GROUND-WATER QUALITY AND PRELIMINARY ASSESSMENT OF THE POTENTIAL FOR CONTAMINATION BENEATH AGRICULTURAL LANDS IN CENTRAL LONOKE COUNTY, ARKANSAS

By Valarie A. Leidy and E.E. Morris

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CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, rather than the inch-pound units used in this report, the following conversion factors may be used:

Multiply inch-pound unit	By	To obtain metric unit
foot (ft)	0.3048	meter (m)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
gallon per minute (gal/min)	0.0630	liter per second (L/s)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = 1.8 \times °C + 32$$

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

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ABSTRACT

As part of an effort to monitor ground-water quality and to assess the potential for ground-water contamination on a statewide basis ground-water quality was studied in central Lonoke County, an agricultural area with heavy pesticide and fertilizer use. Ground water from 21 wells in the alluvial aquifer and 1 well each in the Sparta aquifer and Wilcox aquifer was sampled and analyzed for physical properties, major inorganic constituents, nutrients, trace inorganic constituents, total organic carbon, and selected pesticides.

With the exception of iron and manganese, the water in the alluvial aquifer generally did not exceed U.S. Environmental Protection Agency primary and secondary maximum contaminant levels for drinking water. High iron and manganese concentrations, although suitable for irrigation purposes, indicate that some treatment for iron and manganese removal might be desirable for drinking water use. Dissolved-solids concentrations in the alluvial aquifer ranged from 88 to 536 milligrams per liter with the higher concentrations occurring in the southern one-half of the study area. Of the pesticides tested for, none were detected in the alluvial aquifer.

The potential for widespread ground-water contamination in the study area is low because of the relatively impermeable clay and silt deposits of the alluvial confining unit that overlie the alluvial aquifer in most of, if not all, of the study area. Locally, however, potential contaminants could enter the aquifer from streams incised into and in hydraulic connection with the alluvial aquifer.

INTRODUCTION

Land in Lonoke County, Ark., has been intensively developed for agriculture and aquaculture (primarily minnows). Increased and prolonged use of pesticides and fertilizers associated with production of rice, soybeans, and cotton in this area potentially can affect shallow ground-water supplies that are used as sources of irrigation, aquaculture, public, and domestic supplies. Concern over this potential for contamination prompted the U.S. Geological Survey (USGS), in cooperation with the Arkansas Department of Pollution Control and Ecology (ADPCE), to initiate a study of ground-water quality in 1988. In this study water samples were collected from irrigation, public, and domestic wells in central Lonoke County. This study is one of five investigations developed by the ADPCE to monitor ground-water quality in different geohydrologic and land-use settings.

Purpose and Scope

The purposes of this report are (1) to describe the quality of ground water in the alluvial aquifer of central Lonoke County, Ark., (2) to present the available data for the quality of water in the Sparta and Wilcox aquifers, and (3) to discuss the potential for ground-water contamination of the shallow aquifers from agricultural and aquacultural activities. Discussion of the potential for contamination of the shallow aquifers is necessarily preliminary because of the limited amount of available information.

Study Area Description

The study area comprises approximately 90 square miles (mi^2) in central Lonoke County, Ark. (fig. 1). Physiographically, the area lies within the Mississippi Alluvial Plain, which has minimal surface relief and slopes southward. Principal streams in the area include Bayou Two Prairie and Bayou Meto.

Approximately 50 percent of the study area is agricultural land used for production of rice, soybeans, and cotton. About 30 percent of the land is used for aquaculture, primarily minnow farming. The remaining 20 percent includes the town of Lonoke and the woodlands that border the principal streams.

Quaternary alluvium and terrace deposits are present at the surface in the study area and extend to a depth of about 150 feet. These deposits consist of an upper unit of silt and clay, and a basal unit of gravel and coarse sand. The basal gravel and sand constitute the alluvial aquifer and locally may be more than half the thickness of the alluvium and terrace deposits.

Beneath the alluvium and terrace deposits are approximately 2,000 feet of sediments of Tertiary age (table 1). These formations consist of alternating beds of sand and clay that contain some silt and lignite. The Sparta Sand and Wilcox Group, which include the Sparta and Wilcox aquifers, thin northwesterly and subcrop beneath the alluvium in the study area.

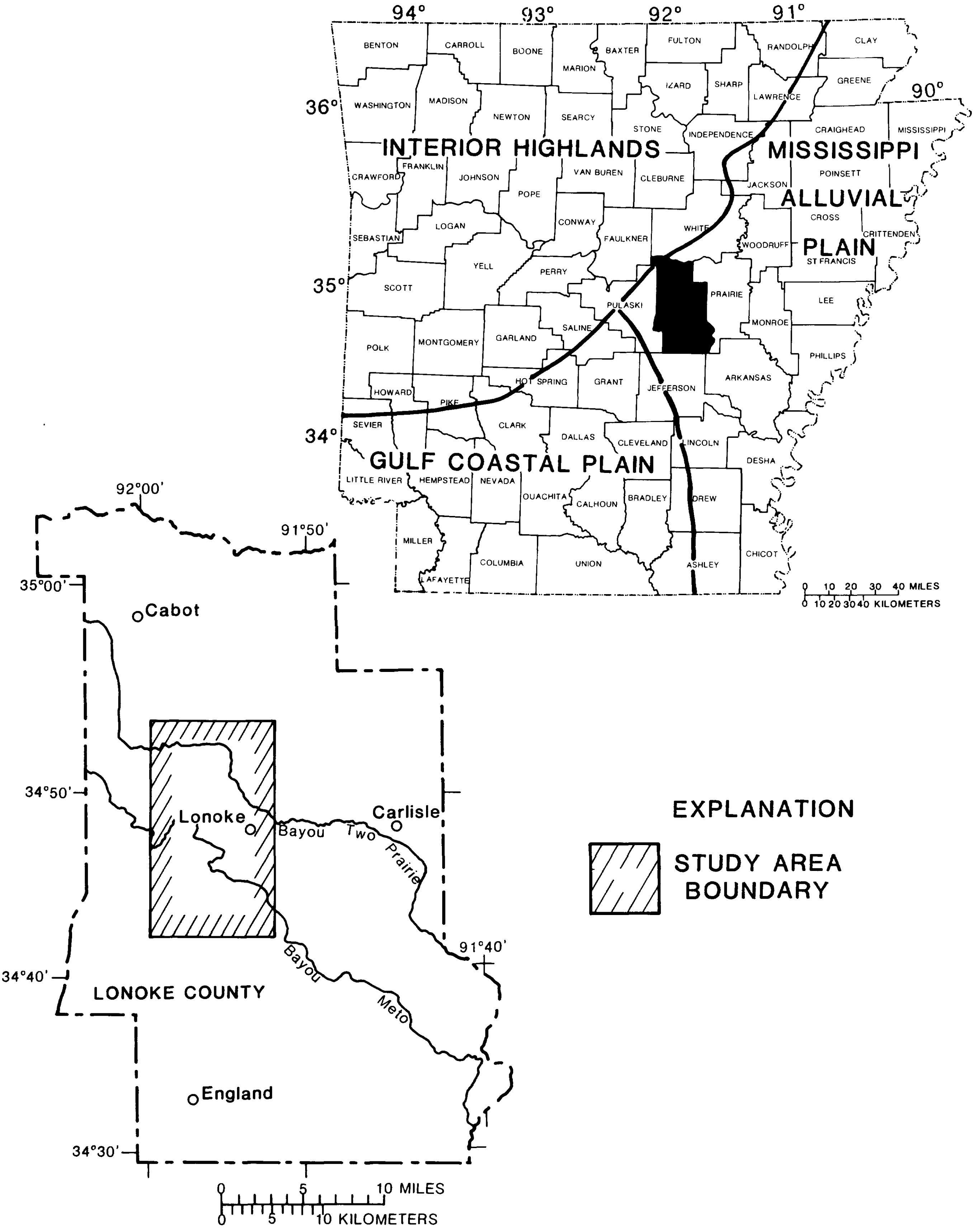


Figure 1.--Location of study area.

Table 1.--Correlation chart of geologic units and their geohydrologic properties in the vicinity of Lonoke, Arkansas

Erathem	System	Series	Group	Formation	Hydrostratigraphic units	Geohydrologic properties
Cenozoic	Quaternary	Holocene and Pleistocene		Alluvium and terrace deposits	Alluvial confining unit	Clay and silt. Non-water bearing. Maximum thickness about 80 feet.
					Alluvial aquifer	Sand and gravel. Major aquifer used mainly for irrigation. Commonly yields 1,000 to 3,000 gallons per minute. Maximum thickness about 150 feet.
	Tertiary	Eocene	Jackson	Undifferentiated	Jackson confining unit	Mostly clay with some fine sand and silt. Non-water bearing. Maximum thickness about 50 feet.
			Claiborne	Cockfield Formation	Cockfield aquifer	Fine sand with interbedded clay. Aquifer used mainly as a source of domestic water supply. Locally yields up to 400 gallons per minute. Maximum thickness about 150 feet.
				Cook Mountain Formation	Cook Mountain confining unit	Clay with interbedded fine sand. Non-water bearing. Maximum thickness about 150 feet.
				Sparta Sand	Sparta aquifer	Fine to medium sand with some interbedded clay. Major aquifer used mainly as a source of municipal and industrial water supply. Commonly yields up to 1,000 gallons per minute. Maximum thickness less than 300 feet.
				Cane River Formation		Geohydrologic properties are unknown in vicinity of Lonoke, Arkansas.
				Carrizo Sand		
			Wilcox	Undifferentiated	Wilcox aquifer	Interbedded sand and clay. Source of domestic water supply in and near its outcrop area. Maximum thickness about 400 feet.
		Paleocene	Midway	Undifferentiated	Midway-Arkadelphia confining unit	Clay and marl. Major confining unit. Maximum thickness about 600 feet.
Mesozoic	Cretaceous	Upper Cretaceous		Arkadelphia Marl		
				Nacatoch Sand	Nacatoch aquifer	Fine sand with interbedded clay and limestone. Aquifer unused in the vicinity of Lonoke, Arkansas. Probably contains only salty water.

Methods of Investigation

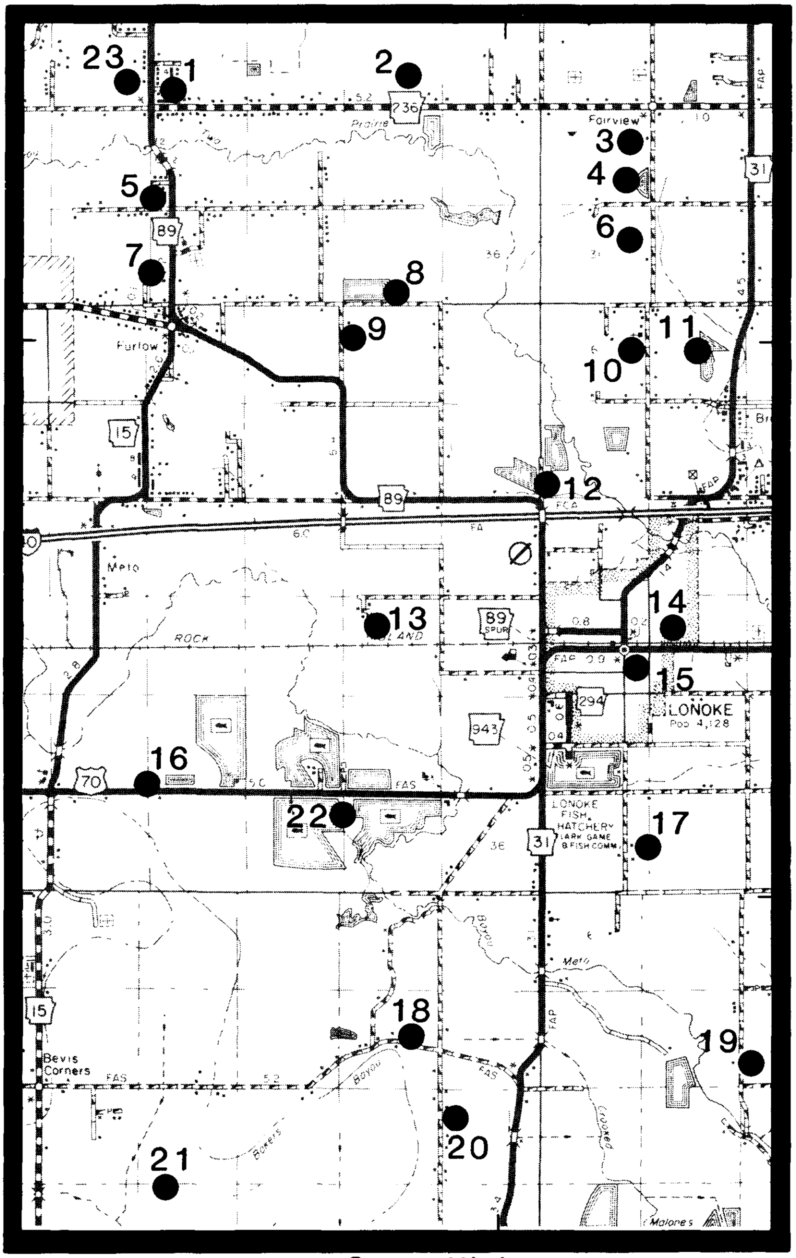
The quality of ground water in central Lonoke County was determined by collecting and analyzing samples from selected wells throughout the study area. Descriptions of the selected wells for which water-quality data are available are listed by site number in table 2. The locations of these wells are shown in figure 2.

Table 2.--Location and description of sampled wells

[I, irrigation; D, domestic; P, public supply; A, aquaculture]

Site number	Station number	Local well number	Latitude (degrees)	Longitude (degrees)	Owner	Aquifer	Altitude of land surface (feet)	Depth of well (feet)	Primary use of water
1	345202091584701	03N09W21CCD1	345202	915847	Barrett, Tom	Alluvial	263	28	D
2	345204091560701	03N09W23CCA1	345204	915607	Glover, Joe	Alluvial	250	135	I
3	345139091533701	03N08W30AAD1	345139	915337	Rochelle, Gene	Alluvial	250	135	I
4	345116091533801	03N08W30DAA1	345116	915338	Tomlinson, H.	Alluvial	249	137	I
5	345112091585401	03N09W28CCA1	345112	915854	Cole, Boe	Alluvial	250	103	D
6	345049091534001	03N08W31AAD1	345049	915340	Tomlinson, Henry	Alluvial	247	159	I
7	345025091585301	03N09W33CBD1	345025	915853	Hicks, Minnie	Alluvial	260	32	D
8	345012091562201	03N09W35DCC1	345012	915622	Shite	Alluvial	248	--	I
9	344957091565501	02N09W02BBC1	344957	915655	Goacher, Joe B.	Alluvial	255	157	I
10	344948091534101	02N08W06ADA1	344948	915341	Shields, Floyd	Alluvial	245	160	I
11	344944091530201	02N08W05ACC1	344944	915302	Elcan, M.W., Jr.	Alluvial	250	152	A
12	344830091545001	02N08W07CCC1	344830	915450	Saylor, Nora	Alluvial	230	100	D
13	344718091564401	02N09W23BAC1	344718	915644	Hamilton, Preston	Alluvial	240	150	I
14	344705091535001	02N08W19ADD1	344705	915350	Pack, Jim	Alluvial	240	155	P
15	344701091535801	02N08W19DAB1	344701	915358	City of Lonoke	Alluvial	238	125	P
16	344547091591001	02N09W28CCC1	344547	915910	Fletcher, Bill	Alluvial	230	136	I
17	344519091534401	02N08W32BCC1	344519	915344	Willman, Lloyd	Alluvial	240	195	I
18	344333091562401	01N09W11DBA1	344333	915624	Brumett, Joe	Alluvial	230	105	I
19	344319091524601	01N08W09CBC1	344319	915246	Tomlinson, Ben	Alluvial	235	150	I
20	344251091560201	01N09W13BCB1	344251	915602	Cole, D.E.	Alluvial	229	125	I
21	344219091590201	01N09W21BAB1	344219	915902	Stecks, Fred	Alluvial	230	100	I
22	344541091570201	02N09W35BBB1	344541	915702	Anderson, Neal	Sparta	225	354	A
23	345210091590701	03N09W20DDA1	345210	915907	Gertsch, Chris	Wilcox	285	397	D

Water samples were obtained between 1946 and 1988 from 23 wells (14 irrigation wells, 5 domestic wells, 2 public supply wells, and 2 aquaculture wells). Sixteen of the samples were collected by the USGS and the ADPCE during the peak irrigation season (June through August) of 1988. Analyses of these samples for major inorganic constituents, nutrients, trace inorganic constituents, total organic carbon, and selected pesticides (including organochlorine compounds, organophosphorus insecticides, chlorophenoxy acid herbicides, and triazine herbicides) were performed by the ADPCE. Due to laboratory constraints some organic compounds including propanil, bentazon, fluometuron, norflurazon, MSMA, and cypermethrin, which are commonly used (upon at least 40 percent of acreage of the crop) in rice, soybeans, and cotton production (Waldrum, 1984; Waldrum, 1986; and J.D. Waldrum, Arkansas Cooperative Extension Service, written commun., 1989) were not analyzed for in this study. The analyses followed procedures documented by ADPCE in their quality assurance plan (Arkansas Department of Pollution Control and Ecology, 1986). For quality-control purposes, a duplicate sample was analyzed by the USGS following procedures described by Skougstad and others (1979); Wood (1976); and Wershaw and others (1987). Field measurements of temperature, pH, specific conductance, and alkalinity were completed according to techniques recommended by the USGS (U.S. Geological Survey, 1977). The results of the analyses and historical data are listed by site number in tables 4 and 5 (at the end of report).



Base from Arkansas State Highway and Transportation Department Lonoke County 1:126,720

0 1 2 3 MILES

0 1 2 3 KILOMETERS

EXPLANATION

● 16 WELL AND WATER-QUALITY SITE NUMBER--Number corresponds to site number in tables 2, 4 and 5.

Figure 2.--Location of wells for which water-quality data are available.

AQUIFERS

The major water-bearing units pertinent to this investigation in descending order are the alluvial aquifer, the Sparta aquifer, and the Wilcox aquifer (table 1). The stratigraphic position of the alluvial, Sparta, and Wilcox aquifers in relation to other principal aquifers in the study area is shown in a hydrogeologic section through the study area (fig. 3).

The alluvial aquifer is the most productive and important aquifer in the Mississippi Alluvial Plain with irrigation wells generally producing as much as 1,000 to 3,000 gallons per minute (gal/min). In the study area, the alluvial aquifer is approximately 50 to 150 feet thick and overlain by a confining unit consisting of 10 to 80 feet of clay and silt (table 1). Depth to water ranges from 60 to 100 feet below land surface (Plafcan and Remsing, 1989). The alluvial aquifer is under artesian conditions where the water level in wells rises above the gravel and coarse sand into the clay and silt of the confining unit. Recharge to the alluvial aquifer occurs by infiltration of water from streams and lakes that are in hydraulic connection with the aquifer. Generally lesser amounts of recharge to the alluvial aquifer occur by percolation through the clay and silt. The amount of recharge through the clay and silt depends largely on thickness and permeability of these sediments. Both recharge and discharge occur between the alluvial aquifer and underlying formations of Tertiary age (Ackerman, 1989). Discharge of water occurs primarily by withdrawal from wells and by natural seepage to streams and lakes. Ground-water movement generally is southeast towards a large cone of depression that has developed just southeast of the study area since pumping for rice irrigation began in 1904 (Plafcan and Remsing, 1989; Halberg and Reed, 1964). Presently, the largest use of ground water in Lonoke County from the alluvial aquifer is for irrigation and aquaculture, with additional withdrawals in the study area for the city of Lonoke's public water supply (Holland, 1987).

The Sparta aquifer is less than 300 feet thick (Petersen and others, 1985) and subcrops the alluvial aquifer throughout most of the study area (fig. 3). Although the amount of water withdrawn from the Sparta aquifer in the study area is small, the aquifer is capable of yielding as much as 1,000 gal/min of water to wells. Water from the Sparta aquifer primarily is used for industrial purposes, however, in parts of Lonoke County some water from the aquifer is used for irrigation and aquaculture (Edds and Fitzpatrick, 1989). Recharge to the Sparta aquifer occurs both in the subcrop areas and in the outcrop areas just southwest of the study area. Recharge also may be derived from formations underlying the Sparta aquifer. Discharge of water occurs by withdrawal from wells and by natural discharge to adjacent geologic units. Ground-water flow is south towards an area of large water withdrawals just south of the study area. In the study area where the Sparta aquifer is relatively unstressed, gradients are 2 to 5 feet per mile (Ackerman, 1987).

The Wilcox aquifer is less than 400 feet thick (Petersen and others, 1985) and subcrops the alluvial aquifer in the northwest corner of the study area (fig. 3). In this area, the aquifer primarily is used as a source of domestic water supply. Recharge to the Wilcox aquifer occurs both in the subcrop areas and in the outcrop areas just northwest of the study area. Water in the Wilcox aquifer generally moves southeast from the outcrop and subcrop areas.

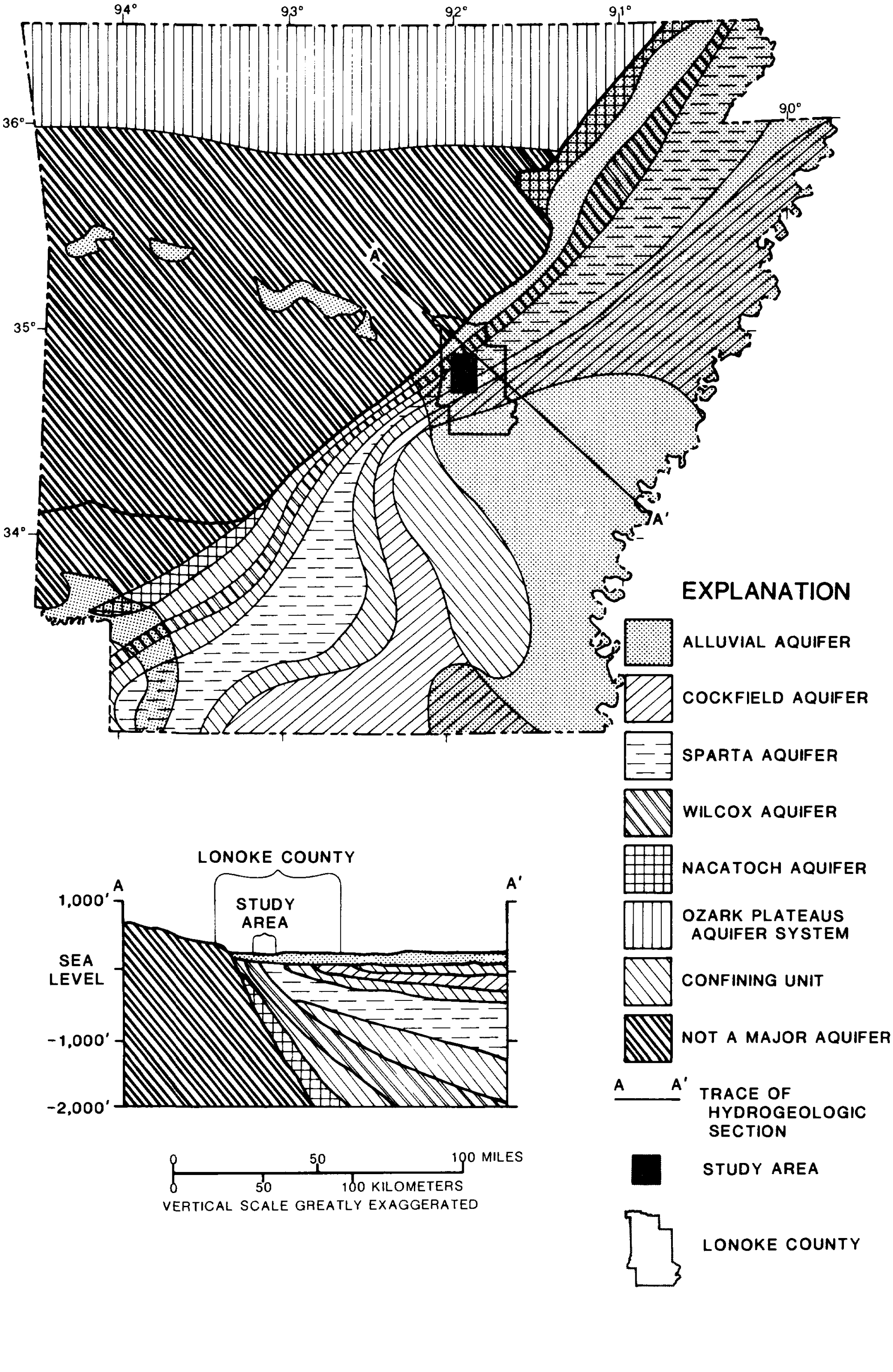


Figure 3.--Generalized hydrogeologic map and section for major aquifers in Arkansas (Modified from Ludwig, 1985).

GROUND-WATER QUALITY

Alluvial Aquifer

Twenty-one wells screened in the alluvial aquifer were sampled in the study area to quantify the quality of water. The inorganic and organic analyses of these samples are listed in tables 4 and 5, respectively. A statistical summary for selected water-quality properties is given in table 3. Means and standard deviations of data sets that contain nondetectable (below the detection limits) values were estimated using log-probability regression (Helsel and Cohn, 1988). Mean and standard deviations are not reported when greater than 80 percent of the values were nondetectable.

Inorganic Constituents

A statistical summary for selected water-quality properties (table 3) indicates water from the alluvial aquifer is of acceptable quality for irrigation and, with treatment, for public supply. Wells in the study area yield a calcium bicarbonate water that is soft to very hard (Hem, 1985) with a median hardness concentration (as calcium carbonate) of 102 milligrams per liter (mg/L) (table 3).

The dissolved-solids concentrations ranged from 88 to 536 mg/L with a median concentration of 185 mg/L (table 3). Although three samples exceeded the secondary maximum contaminant level for drinking water of 500 mg/L dissolved solids (U.S. Environmental Protection Agency, 1986b), dissolved-solids concentrations in all the samples were below the limit of 1,000 mg/L commonly used to judge the suitability of water for irrigation. The dissolved-solids concentrations generally were higher in the southern part of the study area than in the northern part.

The median concentration of nitrate in water from the alluvial aquifer was 0.02 mg/L as nitrogen (table 3), which is substantially less than the primary maximum contaminant level for drinking water of 10 mg/L as nitrogen (U.S. Environmental Protection Agency, 1986a). The highest nitrate concentration was 2.5 mg/L as nitrogen (table 4). Because this particular sample came from a shallow domestic well (32 feet deep), a septic system or a surface source such as a feedlot could be a possible source of the slightly elevated nitrate concentration.

Iron and manganese concentrations exceeded secondary maximum contaminant levels for drinking water. Iron concentrations ranged from nondetectable to 20,000 micrograms per liter (µg/L) and generally were less than 5,000 µg/L (table 4). However, iron concentrations in most of the samples exceeded the 300 µg/L secondary maximum contaminant level for drinking water (U.S. Environmental Protection Agency, 1986b). The median iron concentration was 1,900 µg/L (table 3). Manganese concentrations ranged from nondetectable to 1,400 µg/L with a median concentration of 480 µg/L (table 3). The recommended secondary maximum contaminant level for manganese in public water supplies in the United States is 50 µg/L (U.S. Environmental Protection Agency, 1986b).

Table 3.--Statistical summary of selected water-quality characteristics for water in the alluvial aquifer

[N=number of observations. NLT=number of less thans; Units are milligrams per liter (mg/L) except pH, temperature (degrees Celsius), specific conductance (microsiemens per centimeter at 25 degrees Celsius), sodium adsorption ratio, and arsenic, cadmium, chromium, copper, lead, iron, manganese, zinc, mercury, and selenium (dissolved or total recoverable in micrograms per liter). Alkalinity and hardness are reported as $CaCO_3$, silica is reported as SiO_2, and the phosphorus and nitrogen species are reported as P and N; Means and standard deviations of constituents containing nondetectable values were estimated using log-probability regression. Data for dissolved and total recoverable analyses were considered equivalent and reported as dissolved for statistical purposes]

Property	N	NLT	Minimum	25th percentile	50th percentile (median)	Mean	75th percentile	Maximum	Standard deviation
pH	24	0	5.6	6.7	6.9	6.9	7.3	8.1	0.5
Temperature	22	0	16.0	17.9	18.3	18.1	18.5	21.0	1.1
Specific conductance	24	0	74	211	284	376	555	850	242
Total alkalinity	24	0	11	70	114	135	178	310	86
Total hardness	16	0	10	54	102	106	120	380	83
Dissolved calcium	24	0	2.2	13.3	23.0	32.6	55.0	91.0	27.6
Dissolved magnesium	10	0	1.1	3.4	4.9	5.8	8.5	11.0	3.1
Dissolved sodium	24	0	10.0	13.0	15.0	17.6	18.8	43.0	7.7
Sodium adsorption ratio	10	0	.6	.7	.7	.9	.9	2.0	.4
Dissolved potassium	19	0	.3	1.0	2.0	2.9	5.0	8.0	2.3
Dissolved chloride	24	0	.5	7.6	10.0	13.3	16.0	48.0	10.8
Dissolved sulfate	22	0	1.0	1 2.9	6.5	23.4	12.5	90.0	48.9
Dissolved fluoride	5	0	.1	.2	.2	.3	.4	.4	.1
Dissolved silica	5	0	18.0	18.0	24.0	26.6	36.5	40.0	9.7
Dissolved solids	24	0	88	146	185	239	307	536	139
Dissolved nitrogen nitrite+nitrate	21	4	<.01	.01	.02	.23	.202	.50	.55
Total ammonia	14	1	<.01	.07	.18	.29	.50	.83	.27
Dissolved phosphorus ortho	9	1	<.01	.08	.10	.14	.17	.36	.09
Total organic carbon	14	0	1.8	2.9	3.6	4.8	7.7	9.6	2.7
Total arsenic	14	11	<5	<5	<5	7	<5	11	2
Dissolved cadmium	15	14	<.5	<.5	<.5	--	<.5	1.0	--
Dissolved chromium	15	13	<1	<1	<1	--	<1	60	--
Dissolved copper	15	13	<10	<15	<15	--	<15	40	--
Dissolved lead	15	12	<1	<1	<1	1	<1	6	2
Total recoverable iron	20	3	<200	400	1,900	3,074	3,550	20,000	4,461
Dissolved manganese	17	3	<100	100	480	508	790	1,400	411
Dissolved zinc	15	5	<3	<3	10	105	20	1,100	294
Total recoverable mercury	11	11	<1	<1	<1	--	<1	<1	--
Total recoverable selenium	14	14	<5	<5	<5	--	<5	<5	--

Concentrations of other constituents (table 4) were below primary and secondary maximum contaminant levels for drinking water. These constituents, and their maximum contaminant levels, were chloride (250 mg/L), sulfate (250 mg/L), fluoride (4 mg/L), arsenic (0.05 mg/L), cadmium (0.010 mg/L), chromium (0.05 mg/L), lead (0.05 mg/L), mercury (0.002 mg/L), selenium (0.01 mg/L), copper (1 mg/L), and zinc (5 mg/L) (U.S. Environmental Protection Agency, 1986a 1986b).

Organic Constituents

Fourteen ground-water samples collected from the alluvial aquifer during the peak irrigation season (June through August) of 1988 were analyzed for total organic carbon and 34 selected pesticides (including organochlorine compounds, organophosphorus insecticides, chlorophenoxy acid herbicides, and triazine herbicides). Total organic carbon concentrations ranged from 1.8 to 9.6 mg/L. No pesticides were detected at any of the sites (table 5).

Sparta and Wilcox Aquifers

Because deeper aquifers are less susceptible to surface contamination and very few wells in the study area penetrate the Sparta and Wilcox aquifers, only one sample from each aquifer was analyzed. The inorganic and organic analyses of these two samples are listed by aquifer in tables 4 and 5, respectively.

Inorganic Constituents

Water from the Sparta and Wilcox aquifers generally is suitable for drinking with little or no treatment. Limited data (one sample from each aquifer) make it impossible to characterize the overall water quality of the deeper Sparta and Wilcox aquifers throughout the study area. However, the water quality of the two samples collected (table 4) is characteristic of water from the Sparta and Wilcox aquifers as determined by regional investigations (Ludwig, 1985).

With the exception of iron and manganese concentrations, available data indicate that water from the Sparta and Wilcox aquifers in the study area is of suitable quality for drinking. An iron concentration of 3,400 µg/L and manganese concentration of 250 µg/L from water of the Sparta aquifer (table 4) exceeded the secondary maximum contaminant level for drinking water of 300 µg/L and 50 µg/L, respectively, indicating that some treatment for iron and manganese removal might be necessary.

Organic Constituents

One ground-water sample was collected during the peak irrigation season in 1988 from a well screened in the Sparta aquifer. This sample was analyzed for total organic carbon and 34 pesticides (table 5). The sample contained 2.0 mg/L total organic carbon. No pesticides were detected in water from this well (table 5).

POTENTIAL FOR GROUND-WATER CONTAMINATION

The potential for widespread ground-water contamination from the surface application of agricultural chemicals and fertilizers is considered to be low because of the relatively impermeable clay and silt deposits of the confining unit (table 1) that overlie the alluvial aquifer in most of the area. Extensive clay and silt deposits (10 to 80 feet thick) retard the vertical flow of water from the surface to the underlying alluvial aquifer. According to Bryant and others (1985), the recharge potential is greater in the southern half of the study area where the clay and silt deposits are thinner than in the northern half. Therefore, the potential for contamination, although low, is greater in the southern half of the study area. Locally, however, the channels and bottoms of streams or lakes that fully penetrate the confining unit, and thus provide hydraulic connection with the alluvial aquifer, could provide a direct passageway for contaminants to enter the alluvial aquifer. Some streams in or near the study area do at times carry detectable concentrations of pesticides (Petersen, 1990).

The movement of any contaminants from the alluvial aquifer to deeper aquifers potentially could occur depending largely on the degree of hydraulic connection and the direction of the hydraulic gradient between the alluvial aquifer and deeper aquifers. Adequate hydraulic connection to allow for the movement of potential contaminants between the alluvial and Sparta aquifers exists because the Sparta Sand subcrops the alluvium in central Lonoke County (fig. 3). The direction of the hydraulic gradient between the two aquifers varies spatially depending largely on the amount of pumpage from the alluvial aquifer in a given area. When the water level in the alluvial aquifer is above the water level in the Sparta aquifer the hydraulic gradient is downward and thus, contaminants entering the alluvial aquifer could move downward into the Sparta aquifer. Conversely, in areas of substantial drawdown where the water level in the alluvial aquifer is below the water level in the Sparta aquifer, the hydraulic gradient is upward and thus, contaminants reaching the alluvial aquifer would not migrate into the Sparta aquifer. Comparison of spring 1986 water levels in the alluvial and Sparta aquifers in the study area indicated that the hydraulic gradient is either upward or downward depending on location (Edds and Fitzpatrick, 1989; Plafcan and Remsing, 1989).

Potential contaminants in the study area include pesticides and nitrates originating from agricultural practices. Landfills, septic systems, and an ammunitions plant (west of study area) are other possible sources of potential contamination.

SUMMARY

As part of an effort to monitor ground-water quality and to assess the potential for ground-water contamination on a statewide basis, ground-water quality was studied in central Lonoke County, an agricultural area with heavy pesticide and fertilizer use. Ground water samples were collected from 21 wells in the alluvial aquifer and 1 well each in the Sparta aquifer and Wilcox aquifer and analyzed for physical properties, major inorganic constituents, nutrients, trace inorganic constituents, total organic carbon, and selected pesticides (including organochlorine compounds, organophosphorus insecticides, chlorophenoxy acid herbicides, and thiazine herbicides).

Water from the alluvial aquifer is of acceptable quality for irrigation and, with treatment, for public supply. With the exception of iron and manganese, the water in the alluvial aquifer generally did not exceed U.S. Environmental Protection Agency primary and secondary maximum contaminant levels for drinking water. Median iron (1,900 μg/L) and manganese (480 μg/L) concentrations exceeded the secondary maximum contaminant level of 300 μg/L for iron and 50 μg/L for manganese indicating that some treatment for iron and manganese removal might be desirable for drinking water use. Dissolved-solids concentrations in the alluvial aquifer ranged from 88 to 536 mg/L with the higher concentrations generally occurring in the southern half of the study area. No pesticides were detected in water from the alluvial aquifer.

Although data from the Sparta and Wilcox aquifers were insufficient to characterize the overall water quality in the study area, the water quality of the two samples from these aquifers was similar to that described in regional investigations of the Sparta and Wilcox aquifers. With the exception of iron and manganese concentrations, available data indicate that water from the Sparta and Wilcox aquifers in the study area is of suitable quality for drinking. No pesticides were detected in the one water sample from the Sparta aquifer that was analyzed for organic compounds.

The potential for widespread ground-water contamination from the application of agricultural chemicals and fertilizers in the study area is low because of the relatively impermeable clay and silt deposits of the confining unit that overlies the alluvial aquifer in most of the study area. Locally, however, the channels and bottoms of streams or lakes that fully penetrate the confining unit, and thus provide hydraulic connection with the alluvial aquifer, could provide a direct passageway for contaminants to enter the alluvial aquifer. Potential contaminants in the study area include pesticides and nitrates originating from agricultural practices, and leachates from landfills and septic systems.

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Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water

[deg C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; USGS, U.S. Geological Survey; ADPCE, Arkansas Department of Pollution Control and Ecology; --, no data; µg/L, micrograms per liter]

Site number	Agency analyzing sample	Date	Time	pH (standard units) (00400)	pH lab (standard units) (00403)	Temperature water (deg C) (00010)	Specific conductance (µS/cm) (00095)	Bicarbonate total field (mg/L as HCO_3) (00440)	Carbonate total field (mg/L as CO_3) (00445)
ALLUVIAL AQUIFER									
1	USGS	08-18-54	--	6.70	--	--	314	58	0
2	ADPCE	07-28-88	1145	6.80	6.28	18.0	198	73	0
3	ADPCE	08-23-88	0915	6.90	6.30	18.5	210	85	0
	USGS	08-23-88	0916	6.90	6.80	18.5	210	85	0
4	USGS	08-09-54	--	6.60	--	18.0	147	76	0
5	ADPCE	07-12-88	1030	6.55	--	21.0	217	85	0
6	USGS	09-01-55	--	6.60	--	18.0	145	76	0
7	USGS	08-18-54	--	5.60	--	--	74	13	0
8	USGS	08-09-54	--	7.60	--	17.0	214	99	0
9	ADPCE	07-12-88	1000	6.75	--	18.5	290	130	0
10	ADPCE	07-28-88	1030	6.80	6.30	18.0	278	140	0
11	USGS	05-19-64	--	8.10	--	17.0	252	140	0
12	ADPCE	07-28-88	0900	6.80	6.51	19.5	310	170	0
	ADPCE	03-07-90	0950	--	--	--	--	--	--
13	ADPCE	08-23-88	1030	7.00	6.53	18.0	420	210	0
14	ADPCE	07-12-88	1300	6.45	6.41	16.0	222	93	0
15	USGS	06-26-46	--	7.00	--	16.0	367	170	0
	USGS	03-05-56	--	7.30	--	18.5	302	160	0
	USGS	10-09-61	--	7.40	--	19.0	276	160	0
16	ADPCE	06-28-88	0945	7.32	--	17.5	840	380	0
17	ADPCE	06-28-88	1045	7.00	--	18.0	600	300	0
18	ADPCE	08-23-88	1130	6.80	6.58	18.5	850	340	0
19	ADPCE	08-09-88	1230	7.20	6.73	18.5	750	330	0
20	ADPCE	08-09-88	0930	7.00	6.83	18.5	765	220	0
21	ADPCE	08-09-88	1100	7.40	6.75	18.5	765	360	0
SPARTA AQUIFER									
22	ADPCE	06-28-88	0930	7.22	--	19.5	420	220	0
WILCOX AQUIFER									
23	USGS	08-09-54	--	7.50	--	--	392	160	0

Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water (continued)

Site number	Alak- linity total field (mg/L as) $CaCO_3$ (00410)	Alka- linity total lab (mg/L as $CaCO_3$) (00417)	Carbon dioxide dis- solved (mg/L as CO_2) (00405)	Color (plat- inum- cobalt units) (00080)	Hard- ness total (mg/L as CaCO3) (00900)	Calcium dis- solved (mg/L as Ca) (00915)	Calcium total recover- able (mg/L as Ca) (00918)	Magne- sium, dis- solved (mg/L as Mg) (00925)
				ALLUVIAL AQUIFER				
1	48	--	18	6	49	15	--	2.9
2	60	680	18	--	110	--	6.0	--
3	70	70	17	--	66	--	6.0	--
	70	69	17	--	67	18	--	5.2
4	62	--	30	3	47	13	--	3.6
5	70	144	38	--	--	--	3.0	--
6	62	--	30	7	50	13	--	4.2
7	11	--	52	7	10	2.2	--	1.1
8	81	--	4.0	4	74	22	--	4.6
9	108	98	37	--	--	--	14	--
10	114	111	35	--	110	--	14	--
11	114	--	1.8	1	93	25	--	7.4
12	140	135	43	--	110	--	19	--
	--	--	--	--	--	--	--	--
13	172	296	33	--	380	--	34	--
14	76	144	52	--	--	--	24	--
15	136	--	26	--	120	33	--	9.5
	135	--	13	5	120	34	--	8.1
	135	--	10	0	120	29	--	11
16	310	307	29	--	--	--	91	--
17	246	243	48	--	--	--	62	--
18	282	180	87	--	170	--	80	--
19	272	284	33	--	--	--	72	--
20	180	175	35	--	--	--	76	--
21	292	300	23	--	--	--	76	--
				SPARTA AQUIFER				
22	180	192	21	--	--	--	28	--
				WILCOX AQUIFER				
23	135	--	8.3	5	42	9.4	--	4.5

Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water (continued)

Site number	Sodium, dis-solved (mg/L as Na) (00930)	Sodium, total recover-able (mg/L as Na) (00923)	Sodium percent (00932)	Sodium ad-sorp-tion ratio (00931)	Potas-sium, dis-solved (mg/L as K) (00935)	Potas-sium, total recover-able (mg/L as K) (00939)	Chlo-ride, dis-solved (mg/L as Cl) (00940)	Sulfate dis-solved (mg/L as SO_4) (00945)	Fluo-ride, dis-solved (mg/L as F) (00950)
ALLUVIAL AQUIFER									
1	31	--	--	2	--	--	48	1.0	--
2	--	11	--	--	--	0.90	6.0	7.0	--
3	--	13	--	--	--	1.0	9.0	8.0	--
	13	--	29	0.7	1.0	--	9.2	10	0.10
4	11	--	--	.7	--	--	3.8	1.4	--
5	--	30	--	--	--	0.30	17	3.0	--
6	11	--	32	.7	--	--	7.0	2.2	--
7	10	--	--	1	--	--	6.5	1.6	--
8	14	--	--	.7	--	--	10	12	--
9	--	14	--	--	--	2.0	13	14	--
10	--	15	--	--	--	1.0	8.0	3.0	--
11	18	--	29	.8	1.0	--	10	2.4	.20
12	--	17	--	--	--	2.0	8.0	5.0	--
	--	--	--	--	--	--	--	--	--
13	--	15	--	--	--	3.0	10	150	--
14	--	19	--	--	--	1.0	18	3.0	--
15	15	--	20	.6	4.6	--	12	5.7	.40
	18	--	25	.7	1.5	--	11	7.0	.40
	15	--	22	.6	1.0	--	7.5	7.2	.20
16	--	20	--	--	--	6.0	0.50	--	--
17	--	14	--	--	--	5.0	9.0	--	--
18	--	16	--	--	--	8.0	19	6.0	--
19	--	43	--	--	--	5.0	34	39	--
20	--	13	--	--	--	6.0	10	190	--
21	--	26	--	--	--	5.0	33	36	--
SPARTA AQUIFER									
22	--	24	--	--	--	4.0	6.0	--	--
WILCOX AQUIFER									
23	69	--	77	5	3.1	--	41	.40	.10

Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water (continued)

Site number	Silica, dis- solved (mg/L as SiO_2) (00955)	Solids, residue at 180 deg. C dis- solved (mg/L) (70300)	Solids, sum of consti- tuents, dis- solved (mg/L) (70301)	Nitro- gen, ammonia total (mg/L as N) (00610)	Nitro- gen, nitrate dis- solved (mg/L as N) (00618)	Nitro- gen, NO_2+NO_3 dis- solved (mg/L as N) (00631)	Nitro- gen, NO_2+NO_3 total (mg/L as N) (00630)	Phos- phorus ortho, dis- solved (mg/L as P) (00671)	Phos- phorus, ortho, total (mg/L as P) (70507)
ALLUVIAL AQUIFER									
1	--	195	128	--	0.470	--	--	--	--
2	--	142	--	<0.010	--	--	0.210	--	--
3	--	141	--	.040	--	--	--	--	0.180
	40	134	142	--	--	0.650	--	0.150	--
4	--	118	72	--	.430	--	--	--	--
5	--	208	--	.130	--	--	.010	--	.080
6	--	116	75	--	.070	--	--	--	--
7	--	88	39	--	2.50	--	--	--	--
8	--	158	111	--	< .010	--	--	--	--
9	--	166	--	.080	--	--	.010	--	.080
10	--	173	--	.110	--	--	< .010	--	--
11	33	165	166	--	< .010	--	--	--	--
12	--	201	--	.030	--	--	< .010	--	--
	--	--	--	--	--	--	--	--	--
13	--	520	--	.410	--	--	--	--	< .010
14	--	207	--	.120	--	--	.010	--	.100
15	24	184	186	--	.090	--	--	--	--
	18	186	179	--	.160	--	--	--	--
	18	175	170	--	.200	--	--	--	--
16	--	516	--	.730	--	--	.010	--	.360
17	--	332	--	.240	--	--	.010	--	.170
18	--	230	--	.260	--	--	--	--	.100
19	--	425	--	.830	--	--	.020	--	--
20	--	536	--	.520	--	--	.020	--	--
21	--	426	--	.500	--	--	.010	--	--
SPARTA AQUIFER									
22	--	217	--	.210	--	--	.010	--	.180
WILCOX AQUIFER									
23	6.2	224	215	--	.020	--	--	--	--

Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water (continued)

Site number	Aluminum, total recoverable (µg/L as Al) (01105)	Arsenic total recoverable (µg/L as As) (01002)	Barium, dissolved (µg/L as Ba) (01005)	Beryllium, dissolved (µg/L as Be) (01010)	Boron, dissolved (µg/L as B) (01020)	Cadmium dissolved (µg/L as Cd) (01025)	Cadmium total recoverable (µg/L as Cd) (01027)	Chromium, dissolved (µg/L as Cr) (01030)
ALLUVIAL AQUIFER								
1	--	--	--	--	--	--	--	--
2	--	<5	--	--	--	--	<1	--
3	--	<5	--	--	--	--	<1	--
	--	--	82	<0.5	<10	1	--	<5
4	--	--	--	--	--	--	--	--
5	--	<5	--	--	--	--	<1	--
6	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--
9	--	<5	--	--	--	--	<1	--
10	--	11	--	--	--	--	<1	--
11	--	--	--	--	--	--	--	--
12	--	<5	--	--	--	--	<1	--
	--	--	--	--	--	--	--	--
13	--	<5	--	--	--	--	<1	--
14	--	<5	--	--	--	--	<1	--
15	12,000	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
16	--	11	--	--	--	--	<1	--
17	--	<5	--	--	--	--	<1	--
18	--	<5	--	--	--	--	<1	--
19	--	9	--	--	--	--	<1	--
20	--	<5	--	--	--	--	<1	--
21	--	<5	--	--	--	--	<1	--
SPARTA AQUIFER								
22	--	<5	--	--	--	--	<1	--
WILCOX AQUIFER								
23	--	--	--	--	--	--	--	--

Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water (continued)

Site number	Chromium, total recoverable (µg/L as Cr) (01034)	Cobalt, dissolved (µg/L as Co) (01035)	Copper dissolved (µg/L as Cu) (01040)	Copper, total recoverable (µg/L as Cu) (01042)	Iron, total recoverable (µg/L as Fe) (01045)	Lead, dissolved (µg/L as Pb) (01049)	Lead, total recoverable (µg/L as Pb) (01051)	Lithium dissolved (µg/L as Li) (01130)	Manganese, dissolved (µg/L as Mn) (01056)
ALLUVIAL AQUIFER									
1	--	--	--	--	120	--	--	--	--
2	<1	--	--	<15	<200	--	<1	--	--
3	<1	--	--	<15	<200	--	<1	--	--
	--	<3	<10	--	--	<10	--	12	3
4	--	--	--	--	<200	--	--	--	--
5	<1	--	--	<15	1,000	--	1	--	--
6	--	--	--	--	4,300	--	--	--	--
7	--	--	--	--	80	--	--	--	--
8	--	--	--	--	5,600	--	--	--	--
9	<1	--	--	<15	1,800	--	<1	--	--
10	<1	--	--	<15	3,800	--	<1	--	--
11	--	--	--	--	--	--	--	--	700
12	60[a]	--	--	<15	2,800	--	<1	--	--
	<1	--	--	--	--	--	--	--	--
13	<1	--	--	<15	1,400	--	<1	--	--
14	<1	--	--	<15	2,000	--	6	--	--
15	--	--	--	--	1,300	--	--	--	--
	--	--	--	--	1,700	--	--	--	--
	--	--	--	--	--	--	--	--	10
16	<1	--	--	<15	--	--	<1	--	--
17	14	--	--	<15	2,600	--	<1	--	--
18	<1	--	--	24	20,000	--	<1	--	--
19	<1	--	--	<15	2,200	--	<1	--	--
20	<1	--	--	<15	2,100	--	<1	--	--
21	<1	--	--	40	8,000	--	1	--	--
SPARTA AQUIFER									
22	<1	--	--	<15	3,400	--	<1	--	--
WILCOX AQUIFER									
23	--	--	--	--	70	--	--	--	--

Table 4.--Physical properties, major inorganic constituents, nutrients, and trace inorganic constituents in ground water (continued)

Site number	Manganese total recoverable (µg/L as Mn) (01123)	Mercury total recoverable (µg/L as Hg) (71900)	Molybdenum, dissolved (µg/L as Mo) (01060)	Nickel, dissolved (µg/L as Ni) (01065)	Selenium, total recoverable (µg/L as Se) (01147)	Silver, dissolved (µg/L as Ag) (01075)	Strontium, dissolved (µg/L as Sr) (01080)	Vanadium, dissolved (µg/L as V) (01085)	Zinc, dissolved (µg/L as Zn) (01090)	Zinc, total recoverable (µg/L as Zn) (01092)
					ALLUVIAL AQUIFER					
1	--	--	--	--	--	--	--	--	--	--
2	<100	<1.0	--	--	<5	--	--	--	--	<3
3	<100	<1.0	--	--	<5	--	--	--	--	<3
	--	--	<10	<10	--	<1.0	130	<6	<3	--
4	--	--	--	--	--	--	--	--	--	--
5	<100	--	--	--	<5	--	--	--	--	30
6	--	--	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--	--	--
9	410	<1.0	--	--	<5	--	--	--	--	8
10	810	<1.0	--	--	<5	--	--	--	--	10
11	--	--	--	--	--	--	--	--	--	--
12	1,400	<1.0	--	--	<5	--	--	--	--	1,100
	--	--	--	--	--	--	--	--	--	--
13	1,100	<1.0	--	--	<5	--	--	--	--	<3
14	380	--	--	--	<5	--	--	--	--	20
15	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
16	350	--	--	--	<5	--	--	--	--	10
17	610	<1.0	--	--	<5	--	--	--	--	340
18	720	<1.0	--	--	<5	--	--	--	--	20
19	480	<1.0	--	--	<5	--	--	--	--	<3
20	820	<1.0	--	--	<5	--	--	--	--	5
21	770	<1.0	--	--	<5	--	--	--	--	10
					SPARTA AQUIFER					
22	250	<1.0	--	--	<5	--	--	--	--	10
					WILCOX AQUIFER					
23	--	--	--	--	--	--	--	--	--	--

[a]Resampled on 03-07-90 and found to be below detection limit.

Table 5.--Pesticide and total organic carbon concentrations in ground water

[mg/L, milligrams per liter; µg/L, micrograms per liter; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; USGS, U.S. Geological Survey; ADPCE, Arkansas Department of Pollution Control and Ecology; --, no data]

Site number	Agency analyzing sample	Date	Time	Carbon, organic total (mg/L as C) (00680)	P,P' DDT, total (µg/L) (39300)	DDT, dissolved (µg/L) (39371)	P,P' DDD, total (µg/L) (39310)	DDD, dissolved (µg/L) (39361)	DDD, total (µg/L) (39360)
				ALLUVIAL AQUIFER					
2	ADPCE	07-28-88	1145	2.9	<0.01	--	<0.01	--	<0.004
3	ADPCE	08-23-88	0915	2.4	< .01	--	< .01	--	--
	USGS	08-23-88	0916	--	--	<0.01	--	<0.01	--
5	ADPCE	07-12-88	1030	3.3	< .01	--	< .01	--	< .002
9	ADPCE	07-12-88	1000	3.7	< .01	--	< .01	--	< .002
10	ADPCE	07-28-88	1030	2.9	< .01	--	< .01	--	< .004
12	ADPCE	07-28-88	0900	4.1	< .01	--	< .01	--	< .004
13	ADPCE	08-23-88	1030	8.3	< .01	--	< .01	--	--
14	ADPCE	07-12-88	1300	3.0	< .01	--	< .01	--	< .002
16	ADPCE	06-28-88	0945	3.4	< .01	--	< .01	--	< .002
17	ADPCE	06-28-88	1045	1.8	< .01	--	< .01	--	< .002
18	ADPCE	08-23-88	1130	4.4	< .01	--	< .01	--	--
19	ADPCE	08-09-88	1230	9.6	< .01	--	< .01	--	< .005
20	ADPCE	08-09-88	0930	7.5	< .01	--	< .01	--	< .005
21	ADPCE	08-09-88	1100	9.2	< .01	--	< .01	--	< .005
				SPARTA AQUIFER					
22	ADPCE	06-28-88	0930	2.0	< .01	--	< .01	--	< .002

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	P,P' DDE, total (µg/L) (39320)	DDE, dis-solved (µg/L) (39366)	Aldrin, dis-solved (µg/L) (39331)	Aldrin, total (µg/L) (39330)	Chlor-dane, dis-solved (µg/L) (39352)	Chlor-dane, total (µg/L) (39350)	Dieldrin dis-solved (µg/L) (39381)	Endo-sulfan alpha total (µg/L) (34361)	Endo-sulfan beta total (µg/L) (34356)
				ALLUVIAL AQUIFER					
2	<0.01	--	--	<0.002	--	<0.1	--	<0.01	<0.01
3	< .01	--	--	< .001	--	--	--	< .01	--
	--	<0.01	<0.01	--	<0.1	--	<0.01	--	--
5	< .01	--	--	< .001	--	< .1	--	< .01	< .01
9	< .01	--	--	< .001	--	< .1	--	< .01	< .01
10	< .01	--	--	< .002	--	< .1	--	< .01	< .01
12	< .01	--	--	< .002	--	< .1	--	< .01	< .01
13	< .01	--	--	< .001	--	--	--	< .01	--
14	< .01	--	--	< .001	--	< .1	--	< .01	< .01
16	< .01	--	--	< .001	--	< .1	--	< .01	< .01
17	< .01	--	--	< .001	--	< .1	--	< .01	< .01
18	< .01	--	--	< .001	--	--	--	< .01	--
19	< .01	--	--	< .002	--	< .1	--	< .01	< .01
20	< .01	--	--	< .002	--	< .1	--	< .01	< .01
21	< .01	--	--	< .002	--	< .1	--	< .01	< .01
				SPARTA AQUIFER					
22	< .01	--	--	< .001	--	< .1	--	< .01	< .01

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	Endo-sulfan sulfate total (µg/L) (34351)	Endo-sulfan dis-solved (µg/L) (82354)	Endrin, dis-solved (µg/L) (39391)	Endrin, total (µg/L) (39390)	Lindane dis-solved (µg/L) (39341)	Lindane total (µg/L) (39340)	Hepta-chlor, dis-solved (µg/L) (39411)	Hepta-chlor, total (µg/L) (39410)	Hepta-chlor epoxide dis-solved (µg/L) (39421)
ALLUVIAL AQUIFER									
2	<0.01	--	--	<0.006	--	<0.001	--	<0.001	--
3	< .08	--	--	--	--	< .001	--	< .001	--
	--	<0.01	<0.01	--	<0.01	--	<0.01	--	<0.01
5	< .01	--	--	< .003	--	< .001	--	< .001	--
9	< .01	--	--	< .003	--	< .001	--	< .001	--
10	< .01	--	--	< .006	--	< .001	--	< .001	--
12	< .01	--	--	< .006	--	< .001	--	< .001	--
13	< .08	--	--	--	--	< .001	--	< .001	--
14	< .01	--	--	< .003	--	< .001	--	< .001	--
16	< .01	--	--	< .002	--	< .001	--	< .001	--
17	< .01	--	--	< .002	--	< .001	--	< .001	--
18	< .08	--	--	--	--	< .001	--	< .001	--
19	< .01	--	--	< .007	--	< .001	--	< .001	--
20	< .01	--	--	< .007	--	< .001	--	< .001	--
21	< .01	--	--	< .007	--	< .001	--	< .001	--
SPARTA AQUIFER									
22	< .01	--	--	<0.002	--	<0.001	--	<0.001	--

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	Heptachlor epoxide total (µg/L) (39420)	Methoxychlor dissolved (µg/L) (82350)	Trithion dissolved (µg/L) (82342)	Toxaphene, dissolved (µg/L) (39401)	Mirex, dissolved (µg/L) (39756)	Perthane dissolved (µg/L) (82348)	Chlorpyrifos total (µg/L) (81403)	Diazinon, dissolved (µg/L) (39572)	Diazinon, total (µg/L) (39570)
ALLUVIAL AQUIFER									
2	<0.003	--	--	--	--	--	<0.01	--	<0.03
3	< .002	--	--	--	--	--	--	--	--
	--	<0.01	<0.01	<1.0	<0.01	<0.10	--	<0.01	--
5	< .002	--	--	--	--	--	< .01	--	< .01
9	< .002	--	--	--	--	--	< .01	--	< .01
10	< .003	--	--	--	--	--	< .01	--	< .03
12	< .003	--	--	--	--	--	< .01	--	< .03
13	< .002	--	--	--	--	--	--	--	< --
14	< .002	--	--	--	--	--	< .01	--	< .01
16	< .001	--	--	--	--	--	< .01	--	< .01
17	< .001	--	--	--	--	--	< .01	--	< .01
18	< .002	--	--	--	--	--	--	--	--
19	< .003	--	--	--	--	--	< .01	--	< .03
20	< .003	--	--	--	--	--	< .01	--	< .03
21	< .003	--	--	--	--	--	< .01	--	< .03
SPARTA AQUIFER									
22	< .001	--	--	--	--	--	< .01	--	< .01

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	Malathion, dissolved (µg/L) (39532)	Malathion, total (µg/L) (39530)	Methyl parathion, dissolved (µg/L) (39602)	Methyl parathion, total (µg/L) (39600)	Methyl-trithion dissolved (µg/L) (82344)	Ethion dissolved (µg/L) (82346)	Parathion, dissolved (µg/L) (39542)	Aroclor 1232 PCB total (µg/L) (39492)	Aroclor 1254 PCB total (µg/L) (39504)
					ALLUVIAL AQUIFER				
2	--	<0.04	--	<0.01	--	--	--	<0.07	<0.2
3	--	--	--	--	--	--	--	--	--
	<0.01	--	<0.01	--	<0.01	<0.01	<0.01	--	--
5	--	< .01	--	< .01	--	--	--	< .03	< .1
9	--	< .01	--	< .01	--	--	--	< .03	< .1
10	--	< .04	--	< .01	--	--	--	< .07	< .2
12	--	< .04	--	< .01	--	--	--	< .07	< .2
13	--	--	--	--	--	--	--	--	--
14	--	< .01	--	< .01	--	--	--	< .03	< .1
16	--	< .01	--	< .01	--	--	--	< .03	< .1
17	--	< .01	--	< .01	--	--	--	< .03	< .1
18	--	--	--	--	--	--	--	--	--
19	--	< .05	--	< .01	--	--	--	< .05	< .1
20	--	< .05	--	< .01	--	--	--	< .05	< .1
21	--	< .05	--	< .01	--	--	--	< .05	< .1
					SPARTA AQUIFER				
22	--	< .01	--	< .01	--	--	--	< .03	< .1

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	PCB, dis-solved (µg/L) (39517)	PCN, dis-solved (µg/L) (82360)	2,4-D, dis-solved (µg/L) (39732)	2,4-D, total (µg/L) (39730)	2,4-DP dis-solved (µg/L) (82356)	2,4,5-T dis-solved (µg/L) (39742)	2,4,5-T total (µg/L) (39740)	Silvex, dis-solved (µg/L) (39762)	Silvex, total (µg/L) (39760)
				ALLUVIAL AQUIFER					
2	--	--	--	<0.01	--	--	<0.01	--	<0.01
3	--	--	--	< .01	--	--	< .01	--	< .01
	<0.1	<0.10	<0.01	--	<0.01	<0.01	--	<0.01	--
5	--	--	--	< .01	--	--	< .01	--	< .01
9	--	--	--	< .01	--	--	< .01	--	< .01
10	--	--	--	< .01	--	--	< .01	--	< .01
12	--	--	--	< .01	--	--	< .01	--	< .01
13	--	--	--	< .01	--	--	< .01	--	< .01
14	--	--	--	< .01	--	--	< .01	--	< .01
16	--	--	--	< .01	--	--	< .01	--	< .01
17	--	--	--	< .01	--	--	< .01	--	< .01
18	--	--	--	< .01	--	--	< .01	--	< .01
19	--	--	--	< .01	--	--	< .01	--	< .01
20	--	--	--	< .01	--	--	< .01	--	< .01
21	--	--	--	< .01	--	--	< .01	--	< .01
				SPARTA AQUIFER					
22	--	--	--	< .01	--	--	< .01	--	< .01

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	Propachlor in whole water (µg/L) (77729)	Alachlor total recoverable (µg/L) (77825)	Atrazine, total (µg/L) (39630)	Prometryne total (µg/L) (39057)	Propazine total (µg/L) (39024)	Simetryne total (µg/L) (39054)	Simazine total (µg/L) (39055)	Prometon total (µg/L) (39056)	Trifluralin total recoverable (µg/L) (39030)
ALLUVIAL AQUIFER									
2	<0.02	<0.02	<0.15	--	--	--	--	--	--
3	--	--	--	--	--	--	--	--	--
	--	< .10	< .10	<0.1	<0.10	<0.1	<0.10	<0.1	<0.10
5	< .02	< .01	< .08	--	--	--	--	--	--
9	< .02	< .01	< .08	--	--	--	--	--	--
10	< .02	< .02	< .15	--	--	--	--	--	--
12	< .02	< .02	< .15	--	--	--	--	--	--
13	--	--	--	--	--	--	--	--	--
14	< .04	< .01	< .08	--	--	--	--	--	--
16	< .01	< .01	< .06	--	--	--	--	--	--
17	< .01	< .01	< .06	--	--	--	--	--	--
18	--	--	--	--	--	--	--	--	--
19	< .02	< .02	< .20	--	--	--	--	--	--
20	< .02	< .02	< .20	--	--	--	--	--	--
21	< .02	< .02	< .20	--	--	--	--	--	--
SPARTA AQUIFER									
22	< .01	< .01	< .06	--	--	--	--	--	--

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	Cyan- azine total (µg/L) (81757)	Ame- tryne total (82184)	Metri- buzin in whole water (µg/L) (81408)	Metri- buzin water whole total recover- able (µg/L) (82611)	Metola- chlor in whole water (µg/L) (39356)	Metola- chlor water whole total recover- able (µg/L) (82612)	Alpha ben- zene hexa- chlor- ide total (µg/L) (39337)
			ALLUVIAL AQUIFER				
2	<0.02	--	<0.01	--	<0.04	--	<0.01
3	--	--	--	--	--	--	< .01
	< .10	<0.10	--	<0.1	--	<0.1	--
5	< .01	--	< .01	--	< .02	--	< .01
9	< .01	--	< .01	--	< .02	--	< .01
10	< .02	--	< .01	--	< .04	--	< .01
12	< .02	--	< .01	--	< .04	--	< .01
13	--	--	--	--	--	--	< .01
14	< .01	--	< .01	--	< .02	--	< .01
16	< .07	--	< .01	--	< .02	--	< .01
17	< .07	--	< .01	--	< .02	--	< .01
18	--	--	--	--	--	--	< .01
19	< .03	--	< .01	--	< .06	--	< .01
20	< .03	--	< .01	--	< .06	--	< .01
21	< .03	--	< .01	--	< .06	--	< .01
			SPARTA AQUIFER				
22	< .07	--	< .01	--	< .02	--	< .01

Table 5.--Pesticide and total organic carbon concentrations in ground water (continued)

Site number	Beta benzene hexa-chloride total (μg/L) (39338)	Delta benzene hexa-chloride total (μg/L) (34259)	Fonofos (dyfonate) water whole total recoverable (μg/L) (82614)	Pendi-methalin total (μg/L) (79190)
		ALLUVIAL AQUIFER		
2	<0.01	<0.01	<0.1	<0.02
3	< .01	--	--	--
	--	--	--	--
5	< .01	< .01	< .1	< .01
9	< .01	< .01	< .1	< .01
10	< .01	< .01	< .1	< .02
12	< .01	< .01	< .1	< .02
13	< .01	--	--	--
14	< .01	< .01	< .1	< .01
16	< .01	< .01	< .1	< .01
17	< .01	< .01	< .1	< .01
18	< .01	--	--	--
19	< .01	< .01	< .1	< .02
20	< .01	< .01	< .1	< .02
21	< .01	< .01	< .1	< .02
		SPARTA AQUIFER		
22	< .01	< .01	< .1	< .01