.4	4.3	---	---	---	---	7.2	11.7	21.7	---	---	---
9	12.5	6.3	---	---	---	---	3.9	14.1	17.1	---	---	---
10	12.7	4.8	---	---	---	---	4.7	15.3	19.0	---	---	---
11	10.5	3.9	---	---	---	---	6.3	16.2	18.8	---	---	---
12	8.3	3.3	---	---	---	---	7.3	16.7	19.1	---	---	---
13	7.9	4.8	---	---	---	---	8.1	17.4	20.7	---	---	---
14	10.9	4.6	---	---	---	---	10.7	17.9	18.8	---	---	---
15	13.1	7.9	---	---	---	---	11.1	19.5	17.9	---	---	---
16	15.2	6.9	---	---	---	---	11.7	19.6	19.6	---	---	---
17	12.6	3.2	---	---	---	---	11.9	18.7	20.1	---	---	---
18	10.8	3.6	---	---	---	---	11.5	17.5	21.3	---	---	---
19	9.7	4.5	---	---	---	---	12.0	17.8	24.1	---	---	---
20	8.6	2.4	---	---	---	---	10.7	10.8	23.1	---	---	---
21	8.8	1.2	---	---	---	---	13.0	17.1	23.8	---	---	---
22	7.5	---	---	---	---	---	10.9	17.6	25.0	---	---	---
23	8.6	---	---	---	---	---	12.5	17.1	24.7	---	---	---
24	6.5	---	---	---	---	---	14.4	19.7	23.9	---	21.7	---
25	5.3	---	---	---	---	---	17.5	19.4	23.3	---	21.3	---
26	5.4	---	---	---	---	---	17.7	17.7	22.5	---	21.8	---
27	6.7	---	---	---	---	---	17.4	9.9	23.8	---	21.9	---
28	4.5	---	---	---	---	---	13.2	7.6	24.6	---	22.7	---
29	4.3	---	---	---		---	11.7	17.2	23.3	---	24.0	---
30	3.5	---	---	---		---	12.5	16.6	---	---	22.1	---
31	4.1		---	---		1.9		18.2		---	21.5	
						Daily median pH						
1	8.04	7.89	---	---	---	---	8.14	8.70	7.97	7.48	---	7.62
2	8.08	7.73	---	---	---	---	8.19	8.83	7.76	7.58	---	7.50
3	8.06	7.85	---	---	---	---	8.23	8.76	7.57	7.40	7.83	7.22
4	8.31	7.69	---	---	---	---	8.19	8.56	7.72	7.52	7.64	---
5	8.15	7.84	---	---	---	---	8.18	8.60	7.69	---	7.60	---
6	7.82	7.88	---	---	---	---	8.20	8.68	7.39	---	7.43	---
7	7.53	7.89	---	---	---	---	8.31	8.58	7.52	---	7.27	---
8	8.18	7.78	---	---	---	---	8.51	8.34	7.60	7.73	---	---
9	8.15	7.70	---	---	---	---	8.66	8.24	7.88	---	---	---
10	8.23	7.93	---	---	---	---	8.68	8.21	7.77	---	---	---
11	8.18	7.93	---	---	---	---	8.56	8.25	7.64	---	---	---
12	7.90	7.94	---	---	---	---	8.48	8.07	7.37	---	---	---
13	7.61	7.94	---	---	---	---	8.69	7.95	7.85	---	---	---
14	7.39	7.97	---	---	---	---	8.66	7.72	7.73	---	---	---
15	7.27	7.91	---	---	---	---	8.38	7.68	8.05	---	---	---
16	7.33	7.73	---	---	---	---	8.27	7.66	7.93	---	---	---
17	7.22	7.66	---	---	---	---	8.10	7.64	7.89	---	---	---
18	7.39	7.57	---	---	---	---	---	7.63	7.79	---	---	---
19	7.84	7.52	---	---	---	---	---	7.51	7.70	---	---	---
20	7.69	7.61	---	---	---	---	---	7.47	7.72	---	---	---
21	7.60	7.68	---	---	---	---	---	7.27	7.95	---	---	---
22	7.52	---	---	---	---	---	---	7.23	7.63	---	---	---
23	7.79	---	---	---	---	---	---	7.21	7.36	---	7.46	---
24	7.64	---	---	---	---	---	---	7.18	7.55	---	7.30	---
25	7.64	---	---	---	---	---	8.09	7.27	7.71	---	7.12	---
26	7.65	---	---	---	---	---	8.29	7.41	7.88	---	7.20	---
27	7.34	---	---	---	---	---	8.52	7.31	7.70	---	7.32	---
28	7.38	---	---	---	---	---	8.70	7.40	7.47	---	7.38	---
29	7.17	---	---	---		---	8.87	7.26	7.42	---	7.92	---
30	7.25	---	---	---		---	8.86	7.19	7.56	---	7.88	---
31	7.59		---	---		8.16		7.54		---	7.52	

Table 15.--Daily mean sediment load at site RC2, Roberts Creek above Saint Olaf, Iowa, water year 1989

[---, data not available to calculate mean values; sediment load in tons per day]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
1	0.03	0.51	0.19	0.06	6.1	0.05	0.21	0.06	0.31	---	0.00	---
2	.02	.26	.23	.06	.86	.05	.17	.13	.14	---	---	---
3	.02	.31	.21	.06	.32	.05	.11	.13	.17	---	---	---
4	.02	.43	.19	.05	.30	.05	.06	.14	.11	---	---	---
5	.01	.60	.22	.05	.18	.05	.04	.17	.06	---	---	---
6	.01	.57	.22	.06	.10	.06	.05	.10	.03	---	---	---
7	.02	.97	.18	.06	.07	.06	.07	.03	.01	---	.03	---
8	.14	.46	.13	.05	.06	.05	.10	.04	.01	---	.00	---
9	.03	.33	.10	.05	.06	.06	.10	.10	.02	---	.00	---
10	.02	.35	.07	.04	.05	11	.07	.10	.01	---	.00	---
11	.01	.34	.06	.05	.06	111	.05	.08	.02	---	.00	---
12	.01	.36	.06	.05	.05	40	.05	.06	.07	---	.00	---
13	.01	.38	.06	.04	.05	10	.06	.04	.07	---	.00	---
14	.01	.63	.06	.05	.04	220	.04	.02	---	---	.00	---
15	.01	1.7	.05	.05	.04	40	.02	.02	---	---	.00	---
16	.02	12	.03	.04	.04	4.9	.02	.01	---	---	.00	---
17	.02	5.3	.03	.05	.04	1.8	.01	.01	---	---	.00	---
18	.03	.62	.04	.05	.04	.33	.01	.04	---	---	.00	---
19	.03	.55	.05	.19	.04	.77	.01	.09	---	---	.00	---
20	.03	.56	.16	5.0	.04	.58	.02	.07	---	---	.00	---
21	.04	.49	.05	2.5	.04	.49	.03	.36	---	---	.00	---
22	.04	.42	.06	.83	.03	.73	.06	.03	---	---	.00	---
23	---	.43	.06	5.0	.03	14	1.1	.02	---	---	16	---
24	---	.41	.06	3.1	.04	16	.37	.05	---	---	7.3	---
25	---	.40	.04	1.6	.05	5.8	.10	.10	---	.00	.47	---
26	---	.33	.04	.48	.06	2.9	.11	.05	---	.00	.20	---
27	---	.34	.04	.39	.05	2.1	.10	.02	---	.00	.08	---
28	.13	.32	.04	2.8	.05	1.3	.13	.01	---	.00	.11	---
29	.08	.21	.04	7.0		1.1	.18	.02	---	.00	.08	---
30	.13	.29	.05	34		.53	.09	.12	---	.00	.05	---
31	.32		.06	18		.28		.62		.00	.14	
Total measured	1.2	31	2.9	82	8.9	490	3.5	2.8	1.0	0.00	24	---

Table 16.--Daily mean water levels in unconsolidated aquifers, Clayton County, Iowa, water year 1989

[Water levels in feet below land surface; ---, data not available to calculate mean values]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well BS1-A						
1	---	---	---	14.41	12.63	13.99	13.69	13.68	13.89	14.61	14.86	14.13
2	---	---	---	14.43	13.22	14.00	---	13.73	13.96	14.63	14.86	13.64
3	---	---	---	14.43	13.52	14.01	---	13.80	14.07	14.64	14.86	13.85
4	---	---	---	14.44	13.60	14.03	---	13.85	14.16	14.65	14.86	14.06
5	---	---	---	13.92	13.59	14.01	13.75	13.88	14.22	14.66	14.57	14.17
6	---	---	---	14.36	13.60	14.12	13.79	13.92	14.27	14.71	14.45	14.18
7	---	---	---	14.31	13.65	14.26	13.84	13.97	14.32	14.77	14.58	14.26
8	---	---	---	14.04	13.74	14.26	13.88	14.01	14.37	14.77	14.66	14.31
9	---	---	---	14.41	---	14.22	13.92	14.02	14.40	14.78	14.72	14.31
10	---	---	---	14.36	---	12.95	13.96	14.04	14.43	14.80	14.76	14.31
11	---	---	---	14.36	---	10.88	13.99	14.06	14.45	14.82	14.80	14.32
12	---	---	---	14.36	---	10.35	14.04	14.10	14.46	14.82	14.83	14.35
13	---	---	---	14.37	---	10.27	14.05	14.14	14.39	14.82	14.86	14.39
14	---	---	---	14.36	---	9.84	14.07	14.17	14.39	14.83	14.86	14.42
15	---	---	---	14.36	13.87	10.85	14.10	14.20	14.42	14.84	14.87	14.44
16	---	---	---	14.34	13.89	11.75	14.11	14.21	14.45	14.84	14.87	14.47
17	---	---	---	14.34	13.91	12.59	14.12	14.23	14.48	14.86	14.87	14.49
18	---	---	---	14.33	13.92	13.01	14.13	14.24	14.50	14.85	14.87	14.52
19	---	---	---	14.31	13.92	13.21	14.15	14.25	14.52	14.79	14.87	14.53
20	---	---	---	14.07	13.93	13.28	14.16	14.25	14.54	14.73	14.87	14.54
21	---	---	---	13.87	13.93	13.37	14.16	14.26	14.57	14.78	14.87	14.56
22	---	---	14.39	13.85	13.95	12.90	14.17	14.28	14.59	14.80	14.86	14.58
23	---	---	14.38	13.74	13.98	12.55	14.07	14.30	14.58	14.80	14.40	14.58
24	---	---	14.37	13.64	13.99	12.67	13.68	14.32	14.59	14.81	14.36	14.58
25	---	---	14.46	13.65	13.99	12.86	13.48	14.34	14.61	14.83	14.49	14.58
26	---	---	14.40	13.75	13.99	13.01	13.50	14.34	14.58	14.83	14.59	14.59
27	---	---	14.36	13.87	13.99	13.14	13.57	14.36	14.53	14.83	14.64	14.61
28	---	---	14.42	13.74	13.99	13.27	13.61	14.38	14.53	14.83	14.68	14.62
29	---	---	14.46	13.61		13.42	13.65	14.40	14.55	14.85	14.66	14.62
30	---	---	14.42	13.30		13.53	13.71	14.37	14.59	14.85	14.64	14.54
31	---		12.24	12.74		13.62		14.21		14.85	14.68	
						Well BS3-C						
1	---	---	---	---	14.64	15.70	16.28	15.78	15.05	15.57	15.74	15.66
2	---	---	---	---	14.85	15.75	16.24	15.56	15.10	15.55	15.75	15.69
3	---	---	---	---	15.06	15.66	16.21	15.34	15.10	15.55	15.70	15.72
4	---	---	---	---	15.19	15.61	16.20	15.10	15.13	15.57	15.64	15.70
5	---	---	---	---	14.94	15.78	16.28	14.86	15.17	15.60	15.61	15.65
6	---	---	---	---	15.01	15.86	16.32	14.76	15.16	15.62	15.65	15.59
7	---	---	---	---	14.99	15.82	16.34	14.73	15.14	15.64	15.76	15.50
8	---	---	---	---	15.09	15.93	16.32	14.61	15.15	15.64	15.80	15.40
9	---	---	---	---	15.22	15.95	16.37	14.56	15.20	15.58	15.83	15.30
10	---	---	---	---	15.14	15.93	16.45	14.61	15.30	15.54	15.86	15.27
11	---	---	---	---	15.09	15.88	16.47	14.62	15.35	15.56	15.88	15.18
12	---	---	---	---	15.16	15.94	16.47	14.54	15.28	15.60	15.89	14.28
13	---	---	---	---	15.08	15.90	16.49	14.46	15.22	15.63	15.87	14.22
14	---	---	---	---	15.20	15.76	16.46	14.46	15.22	15.65	15.83	14.39
15	---	---	---	---	15.36	15.79	16.46	14.48	15.28	15.67	15.81	14.37
16	---	---	---	---	15.57	15.93	16.45	14.51	15.33	15.68	15.81	14.29
17	---	---	---	---	15.66	16.00	16.46	14.55	15.33	15.67	15.84	14.39
18	---	---	---	---	15.60	16.07	16.52	14.55	15.33	15.61	15.87	14.42
19	---	---	---	14.31	15.45	16.12	16.55	14.49	15.37	15.58	15.85	14.36
20	---	---	---	14.52	15.36	16.08	16.56	14.53	15.40	15.60	15.78	14.35
21	---	---	---	14.62	15.31	16.14	16.55	14.64	15.39	15.64	15.76	14.34
22	---	---	---	14.52	15.44	16.16	16.57	14.67	15.37	15.68	15.73	14.34
23	---	---	---	14.47	15.63	16.15	16.57	14.69	15.38	15.73	15.74	14.34
24	---	---	---	14.60	15.67	16.12	16.57	14.61	15.44	15.76	15.77	14.36
25	---	---	---	14.68	15.59	16.11	16.56	14.58	15.47	15.77	15.79	---
26	---	---	---	14.68	15.53	16.11	16.55	14.72	15.45	15.77	15.79	---
27	---	---	---	14.72	15.54	16.10	16.49	14.94	15.43	15.75	15.78	---
28	---	---	---	14.71	15.55	16.10	16.33	15.04	15.46	15.73	15.78	---
29	---	---	---	14.72		16.15	16.11	15.01	15.56	15.72	15.75	---
30	---	---	---	14.66		16.19	15.95	14.92	15.60	15.69	15.75	---
31	---		---	14.52		16.23		14.95		15.70	15.72	

Table 16.--Daily mean water levels in unconsolidated Aquifers, Clayton County, Iowa, water year 1989--Continued

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well BS4-B						
1	---	---	---	---	---	---	---	---	---	---	---	72.96
2	---	---	---	---	---	---	---	---	---	---	---	72.91
3	---	---	---	---	---	---	---	---	---	---	---	72.91
4	---	---	---	---	---	---	---	---	---	---	---	72.90
5	---	---	---	---	---	---	---	---	---	---	---	72.91
6	---	---	---	---	---	---	---	---	---	---	---	72.92
7	---	---	---	---	---	---	---	---	---	---	---	72.92
8	---	---	---	---	---	---	---	---	---	---	---	72.92
9	---	---	---	---	---	---	---	---	---	---	---	72.89
10	---	---	---	---	---	---	---	---	---	---	---	72.91
11	---	---	---	---	---	---	---	---	---	---	---	72.92
12	---	---	---	---	---	---	---	---	---	---	---	72.95
13	---	---	---	---	---	---	---	---	---	---	---	72.96
14	---	---	---	---	---	---	---	---	---	---	---	72.96
15	---	---	---	---	---	---	---	---	---	---	---	72.96
16	---	---	---	---	---	---	---	---	---	---	---	72.97
17	---	---	---	---	---	---	---	---	---	---	---	72.99
18	---	---	---	---	---	---	---	---	---	---	---	73.01
19	---	---	---	---	---	---	---	---	---	---	---	73.03
20	---	---	---	---	---	---	---	---	---	---	---	73.05
21	---	---	---	---	---	---	---	---	---	---	---	73.05
22	---	---	---	---	---	---	---	---	---	---	---	73.03
23	---	---	---	---	---	---	---	---	---	---	---	73.09
24	---	---	---	---	---	---	---	---	---	---	---	73.09
25	---	---	---	---	---	---	---	---	---	---	---	73.06
26	---	---	---	---	---	---	---	---	---	---	---	73.11
27	---	---	---	---	---	---	---	---	---	---	---	73.13
28	---	---	---	---	---	---	---	---	---	---	---	73.10
29	---	---	---	---		---	---	---	---	---	---	71.44
30	---	---	---	---		---	---	---	---	---	73.08	73.11
31	---		---	---		---		---		---	73.35	
						Well BS4-C						
1	---	---	---	---	---	---	---	---	---	---	---	57.05
2	---	---	---	---	---	---	---	---	---	---	---	57.14
3	---	---	---	---	---	---	---	---	---	---	---	57.06
4	---	---	---	---	---	---	---	---	---	---	---	56.95
5	---	---	---	---	---	---	---	---	---	---	---	56.55
6	---	---	---	---	---	---	---	---	---	---	---	55.98
7	---	---	---	---	---	---	---	---	---	---	---	55.99
8	---	---	---	---	---	---	---	---	---	---	---	56.01
9	---	---	---	---	---	---	---	---	---	---	---	56.07
10	---	---	---	---	---	---	---	---	---	---	---	56.12
11	---	---	---	---	---	---	---	---	---	---	---	56.09
12	---	---	---	---	---	---	---	---	---	---	---	56.13
13	---	---	---	---	---	---	---	---	---	---	---	56.06
14	---	---	---	---	---	---	---	---	---	---	---	56.03
15	---	---	---	---	---	---	---	---	---	---	---	56.05
16	---	---	---	---	---	---	---	---	---	---	---	56.04
17	---	---	---	---	---	---	---	---	---	---	---	56.10
18	---	---	---	---	---	---	---	---	---	---	---	56.10
19	---	---	---	---	---	---	---	---	---	---	---	56.10
20	---	---	---	---	---	---	---	---	---	---	---	56.10
21	---	---	---	---	---	---	---	---	---	---	---	56.07
22	---	---	---	---	---	---	---	---	---	---	---	56.05
23	---	---	---	---	---	---	---	---	---	---	---	56.28
24	---	---	---	---	---	---	---	---	---	---	---	56.09
25	---	---	---	---	---	---	---	---	---	---	---	56.05
26	---	---	---	---	---	---	---	---	---	---	---	56.22
27	---	---	---	---	---	---	---	---	---	---	---	56.15
28	---	---	---	---	---	---	---	---	---	---	---	56.03
29	---	---	---	---		---	---	---	---	---	---	56.15
30	---	---	---	---		---	---	---	---	---	57.02	56.11
31	---		---	---		---		---		---	56.94	

Table 16.--Daily mean water levels in unconsolidated aquifers, Clayton County, Iowa, water year 1989--Continued

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well DCW1						
1	---	---	6.15	6.03	5.09	6.11	5.08	5.09	5.22	---	6.83	4.68
2	---	---	6.12	6.10	5.31	6.09	5.14	5.12	5.23	---	6.86	4.79
3	---	---	6.12	6.09	5.42	5.99	5.16	5.09	5.24	---	6.88	5.03
4	---	---	6.13	6.16	5.40	6.05	5.23	5.11	5.31	---	6.88	5.11
5	---	---	6.04	6.10	5.38	6.14	5.41	5.14	5.36	---	6.73	5.22
6	---	---	6.02	5.96	5.50	6.14	5.36	5.16	5.42	6.30	6.71	5.30
7	---	---	6.07	5.93	5.60	6.15	5.36	5.16	5.46	6.33	6.74	5.43
8	---	---	6.12	6.05	5.74	6.15	5.38	5.17	5.48	6.34	---	5.46
9	---	---	6.06	6.07	5.71	6.13	5.43	5.15	5.52	6.35	---	5.28
10	---	---	6.03	6.05	5.72	5.57	5.47	5.15	5.58	6.42	---	5.18
11	---	---	6.03	6.06	5.75	4.85	5.46	5.14	5.59	6.48	---	5.19
12	---	---	5.95	6.08	5.79	5.03	5.47	5.15	5.54	6.32	---	5.29
13	---	---	5.95	6.14	5.74	5.06	5.48	5.16	5.00	6.52	---	5.36
14	---	---	6.02	6.04	5.91	4.71	5.46	5.19	5.54	6.54	---	5.43
15	---	---	6.24	6.09	5.97	5.07	5.48	5.22	5.58	6.57	---	5.50
16	---	---	6.14	6.09	6.05	5.29	5.47	5.23	5.59	6.60	---	5.54
17	---	---	6.16	6.05	6.05	5.41	5.56	5.21	5.61	6.62	---	5.62
18	---	6.36	6.10	6.03	5.95	5.55	5.61	5.19	5.67	6.61	---	5.72
19	---	6.34	6.06	5.86	5.90	5.60	5.60	5.24	5.73	5.67	---	5.78
20	---	6.33	6.02	5.74	5.90	5.64	5.58	5.26	5.76	6.59	---	5.83
21	---	6.34	6.13	5.75	5.92	5.69	5.55	5.28	5.78	6.62	---	5.87
22	---	6.30	6.02	5.62	6.04	5.65	5.48	5.30	5.81	6.65	---	5.89
23	---	6.24	6.00	5.49	6.08	5.46	4.89	5.30	5.86	6.68	---	6.02
24	---	6.21	6.06	5.53	6.04	5.12	4.78	5.39	5.88	6.69	6.07	6.01
25	---	6.22	6.15	5.59	5.97	5.03	4.83	5.47	5.91	6.73	6.20	6.00
26	---	6.13	6.10	5.66	5.96	5.01	4.93	5.51	5.90	6.74	6.30	6.12
27	---	6.11	5.96	5.59	5.97	4.99	5.04	---	5.82	6.75	6.37	6.14
28	---	6.16	6.05	5.45	6.03	4.85	5.03	---	5.76	6.78	5.96	6.10
29	---	6.12	6.03	5.21		4.71	5.01	---	5.84	6.79	5.83	6.15
30	---	6.12	5.95	5.15		4.90	5.04	---	5.91	6.79	5.94	6.16
31	---		6.02	4.92		5.04		5.21		6.81	5.95	

Table 17.--Concentrations of major ions at selected ground-water sites in the Big Spring Basin

[Dissolved constituents are in milligrams per liter; --, data not collected]

Date	Time	Calcium	Magne-sium	So-dium	Potas-sium	Bi-carbo-nate	Car-bo-nate	Sul-fate	Chlo-ride	Silica
Deer Creek well (DCW2)										
12-01-88	1300	92	28	6.2	<0.1	342	0	77	18	7.2
1-04-89	1500	120	35	7.9	< .1	400	0	110	25	11
2-02-89	1100	120	38	7.8	< .1	399	0	110	26	--
3-07-89	1130	120	37	6.6	< .1	464	0	52	25	9.8
3-11-89	1220	100	30	7.6	< .1	376	0	87	28	9.8
4-11-89	1330	120	34	6.7	.40	--	--	98	26	8.9
5-02-89	1130	110	34	6.4	.50	373	0	88	26	--
5-24-89	2145	120	34	7.0	.50	390	0	89	24	--
6-06-89	1200	120	36	6.3	.50	405	0	97	24	--
7-06-89	0915	--	--	7.9	--	--	--	93	25	11
8-02-89	1230	120	34	6.9	.50	--	0	96	26	--
9-07-89	1020	120	34	6.0	.60	471	0	95	26	11
Deer Creek well (DCW3)										
7-07-89	0930	93	26	7.4	2.1	--	--	18	1.0	29
8-02-89	1400	100	28	6.2	2.3	462	0	20	1.5	--
9-07-89	1300	100	29	5.3	2.2	509	0	17	2.5	27
Deer Creek lysimeter (DCLA)										
8-03-89	1055	--	--	--	--	--	--	100	27	10
Deer Creek lysimeter (DCLB)										
8-03-89	1056	--	--	--	--	--	--	100	49	29
Deer Creek lysimeter (DCLC)										
8-03-89	1057	--	--	--	--	--	--	130	26	30

Table 17.--Concentrations of major ions at the selected ground-water sites in the Big Spring Basin--Continued

Date	Time	Calcium	Magne-sium	So-dium	Pot-tas-sium	Bi-carbo-nate	Car-bo-nate	Sul-fate	Chlo-ride	Silica
					Big Spring					
10-03-88	1015	90	38	13	6.2	370	0	48	25	--
11-04-88	1030	84	35	12	3.2	382	0	36	--	--
12-01-88	0900	83	35	25	4.1	373	0	37	30	12
2-01-89	1030	--	17	6.5	19	185	0	4.8	18	--
3-06-89	1220	88	37	14	4.7	378	0	42	24	15
3-12-89	0900	24	9.0	4.4	16	115	0	<0.1	8.5	8.2
3-16-89	1000	37	14	4.9	15	174	0	6.6	14	10
6-07-89	0900	90	37	15	3.6	381	0	43	26	--
9-06-89	1500	89	35	16	6.7	376	0	39	38	--

Table 18.--Selected nitrogen, phosphorus, and carbon species at ground-water sites in the Big Spring Basin

[Dissolved constituents in milligrams per liter; N, nitrogen; P, phosphorus; C, carbon; --, data not collected; <, less than detection limit indicated]

Date	Time	Nitrate plus nitrite (as N)	Ammonia (as N)	Organic nitrogen (as N)	Ortho-phos-phorus (as P)	Total Organic carbon (as C)
			Deer Creek Well (DCW2)			
12-01-88	1300	0.9	<0.1	0.4	<0.1	3.0
1-04-89	1500	< .1	< .1	.8	< .1	2.5
2-02-89	1100	< .1	.1	< .1	< .1	2.0
3-07-89	1130	< .1	.1	< .1	< .1	2.0
3-11-89	1220	.6	.2	.3	.1	5.9
4-11-89	1330	< .1	< .1	.2	--	2.3
5-02-89	1130	< .1	< .1	< .1	< .1	2.0
5-24-89	1100	< .1	< .1	.5	< .1	1.8
5-25-89	1100	< .1	< .1	.1	.2	1.8
6-06-89	1200	< .1	< .1	.3	< .1	1.8
7-06-89	0915	< .1	< .1	.9	--	--
7-25-89	1030	< .1	< .1	.3	< .1	3.5
8-02-89	1230	< .1	< .1	< .1	< .1	2.0
8-23-89	1040	.1	< .1	< .1	< .1	2.4
9-07-89	1020	.1	< .1	.2	< .1	6.2
			Deer Creek well (DCW3)			
7-07-89	0930	.1	.2	.4	--	1.8
7-25-89	0930	< .1	.2	.4	< .1	8.7
8-02-89	1400	< .1	.2	< .1	< .1	1.6
9-07-89	1300	< .1	.2	< .1	< .1	3.7

Table 18.--Selected nitrogen, phosphorus and carbon species at ground-water sites in the Big Spring Basin--Continued

Date	Time	Nitrate plus nitrite (as N)	Ammonia (as N)	Organic nitrogen (as N)	Ortho-phos-phorus (as P)	Total Organic carbon (as C)
			Deer Creek lysimeter (DCLA)			
4-18-89	1100	< .1	< .1	< .1	< .1	--
5-04-89	1630	< .1	< .1	.3	< .1	1.5
5-18-89	1101	< .1	< .1	< .1	< .1	--
6-06-89	1301	< .1	< .1	.2	< .1	1.4
7-07-89	0821	< .1	< .1	.1	< .1	--
7-25-89	1101	< .1	< .1	< .1	< .1	1.7
8-02-89	1101	< .1	< .1	< .1	< .1	--
8-07-89	1031	< .1	< .1	.4	< .1	--
8-09-89	1131	< .1	< .1	.2	< .1	--
8-11-89	1101	< .1	< .1	.4	< .1	--
8-15-89	1621	< .1	.1	< .1	< .1	--
8-24-89	0845	< .1	< .1	.3	< .1	--
8-29-89	1121	< .1	< .1	.4	< .1	--
9-06-89	1305	< .1	< .1	.1	< .1	--
			Deer Creek lysimeter (DCLB)			
4-18-89	1101	< .1	< .1	< .1	< .1	--
5-04-89	1633	< .1	< .1	.3	< .1	1.6
5-18-89	1102	< .1	< .1	.1	< .1	--
6-06-89	1302	< .1	< .1	.1	< .1	1.6
7-07-89	1820	< .1	.1	< .1	--	--
7-25-89	1102	< .1	< .1	.1	< .1	1.7
8-02-89	1102	< .1	< .1	< .1	< .1	--
8-07-89	1032	< .1	< .1	.3	< .1	--
8-09-89	1132	< .1	< .1	.2	< .1	--
8-11-89	1102	< .1	< .1	< .1	< .1	--
8-15-89	1622	< .1	< .1	.1	< .1	--
8-24-89	0846	< .1	< .1	.3	< .1	--
8-29-89	1122	< .1	< .1	< .1	< .1	--
9-06-89	1306	< .1	< .1	.2	< .1	--

Table 18.--Selected nitrogen, phosphorus and carbon species at ground-water sites in the Big Spring Basin--Continued

Date	Time	Nitrate plus nitrite (as N)	Ammonia (as N)	Organic nitrogen (as N)	Ortho-phos-phorus (as P)	Total Organic carbon (as C)
			Deer Creek lysimeter (DCLC)			
4-18-89	1102	.2	.1	.1	< .1	--
5-04-89	1312	.2	< .1	< .1	< .1	3.6
5-18-89	1103	.2	< .1	.1	< .1	--
6-06-89	1303	< .1	< .1	.2	< .1	3.9
7-07-89	0823	.2	< .1	.4	--	--
7-25-89	1103	.3	< .1	.4	< .1	5.3
8-02-89	1103	.4	< .1	< .1	< .1	--
8-07-89	1033	.5	< .1	.4	< .1	--
8-09-89	1133	.5	< .1	.4	< .1	--
8-11-89	1103	.5	< .1	.2	< .1	--
8-15-89	1623	.5	< .1	< .1	< .1	--
8-24-89	0847	.5	< .1	.8	< .1	--
8-29-89	1123	.4	< .1	.7	< .1	--
9-06-89	1307	.1	< .1	.3	< .1	--
			Deer Creek lysimeter (DCLD)			
4-18-89	1103	6.6	.1	.1	< .1	--
5-04-89	1642	6.6	< .1	.2	< .1	5.0
5-18-89	1104	4.5	< .1	.3	< .1	--
6-06-89	1304	13	< .1	.4	< .1	5.7
7-07-89	0825	13	< .1	.4	--	--
7-25-89	1104	12	< .1	.8	.1	5.6
8-15-89	1624	8.2	< .1	.5	< .1	--
8-29-89	1124	5.0	< .1	.8	< .1	--
			Deer Creek tile (DCT2)			
2-02-89	1300	20	< .1	1.4	< .1	--
3-11-89	1045	5.2	< .1	1.0	.1	--
3-12-89	1030	6.8	< .1	.7	.1	--
4-23-89	0900	16	< .1	1.6	< .1	--
5-02-89	0900	7.0	< .1	.6	< .1	--
6-06-89	1145	3.2	< .1	.7	< .1	7.8
7-06-89	1015	1.7	< .1	.6	--	--
9-07-89	0845	12	.1	1.3	< .1	--

Table 18.--Selected nitrogen, phosphorus and carbon species at ground-water sites in the Big Spring Basin--Continued

Date	Time	Nitrate plus nitrite (as N)	Ammonia (as N)	Organic nitrogen (as N)	Ortho-phos-phorus (as P)	Total Organic carbon (as C)
			Big Spring			
10-03-88	1015	7.4	< .1	.3	.3	2.8
11-04-88	1030	7.3	< .1	< .1	--	1.3
11-16-88	0700	7.1	< .1	.2	.2	--
12-01-88	0900	7.3	< .1	.3	.3	1.4
1-04-89	1100	7.4	< .1	.9	.2	<1.0
2-01-89	1030	2.0	2.4	3.5	--	33
3-06-89	1220	6.7	.1	.3	.4	1.6
3-11-89	0900	4.8	1.3	2.0	.5	--
3-12-89	0900	2.6	3.6	2.1	.8	38
3-16-89	1000	4.5	1.7	3.0	.6	28
4-04-89	1045	5.6	< .1	.4	--	--
4-23-89	1410	5.6	< .1	.1	.2	--
5-01-89	1130	5.6	< .1	.5	.2	1.7
6-07-89	0900	5.5	< .1	.1	.3	1.5
7-06-89	1130	5.6	< .1	1.2	--	1.6
8-02-89	0915	6.3	< .1	.1	.7	--
8-05-89	1430	6.1	< .1	.6	.3	1.4
8-23-89	1200	6.0	< .1	.6	.4	2.5
9-06-89	1500	5.8	< .1	.5	.5	4.0

Table 19.--Selected pesticides in ground water in the Big Spring Basin

[Total recoverable constituents in micrograms per liter;
<, less than detection limit indicated]

Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
				Deer Creek well (DCW2)				
12-01-88	1300	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-04-89	1500	< .1	< .1	< .1	< .1	< .1	< .1	< .1
2-02-89	1100	< .1	< .1	< .1	< .1	< .1	< .1	< .1
3-07-89	1130	< .1	< .1	< .1	< .1	< .1	< .1	< .1
3-11-89	1220	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-02-89	1130	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-24-89	2145	< .1	< .1	.11	< .1	< .1	--	< .1
5-25-89	1100	< .1	< .1	< .1	< .1	< .1	< .1	< .1
6-06-89	1200	< .1	< .1	< .1	< .1	< .1	< .1	< .1
7-06-89	0915	< .1	< .1	< .1	< .1	< .1	< .1	.20
7-25-89	1030	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-02-89	1230	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-23-89	1040	< .1	< .1	< .1	< .1	< .1	< .1	< .1
9-07-89	1020	< .1	< .1	< .1	< .1	< .1	< .1	< .1
				Deer Creek well (DCW3)				
7-07-89	0930	< .1	< .1	< .1	< .1	< .1	--	< .1
7-25-89	0930	< .1	< .1	< .1	< .1	< .1	--	< .1
8-02-89	1400	< .1	< .1	< .1	< .1	< .1	--	< .1
9-07-89	1300	< .1	< .1	< .1	< .1	< .1	< .1	< .1
				Deer Creek lysimeter (DCLA)				
4-11-89	1255	< .1	< .1	< .1	< .1	< .1	< .1	< .1
4-24-89	1318	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-02-89	1400	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-30-89	1101	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-31-89	1201	< .1	< .1	< .1	< .1	< .1	< .1	< .1
6-07-89	1231	< .1	< .1	< .1	.13	< .1	< .1	< .1
7-07-89	0820	< .1	< .1	< .1	< .1	< .1	< .1	< .1
7-25-89	1101	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-02-89	1101	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-07-89	1031	< .1	< .1	< .1	< .1	< .1	< .1	< .1

Table 19.--Selected pesticides in ground water in the Big Spring Basin--Continued

Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
			Deer Creek lysimeter (DCLA)--Continued					
8-09-89	1131	<0.1	< .1	< .1	< .1	< .1	< .1	< .1
8-11-89	1101	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-24-89	0845	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-29-89	1121	< .1	< .1	< .1	< .1	< .1	< .1	< .1
9-06-89	1305	< .1	.14	< .1	< .1	< .1	< .1	< .1
			Deer Creek lysimeter (DCLB)					
4-11-89	1247	< .1	< .1	< .1	< .1	< .1	< .1	< .1
4-24-89	1315	.10	< .1	< .1	< .1	< .1	< .1	< .1
5-02-89	1401	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-30-89	1102	< .1	< .1	< .1	< .1	< .1	< .1	< .1
5-31-89	1202	< .1	< .1	< .1	< .1	< .1	< .1	< .1
6-07-89	1232	< .1	< .1	< .1	.46	< .1	< .1	< .1
7-07-89	0821	< .1	< .1	< .1	< .1	< .1	--	< .1
7-25-89	1102	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-02-89	1102	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-07-89	1032	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-09-89	1132	< .1	< .1	< .1	.18	< .1	< .1	< .1
8-11-89	1102	< .1	< .1	< .1	< .1	< .1	< .1	< .1
8-24-89	0846	< .1	.92	< .1	< .1	< .1	< .1	< .1
8-29-89	1122	< .1	< .1	< .1	< .1	< .1	< .1	< .1
9-06-89	1306	< .1	.17	< .1	< .1	< .1	< .1	< .1
			Deer Creek lysimeter (DCLC)					
4-11-89	1246	.96	< .1	.33	< .1	< .1	< .1	< .1
4-24-89	1312	.53	< .1	.12	< .1	< .1	< .1	< .1
5-02-89	1402	.46	< .1	< .1	< .1	< .1	< .1	< .1
5-30-89	1103	.46	< .1	.19	< .1	< .1	< .1	< .1
5-31-89	1203	.57	< .1	< .1	< .1	< .1	< .1	< .1
6-06-89	1233	.42	< .1	< .1	.35	< .1	< .1	< .1
7-07-89	0823	.55	< .1	< .1	< .1	< .1	< .1	< .1
7-25-89	1103	.78	< .1	.50	< .1	< .1	< .1	< .1
8-02-89	1103	.57	< .1	< .1	< .1	< .1	< .1	< .1
8-07-89	1033	.34	.20	< .1	< .1	< .1	--	< .1

Table 19.--Selected pesticides in ground water in the Big Spring Basin--Continued

Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
			Deer Creek Lysimeter (DCLC)--continued					
8-09-89	1133	< .1	< .1	.24	< .1	< .1	< .1	< .1
8-11-89	1103	.28	< .1	< .1	< .1	< .1	< .1	< .1
8-24-89	0847	.37	1.4	< .1	< .1	< .1	< .1	< .1
8-29-89	1123	.22	< .1	< .1	< .1	< .1	< .1	< .1
9-06-89	1307	.42	< .1	< .1	< .1	< .1	< .1	< .1
			Deer Creek lysimeter (DCLD)					
4-11-89	1245	.57	< .1	.11	< .1	< .1	< .1	< .1
4-24-89	1308	.44	< .1	< .1	< .1	< .1	< .1	< .1
5-02-89	1403	.46	< .1	< .1	< .1	< .1	< .1	< .1
5-30-89	1104	.48	< .1	< .1	< .1	< .1	< .1	< .1
5-31-89	1204	.54	< .1	< .1	< .1	< .1	< .1	< .1
6-07-89	1234	.53	< .1	< .1	.45	< .1	< .1	< .1
7-07-89	0825	.44	< .1	< .1	< .1	< .1	--	< .1
8-02-89	1104	.66	< .1	.24	< .1	< .1	< .1	< .1
8-07-89	1034	.57	< .1	< .1	< .1	< .1	< .1	< .1
8-09-89	1134	.60	--	< .1	< .1	< .1	< .1	< .1
8-11-89	1104	.59	.15	< .1	.60	< .1	< .1	< .1
9-06-89	1308	.49	.23	< .1	< .1	< .1	< .1	< .1
			Deer Creek tile (DCT2)					
2-02-89	1300	.11	< .1	< .1	< .1	< .1	< .1	< .1
3-11-89	1045	< .1	< .1	.17	< .1	< .1	< .1	< .1
3-12-89	1030	.30	< .1	.41	< .1	< .1	< .1	< .1
4-23-89	0900	.19	< .1	.41	< .1	< .1	< .1	< .1
5-02-89	0900	< .1	< .1	< .1	< .1	< .1	< .1	< .1
6-06-89	1145	.48	< .1	< .1	< .1	< .1	< .1	< .1
7-06-89	1015	< .1	< .1	< .1	< .1	< .1	< .1	< .1
9-07-89	0845	.51	< .1	< .1	< .1	< .1	< .1	< .1

Table 19.--Selected pesticides in ground water in the Big Spring Basin--Continued

Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
				Big Spring				
10-03-88	1015	.32	< .1	< .1	< .1	< .1	< .1	< .1
11-04-89	1030	< .1	< .1	< .1	< .1	< .1	< .1	< .1
11-16-88	0700	.11	< .1	< .1	< .1	< .1	< .1	< .1
12-01-88	0900	.15	< .1	< .1	< .1	< .1	< .1	< .1
1-04-89	1100	.12	< .1	< .1	< .1	< .1	< .1	< .1
2-01-89	1030	2.5	.20	.19	.13	< .1	< .1	< .1
3-06-89	1220	.28	< .1	< .1	< .1	< .1	< .1	< .1
3-11-89	0900	1.0	.11	< .1	< .1	< .1	< .1	< .1
3-12-89	0900	2.7	< .1	.21	.17	< .1	< .1	< .1
3-16-89	1000	3.3	.34	.22	.16	< .1	< .1	< .1
4-04-89	1045	.59	< .1	< .1	< .1	< .1	< .1	< .1
4-23-89	1410	.30	< .1	< .1	< .1	< .1	< .1	< .1
5-01-89	1130	.21	< .1	< .1	< .1	< .1	< .1	< .1
6-07-89	0900	.83	.12	< .1	< .1	< .1	< .1	< .1
7-06-89	1130	.40	< .1	< .1	< .1	< .1	< .1	< .1
8-02-89	0915	.24	< .1	< .1	< .1	< .1	< .1	< .1
8-05-89	1430	.24	< .1	< .1	< .1	< .1	< .1	< .1
8-23-89	1200	.36	< .1	< .1	< .1	< .1	< .1	< .1
9-06-89	1500	.98	.14	< .1	< .1	< .1	< .1	< .1

Table 20.--Daily mean water levels in the Galena Aquifer, Clayton County, Iowa, water year 1989

[Water levels in feet below land surface; ---, data not available to calculate mean values]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well BS1-B						
1	---	---	---	9.52	7.03	9.55	8.32	8.50	9.47	9.99	---	8.14
2	---	---	---	9.51	7.78	9.55	8.41	8.54	9.19	10.04	---	7.75
3	---	---	---	9.58	8.22	9.55	8.48	8.61	9.10	10.08	---	8.07
4	---	---	---	9.54	8.32	9.62	8.56	8.67	9.23	10.15	---	8.35
5	---	---	---	9.40	8.41	9.62	8.60	8.68	9.33	10.14	---	8.58
6	---	---	---	9.29	8.55	9.61	8.65	8.70	9.48	10.13	---	8.72
7	---	---	---	9.32	8.64	9.61	8.69	8.75	9.59	10.18	---	8.86
8	---	---	---	9.48	8.80	9.61	8.75	8.84	9.64	10.10	9.86	---
9	---	---	---	9.47	8.86	9.57	8.84	8.88	9.67	10.19	9.98	---
10	---	---	---	9.53	8.97	8.78	8.91	8.93	9.67	10.23	10.07	---
11	---	---	---	9.54	9.07	6.74	8.94	8.93	9.65	10.25	10.13	---
12	---	---	---	9.58	9.13	5.77	9.00	9.00	9.62	10.27	10.16	---
13	---	---	---	9.58	9.15	5.87	9.03	9.05	9.65	10.28	10.20	---
14	---	---	---	9.57	9.24	5.42	9.06	9.14	9.70	10.29	10.24	---
15	---	---	---	9.57	9.28	5.29	9.10	9.19	9.73	10.30	10.26	---
16	---	---	---	9.54	9.33	6.17	9.11	9.22	9.76	10.32	10.28	---
17	---	---	---	9.45	9.34	6.85	9.17	9.27	9.80	10.35	10.31	---
18	---	---	---	9.47	9.33	7.60	9.18	9.28	9.83	10.36	10.32	---
19	---	---	---	8.99	9.35	7.95	9.22	9.28	9.84	10.35	10.31	---
20	---	---	---	8.60	9.38	8.14	9.25	9.31	9.88	10.38	10.30	---
21	---	---	9.26	8.75	9.41	8.23	9.22	9.34	9.89	10.37	10.34	---
22	---	---	9.28	8.50	9.48	8.18	9.20	9.37	9.73	10.37	10.21	---
23	---	---	9.29	8.11	9.50	7.64	8.73	9.41	9.81	10.36	8.91	---
24	---	---	9.40	8.09	9.49	7.20	8.24	9.43	9.78	10.37	8.73	---
25	---	---	9.35	8.34	9.49	7.19	8.27	9.44	9.50	---	9.06	---
26	---	---	9.32	8.59	9.48	7.25	8.38	9.47	9.56	---	9.30	---
27	---	---	9.38	8.53	9.49	7.34	8.47	9.49	9.70	---	9.38	---
28	---	---	9.42	8.06	9.52	7.52	8.46	9.53	9.81	---	9.40	---
29	---	---	9.43	7.65		7.75	8.45	9.55	9.90	---	9.38	---
30	---	---	9.50	7.27		7.96	8.52	9.55	9.96	---	9.45	---
31	---		9.49	6.77		8.16		9.54		---	9.53	
						Well BS2-E						
1	---	---	---	---	153.83	154.50	---	154.34	154.40	154.51	154.78	153.78
2	---	---	---	---	154.17	154.49	---	154.35	154.40	154.56	154.61	154.06
3	---	---	---	---	154.28	154.47	---	154.36	154.40	154.56	154.61	154.21
4	---	---	---	---	154.30	154.52	154.28	154.34	154.40	154.59	154.62	154.30
5	---	---	---	---	154.32	154.54	154.27	154.36	154.40	154.59	154.20	154.36
6	---	---	---	154.48	154.37	151.39	154.28	154.38	154.43	154.59	154.40	154.40
7	---	---	---	154.49	154.39	151.43	154.29	154.39	154.47	154.71	154.41	154.41
8	---	---	---	154.53	154.45	152.34	154.31	154.39	154.48	154.84	154.45	154.41
9	---	---	---	154.50	154.41	154.47	154.33	154.41	154.48	154.85	154.52	154.41
10	---	---	---	154.53	154.44	148.92	154.32	154.39	154.49	154.87	154.54	154.41
11	---	---	---	154.50	154.46	---	154.33	154.38	154.49	154.87	154.57	154.41
12	---	---	---	154.53	154.46	---	154.33	154.38	154.48	154.87	154.57	154.43
13	---	---	---	154.52	154.46	---	154.32	154.39	154.49	154.87	154.57	154.43
14	---	---	---	154.48	154.49	---	154.34	154.39	154.48	154.87	154.58	154.45
15	---	---	---	154.51	154.48	---	154.32	154.40	154.49	154.87	154.59	154.46
16	---	---	---	154.48	154.49	---	154.33	154.40	154.49	154.87	154.60	154.46
17	---	---	---	154.49	154.46	---	154.36	154.40	154.49	154.87	154.61	154.48
18	---	---	---	154.53	154.44	---	154.36	154.40	154.49	154.87	154.62	154.48
19	---	---	---	153.84	154.44	---	154.36	154.40	154.50	154.78	154.60	154.48
20	---	---	---	153.96	154.46	---	154.36	154.40	154.50	154.81	154.60	154.50
21	---	---	---	154.28	154.47	---	154.35	154.40	154.53	154.82	154.61	154.53
22	---	---	---	153.40	154.50	---	154.32	154.40	154.53	154.83	154.51	154.54
23	---	---	---	153.39	154.50	---	154.13	154.40	154.53	154.84	154.12	154.56
24	---	---	---	153.75	154.48	---	154.18	154.40	154.52	154.85	154.26	154.54
25	---	---	---	154.12	154.46	---	154.27	154.40	154.53	154.85	154.37	154.55
26	---	---	---	154.26	154.45	---	154.29	154.40	154.50	154.85	154.40	154.57
27	---	---	---	153.51	154.46	---	154.30	154.40	154.47	154.85	154.42	154.57
28	---	---	---	153.60	154.49	---	154.28	154.40	154.48	154.89	154.35	154.56
29	---	---	---	152.34		---	154.30	154.40	154.50	154.88	154.35	154.57
30	---	---	---	151.40		---	154.33	154.40	154.50	154.89	154.36	154.55
31	---		---	151.49		---		154.40		154.88	154.39	

Table 20.--Daily mean water levels in the Galena Aquifer, Clayton County, Iowa, water year 1989--continued

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well BS3-A						
1	---	---	---	---	167.92	167.64	---	---	---	---	167.90	167.75
2	---	---	---	---	168.00	---	---	---	---	---	167.84	167.92
3	---	---	---	---	168.13	---	---	---	---	---	167.68	167.91
4	---	---	---	---	168.03	---	---	---	---	---	167.63	167.83
5	---	---	---	---	167.87	---	---	---	---	---	167.66	167.87
6	---	---	---	---	167.78	---	---	---	---	---	167.80	167.82
7	---	---	---	---	167.82	167.75	---	---	167.79	---	167.86	167.78
8	---	---	---	---	167.98	167.96	---	---	167.84	167.82	167.83	167.75
9	---	---	---	---	167.94	167.92	---	---	167.93	167.74	167.86	167.78
10	---	---	---	---	167.79	167.96	---	---	167.90	167.83	167.90	167.90
11	---	---	---	---	167.78	167.96	---	---	167.87	167.90	167.91	167.92
12	---	---	---	---	167.84	167.96	---	---	167.89	167.90	167.88	167.97
13	---	---	---	---	167.68	167.90	---	---	167.94	167.89	167.83	167.94
14	---	---	---	---	167.87	167.93	---	---	167.91	167.90	167.79	167.90
15	---	---	---	---	167.95	167.95	---	---	167.86	167.90	167.82	167.84
16	---	---	---	---	168.11	167.95	---	---	167.88	167.87	167.86	167.84
17	---	---	---	---	168.08	166.53	---	---	167.94	167.83	167.92	167.89
18	---	---	---	---	167.99	167.74	---	---	167.96	167.54	167.93	167.90
19	---	---	---	167.82	167.87	167.91	---	---	167.90	167.85	167.77	167.91
20	---	---	---	168.04	167.72	167.95	---	---	167.82	167.84	167.72	167.91
21	---	---	---	167.86	167.67	167.91	---	---	167.86	167.85	167.79	---
22	---	---	---	167.77	167.71	167.95	---	---	167.95	167.93	167.73	---
23	---	---	---	167.84	167.84	---	---	---	167.98	167.95	167.81	---
24	---	---	---	167.92	167.98	---	---	---	167.89	167.93	167.86	---
25	---	---	---	167.85	167.85	---	---	---	167.84	167.92	167.85	---
26	---	---	---	167.88	167.69	---	---	---	167.85	167.89	167.84	---
27	---	---	---	167.83	167.60	---	---	---	167.87	167.83	167.89	---
28	---	---	---	167.83	167.64	---	---	---	167.90	167.88	167.79	---
29	---	---	---	167.77		---	---	---	167.90	167.80	167.84	---
30	---	---	---	167.73		---	---	---	167.89	167.84	167.87	---
31	---		---	167.54		---		---		167.90	167.72	
						Well BS4-A						
1	---	---	---	---	---	---	215.54	216.41	217.30	217.86	219.33	219.60
2	---	---	---	---	---	---	215.43	216.32	217.25	217.90	219.24	219.89
3	---	---	---	---	---	---	215.32	216.35	217.20	218.00	219.08	219.86
4	---	---	---	---	---	---	215.43	216.07	217.33	218.11	219.03	219.69
5	---	---	---	---	---	---	215.71	216.16	217.29	---	219.13	219.72
6	---	---	---	---	---	215.19	215.67	216.44	217.21	---	219.34	219.63
7	---	---	---	---	---	215.80	215.58	216.52	217.20	218.72	219.43	219.56
8	---	---	---	---	---	215.84	215.56	216.39	217.28	218.65	219.40	219.51
9	---	---	---	---	---	215.87	215.79	216.55	217.40	218.54	219.44	219.52
10	---	---	---	---	---	215.69	215.96	216.66	217.57	218.66	219.53	219.69
11	---	---	---	---	---	215.69	215.77	216.68	217.50	218.84	219.56	219.73
12	---	---	---	---	---	215.82	215.79	216.56	217.24	218.89	219.53	219.86
13	---	---	---	---	---	215.52	215.82	216.50	217.32	218.91	219.45	219.79
14	---	---	---	---	---	215.12	215.63	216.61	217.44	218.95	219.42	219.69
15	---	---	---	---	---	215.60	215.75	216.65	217.60	219.00	219.48	219.64
16	---	---	---	---	---	215.71	215.60	216.69	217.58	218.99	219.56	219.57
17	---	---	---	---	---	215.66	215.88	216.75	217.57	218.92	219.69	219.62
18	---	---	---	---	---	215.89	216.01	216.69	217.62	218.81	219.72	219.66
19	---	---	---	---	---	215.76	216.04	216.61	217.74	218.90	219.49	219.68
20	---	---	---	---	---	215.62	215.94	216.79	217.75	219.02	219.44	219.70
21	---	---	---	---	---	215.81	215.97	216.90	217.70	219.06	219.55	219.68
22	---	---	---	---	---	215.69	215.98	216.87	217.76	219.16	219.52	219.55
23	---	---	---	---	---	215.60	215.96	216.83	217.87	219.25	219.67	219.96
24	---	---	---	---	---	215.45	215.96	216.61	217.99	219.28	219.76	219.86
25	---	---	---	---	---	215.56	215.97	216.78	217.93	219.28	219.71	219.68
26	---	---	---	---	---	215.44	216.09	217.08	217.84	219.28	219.66	219.93
27	---	---	---	---	---	215.41	216.10	217.39	217.91	219.19	219.75	219.99
28	---	---	---	---	---	215.43	216.05	217.27	217.70	219.28	219.64	219.75
29	---	---	---	214.94		215.58	216.12	217.02	218.04	219.22	219.70	219.79
30	---	---	---	---		215.58	216.41	216.96	217.95	219.20	219.75	219.77
31	---		---	---		215.63		217.17		219.33	219.56	

Table 21.--Daily mean specific conductance and water temperature at Big Spring, water year 1989

[---, data not available to calculate mean values]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Daily mean specific conductance, in microsiemens per centimeter at 25 degrees Celsius												
1	714	724	793	731	413	749	635	709	727	722	745	706
2	713	723	792	734	394	748	639	709	728	726	745	701
3	719	723	789	737	418	746	646	711	727	728	743	710
4	724	725	782	742	451	746	651	712	725	727	741	694
5	725	727	769	745	494	747	656	713	725	725	736	684
6	724	727	757	747	524	750	663	714	727	727	739	693
7	725	726	752	745	540	753	669	715	727	728	734	704
8	727	725	751	744	555	755	673	715	727	730	734	712
9	728	724	748	746	572	---	676	713	725	731	728	718
10	730	722	748	750	587	721	677	712	726	732	---	724
11	731	722	748	747	610	491	679	714	728	---	---	726
12	733	721	738	746	632	271	683	714	730	738	719	727
13	733	721	731	745	655	289	686	714	729	736	726	726
14	732	720	730	746	680	331	690	713	728	736	731	729
15	730	719	729	747	700	359	694	714	730	739	736	733
16	727	718	727	747	713	366	698	---	730	742	739	733
17	726	721	727	747	723	395	701	714	730	744	740	734
18	725	724	729	745	730	431	703	715	728	744	738	738
19	725	720	730	742	736	466	703	715	732	744	736	742
20	730	718	731	733	743	486	---	715	730	740	738	743
21	731	717	739	734	746	505	---	716	728	739	739	742
22	727	721	742	713	747	525	---	717	727	741	---	744
23	726	718	741	665	747	541	---	717	728	737	725	746
24	726	717	736	624	747	554	---	719	727	734	724	748
25	727	717	735	566	747	558	---	722	728	738	729	750
26	725	717	734	585	749	552	696	725	731	739	718	750
27	723	733	735	580	749	547	699	725	727	740	709	750
28	721	755	734	582	747	570	704	725	725	741	713	747
29	721	776	731	553		597	707	724	728	742	719	746
30	722	788	731	530		615	708	725	725	744	723	747
31	724		732	462		628		726		746	730	
Daily mean water temperature, in degrees Celsius												
1	10.3	10.1	9.9	9.8	6.8	9.0	8.5	9.5	9.9	10.3	10.2	10.5
2	10.3	10.1	10.0	9.8	6.7	9.0	8.6	9.5	10.0	10.3	10.2	10.5
3	10.4	10.1	10.0	9.8	6.9	9.1	8.7	9.5	10.0	10.3	10.2	10.5
4	10.4	10.1	10.0	9.8	7.2	9.1	8.7	9.5	10.0	10.3	10.2	10.5
5	10.4	10.0	10.0	9.8	7.5	9.1	8.8	9.6	10.0	10.3	10.2	10.6
6	10.3	10.0	10.0	9.8	7.7	9.2	8.8	9.5	10.0	10.3	10.3	10.6
7	10.3	10.0	10.0	9.7	7.8	9.2	8.9	9.6	10.0	10.3	10.3	10.6
8	10.3	10.0	9.9	9.7	7.9	9.2	8.9	9.6	10.0	10.3	10.3	10.6
9	10.3	10.0	9.9	9.7	8.0	9.2	8.9	9.6	10.0	10.3	10.3	10.5
10	10.3	10.0	9.9	9.7	8.1	9.0	8.9	9.6	10.0	10.3	---	10.5
11	10.3	10.0	9.9	9.7	8.2	7.6	9.0	9.6	10.0	---	---	10.5
12	10.3	10.0	9.9	9.7	8.3	5.1	9.0	9.6	10.1	10.2	10.4	10.5
13	10.3	10.0	9.9	9.7	8.3	5.4	9.1	9.7	10.1	10.2	10.4	10.6
14	10.3	10.0	9.9	9.7	8.4	5.9	9.1	9.7	10.1	10.2	10.4	10.6
15	10.3	10.0	9.8	9.7	8.5	5.8	9.1	9.7	10.1	10.2	10.3	10.6
16	10.3	10.0	9.8	9.6	8.6	6.0	9.2	9.6	10.1	10.2	10.2	10.6
17	10.2	10.0	9.9	9.6	8.6	6.3	9.2	9.7	10.1	10.2	10.2	10.5
18	10.2	10.0	9.9	9.6	8.7	6.6	9.2	9.7	10.2	10.2	10.2	10.5
19	10.2	10.0	9.9	9.6	8.7	6.9	9.2	9.7	10.1	10.2	10.2	10.5
20	10.2	10.0	9.9	9.5	8.8	7.1	---	9.7	10.2	10.2	10.2	10.5
21	10.2	10.0	---	9.5	8.8	7.2	---	9.8	10.1	10.2	10.2	10.5
22	10.2	10.0	9.8	9.5	8.8	7.3	---	9.8	10.1	10.2	---	10.5
23	10.2	10.0	9.8	9.1	8.9	7.4	---	9.8	10.1	10.2	10.3	10.5
24	10.2	10.0	9.8	9.0	8.9	7.5	---	9.8	10.1	10.2	10.4	10.5
25	10.2	10.0	9.8	8.5	9.0	7.7	---	9.8	10.2	10.2	10.5	10.5
26	10.2	10.0	9.8	8.6	9.0	7.9	9.3	9.8	10.2	10.2	10.5	---
27	10.2	10.0	9.8	8.6	9.0	8.0	9.4	9.8	10.2	10.2	10.5	10.4
28	10.1	9.9	9.8	8.6	9.0	8.1	9.4	9.9	10.2	10.2	10.5	10.4
29	10.1	9.9	9.8	8.5		8.2	9.4	9.9	10.2	10.2	10.5	10.4
30	10.1	9.9	9.8	8.1		8.3	9.4	9.9	10.3	10.2	10.4	10.4
31	10.1			7.4		8.4		10.0		10.2	10.4	

Table 22.--Daily median pH and daily mean suspended sediment concentration at Big Spring, water year 1989

[---, data not available to calculate median values]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Daily median pH						
1	6.82	6.91	6.93	7.01	6.54	6.96	6.92	7.01	6.97	6.94	6.81	6.81
2	6.82	6.89	6.89	7.02	6.56	6.97	6.89	6.99	6.96	6.93	6.81	6.80
3	6.84	6.88	6.90	7.01	6.64	6.98	6.87	6.99	6.96	6.92	6.81	6.81
4	6.84	6.89	6.90	7.02	6.68	6.98	6.87	6.98	6.97	6.90	6.81	6.80
5	6.81	6.90	6.88	7.07	6.73	6.98	6.88	6.98	6.95	6.88	6.81	6.79
6	6.83	6.88	6.91	7.03	6.76	7.00	6.88	6.99	6.95	6.84	6.81	6.81
7	6.82	6.88	6.93	7.01	6.78	7.02	6.89	7.00	6.97	6.83	6.82	6.80
8	6.81	6.89	6.95	7.00	6.81	7.00	6.90	7.01	6.98	6.82	6.82	6.81
9	6.81	6.88	6.95	7.02	6.84	---	6.92	7.00	6.96	6.82	6.83	6.83
10	6.81	6.86	6.98	7.02	6.85	---	6.93	7.00	6.95	6.82	---	6.83
11	6.82	6.86	7.02	7.02	6.87	6.93	6.96	6.99	6.95	---	---	6.82
12	6.82	6.86	7.06	7.02	6.89	6.71	6.97	6.99	6.95	6.84	6.79	6.82
13	6.82	6.87	7.04	7.01	6.90	6.73	6.94	6.97	6.94	6.83	6.81	6.82
14	6.84	6.87	7.02	7.02	6.93	6.79	6.90	6.97	6.93	6.83	6.82	6.82
15	6.86	6.87	7.02	7.02	6.95	6.86	6.86	6.96	6.93	6.82	6.82	6.83
16	6.86	6.88	7.02	7.02	6.94	6.72	6.82	---	6.93	6.82	6.84	6.83
17	6.86	6.87	7.01	7.02	6.93	6.79	6.90	6.97	6.93	6.82	6.82	6.82
18	6.88	6.87	7.02	7.06	6.92	6.83	6.98	6.96	6.92	6.83	6.83	6.83
19	6.86	6.87	7.03	7.02	6.93	6.89	6.96	6.96	6.93	6.85	6.84	6.82
20	6.86	6.88	7.03	6.96	6.94	6.92	---	6.97	6.93	6.84	6.84	6.83
21	6.84	6.89	---	6.94	6.94	6.94	---	6.98	6.94	6.83	6.85	6.82
22	6.82	6.91	7.04	6.91	6.96	6.96	---	6.98	6.95	6.82	---	6.83
23	6.81	6.94	7.00	6.84	6.95	6.98	---	6.98	6.94	6.82	6.84	6.82
24	6.85	6.91	6.98	6.80	6.94	6.99	---	6.99	6.95	6.82	6.83	6.83
25	6.87	6.89	6.99	6.72	6.94	6.99	---	7.00	6.94	6.81	6.81	6.84
26	6.85	6.88	6.99	6.73	6.94	6.98	6.97	7.00	6.94	6.80	6.81	6.83
27	6.84	6.89	6.98	6.74	6.94	6.96	6.98	7.01	6.95	6.80	6.81	6.82
28	6.86	6.92	7.00	6.75	6.95	6.97	7.00	7.00	6.94	6.81	6.81	6.81
29	6.89	6.93	7.01	6.69		6.97	7.01	6.99	6.93	6.82	6.84	6.81
30	6.87	6.94	7.00	6.65		6.97	7.02	6.99	6.92	6.82	6.82	---
31	6.87		---	6.57		6.95		6.99		6.81	6.81	
				Daily mean suspended sediment concentration, in milligrams per liter								
1	3	2	4	6	78	1	7	11	35	18	4	33
2	3	3	4	6	43	1	7	19	19	15	4	17
3	3	3	4	5	26	1	7	10	16	13	3	13
4	3	3	6	6	15	1	7	16	7	15	4	10
5	3	2	13	7	8	1	7	19	6	15	59	9
6	3	2	4	10	5	1	7	16	6	15	35	7
7	3	3	4	6	5	1	7	11	6	15	8	6
8	3	2	4	6	5	1	7	22	6	16	6	11
9	3	3	4	6	5	1	7	20	6	15	8	11
10	2	2	4	6	6	310	7	16	6	14	6	9
11	2	2	4	9	6	840	7	16	7	16	6	8
12	5	2	4	9	6	620	7	16	14	13	6	7
13	4	2	4	5	6	70	7	16	13	12	6	7
14	6	2	4	5	6	440	7	16	14	12	6	6
15	7	3	4	5	6	355	7	16	14	12	6	5
16	13	10	4	5	6	250	7	16	14	11	8	4
17	13	2	4	5	6	205	7	16	15	7	16	4
18	6	2	4	7	5	128	7	16	16	26	6	3
19	5	7	4	6	5	90	7	18	17	21	7	3
20	5	2	4	19	4	70	7	40	24	2	7	3
21	7	2	4	11	3	45	7	21	23	2	8	3
22	8	2	5	10	3	88	13	16	20	6	95	3
23	8	2	4	10	2	60	12	15	28	12	39	3
24	8	2	4	5	2	48	7	32	14	17	30	3
25	8	17	4	4	1	178	7	19	22	19	20	3
26	6	9	13	4	1	15	7	15	50	21	30	3
27	5	8	8	5	1	12	9	15	33	21	17	3
28	3	8	8	8	1	10	12	15	31	19	40	3
29	3	8	14	7		9	7	20	27	19	5	3
30	5	13	7	21		7	7	24	22	18	5	4
31	2		7	62		7		51		12	5	

Table 23.--Daily mean water level in the Saint Peter aquifer, Clayton County, Iowa, water year 1989

[Water levels in feet below land surface; ---, data not available to calculate mean values]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well BS2-G						
1	---	---	---	---	183.97	184.33	184.39	184.61	184.66	184.88	185.34	184.97
2	---	---	---	---	184.16	184.31	184.22	184.62	184.60	184.94	185.26	185.22
3	---	---	---	---	184.42	184.08	184.07	184.57	184.60	185.01	185.16	185.36
4	---	---	---	---	184.42	184.10	184.06	184.31	184.70	185.01	184.94	185.25
5	---	---	---	---	184.20	184.40	184.29	184.29	184.61	185.04	184.95	185.69
6	---	---	---	183.73	184.32	184.43	184.29	184.51	184.54	185.10	185.19	185.20
7	---	---	---	183.59	184.13	184.52	184.33	184.60	184.51	185.19	185.19	185.12
8	---	---	---	183.93	184.39	184.55	184.20	184.49	184.53	185.06	185.18	185.06
9	---	---	---	184.05	184.34	184.50	184.36	184.54	184.60	184.94	185.25	185.06
10	---	---	---	183.98	184.16	184.29	184.51	184.66	184.89	185.09	185.32	185.19
11	---	---	---	183.93	184.10	184.17	184.40	184.67	184.74	185.27	185.34	185.31
12	---	---	---	184.01	184.11	184.30	184.53	184.60	184.51	185.22	185.34	185.56
13	---	---	---	184.17	184.02	184.31	184.49	184.57	184.52	185.23	185.26	185.44
14	---	---	---	183.86	184.23	183.75	184.31	184.54	184.57	185.27	185.16	185.31
15	---	---	---	184.00	184.38	184.12	184.32	184.57	184.77	185.43	185.21	185.25
16	---	---	---	183.99	184.64	184.26	184.17	184.64	184.70	185.34	185.30	185.17
17	---	---	---	183.84	184.64	184.29	184.34	184.68	184.74	185.25	185.32	185.24
18	---	---	---	183.96	184.41	184.50	184.54	184.53	184.70	185.11	185.35	185.36
19	---	---	---	183.88	184.30	184.46	184.47	184.39	184.79	185.22	185.18	185.34
20	---	---	---	184.16	184.11	184.34	184.54	184.51	184.77	185.30	185.14	185.34
21	---	---	---	184.08	184.01	184.53	184.46	184.61	184.68	185.27	185.13	185.34
22	---	---	---	183.99	184.32	184.51	184.38	184.58	184.69	185.34	185.08	185.16
23	---	---	---	183.96	184.49	184.38	184.29	184.70	184.81	185.41	185.15	185.43
24	---	---	---	184.11	184.33	184.23	184.31	184.34	184.94	185.46	185.27	185.40
25	---	---	---	184.07	184.07	184.27	184.24	184.34	184.88	185.48	185.23	185.26
26	---	---	---	184.04	184.05	184.18	184.29	184.53	184.80	185.44	185.15	185.42
27	---	---	---	184.06	184.13	184.20	184.26	184.75	184.76	185.34	185.22	185.46
28	---	---	---	183.98	184.11	184.23	184.20	184.74	184.87	185.54	185.18	185.37
29	---	---	---	183.91	---	184.36	184.25	184.57	185.15	185.35	185.13	185.40
30	---	---	---	183.76	---	184.35	184.48	184.51	184.98	185.28	185.19	185.26
31	---	---	---	183.54	---	184.43	---	184.69	---	185.37	185.06	---
						WELL BS3						
1	---	---	---	---	---	300.07	---	---	300.11	---	300.15	---
2	---	---	---	---	299.87	299.92	---	---	---	---	---	---
3	---	---	---	---	300.21	299.67	---	---	---	---	---	---
4	---	---	---	---	300.24	299.68	---	---	---	---	---	---
5	---	---	---	---	299.40	299.90	---	300.07	---	---	---	300.20
6	---	---	---	---	299.97	299.54	---	---	---	300.08	---	---
7	---	---	---	---	299.9	300.07	---	---	---	---	---	---
8	---	---	---	---	300.03	300.07	---	---	---	---	---	---
9	---	---	---	---	300.25	300.07	---	---	---	---	---	---
10	---	---	---	---	299.92	300.07	---	---	---	---	---	---
11	---	---	---	---	299.84	300.12	---	300.10	---	---	---	---
12	---	---	---	---	299.94	300.16	---	---	---	---	---	---
13	---	---	---	---	299.67	300.21	---	---	---	---	---	---
14	---	---	---	---	300.07	299.39	299.39	---	---	---	---	---
15	---	---	---	---	300.15	299.99	---	---	---	---	---	---
16	---	---	---	---	300.42	299.99	---	---	---	---	---	---
17	---	---	---	---	300.53	299.99	---	---	---	---	---	---
18	---	---	---	---	300.95	299.99	---	---	---	---	---	---
19	---	---	---	---	299.81	299.99	---	---	---	---	---	---
20	---	---	---	---	299.73	299.99	---	---	---	---	---	---
21	---	---	---	---	300.68	299.99	---	---	---	---	---	---
22	---	---	---	---	300.25	299.99	---	---	---	---	---	---
23	---	---	---	---	300.14	---	---	---	---	---	---	---
24	---	---	---	---	299.18	---	---	---	---	---	---	---
25	---	---	---	---	299.83	---	---	---	---	---	---	---
26	---	---	---	---	299.76	---	---	---	---	---	---	---
27	---	---	---	---	299.23	---	---	---	---	---	---	---
28	---	---	---	---	299.30	---	---	---	---	---	---	---
29	---	---	---	---		---	---	---	---	---	---	---
30	---	---	---	---		---	---	---	---	---	---	---
31	---		---	---		---		---		---	---	

Table 23.--Daily mean water level in the Saint Peter aquifer, Clayton County, Iowa, water year 1989--Continued

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
						Well BS4						
1	---	---	---	---	---	---	---	---	---	368.60	369.27	369.55
2	---	---	---	---	366.97	---	---	367.64	---	368.62	369.15	369.87
3	---	---	---	---	---	---	---	---	---	368.68	368.97	369.93
4	---	---	---	---	---	---	---	---	---	368.77	368.86	369.86
5	---	---	---	---	---	---	---	---	---	---	368.90	369.88
6	---	---	---	---	---	---	---	---	367.81	368.81	369.12	369.89
7	---	---	---	---	---	367.73	367.16	---	367.91	368.84	369.22	369.92
8	---	---	---	---	---	---	---	---	367.96	368.74	369.20	369.90
9	---	---	---	---	---	---	---	---	368.07	368.59	369.25	369.92
10	---	---	---	---	---	---	---	---	368.25	368.65	369.30	369.95
11	---	---	---	---	---	---	---	---	368.21	368.76	369.35	369.89
12	---	---	---	---	---	---	---	---	367.97	368.81	369.33	369.91
13	---	---	---	---	---	---	---	---	368.04	368.82	369.27	369.90
14	---	---	---	---	---	---	---	---	368.12	368.86	369.25	369.89
15	---	---	---	---	---	---	---	---	368.26	368.90	369.30	369.88
16	---	---	---	---	---	---	---	---	368.24	368.92	369.38	369.91
17	---	---	---	---	---	---	---	---	368.23	368.88	369.48	369.90
18	---	---	---	---	---	---	---	---	368.29	368.78	369.53	369.89
19	---	---	---	---	---	---	---	---	368.41	368.88	369.35	369.93
20	---	---	---	---	---	---	---	---	368.40	368.99	369.30	369.94
21	---	---	---	---	---	---	---	---	368.33	369.07	369.40	369.93
22	---	---	---	---	---	---	---	---	368.34	369.18	369.37	369.92
23	---	---	---	---	---	---	---	---	368.42	369.30	369.45	369.94
24	---	---	---	---	---	---	---	---	368.53	369.34	369.55	369.96
25	---	---	---	---	---	---	---	---	368.50	369.34	369.54	369.97
26	---	---	---	---	---	---	---	---	368.41	369.31	369.52	369.97
27	---	---	---	---	---	---	---	---	368.46	369.19	369.61	369.99
28	---	---	---	---	---	---	---	---	368.61	369.24	369.55	370.02
29	---	---	---	---		---	---	---	368.75	369.14	369.61	370.03
30	---	---	---	---		---	---	---	368.68	369.14	369.69	370.06
31	---		---	---		---		---		369.25	369.53	

Table 24.--Field measurements and chemical analyses of samples from streams in the Big Spring Basin during low-flow conditions

[Dissolved chemical constituents in milligrams per liter]

[--, missing data; ft^3/s, cubic feet per second: µS/cm, microsiemens per centimeter; °C, degrees celsius; N, nitrogen; P, phosphorus; C, carbon; <, less than detection limit indicated]

Station number	Date	Time	Streamflow (ft^3/s)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Nitrite plus nitrate (as N)	Ammonia (as N)	Organic nitrogen (as N)	Orthophosphorus (as P)	Total organic carbon (as C)
HS5	8-17-89	0930	0.09	802	8.0	15.0	2.1	<0.1	1.0	0.2	3.3
HS6	8-17-89	1115	.01	669	8.2	16.0	0.2	< .1	0.6	0.2	5.3
HS4	8-17-89	1030	.08	662	8.2	16.0	6.0	< .1	.4	.2	--
HS2	8-17-89	1200	.03	682	8.4	15.0	< .1	< .1	.7	.4	2.7
HS3	8-17-89	1330	.13	595	8.7	25.0	1.9	< .1	2.2	.2	4.3
HS1	8-17-89	--	.00	--	--	--	--	--	--	--	--
RC13	8-16-89	1530	.01	970	7.8	20.0	.1	8.7	3.9	8.4	--
RC27	8-16-89	1730	.67	--	--	--					
RC26	8-16-89	1740	.56	495	8.3	23.0	< .1	< .1	.1	1.1	1.1
RC25	8-16-89	1645	.01	798	8.0	20.0	2.3	< .1	.5	.1	--
RC21	8-16-89	1345	.31	645	8.8	20.5	3.5	< .1	1.1	.2	3.4
RC20	8-16-89	1330	.91	580	8.6	22.0	.9	< .1	.4	.8	2.5
RC11	8-16-89	1130	1.05	618	8.6	20.0	.6	< .1	.7	.4	4.2
RC10	8-16-89	0930	.57	570	8.6	18.5	< .1	.4	.4	.3	4.6
RC15	8-16-89	1015	1.12	550	8.7	18.0	.2	< .1	.8	.2	6.5
DC2	8-16-89	1230	.08	760	8.0	17.5	1.0	.1	4.8	.3	2.8
RC28	8-16-89	--	.00	--	--	--	--	--	--	--	--
F45	8-16-89	1515	1.22	565	8.5	22.5	.2	< .1	.8	.2	7.0
RC29	8-16-89	1715	.24	690	8.0	17.5	3.6	< .1	.3	.1	2.7
RC16	8-16-89	1900	1.09	498	9.1	25.5	.4	< .1	1.0	.2	5.6
RC17	8-16-89	1840	.74	--	8.8	24.0	.1	< .1	1.5	.3	7.7
SC10	8-16-89	1000	.08	1425	7.7	15.0	32	< .1	1.4	5.4	5.8
SC13	8-16-89	0920	1.03	990	7.8	33.0	.1	2.4	1.3	5.6	5.8
SC3	8-16-89	1205	1.01	1305	8.0	22.0	2.9	2.3	2.7	7.4	7.5
SC6	8-16-89	--	.00	--	--	--	--	--	--	--	--
SCU1	8-17-89	--	.00	--	--	--	--	--	--	--	--
SCU2	8-17-89	--	.00	--	--	--	--	--	--	--	--
L23S	8-17-89	1030	.05	730	7.5	17.0	4.7	2.5	1.4	.9	4.2
SC5	8-17-89	1220	.07	700	8.0	16.0	2.8	< .1	.6	.3	4.4
SC1	8-16-89	--	.00	--	--	--					
SC2	8-16-89	--	.01	--	--	--	.2	.3	.9	.3	7.1
SC4	8-16-89	--	.00	--	--	--	--	--	--	--	--
RC18	8-16-89	1045	.48	510	8.0	17.0	.1	.3	2.4	.3	10.0
RC19	8-16-89	1310	.27	510	8.8	25.0	.1	< .1	2.5	.2	12.0
F47	8-16-89	1420	.20	510	8.7	23.0	< .1	< .1	2.2	.3	11.0
RC24	8-16-89	--	.00	--	--	--	--	--	--	--	--
RC23	8-16-89	--	.00	--	--	--	--	--	--	--	--
RC22	8-16-89	--	.00	--	--	--	--	--	--	--	--
RC2	8-16-89	--	.00	--	--	--	--	--	--	--	--
HC1	8-17-89	0945	.14	667	8.2	15.5	1.2	< .1	.5	.2	2.2
HC2	8-17-89	0900	.07	636	7.5	15.0	1.0	< .1	1.3	.1	2.3

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Table 25.--Selected pesticides in samples from streams in the Big Spring basin during low-flow conditions

[Total recoverable constituents in micrograms per liter; [<, less than detection limit indicated; --, data not collected]

Station number	Date	Time	Atrazine	Cyanazine	Metolachlor	Alachlor	Metribuzin	Butylate	Trifluralin
HS5	8-17-89	0930	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HS6	8-17-89	1115	--	--	--	--	--	--	--
HS4	8-17-89	1030	--	--	--	--	--	--	--
HS2	8-17-89	1200	< .1	< .1	< .1	< .1	< .1	< .1	< .1
HS3	8-17-89	1330	.20	< .1	< .1	< .1	< .1	< .1	< .1
HS1	8-17-89	--	--	--	--	--	--	--	--
RC13	8-16-89	1530	--	--	--	--	--	--	--
RC27	8-16-89	1730	--	--	--	--	--	--	--
RC26	8-16-89	1740	--	--	--	--	--	--	--
RC25	8-16-89	1645	--	--	--	--	--	--	--
RC21	8-16-89	1345	.1	< .1	< .1	< .1	< .1	< .1	< .1
RC20	8-16-89	1330	.11	< .1	< .1	< .1	< .1	< .1	< .1
RC11	8-16-89	1130	.20	< .1	< .1	< .1	< .1	< .1	< .1
RC10	8-16-89	0930	.48	.19	< .1	< .1	< .1	< .1	< .1
RC15	8-16-89	1015	.39	< .1	< .1	< .1	< .1	< .1	< .1
DC2	8-16-89	1230	.14	< .1	< .1	< .1	< .1	< .1	< .1
RC28	8-16-89	--	--	--	--	--	--	--	--
F45	8-16-89	1515	--	--	--	--	--	--	--
RC29	8-16-89	1715	< .1	< .1	< .1	< .1	< .1	< .1	< .1
RC16	8-16-89	1900	.41	< .1	< .1	< .1	< .1	< .1	< .1
RC17	8-16-89	1840	.29	< .1	< .1	< .1	< .1	< .1	< .1
SC10	8-16-89	1000	--	--	--	--	--	--	--
SC13	8-16-89	0920	--	--	--	--	--	--	--
SC3	8-16-89	1205	--	--	--	--	--	--	--
SC6	8-16-89	--	--	--	--	--	--	--	--
SCU1	8-17-89	--	--	--	--	--	--	--	--
SCU2	8-17-89	--	--	--	--	--	--	--	--
L23S	8-17-89	1030	< .1	< .1	< .1	< .1	< .1	< .1	< .1
SC5	8-17-89	1220	.16	< .1	< .1	< .1	< .1	< .1	< .1
SC1	8-16-89	--	--	--	--	--	--	--	--
SC2	8-16-89	--	.16	< .1	< .1	< .1	< .1	< .1	< .1
SC4	8-16-89	--	--	--	--	--	--	--	--
RC18	8-16-89	1045	.32	< .1	< .1	< .1	< .1	< .1	< .1
RC19	8-16-89	1310	--	--	--	--	--	--	--
F47	8-16-89	1420	.19	< .1	< .1	< .1	< .1	< .1	< .1
RC24	8-16-89	--	--	--	--	--	--	--	--
RC23	8-16-89	--	--	--	--	--	--	--	--
RC2	8-16-89	--	--	--	--	--	--	--	--
HC1	8-17-89	0945	< .1	< .1	< .1	< .1	< .1	< .1	< .1
HC2	8-17-89	0900	.11	< .1	< .1	< .1	< .1	< .1	< .1