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WATER-RESOURCES INVESTIGATIONS REPORT 86-4166

QUALITY OF WATER RESOURCES OF THE OUACHITA NATIONAL FOREST, ARKANSAS

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INTRODUCTION

A variety of mineral resources such as barite, manganese, quartz crystals, clay, gravel and construction stone are found on or near the Ouachita National Forest, Arkansas. Recently, a great deal of interest has been generated over the possibility of large oil and gas reserves in western Arkansas, including the southern one-half of the Ouachita National Forest. Exploration and removal of the mineral resources in the Ouachita National Forest may have a significant effect on the hydrologic environment. A hydrologic data base is needed that can be used to identify effects of any mineral development or other land-use changes on water quality of the area.

Purpose and Scope

The purpose of this report is to document surface-water and ground-water quality conditions in the Ouachita National Forest, including parameters that may be affected by future mineral development. The report also provides a summary of selected historic water-quality data for characterization of past water-quality conditions in the area.

The study involved collection of surface-water quality data at 15 sites and ground-water quality data at 11 sites in the Ouachita National Forest and surrounding area during April 1984 through August 1985. Results of the analyses were compared with Federal and State water-quality standards. Federal primary and secondary drinking-water standards for public water systems have been established by the U.S. Environmental Protection Agency (1977, 1982, 1985). Primary drinking-water regulations are enforceable standards which have been established for contaminants that may have an adverse effect on the health of persons. Secondary drinking-water standards represent reasonable goals for drinking-water quality. The State water-quality regulatory agency may establish higher or lower levels dependent upon local conditions. Drinking-water standards were used for comparison with results of the water-quality analyses to identify water-quality problems that may limit the use of water in the study area.

Description of Study Area

The Ouachita National Forest in western Arkansas includes all or parts of the following counties: Sebastian, Logan, Scott, Yell, Perry, Polk, Howard, Pike, Montgomery, Garland, Saline, and Hot Spring (fig. 1). The study area lies in two physiographic provinces of the Interior Highlands. The majority of the area is within the Ouachita Mountain region. Only the northern parts; in Sebastian, Logan, Scott, and Yell Counties; lie within the Arkansas Valley region (Fenneman, 1946).

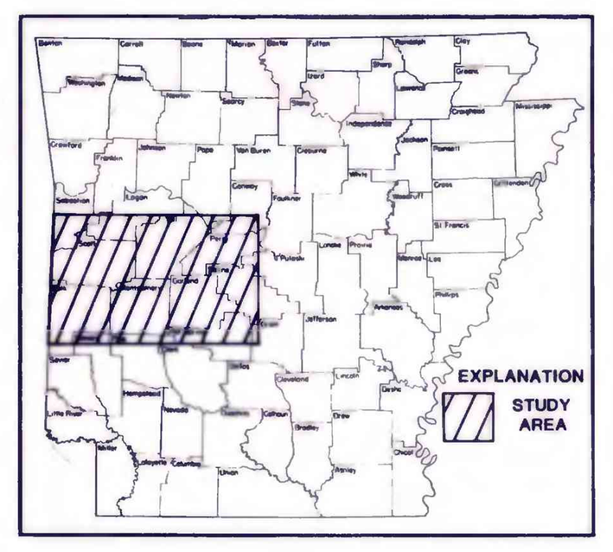


Figure 1.--Location of study area.

The northern part of the forest is in the Arkansas River basin and is drained by Petit Jean, Fourche Lafave, and South Fourche Lafave Rivers. The streams generally are not well sustained during base flow conditions. The southern part of the study area is in the Red River basin and is drained by the Ouachita River and its tributaries. Generally, base flow is well-sustained in these streams. There are numerous lakes within or adjacent to the Ouachita National Forest including Blue Mountain, Nimrod, Maumelle, Winona, Ouachita, Hamilton, and DeGray. Approximately 5,100 stock ponds (surface area of less than 5 acres each) are located in the study area (Arkansas Soil and Water Conservation Commission, 1981). Surface water in the study area is used primarily for municipal water supply, recreation, fish and wildlife, and livestock.

Climate of the Ouachita National Forest is characterized by hot summers and mild winters. Precipitation is usually in the form of rain, with very light and infrequent snowfall. Average annual precipitation ranges from approximately 42 inches in the northwestern part of the study area to approximately 58 inches in the south-central and southwestern parts of the study area (Freiwald, 1985). An area in the southwestern part of the Ouachita National Forest has the highest (greater than 32 inches) average annual runoff in the State. High annual precipitation, steep mountain gradients, and surface geology predominantly of shale contribute to rapid runoff in this area (Freiwald, 1985).

The Ouachita National Forest is underlain by consolidated rocks of Ordovician to Cretaceous age and by flood-plain deposits of Quaternary age (Haley and others, 1976). Rocks of Ordovician age (Collier Shale, Crystal Mountain Sandstone, Mazarn Shale, Blakely Sandstone, Womble Shale, Bigfork Chert, and Polk Creek Shale) crop out in the southeastern part of the study area, mainly in Montgomery, Garland, and Saline Counties (fig. 2). The Blaylock Sandstone and Missouri Mountain Shale of Silurian age, Arkansas Novaculite of Devonian and Mississippian age, and Stanley Shale (including the Hot Springs Sandstone Member) of Mississippian age crop out in the southern part of the study area. Rocks of Pennsylvanian age (Jackfork Sandstone, Johns Valley Shale, Atoka Formation, Hartshorne Sandstone, McAlester Formation, and Savanna Formation) crop out in the northern part of the Ouachita National Forest, mainly in Scott, Yell, and Perry Counties. Igneous intrusive rocks of Cretaceous age occur as isolated outcrops in Garland and Hot Spring Counties. Alluvial deposits of Quaternary age are present as a mapped unit in the flood plain of the Fourche Lafave River in Perry County but are also present in minor amounts along the smaller streams in the area.

Shale and sandstone are the most abundant rock types in the Ouachita National Forest. The rocks in the area are extensively folded and faulted, and the primary porosity of most rocks has been destroyed by compaction and cementation (Albin, 1965). Ground water occurs in secondary openings along joints, fractures, and bedding planes. According to Albin (1965), most wells in the area yield less than 10 gal/min and yields greater than 50 gal/min are rare.

A variety of mineral resources, including barite, manganese, wavellite, novaculite, copper, quartz crystals, tripoli, coal, and natural gas are found on or near the Ouachita National Forest. Materials such as gravel, construction stone, and slate are also found in significant quantities in the study area. Generally, the energy minerals such as coal and natural gas are found in the Arkansas Valley region of the Ouachita National Forest, and the nonenergy resources are found in the Ouachita Mountain region of the forest (Sick, 1980). There has been no production of oil or natural gas from the Ouachita National Forest, however, coal has been produced intermittently. Mining claims in the forest have been located for silver, copper, lead, zinc, barite, tripoli, quartz crystal, slate, manganese, wavellite, and novaculite. Locations of active and inactive mines, mineral prospects, and areas of mining leases or permits in the Ouachita National Forest as of October, 1980 are shown in figure 3 (G. P. Sick and J. C. Nichols, U.S. Forest Service, written commun., 1985). Recently, the most marketable commodities from this area have been quartz crystals and intermittent production of barite (U.S. Forest Service, 1985).

SURFACE-WATER QUALITY

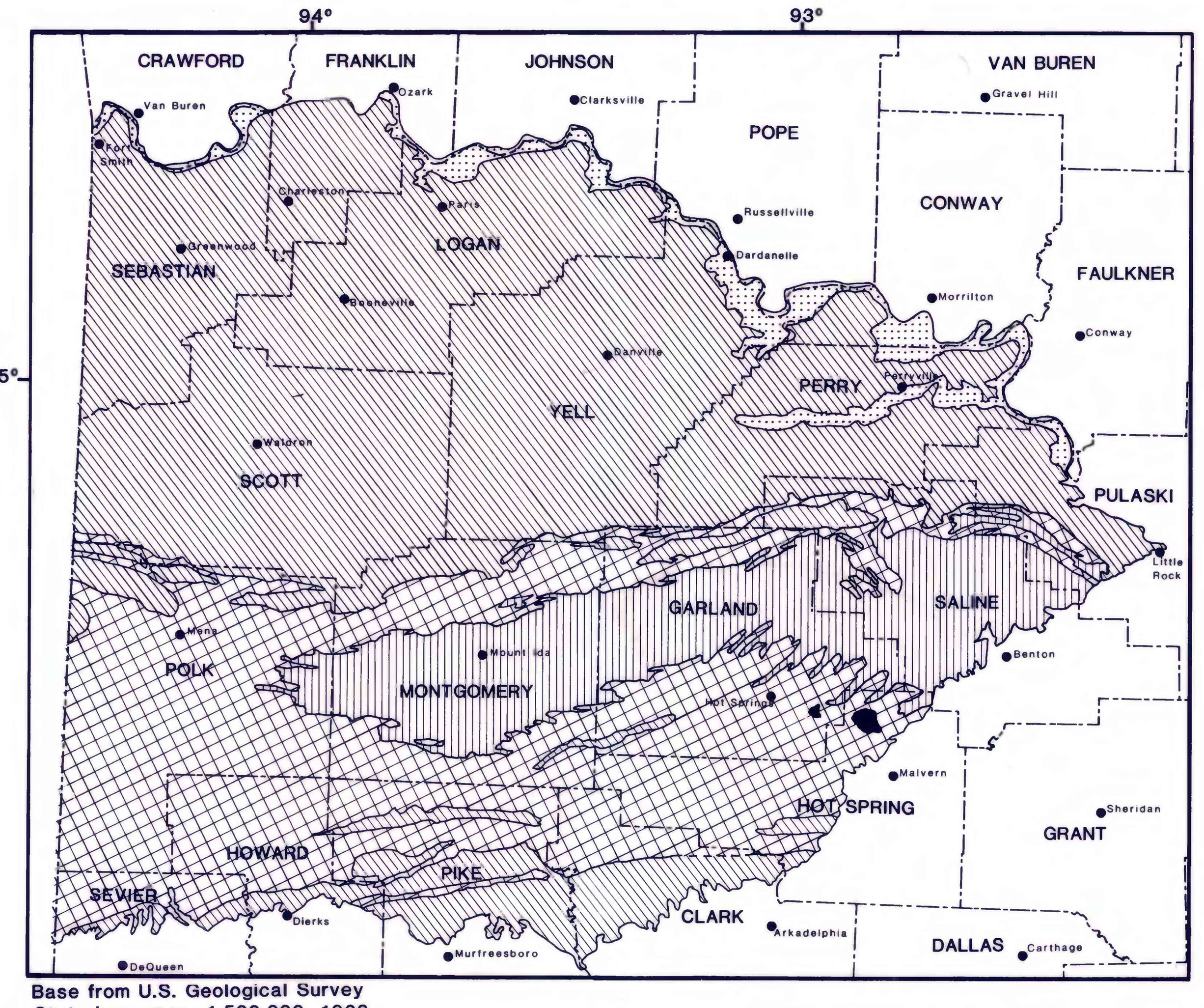
Water samples were collected from 15 streams in the Ouachita National Forest and surrounding area (fig. 3) during April 1984 through August 1985. Samples were collected from the 15 streams at least once during base-flow conditions to determine the water-quality characteristics of streamflow during base-flow conditions. Eight of the streams were also sampled at least once during high-flow conditions to determine water-quality characteristics of runoff in the study area. Results of the laboratory analyses are compiled in table 1.

Specific conductance of the streamflow samples ranged from 21 to 240 µS/cm at 25°C. The pH of the water samples was determined at the time of sampling and varied from 5.1 to 7.8. Concentrations of suspended sediment were relatively low, ranging from 3 to 105 mg/L.

Acceptable concentrations of chloride, sulfate, and dissolved solids have been established by the Arkansas Department of Pollution Control and Ecology (1984) for three rivers that were sampled in the study area (Cossatot, Ouachita, and Little Missouri). Concentrations of these three constituents at the three sites were less than concentrations established in the State water-quality standards. Chloride, sulfate, and dissolved solids concentrations for samples from all 15 sites were within the U.S. Environmental Protection Agency (1982) recommended secondary drinking-water regulations.

Concentrations of the minor elements including arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver did not exceed primary drinking-water standards (U.S. Environmental Protection Agency, 1977, 1985) in any of the streamflow samples. In fact, concentrations of total recoverable antimony, barium, beryllium, boron, lithium, mercury, molybdenum, selenium, and silver were less than the detection limits for most samples. Total recoverable copper and zinc concentrations in all samples were within secondary drinking-water regulations, however, total recoverable iron and manganese concentrations of many samples exceeded drinking-water standards.

Samples collected during base-flow conditions were generally more mineralized than samples collected during high-flow conditions. Base flow is generally more mineralized than overland flow because the water has been in contact with soils and rocks for extended periods of time. Streamflow during high-flow conditions is usually much less mineralized because direct runoff, which is in contact with soluble minerals for a shorter period, tends to dilute base flow. However, concentrations of some of the minor elements such as aluminum and iron increased during high-flow conditions. This is probably a result of resuspension and adsorption of the minor elements to suspended-sediment particles. Generally, the pH of water collected during high-flow conditions was lower than the pH of water collected during base-flow conditions.

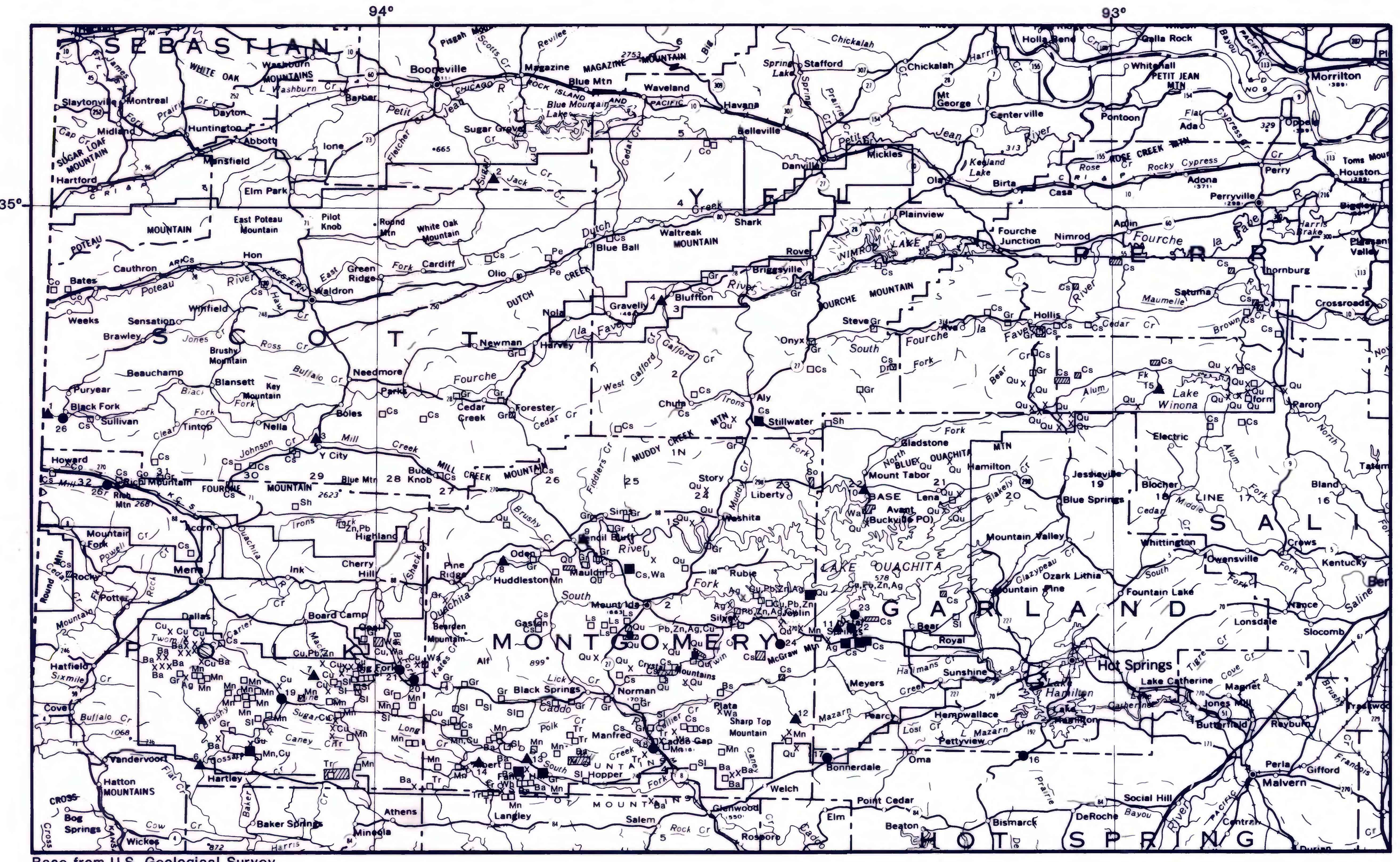


Base from U.S. Geological Survey
State base map, 1:500,000, 1928

Figure 2.--Generalized geologic units in the Ouachita National Forest and surrounding area, (modified from Haley).

EXPLANATION

- ALLUVIAL DEPOSITS OF QUATERNARY AGE. COMPOSED OF CLAY SILT, SAND AND GRAVEL.
- IGNEOUS ROCKS OF CRETACEOUS AGE.
- SANDSTONE AND SHALE OF PENNSYLVANIAN AGE. INCLUDES THE SAVANNA FORMATION, McALESTER FORMATION, HARTSHORNE SANDSTONE, ATOKA FORMATION, JOHNS VALLEY SHALE, AND JACKFORK SANDSTONE.
- SANDSTONE, SHALE, AND NOVACULITE OF MISSISSIPPIAN TO SILURIAN AGE. INCLUDES THE STANLEY SHALE, AND ITS HOT SPRINGS SANDSTONE MEMBER, ARKANSAS NOVACULITE, MISSOURI MOUNTAIN SHALE AND BLAYLOCK SANDSTONE.
- SANDSTONE, SHALE, AND CHERT OF ORDOVICIAN AGE. INCLUDES THE POLK CREEK SHALE, BIGFORK CHERT, WOMBLE SHALE, BLAKELY SANDSTONE, MAZARN SHALE, CRYSTAL MOUNTAIN SANDSTONE AND COLLIER SHALE.



Base from U.S. Geological Survey
State base map, 1:500,000, 1967

Figure 3.--Ground-water and surface-water data collection sites, active and inactive mines, and mineral prospects in the Ouachita National Forest and surrounding area.

EXPLANATION

- OUACHITA NATIONAL FOREST BOUNDARY
- 9 STREAM SITE AND NUMBER
- 17 WELL SITE AND NUMBER
- 22 SPRING SITE AND NUMBER
- INACTIVE MINE, PIT OR QUARRY
- PROSPECT
- AREA OF MINING LEASE OR PERMIT

Ag - Silver	Pe - Peridotite
Ba - Barite	Qu - Quartz crystals
Bs - Building stone	Sh - Shale
Co - Coal	Sl - Slate
Cs - Construction stone	So - Soil
Cu - Copper	Tr - Tripoli
Gr - Gravel	U - Uranium
Ls - Limestone	Wa - Wavellite
Mn - Manganese	Wh - Whetstone
Pb - Lead	Z - Zinc

Minerals development data of 1980 from: Sick, G.P., and Nichols, J.C., U.S. Forest Service, written communication, 1985.

Table 1.--Analyses of surface water and related drinking-water standards at selected sites in the Ouachita National Forest and surrounding area.

[Site numbers correspond to those in figure 3. 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; < = constituent concentration less than detection limit; µS/cm = microsiemens per centimeter; mi² = square mile; ft³/s = cubic feet per second; NS = no standard]

Site number	Station number and name	Drainage area (mi²)	Date of sample	Streamflow, instantaneous (ft³/s) (00061)	Specific conductance (µS/cm at 25°C) (00095)	pH (standard units) (00400)	Temperature (°C) (00010)	Oxygen, dissolved (mg/L) (00300)	Calcium dissolved (mg/L as Ca) (00915)	Magnesium, dissolved (mg/L as Mg) (00925)	Sodium, dissolved (mg/L as Na) (00930)	Potassium, dissolved (mg/L as K) (00935)	Sulfate dissolved (mg/L as SO4) (00945)	Chloride, dissolved (mg/L as Cl) (00940)	Fluoride, dissolved (mg/L as F) (00950)	Silica, dissolved (mg/L as SiO2) (00955)	Solids, residue at 180°C dissolved (mg/L) (70300)	Nitrogen, NO2+NO3 dissolved (mg/L as N) (00631)	Aluminum, total recoverable (µg/L as Al) (01105)	Antimony, total (µg/L as Sb) (01097)	Arsenic total (µg/L as As) (01002)
1	07247095 - Black Fork at Black Fork, Ark.	35.5	07-13-84	a0.02	51	6.7	29.0	6.0	3.2	1.7	3.1	1.1	10	3.0	<0.1	5.9	39	0.11	70	3	2
			08-08-85	a.05	31	6.9	26.5	5.2	1.8	1.5	1.6	0.6	2.7	1.1	<.1	4.3	22	<.10	140	<1	<1
2	07258680 - Sugar Creek near Booneville, Ark.	57.2	07-13-84	a.03	57	6.8	31.0	7.5	2.3	1.9	3.4	1.3	10	4.7	<.1	7.4	46	<.10	30	<1	2
			08-08-85	a.50	77	7.1	31.0	5.2	2.8	2.6	5.0	1.7	1.8	6.1	<.1	5.6	39	<.10	60	<1	<1
3	07261400 - Mill Creek near Boles, Ark.	50.5	07-12-84	a.01	56	7.2	29.0	6.7	3.0	2.3	2.2	1.2	11	2.6	<.1	3.3	46	.31	120	<1	1
			04-23-85	545	21	6.7	19.0	9.6	1.0	0.9	1.2	.6	3.9	2.0	<.1	5.7	14	<.10	450	<1	<1
4	07261600 - Gaffords Creek near Bluffton, Ark.	41.0	07-13-84	a.05	58	6.7	30.5	6.2	2.0	2.0	3.5	1.4	9.6	2.6	<.1	7.9	38	<.10	100	<1	1
			04-23-85	409	30	7.2	17.0	9.3	1.7	1.1	1.9	1.7	11	3.5	<.1	7.0	16	<.10	720	<1	<1
5	07340290 - Brushy Creek near Hartley, Ark.	12.7	05-02-84	127	21	6.6	14.0	10.3	2.9	.8	1.0	.6	4.0	2.3	<.1	5.8	44	<.10	130	<1	1
			07-12-84	a.02	42	7.0	20.0	7.2	1.9	1.6	2.4	1.0	10	2.4	<.1	11	44	.28	150	<1	1
6	07340300 - Cossatot River near Vandervoort, Ark.	89.6	07-12-84	36.5	69	7.4	27.0	7.0	7.4	1.8	1.9	.8	11	2.3	<.1	6.5	50	<.10	<10	<1	1
7	07355850 - Board Camp Creek near Shady, Ark.	4.84	07-12-84	2.48	37	6.9	23.5	7.2	2.3	1.2	1.8	.7	11	2.2	<.1	8.8	38	<.10	110	<1	1
			08-07-85	a1.5	44	7.2	28.0	7.4	4.2	1.6	2.1	.9	3.8	2.2	.1	9.2	33	<.10	120	<1	<1
8	07355980 - Shirley Creek near Oden, Ark.	5.08	07-12-84	2.91	97	7.3	23.0	7.8	12	1.7	1.3	.6	11	2.3	<.1	7.6	62	<.10	20	<1	1
			04-23-85	79	33	7.0	17.5	10.1	3.3	.7	.9	.5	4.7	1.2	<.1	5.7	22	<.10	230	<1	<1
9	07356000 - Ouachita River near Mount Ida, Ark.	414	07-12-84	124	71	7.0	27.0	7.2	6.5	1.7	2.0	1.2	10	2.6	<.1	5.6	48	.26	70	<1	1
10	07356285 - North Fork Creek near Mount Tabor, Ark.	53.6	07-11-84	.72	40	7.5	28.5	7.2	1.9	1.6	2.0	.7	2.7	2.2	<.1	4.6	54	<.10	50	<1	1
			08-09-85	5.6	33	7.2	32.5	6.8	2.0	1.7	2.5	1.1	2.6	2.9	<.1	5.1	21	<.10	100	<1	<1
11	07356853 - Walnut Creek northwest of Crystal Springs, Ark.	8.69	05-02-84	132	74	7.3	16.0	8.4	10	1.9	.9	.8	6.1	1.7	.1	5.4	74	<.10	1,100	<1	1
			07-11-84	3.23	220	7.7	25.0	8.4	31	4.4	1.8	1.2	10	2.6	.2	11	122	<.10	20	<1	1
12	07357790 - Mazarn Creek at Mazarn, Ark.	30.4	05-02-84	218	50	7.2	15.5	9.0	5.6	1.4	1.3	.6	5.3	1.7	<.1	6.7	56	<.10	200	<1	1
			07-11-84	5.48	124	7.8	28.5	7.6	16	2.5	1.5	.9	11	3.3	.2	8.9	76	<.10	40	<1	1
13	07359650 - South Fork Caddo River near Fancy Hill, Ark.	9.94	04-02-84	40.2	102	5.1	11.0	9.8	3.7	3.7	4.0	.6	37	1.5	<.1	8.8	74	<.10	—	<1	—
			07-11-84	1.71	50	6.8	29.0	7.3	3.1	1.4	3.0	.7	13	2.1	<.1	9.7	44	<.10	80	<1	1
			06-18-85	22.6	54	7.0	20.0	8.2	5.0	1.5	1.8	.8	14	1.3	<.1	7.9	45	.26	320	<1	<1
14	07360187 - Little Missouri River at Albert, Ark.	34.0	04-02-84	79.9	240	6.2	11.0	10.4	1.3	.7	1.5	.4	4.6	1.5	<.1	7.4	32	<.10	—	<1	—
			07-11-84	7.68	45	7.2	29.0	7.9	4.2	1.2	2.2	.9	10	2.8	<.1	8.2	38	<.10	80	<1	1
			06-18-85	108	33	7.2	20.0	8.0	3.1	1.0	1.5	.6	3.0	1.4	<.1	7.2	29	.11	280	<1	<1
15	07362587 - Alum Fork Saline River near Reform, Ark.	26.9	07-11-84	a.05	38	7.2	28.0	6.0	2.2	1.6	2.1	.6	1.2	2.0	<.1	3.9	20	<.10	160	<1	1
			08-09-85	.74	33	6.6	25.5	6.1	1.8	1.5	1.5	.7	2.7	2.0	<.1	4.3	24	<.10	180	<1	<1
	U.S. Environmental Protection Agency Primary Drinking Water Standards (1977, 1985)			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.0	NS	NS	10.0	NS	NS	50
	U.S. Environmental Protection Agency Secondary Drinking Water Standards (1982, 1985)			NS	NS	6.5-8.5	NS	NS	NS	NS	NS	NS	250	250	2.0	NS	500	NS	NS	NS	NS

Site number	Date of sample	Barium, total recoverable (µg/L as Ba) (01007)	Beryllium, total recoverable (µg/L as Be) (01012)	Boron, total recoverable (µg/L as B) (01022)	Cadmium total recoverable (µg/L as Cd) (01027)	Chromium, total recoverable (µg/L as Cr) (01034)	Cobalt, total recoverable (µg/L as Co) (01037)	Copper, total recoverable (µg/L as Cu) (01042)	Iron, total recoverable (µg/L as Fe) (01045)	Lead, total recoverable (µg/L as Pb) (01051)	Lithium total recoverable (µg/L as Li) (01132)	Manganese, total recoverable (µg/L as Mn) (01055)	Mercury total recoverable (µg/L as Hg) (71900)	Molybdenum, total recoverable (µg/L as Mo) (01062)	Nickel, total recoverable (µg/L as Ni) (01067)	Selenium, total (µg/L as Se) (01147)	Silver, total recoverable (µg/L as Ag) (01077)	Strontium, total recoverable (µg/L as Sr) (01082)	Zinc, total recoverable (µg/L as Zn) (01092)	Uranium natural dissolved (µg/L as U) (22703)	Carbon, organic total (mg/L as C) (00680)	Sediment, suspended (mg/L) (80154)	Sediment suspended sieve diameter percent finer than 0.062 millimeter (70331)	Station number and name	Site number
1	07-13-84	100	<10	<20	1	10	4	<1	1,500	3	<10	250	<0.1	<1	<1	<1	<1	50	40	<0.4	2.7	14	58	07247095 - Black Fork at Black Fork, Ark.	1
	08-08-85	<100	<10	<20	<1	10	<1	5	950	2	<10	40	<.1	<1	8	<1	<1	40	40	—	3.6	3	86		
2	07-13-84	<100	<10	50	1	10	1	<1	980	1	<10	50	.2	<1	<1	<1	<1	40	10	<.4	2.8	9	40	07258680 - Sugar Creek near Booneville, Ark.	2
	08-08-85	<100	<10	—	1	20	<1	3	1,600	1	<10	110	<.1	<1	7	<1	<1	30	30	—	4.0	4	83		
3	07-12-84	<100	<10	<20	1	10	2	1	850	3	<10	100	.3	47	1	1	<1	40	10	<.4	2.5	11	30	07261400 - Mill Creek near Boles, Ark.	3
	04-23-85	<100	<10	30	1	20	5	6	1,200	3	<10	20	<.1	44	1	<1	<1	20	30	<.4	3.7	9	78		
4	07-13-84	100	<10	150	1	10	3	<1	510	2	<10	140	<.1	<1	<1	<1	<1	60	30	<.4	1.1	13	44	07261600 - Gaffords Creek near Bluffton, Ark.	4
	04-23-85	<100	<10	50	1	10	6	4	200	8	<10	30	<.1	30	3	<1	<1	20	30	<.4	4.2	28	78		
5	05-02-84	100	<10	<20	1	10	1	5	260	6	<10	20	<.1	<1	2	<1	<1	30	<10	<.4	1.5	5	20	07340290 - Brushy Creek near Hartley, Ark.	5
	07-12-84	100	<10	<20	1	10	2	1	290	1	<10	20	<.1	<1	<1	<1	<1	50	10	<.4	1.5	14	38		
6	07-12-84	<100	<10	<20	2	20	1	1	100	3	<10	20	<.1	<1	<1	<1	<1	70	10	<.4	3.9	7	34	07340300 - Cossatot River near Vandervoort, Ark.	6
7	07-12-84	<100	<10	60	1	10	1	1	250	2	<10	10	<.1	<1	<1	<1	1	50	30	<.4	1.2	10	46	07355850 - Board Camp Creek near Shady, Ark.	7
	08-07-85	<100	<10	<20	<1	10	5	9	250	4	<10	10	<.1	<1	5	<1	<1	70	300	—	1.0	6	63		
8	07-12-84	100	<10	<20	1	<20	1	7	170	2	<10	20	.3	24	<1	2	<1	50	30	<.4	1.7	6	61	07355980 - Shirley Creek near Oden, Ark.	8
	04-23-85	<100	<10	40	1	20	6	4	310	1	<10	20	<.1	32	2	<1	<1	20	20	<.4	3.3	9	74		
9	07-12-84	<100	<10	<20	1	10	2	6	300	1	<10	40	<.1	<1	<1	<1	<1	90	10	<.4	2.6	7	49	07356000 - Ouachita River near Mount Ida, Ark.	9
10	07-11-84	<100	<10	<20	1	30	2	2	320	6	<10	<10	<.1	<1	4	<1	<1	40	20	<.4	2.3	8	47	07356285 - North Fork Creek near Mount Tabor, Ark.	10
	08-09-85	<100	<10	<20	2	<10	<1	3	280	3	<10	<10	<.1	<1	3	<1	<1	70	30	—	3.4	3	100		
11	05-02-84	100	<10	<20	1	<10	4	5	2,000	6	<10	230	<.1	<1	7	<1	<1	50	<10	<.4	—	105	13	07356853 - Walnut Creek northwest of Crystal Springs, Ark.	11
	07-11-84	100	<10	50	1	<10	1	1	120	1	<10	20	<.1	<1	<1	<1	<1	120	10	<.4	1.6	10	54		
12	05-02-84	100	<10	<20	1	20	2	2	380	4	<10	30	<.1	<1	2	<1	<1	40	<10	<.4	—	15	34	07357790 - Mazarn Creek at Mazarn, Ark.	12
	07-11-84	100	<10	<20	1	20	1	<1	190	1	<10	20	<.1	<1	<1	<1	<1	70	10	<.4	1.7	7	57		
13	04-02-84	—	—	<20	—	—	—	—	—	—	—	—	—	—	—	—	—	50	—	—	1.7	12	19	07359650 - South Fork Caddo River near Fancy Hill, Ark.	13
	07-11-84	100	<10	<20	1	10	2	1	320	1	<10	80	<.1	<1	<1	<1	<1	60	10	<.4	1.1	6	28		
	06-18-85	<100	<10	<20	1	10	<1	6	510	<1	<10	100	<.1	2	6	<1	<1	10	120	<.4	2.2	11	92		
14	04-02-84	—	—	<20	—	—	—	—	—	—	—	—	—	—	—	—	—	20	—	—	.7	7	13	07360187 - Little Missouri River at Albert, Ark.	14
	07-11-84	100	<10	<20	1	<10	1	2	230	3	<10	20	<.1	2	<1	<1	<1	40	20	<.4	1.2	11	58		
	06-18-85	<100	<10	<20	<1	10	<1	3	560	<1	<10	10	<.1	<1	1	<1	<1	80	30	<.4	1.2	12	86		
15	07-11-84	<100	<10	<20	<1	30	1	3	1,200	5	<10	110	.1	<1	3	<1	<1	50	20	<.4	2.3	11	62	07362587 - Alum Fork Saline River near Reform, Ark.	15
	08-09-85	<100	<10	<20	1	10	<1	5	500	4	<10	30	<.1	<1	5	<1	<1	60	60	—	2.9	4	91		
		1,000	NS	NS	10	50	NS	NS	NS	50	NS	NS	2	NS	NS	10	50	NS	NS	NS	NS	NS	NS	U.S. Environmental Protection Agency Primary Drinking Water Standards (1977, 1985)	
		NS	NS	NS	NS	NS	NS	1,000	300	NS	NS	50	NS	NS	NS	NS	NS	NS	5,000	NS	NS	NS	NS	U.S. Environmental Protection Agency Secondary Drinking Water Standards (1982, 1985)	

a Estimated discharge

Table 3.--Analyses of ground water and related drinking-water standards at selected sites in the Ouachita National Forest and surrounding area.

[Site numbers correspond to those in figure 3. NTU = nephelometric turbidity units; 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; < = constituent concentration less than detection limit; µS/cm = microsiemens per centimeter; NS = no standard]

Site number	Station number	Local number	Date of sample	Geologic unit	Depth of well, total (feet) (72008)	Specific conductance (µS/cm at 25°C) (00095)	pH (standard units) (00400)	Temperature (°C) (00010)	Turbidity (NTU) (00076)	Calcium dissolved (mg/L as Ca) (00915)	Magnesium, dissolved (mg/L as Mg) (00925)	Sodium, dissolved (mg/L as Na) (00930)	Potassium, dissolved (mg/L as K) (00935)	Alkalinity field (mg/L as CaCO3) (00410)	Sulfate dissolved (mg/L as SO4) (00945)	Chloride, dissolved (mg/L as Cl) (00940)	Fluoride, dissolved (mg/L as F) (00950)	Silica, dissolved (mg/L as SiO2) (00955)	Solids, residue at 180°C dissolved (mg/L) (70300)
16	342239093082801	04S20W21AAA1	08-10-84	Arkansas Novaculite	141.00	241	7.5	19.5	0.2	23	6.0	14	1.1	110	3.0	1.6	0.1	24	136
			08-06-85			222	7.4	23.0	1.1	23	6.0	13	.4	109	3.0	.9	.1	25	136
17	342306093224401	04S22W17DCB1	08-10-84	Stanley Shale	110.00	475	7.4	18.0	1.7	48	11	23	.6	150	9.1	47	.1	25	278
18	342358093370801	04S25W13AAD2	08-09-84	Alluvium	a15	152	6.6	19.0	1.8	21	1.5	2.8	2.2	64	3.2	2.9	<.1	7.3	79
			08-06-85			122	7.6	20.0	.6	17	1.2	3.3	2.3	43	3.7	1.9	.1	8.1	67
19	342659094071901	03S29W32BBA1	08-09-84	Missouri Mountain Shale	160.00	180	7.2	14.0	.2	21	3.2	7.8	.6	71	9.2	3.5	<.1	21	106
			08-07-85			218	6.9	21.5	1.0	23	3.3	20	.7	95	13	4.2	<.1	19	135
20	342805093565201	03S28W24CBD1	08-09-84	Polk Creek Shale	(Spring)	176	6.6	14.0	.2	29	1.1	1.0	.3	75	6.3	1.8	.1	8.1	93
21	342906093580701	03S28W15DAA1	08-09-84	Polk Creek Shale	29.50	160	4.8	18.0	2.7	7.5	3.4	5.0	6.0	2	11	11	.1	6.8	89
22	343155093220401	02S22W28CBC1	08-09-84	Blakely Sandstone	(Spring)	291	7.3	17.0	.1	42	6.9	1.8	1.7	130	12	1.9	.3	14	147
			08-06-85			236	7.2	23.0	.7	41	7.0	1.9	1.8	114	3.8	2.3	.3	14	162
23	343234093211001	02S22W21DD1	08-06-85	Womble Shale	75.00	303	7.0	20.5	8.0	35	6.9	6.0	1.3	121	20	3.2	.4	20	180
24	343309093292101	02S23W20BCD1	08-09-84	Womble Shale	a90	1,080	7.1	16.5	37	170	35	3.9	.7	400	210	6.4	.2	9.7	767
25	344109094223401	01S32W11ADC1	08-08-84	Jackfork Sandstone	410.00	278	7.3	15.5	.5	24	8.6	16	1.2	110	18	6.3	.1	31	170
26	344605094251701	01N32W08ABC2	08-08-84	Atoka Formation	100.00	530	7.4	20.0	.4	43	24	33	.6	210	50	12	.2	22	312
	U.S. Environmental Protection Agency Primary Drinking Water Standards (1977, 1985)				NS	NS	NS	NS	1	NS	NS	NS	NS	NS	NS	NS	4.0	NS	NS
	U.S. Environmental Protection Agency Secondary Drinking Water Standards (1982, 1985)				NS	NS	6.5-8.5	NS	NS	NS	NS	NS	NS	NS	250	250	2.0	NS	500

Site number	Date of sample	Aluminum, dissolved (µg/L as Al) (01106)	Antimony, dissolved (µg/L as Sb) (01095)	Arsenic dissolved (µg/L as As) (01000)	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)	Chromium, dissolved (µg/L as Cr) (01030)	Cobalt, dissolved (µg/L as Co) (01035)	Copper, dissolved (µg/L as Cu) (01040)	Iron, dissolved (µg/L as Fe) (01046)	Lead, dissolved (µg/L as Pb) (01049)	Lithium dissolved (µg/L as Li) (01130)	Manganese, dissolved (µg/L as Mn) (01056)	Mercury dissolved (µg/L as Hg) (71890)	Molybdenum, dissolved (µg/L as Mo) (01060)	Nickel, dissolved (µg/L as Ni) (01065)	Selenium, dissolved (µg/L as Se) (01145)	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)	Uranium natural dissolved (µg/L as U) (22703)	Carbon, organic total (mg/L as C) (00680)	Station number	Site number
16	08-10-84	10	<1	<1	23	<0.5	70	<1	<1	<3	19	53	1	18	8	0.1	<10	1	<1	2	350	<6	81	<0.4	0.5	342239093082801	16
	08-06-85	20	<1	<1	24	<.5	20	<1	<1	<3	4	29	<1	15	63	<.1	<10	4	<1	<1	310	<6	120	<.4	3.1		
17	08-10-84	<10	<1	<1	28	<.5	<20	<1	<1	<3	13	10	1	32	190	—	<10	1	<1	1	350	<6	32	<.4	.6	342306093224401	17
18	08-09-84	20	1	<1	49	<.5	<20	<1	<1	<3	1,400	9	4	<4	<1	<.1	<10	2	<1	<1	130	<6	64	<.4	.7	342358093370801	18
	08-06-85	20	<1	<1	33	1.2	<20	<1	3	<3	5	11	<1	<4	1	<.1	<10	5	<1	<1	110	<6	16	<.4	1.7		
19	08-09-84	30	<1	1	10	<.5	60	<1	<1	<3	1	20	5	14	110	<.1	<10	<1	<1	<1	94	<6	75	<.4	.4	342659094071901	19
	08-07-85	10	<1	<1	7	.6	80	<1	1	<3	8	20	<1	16	34	<.1	<10	2	<1	<1	100	<6	760	<.4	2.0		
20	08-09-84	20	<1	<1	10	<.5	<20	<1	<1	<3	1	110	5	6	29	<.1	<10	4	<1	<1	130	<6	29	<.4	.6	342805093565201	20
21	08-09-84	600	<1	<1	320	1.0	20	<1	<1	8	170	170	8	<4	500	.3	<10	2	<1	2	41	<6	550	<.4	1.2	342906093580701	21
22	08-09-84	10	<1	1	30	<.5	<20	<1	<1	<3	1	4	6	10	<1	<.1	<10	<1	<1	<1	86	<6	60	.7	.4	343155093220401	22
	08-06-85	20	<1	<1	27	1.7	<20	<1	<1	<3	2	10	<1	11	<1	<.1	<10	3	<1	<1	82	<6	66	<.4	.6		
23	08-06-85	10	<1	<1	12	<.5	<20	2	<1	<3	3	1,300	1	6	180	.1	<10	12	<1	<1	130	<6	15,000	<.4	3.7	343234093211001	23
24	08-09-84	—	1	2	36	1.0	<20	2	<1	<3	2	4,500	6	10	190	<.1	<10	6	<1	<1	1,300	<6	8,800	.5	1.6	343309093292101	24
25	08-08-84	50	<1	<1	260	<.5	50	<1	<1	<3	5	420	5	18	260	<.1	<10	1	<1	<1	180	<6	13	<.4	.5	344109094223401	25
26	08-08-84	20	<1	<1	96	<.5	130	<1	<1	<3	1	35	6	32	290	.1	<10	1	<1	<1	440	<6	26	<.4	.7	344605094251701	26
		NS	NS	50	1,000	NS	NS	10	50	NS	NS	NS	50	NS	NS	2	NS	NS	10	50	NS	NS	NS	NS	NS	U.S. Environmental Protection Agency Primary Drinking Water Standards (1977, 1985)	
		NS	NS	NS	NS	NS	NS	NS	NS	NS	1,000	300	NS	NS	50	NS	NS	NS	NS	NS	NS	NS	5,000	NS	NS	U.S. Environmental Protection Agency Secondary Drinking Water Standards (1982, 1985)	

a Well depth reported by owner

To characterize pre-1984 water-quality conditions in several areas of the Ouachita National Forest, data were selected from four streamflow sites that have been routinely monitored in the past. The four monitoring stations selected for analysis were: Poteau River south of Bates, Petit Jean River near Centerville, Fourche Lafave River near Gravelly, and Ouachita River near Mount Ida. Selected physical and chemical characteristics of water were summarized for the period of record at each site (table 2).

Generally, the pH of water at the four sites was about 7.0. Median specific conductance varied from 44 µS/cm at 25°C for Fourche Lafave River to 72 µS/cm at 25°C for Petit Jean River. Some samples from the four sites were classified as moderately hard (between 61 and 120 mg/L as $CaCO_3$), but usually water at all sites was soft. Concentrations of arsenic, cadmium, chromium, and selenium did not exceed primary drinking-water standards (U.S. Environmental Protection Agency, 1977, 1985) in any of the samples. However, lead concentrations in samples from the four sites exceeded the drinking-water regulations at times. Sulfate, zinc, dissolved solids, and chloride concentrations were within the recommended secondary drinking-water regulations (U.S. Environmental Protection Agency, 1982). Total recoverable iron and manganese concentrations exceeded secondary drinking-water regulations in many samples collected at the four sites.

In general, surface water in the Ouachita National Forest is relatively abundant. It is low in mineralization and chemically suitable for most uses with minimal treatment.

GROUND-WATER QUALITY

Water samples were collected from nine wells and two springs in the Ouachita National Forest and surrounding area during August 1984 and August 1985 (fig. 3). Sampling sites were selected so that water from a variety of geologic units would be collected. Samples were analyzed for the common constituents and 23 minor elements. Results of the laboratory analyses are compiled in table 3.

Specific conductance of the ground-water samples ranged from 122 to 1,080 µS/cm at 25°C. Determination of pH at the time of sampling showed that generally the ground-water samples were slightly alkaline. Dissolved sulfate and chloride concentrations were within the recommended secondary drinking-water regulations (U.S. Environmental Protection Agency, 1982) for all samples. Dissolved-solids concentrations were within the secondary drinking-water regulations at all sites except site 24. Concentrations of the minor elements arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver did not exceed primary drinking-water standards (U.S. Environmental Protection Agency, 1977, 1985) in any of the samples collected. In fact, concentrations of many of these minor elements were below the detection limits in most of the samples. Dissolved iron, manganese, copper, and zinc concentrations in some samples exceeded secondary drinking-water regulations.

Ground-water quality of each of the geologic units sampled in the study area cannot be characterized based on the information collected during the project due to the limited amount of data available for analysis and to the highly variable nature of the results. There was considerable variation in some constituent concentrations for samples collected at the same site during the two years of the project. The dissolved copper concentration at site 18 was 1,400 µg/L in 1984 and only 5 µg/L in 1985. The pH of water samples also collected at site 18 varied from 6.6 in 1984 to 7.6 in 1985. Samples collected at site 19 contained dissolved zinc concentrations of 75 µg/L in 1984 and 760 µg/L in 1985. The high concentrations of copper and zinc are probably not representative of the ground-water quality of the geologic units, but rather a result of pipe corrosion and dissolution.

Limited historic ground-water quality data are available for wells and springs in the Ouachita National Forest. Several wells in the study area were sampled during the period of 1960-63 by Albin and Stephens (1963). These data and other analyses of miscellaneous samples were compiled and grouped by geologic unit. Results showed that, historically, water from several wells in the alluvium was slightly alkaline and hard (between 121 and 180 mg/L as $CaCO_3$) with total recoverable iron concentrations that exceeded drinking-water standards at times. Water from wells in the Atoka Formation was slightly alkaline and ranged in hardness from soft (less than 60 mg/L as $CaCO_3$) to very hard (greater than 180 mg/L as $CaCO_3$). Samples from these wells contained concentrations of dissolved chloride, dissolved sulfate, total recoverable iron, and dissolved manganese which exceeded secondary drinking-water standards at times.

Bedinger and others (1979) collected water samples from 15 cold wells and springs and 9 hot springs in 1972 to characterize the waters of Hot Springs National Park. Specific conductance of water from the cold wells and springs in the area ranged from 15 to 354 µS/cm at 25°C, and the pH of the water varied from 4.6 to 7.6. Iron and manganese concentrations often exceeded secondary drinking-water standards. The chemical composition of the hot-water springs was similar to that of the cold-water springs and wells in the area. The main differences in the quality of water from the hot springs compared with water from the cold wells and springs, were the high temperature and higher silica concentrations of the hot springs.

Water-quality data were collected from 93 springs and 9 wells in the Ouachita Mountains (excluding Hot Springs), Arkansas during 1978-79 and were compiled in a report by Wagner and Steele (1980). Data from this report showed the spring water in the study area to be slightly acidic and low in mineralization with concentrations of dissolved iron and manganese that exceeded drinking-water standards at times. Additional analyses of these data by Wagner and Steele (1985) indicated that anomalously high iron and manganese concentrations were characteristic of ground water in areas near manganese deposits in the Ouachita Mountains. High concentrations of barium and mercury were also found in ground-water samples collected near barite and cinnabar mineral deposits.

In general, ground water in the Ouachita National Forest is relatively scarce. The low yields of wells limit the use of ground water primarily to domestic use. The water is chemically suitable for most purposes but may require treatment for the removal of iron.

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Table 2 --Summary of selected physical and chemical characteristics of water and related drinking-water standards at sites in the Ouachita National Forest and surrounding area.

[mg/L = milligrams per liter; µg/L = micrograms per liter; < = constituent concentration less than detection limit; ft³/s = cubic feet per second; µS/cm = microsiemens per centimeter; NS = no standard]

Property or constituent	07247012 - Poteau River south of Bates, Ark. Period of record: 1973-83			07260640 - Petit Jean River near Centerville, Ark. Period of record: 1974-83			07261500 - Fourche LaFave River near Gravelly, Ark. Period of record: 1945-83			07356000 - Ouachita River near Mount Ida, Ark. Period of record: 1950-83			U.S. Environmental Protection Agency Primary Drinking Water Standards (1977, 1985)	U.S. Environmental Protection Agency Secondary Drinking Water Standards (1982, 1985)
	Median	Range	Number of Observations	Median	Range	Number of Observations	Median	Range	Number of Observations	Median	Range	Number of Observations		
Discharge at time of water-quality sampling (ft³/s)	88	0.80-3,530	105	151	3.5-15,500	76	127	0.28-13,500	89	350	13-17,600	230	NS	NS
Specific conductance (µS/cm at 25°C)	70	11-139	106	72	42-159	75	44	28-105	94	54	28-112	190	NS	NS
pH (standard units)	7.0	1.9-8.4	141	6.9	6.1-7.8	108	7.0	6.3-8.2	113	7.1	6.1-7.9	210	NS	6.5-8.5
Temperature (°C)	20.0	2.0-33.0	143	19.0	1.0-34.0	111	21.5	4.0-34.0	104	19.0	0.5-32.0	133	NS	NS
Dissolved oxygen (mg/L)	8.1	2.6-12.9	145	7.1	4.1-13.0	108	9.3	5.1-13.7	101	8.9	5.9-13.2	97	NS	NS
Hardness as $CaCO_3$ (mg/L)	24	9-84	57	24	13-110	51	16	7-89	73	21	4-50	166	NS	NS
Noncarbonate hardness as $CaCO_3$ (mg/L)	7	0-55	15	6	0-31	11	0	0-39	34	2	0-24	128	NS	NS
Alkalinity as $CaCO_3$ (mg/L)	16	5-45	56	18	10-79	22	14	5-29	45	20	8-40	136	NS	NS
Chloride, dissolved (mg/L)	6.0	2.5-13	131	7.0	3.0-19	96	4.8	2.0-45	112	3.2	1.5-8.0	199	NS	250
Sulfate, dissolved (mg/L)	9.0	<1.0-67	103	8.0	<1.0-53	102	4.0	<1.0-44	117	4.0	<1.0-48	201	NS	250
Dissolved solids, residue at 180°C (mg/L)	64	42-155	57	74	50-282	56	42	21-72	60	43	19-70	149	NS	500
Arsenic, total (µg/L)	<10	<10-13	58	<10	<10-20	55	<10	<10-15	51	<10	<10-16	49	50	NS
Cadmium, total recoverable (µg/L)	<20	<20-<20	74	<20	<20-20	95	<20	<20-<20	85	<20	<20-<20	67	10	NS
Chromium, total recoverable (µg/L)	<20	<20-<20	69	<5	<5-50	67	<20	<20-<20	58	<20	<20-37	65	50	NS
Copper, total recoverable (µg/L)	<20	<20-200	75	<20	<20-160	105	50	<20-420	98	<20	<20-240	81	NS	1,000
Iron, total recoverable (µg/L)	1,000	290-6,600	39	2,700	760-19,000	71	790	100-2,600	71	340	<10-2,100	48	NS	300
Lead, total recoverable (µg/L)	<20	<20-230	50	<20	<20-200	61	<20	<20-80	43	<20	<20-72	41	50	NS
Manganese, total recoverable (µg/L)	120	11-700	40	300	22-2,400	73	50	<27-250	70	32	<27-2,500	48	NS	50
Zinc, total recoverable (µg/L)	<20	<20-110	66	<20	<20-290	107	40	<20-230	95	<20	<20-160	76	NS	5,000
Selenium, total (µg/L)	<10	<10-<10	23	<10	<10-<10	21	<10	<10-<10	20	<10	<10-<10	21	10	NS

CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
foot (ft)	0.3048	meter (m)
cubic foot per second (ft³/s)	0.02832	cubic meter per second (m³/s)
gallon per minute (gal/min)	0.0631	liter per second (L/s)
inch (in.)	25.4	millimeter (mm)
square mile (mi²)	2.590	square kilometer (km²)
acre	4,047	square meter (m²)
microsiemens per centimeter at 25° Celsius (µS/cm at 25°C)	1.000	micromho per centimeter at 25° Celsius (µmho/cm at 25°C)

°Fahrenheit = 1.8 (°C) + 32 °Celsius = 0.556 (°F - 32)

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, called NGVD of 1929, is referred to as sea level in this report.

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