ARKANSAS STATE WATER PLAN

LOWER OUACHITA BASIN

Arkansas Soil and Water Conservation Commission

FEBRUARY, 1987

ACKNOWLEDGEMENTS

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PREFACE

The Arkansas Soil and Water Conservation Commission received statutory authority to begin work on the first Arkansas State Water Plan in 1969. Act 217 gave specific authority to the Commission to be the designated agency responsible for water resources planning at the state level. The act mandated the preparation of a comprehensive state water plan of sufficient detail to serve as the basic document for defining water policy for the development of land and water resources in the State of Arkansas.

The first State Water Plan was published in 1975 with 5 appendices that addressed specific problems and needs in the state. As more data has become available, it is apparent that the ever-changing nature and severity of water resource problems and potential solutions require the planning process to be dynamic. Periodic revisions to the State Water Plan are necessary for the document to remain valid.

This report is the second of eight River Basin Reports to be published as a component of the 1986 Arkansas State Water Plan. The objectives of this plan are to incorporate new data available from recent research, re-evaluate new and existing problems, present specific solutions and recommendations, and satisfy the requirements of Act 1051 of 1985 for the Lower Ouachita River Basin.

ABSTRACT

The Lower Ouachita Basin consists of approximately 4.9 million acres of gently rolling land located in the south-central part of the state. Forestland accounts for 84 percent and cropland covers 5.9 percent of the total land use in the basin. Water is available from both surface-water and groundwater sources. The Ouachita River and Bayou Bartholomew are the principal streams, and the Quaternary and Sparta Sand Aquifers are the major sources of groundwater in the basin.

Streams in the Lower Ouachita Basin have a combined yield of approximately 11 million acre-feet of water on an average annual basis. Runoff varies seasonally as well as annually, with the area subject to extremes of both flood and drought. Seasonal variability is characterized by low flows which usually occur during August through October. This period of lowest streamflow includes the agricultural growing season, a period of significant water use from some streams such as Bayou Bartholomew. In response to Act 1051 of 1985 the following actions were taken: (1) instream flow requirements were addressed for riparian needs, water quality, fish and wildlife, navigation, and interstate compacts; (2) minimum streamflows were defined and established at selected locations for the purpose of protection of instream flow needs; and (3) safe yield of streams was quantified for selected streams. In the Lower Ouachita Basin, 675,000 acre-feet of water is excess streamflow which is available on an average annual basis for other uses.

Seasonal low flows have caused significant water shortages in many areas of the basin. This is especially true in the agricultural area surrounding Bayou Bartholomew. Streamflow is normally low during the summer irrigation season which has, at times, caused riparian land owners to seek alternate water sources. Because of the current streamflow conditions and the potential increase in irrigated farmland in the surrounding area, Bayou Bartholomew is designated as a critical surface water area.

Water-quality problems are primarily from non-point pollution sources but are generally localized. Pollution from non-point sources such as agriculture, silviculture, strip mining and oil field activity has increased turbidity and chloride and pesticide concentrations, and lowered the pH of the receiving streams. Numerous point sources of pollution are licensed in the basin.

Recommendations for surface-water quantity problems include alternate water sources such as the construction of water storage reservoirs and the transfer of Arkansas River water to Bayou Bartholomew. Best Management Practices (BMP's) can be used to reduce the water-quality problems, and watershed protection projects can help implement BMP's in agricultural areas. Water conservation, if practiced throughout the basin, should provide more water of a higher quality in the basin.

Paleozoic, Tertiary and Quaternary age deposits contain freshwater in the Lower Ouachita River Basin. Groundwater withdrawal in 1980 from the Quaternary Aquifer was 240 M.G.D. which represents 85% of the total groundwater withdrawn in the basin and was used primarily for rice irrigation in eastern Ashley, Lincoln, Drew and southern Jefferson Counties. Withdrawals from the Sparta Sand (30 MGD) and the Cockfield Formation (4 MGD) represent 12% of the total groundwater withdrawals in the basin and were used mainly for public supplies and self supplied industry.

Declining water levels and quality degradation have occurred in certain areas of the Quaternary, Sparta Sand and Cockfield use areas. Major problems in the Quaternary Aquifer include: average annual declines of 0.3 feet in Lincoln and Drew Counties (1975-1985); areas exceeding 500 mg/L total dissolved solids; excessive nitrate concentrations; and a critical use area with less than 50% saturated thickness in Ashley and Lincoln Counties.

Major problems in the Cockfield Formation include: declining levels exceeding one foot per year in Cleveland, Lincoln and Union Counties (1980-1985); areas of high specific conductance in Drew, Ashley and Union Counties; and areas of excessive iron concentrations in Grant, Jefferson and Bradley Counties.

Major problems in the Sparta Sand include: declining levels in Columbia, Jefferson and Union Counties resulting in deep cones of depression; declining levels exceeding one foot per year in Lincoln, and Bradley Counties (1980-1985); excessive sodium concentrations in public supply wells in Union, Bradley and Calhoun Counties; excessive chlorides in the El Dorado area; excessive total dissolved solids in eastern Union County; and a critical use area in portions of Columbia and Union Counties.

The problems of quality degradation within the Sparta Sand use area could be lessened by reducing the overdraft rate. In order to meet current water demands, surface water supplies must be developed in Union County. In the meantime, planning efforts should concentrate on continued research, conservation, groundwater modeling, trends of quality in public supply systems and the gradual redistribution of El Dorado wells outside the zone of influence from the graben (fault). Recommendations for the Quaternary Aquifer focus on alternative supplies such as private reservoirs for agriculture, groundwater modeling, conservation and monitoring public supply systems in the critical use area. Recommendations for the Cockfield include: research, conservation, alternative supplies and rewriting regulation #1 to address waste-holding surface impoundments.

TABLE OF CONTENTS

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

PAGE

Chapter I

Chapter II

Chapter III

PAGE

LIST OF FIGURES (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

PAGE

PAGE

CHAPTER IV

CHAPTER I

GENERAL DESCRIPTION

LOCATION AND SIZE

The Lower Ouachita River Basin consists of about 7,657 square miles or 4,900,525 acres of gently rolling land located in the south-central part of the State adjacent to the Louisiana state line. <87> (See Figure 1-1) (Numbers in angle brackets refer to the reference numbers found in the Bibliography) The basin has an overall length of about 135 miles in a generally north-south direction and averages about 50 miles in width. The main watercourse is a reach of the Ouachita River extending from a point immediately downstream from the City of Camden to the Louisiana state line. Navigation on the Ouachita River is open to Camden. Major tributaries of the Ouachita River include the Saline River, Moro Creek, and Bayou Bartholomew. Major impoundments in the basin are Lake Winona, Seven Devils Lake, Calion Lake, Lake Georgia Pacific and the pool formed by the new lock and dam at Felsenthal. There are all or parts of 20 counties in the basin. <87>

Only ten counties (Ashley, Bradley, Calhoun, Cleveland, Drew, Grant, Lincoln, Ouachita, Saline and Union) were selected as the study area for this report even though there are parts of 20 counties located within the boundary of the basin. (See figure 1-2) The remaining 10 counties were omitted from the study area because only a small portion of the county is located in the basin. Also, the data used in this report is collected by county and inclusion of all the counties located only partially in the basin would distort this report. There is a limited amount of data available by hydrologic boundary and where this is used it will be noted as such.

TOPOGRAPHY

Elevations in this basin range from a maximum elevation of about 1,000 feet above mean sea level in the Ouachita Mountains in the northern portion of the basin to a minimum elevation of about 55 feet mean sea level along the Ouachita River near the Arkansas-Louisiana state line. Slopes range from level or nearly level in the eastern part of the basin to moderately steep in the northwestern part of the basin.

CLIMATE

The climatic data for the period 1941-70 at Benton, Warren and Crossett were obtained from the National Oceanic and Atmospheric Administration (NOAA). <97> Locations of all data collection stations and types of data collected at these stations are shown in Figure 1-3. The data compiled in Figure 1-4 characterize climatic conditions in the northern, central and southern areas of the basin.

figure 1-1

LOWER OUACHITA RIVER BASIN

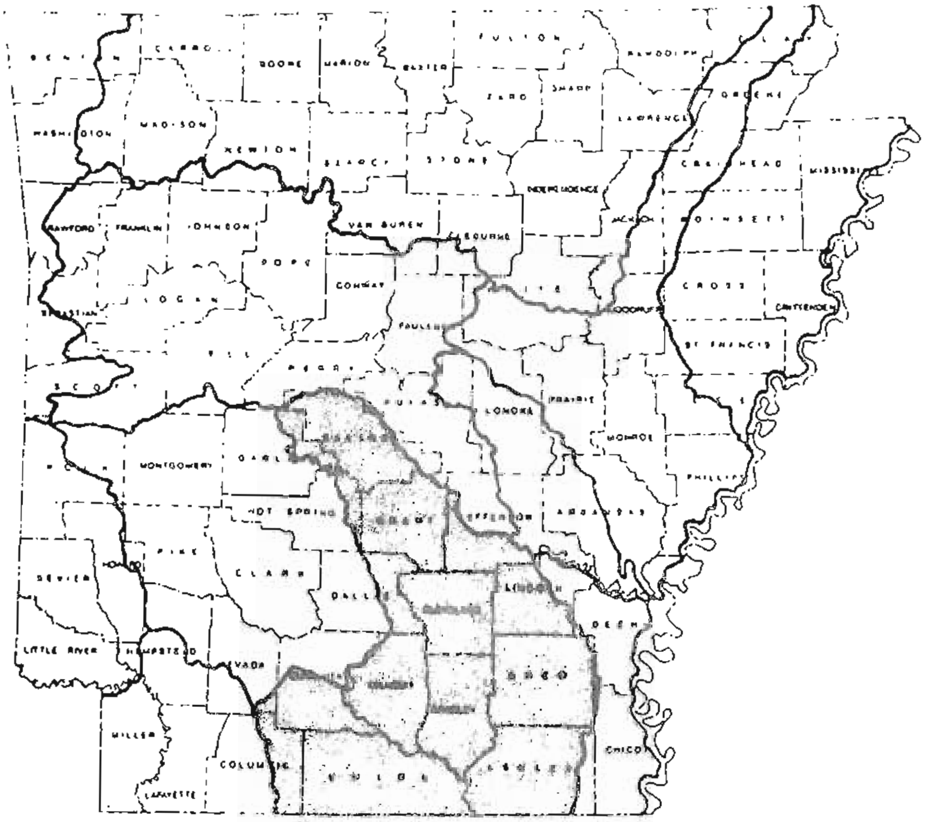


figure 1-2

TEN COUNTY STUDY AREA

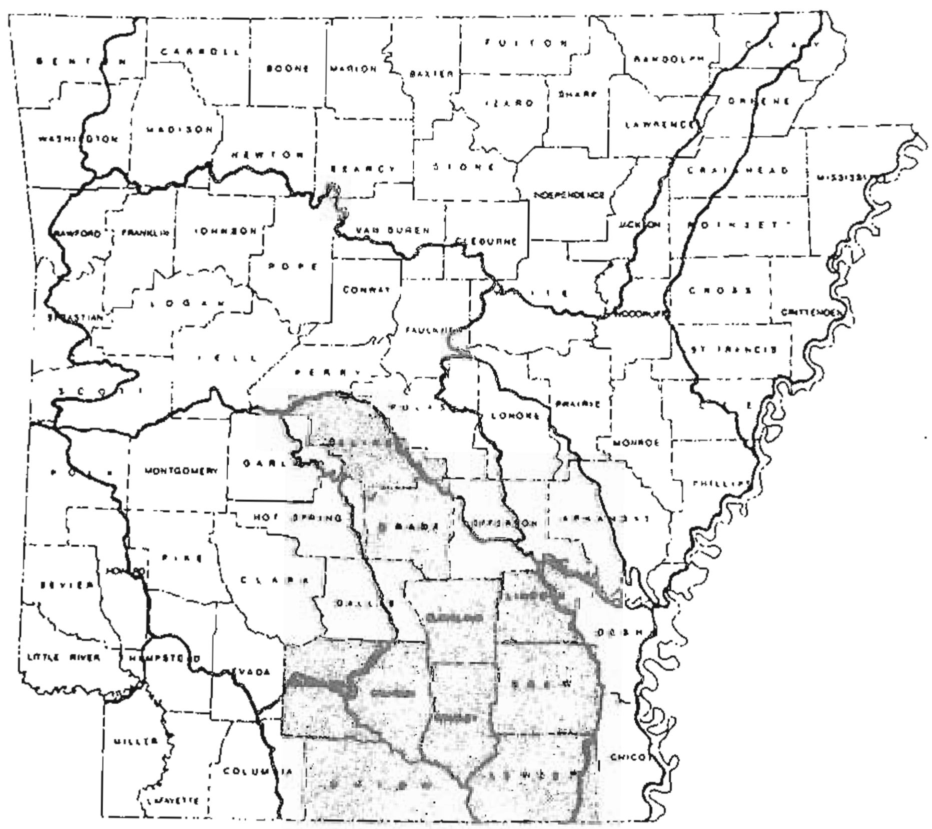
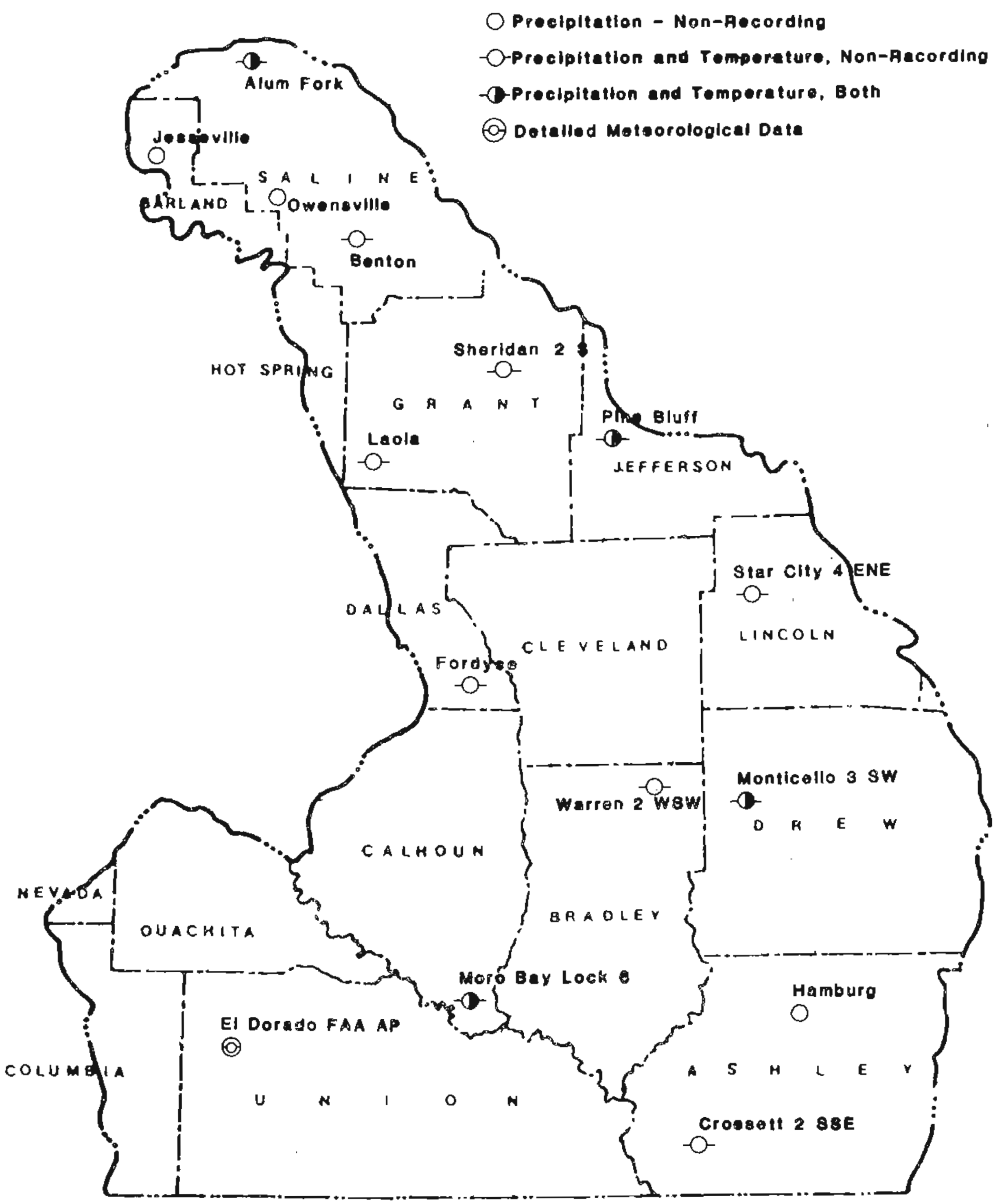


figure 1-3

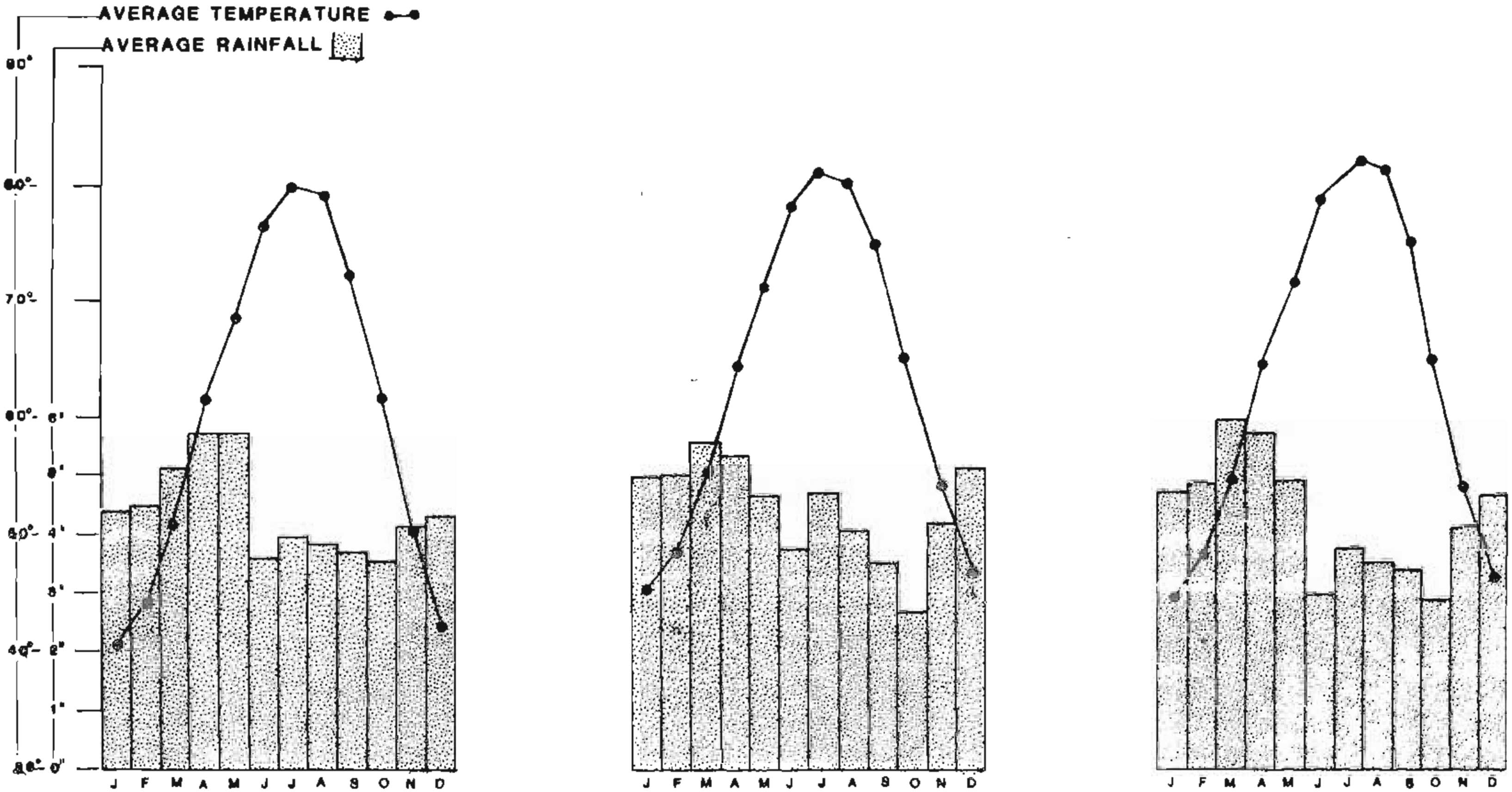
WEATHER STATION LOCATIONS



Source: U.S.Department of Commerce

National Oceanic and Atmospheric Administration, Climatological Data, Arkansas. ⟨83⟩

AVERAGE MONTHLY CLIMATE CONDITIONS IN THE LOWER OUACHITA BASIN 1941-1970



BENTON GAGE
NORTH CENTRAL PORTION OF BASIN

CROSSETT GAGE
SOUTHEAST AREA OF BASIN

WARREN GAGE
CENTRAL AREA OF BASIN

MONTHS	PRECIP	TEMP
JANUARY	4.39	40.5
FEBRUARY	4.45	44.0
MARCH	5.08	50.9
APRIL	5.71	61.7
MAY	5.71	68.8
JUNE	3.59	76.4
JULY	3.93	79.9
AUGUST	3.83	79.2
SEPTEMBER	3.72	72.3
OCTOBER	3.58	61.8
NOVEMBER	4.15	50.5
DECEMBER	4.31	42.4
ANNUAL	52.45	60.7

MONTHS	PRECIP	TEMP
JANUARY	5.00	45.4
FEBRUARY	5.05	48.6
MARCH	5.57	55.2
APRIL	5.36	64.7
MAY	4.66	71.4
JUNE	3.74	78.3
JULY	4.71	81.2
AUGUST	4.08	80.7
SEPTEMBER	3.51	75.1
OCTOBER	2.69	65.2
NOVEMBER	4.21	54.1
DECEMBER	5.12	47.0
ANNUAL	53.70	63.9

MONTHS	PRECIP	TEMP
JANUARY	4.71	44.5
FEBRUARY	4.88	48.1
MARCH	5.98	54.7
APRIL	5.73	64.7
MAY	4.97	71.9
JUNE	2.99	79.0
JULY	3.76	82.2
AUGUST	3.56	81.5
SEPTEMBER	3.43	75.2
OCTOBER	2.91	65.2
NOVEMBER	4.11	54.1
DECEMBER	4.68	46.4
ANNUAL	51.71	64.0

SOURCE: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration. ⟨84⟩

Free water surface (FWS) evaporation varies by six inches annually across the basin. See Figure 1-5. FWS evaporation is defined as "the evaporation from a thin film of water having no appreciable heat storage". <37> This form of evaporation data is more applicable than pan evaporation or lake evaporation data to determine the amount of evaporation loss expected from irrigated acreage. Evaporation from irrigated crops could be as much as 30 inches in the southeast during the period from May to October.

POPULATION AND ECONOMY

Principle economic activities in the basin are agriculture and forest products, mining, and oil and gas production. Forestland accounts for about 84 percent of the present land use. <87> The production and processing of forest products is of major significance to the economy of the region, which contains one of the most highly productive and intensively managed forest areas in the State.

The total 1980 population of the ten counties in the study area was 231,985. This figure represents an increase from the 1970 census of about 32,000 people. Only one of these counties (Ouachita) showed a decrease for that period of time. See Figure 1-6 and Table 1-1 for the population trends in the study area since 1900. <51, 95>

The 1979 per capita personal income for the study area ranged from a low of $5,107 in Lincoln County to a high of $8,032 for Union County. Union County is ranked fifth in the State in regards to high per capita income. The above figures compare to $6,756 for the State and $8,637 nationally.

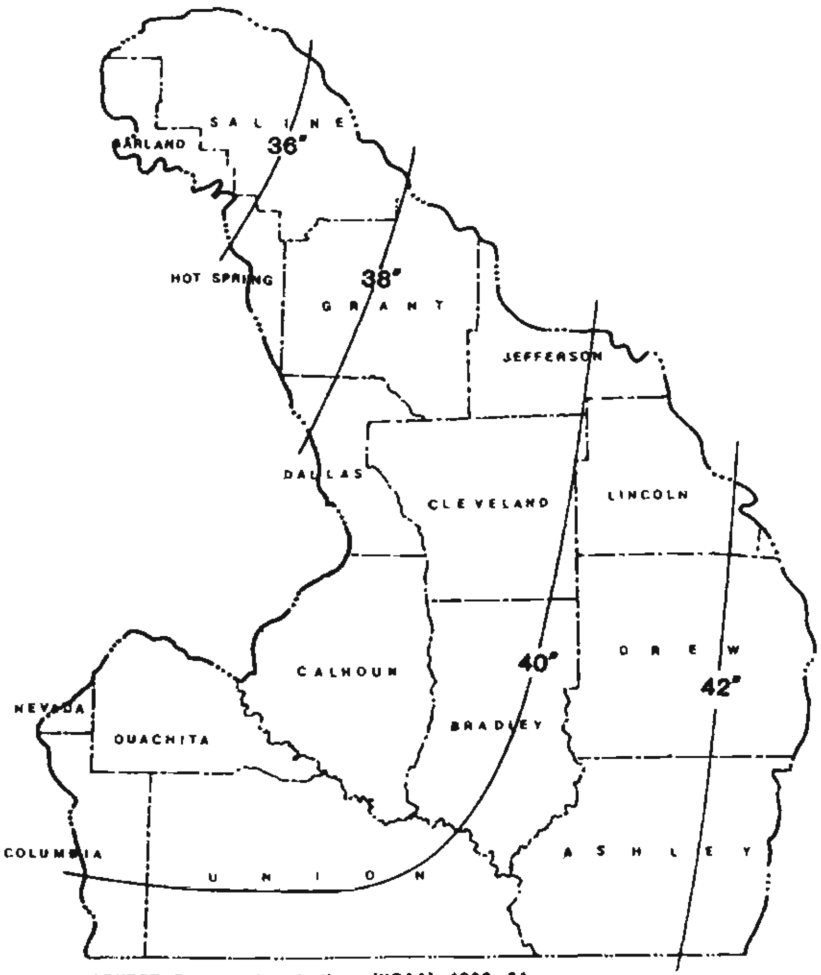
Population projections were made for the year 2000 and the year 2030 for the study area. (Table 1-1) Projections for the year 2000 were made by the Arkansas Department of Pollution Control and Ecology. The Arkansas Soil and Water Conservation Commission's staff extended these projections to the year 2030.

Based on the 1980 census of population data, there was a total of 231,985 people living in the study area. By the year 2000, the number of people living in this area is projected to increase to 301,460, an increase of about 30.0 percent. By the year 2030, projections indicate the population could be 398,990, an increase from the year 2000 of about 32 percent. The above figures show an overall increase in population of about 72 percent from 1980 to the year 2030.

figure 1-6a

FREE WATER SURFACE EVAPORATION

ANNUAL

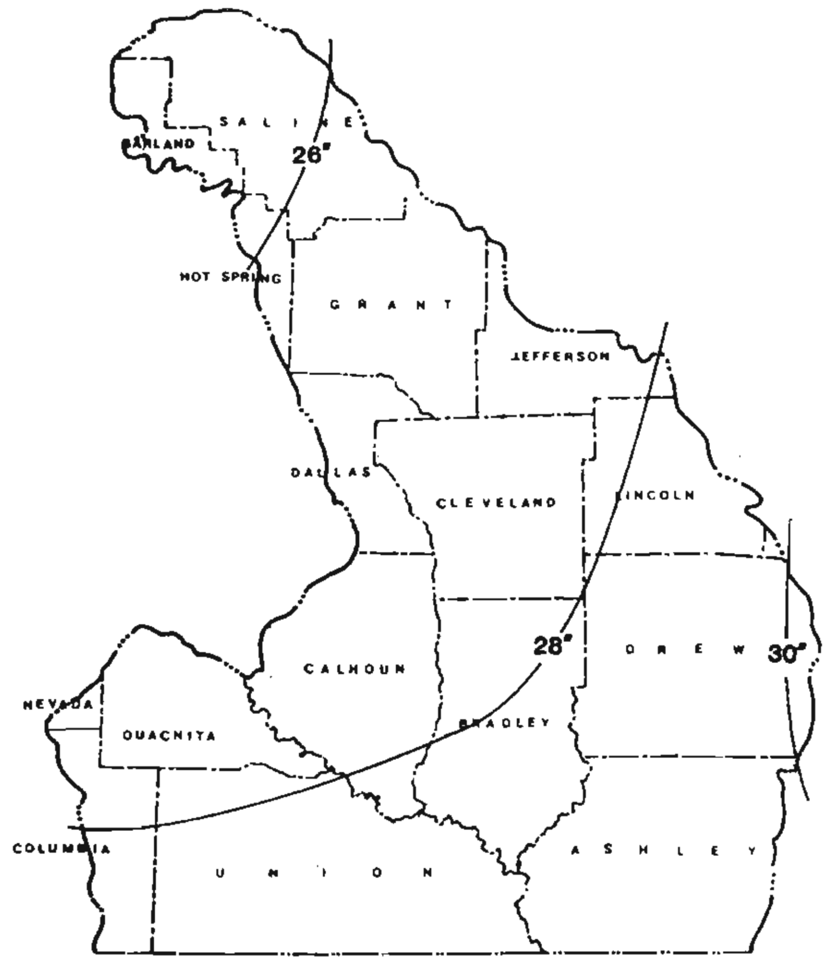


SOURCE: Farnsworth and others (NOAA), 1982 31

figure 1-6b

FREE WATER SURFACE EVAPORATION

MAY - OCTOBER



SOURCE: Farnsworth and Others (NOAA)

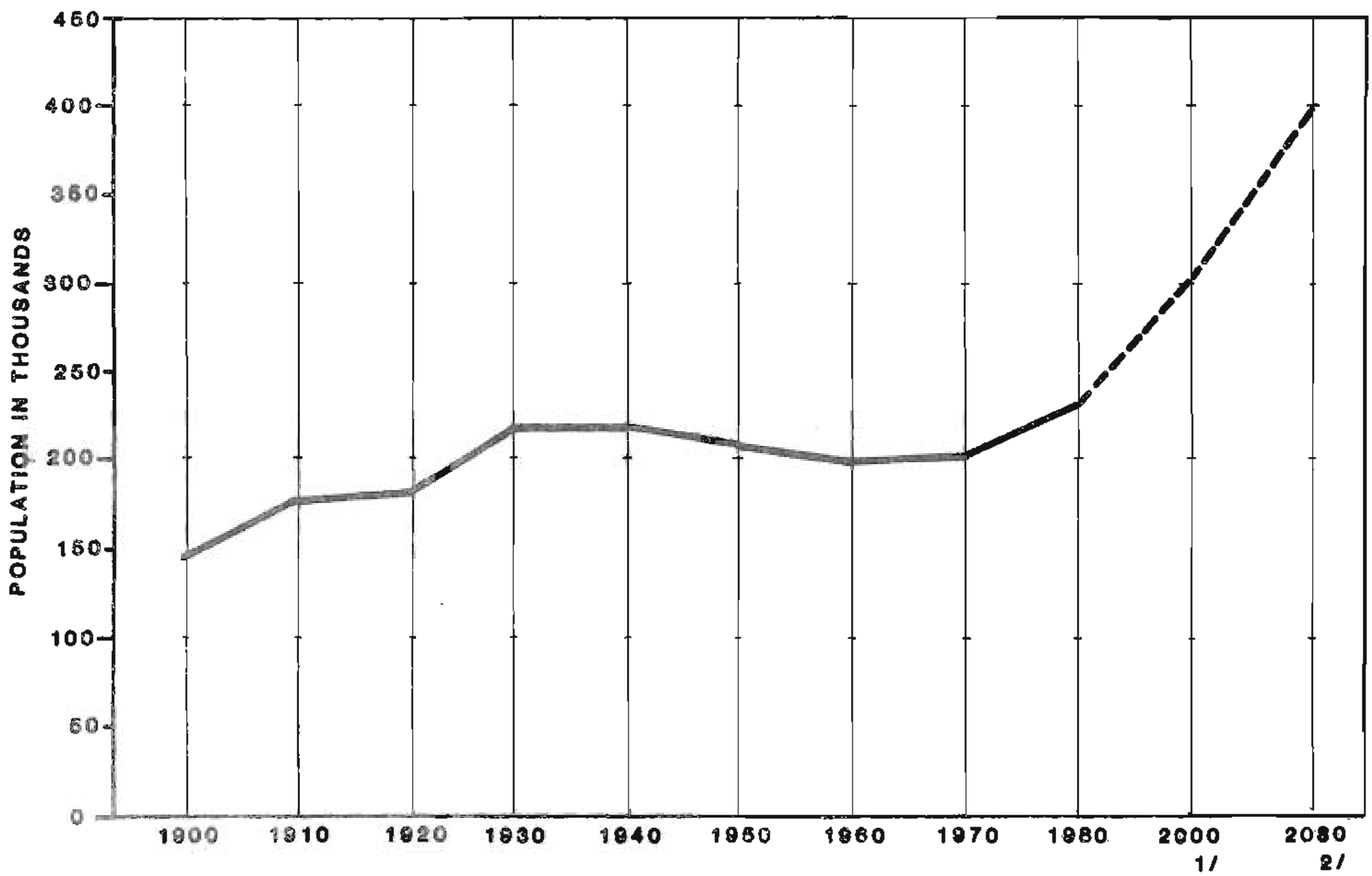
Table 1-1

POPULATION TRENDS AND PROJECTIONS
In The Lower Ouachita Study Area

COUNTY	YEARS 1900	1910	1920	1930	1940	1950	1960	1970	1980	1/ 2000	2/ 2030
ASHLEY	19,734	25,368	23,410	25,151	26,785	25,660	24,220	24,976	26,538	28,900	32,430
BRADLEY	9,651	14,518	15,970	17,494	18,097	15,987	14,029	12,778	13,803	14,400	15,300
CALHOUN	8,539	9,894	11,807	9,752	9,636	7,132	5,991	5,573	6,079	6,670	7,570
CLEVELAND	11,620	13,481	12,260	12,744	12,570	8,956	6,944	6,605	7,868	10,390	14,180
DREW	19,451	21,960	21,822	19,928	19,831	17,959	15,213	15,157	17,910	23,420	31,680
GRANT	7,671	9,425	10,710	9,834	10,477	9,024	8,294	9,711	13,008	19,600	29,500
LINCOLN	13,389	15,118	18,774	20,250	19,709	17,079	14,447	12,913	13,369	16,500	20,990
OUACHITA	20,892	21,774	20,636	29,890	31,151	33,051	31,641	30,896	30,541	39,920	53,520
SALINE	13,122	16,657	16,781	15,660	19,163	23,816	28,956	36,107	52,881	86,430	136,750
UNION	22,495	30,723	29,691	55,800	50,461	49,686	49,518	45,428	49,988	55,230	57,080
TOTAL	146,564	178,918	181,861	216,503	217,880	208,350	199,253	200,144	231,985	301,460	398,990

Source: Industrial Research & Extension Center <45>
1/ Arkansas Department of Pollution Control & Ecology
2/ Arkansas Soil and Water Conservation Commission

figure 1-6
ANNUAL POPULATION TRENDS IN THE STUDY AREA



CHAPTER II

LAND RESOURCES INVENTORY

LAND USE

Most of the land in this basin is composed of forestland. Forestland accounts for approximately 4,118,200 acres or 84 percent of the total 4,900,500 acres in this basin. Grassland occupies 7.5 percent (369,200 acres) and cropland covers 5.9 percent (286,800 acres) of this basin. (See Figure 2-1) Of the remaining lands in the basin, urban and built-up land accounts for 96,900 acres (2.0 percent), and water and other lands account for 29,400 acres (0.6 percent). <87> See Table 2-1 for the Present Land Use by Counties.

The 286,800 acres of cropland found in the basin represent about 3.7 percent of the total cropland in the State. This basin produced about 7 percent of the cotton, 3 percent of the soybeans, and 3 percent of the total rice grown in Arkansas in 1980. This, however, has not always been true. The 40-year trend of major crops grown in the basin is shown in Figure 2-2. As can be seen from this figure, soybeans and rice are the only crops which have had a substantial increase in the number of acres harvested, while the other crops generally remained the same. <85, 87>

Forestland

There are approximately 4,118,200 acres of forestland in this basin. This represents 84 percent of the present land use in the basin and about 22.5 percent of the total forestland in the state. Forestland in the basin is mostly of the Loblolly-Shortleaf Pine type (See Table 2-2). The forestland is used primarily for commercial purposes. In fact, almost 58 percent of the forestland in this basin is owned by the forest industry alone (See Table 2-3). <87>

TABLE 2-2
FOREST LAND BY TYPE
IN THE LOWER OUACHITA BASIN

FOREST TYPE	ACRES	PERCENT
LOBLOLLY-SHORTLEAF PINE	2,100,300	51.0
OAK-PINE	1,359,000	33.0
OAK-HICKORY	164,700	4.0
OAK-GUM-CYPRESS	494,200	12.0
TOTAL	4,118,200	100.0

SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

TABLE 2-3
FOREST LAND BY OWNERSHIP
IN THE LOWER OUACHITA BASIN

OWNERSHIP	ACRES	PERCENT
FEDERAL	122,700	2.9
STATE	20,200	0.5
CITY	2,400	0.1
FOREST INDUSTRY	2,371,600	57.6
MISC., PRIVATE	1,601,300	38.9
TOTAL	4,118,200	100.0

SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

Wetlands

Wetlands are areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support a prevalence of plants which are adapted for life in saturated soil conditions. Such areas in Arkansas are commonly referred to as swamps, sloughs, shallow lakes, ponds, and river-overflow lands.

As part of an inventory of the Nation's resources, the SCS collected information about wetlands in 1982. <90> Inventory sample areas were classified with respect to types of wetlands as described in Wetlands of the United States, Circular 39. <71> Within the Lower Ouachita Basin, a total of 474,000 acres of wetlands, including river-overflow lands and permanently flooded sloughs and swamps, were estimated to occur. <90>

An estimated 94 percent of the wetlands in this basin are forested wetlands. <90> A high percentage of the forested wetlands are seasonally flooded bottomland hardwoods. These wetlands have numerous functional values. Major functions of these bottomland hardwood wetlands are food and cover for fish and wildlife, water quality improvement, groundwater recharge, soil enrichment, erosion control, and downstream fishery benefits. (See comments from the Little Rock District, Corps of Engineers in the appendix).

Wetlands are waters of the United States and are subject to regulation by the U.S. Army Corps of Engineers as promulgated by Section 404 of the Clean Water Act of 1977, as amended. Any discharge of dredge or fill material in a wetland that is adjacent to a Phase I, II, or III stream (as described in Section 404 of the Clean Water Act, 1977) requires a permit from the Corps of Engineers.

Cropland

There are about 286,000 acres of cropland within this basin. This represents about 6 percent of the present land use in this basin.

Prime Farmland

Prime Farmland is land that is well suited to the production of food and fiber. This land has the quality needed to produce sustained yields of crops economically, if managed according to acceptable farm practices. The land use of prime farmland could be cropland, pastureland, rangeland, forest land, or other land, but not urban land, built-up land, or water. The Prime Farmland Map, Figure 2-3, indicates that most of the land in this basin is in the 25 to 50 percent prime farmland region.

There are 1,529,000 acres of prime farmland in this basin which is 13 percent of the 11,624,500 acres of prime farmland located within the state. The land uses in the basin and the amount of prime farmland occurring on each land use are as follows: forest land - 1,071,000 acres, cropland - 296,000 acres, pastureland - 157,000 acres, and minor land uses - 5,000 acres. <90> A 1979 study conducted by the USDA-SCS showed that 2,000 acres of prime farmland were lost in a one-year period from 1978 to 1979 in the basin, mostly as a result of urban and built-up areas. <92>

TABLE 2-4
PRESENT AND POTENTIAL IRRIGATED CROPS
(1980, 2000, and 2030)
CROPS IN ACRES

YEARS	COTTON	CORN	SOYBEANS	RICE	SORGHUM	TOTAL 4/
	ACRES					
1980	21,500 1/	-	14,700 1/	80,000 1/	-	116,200
2000	34,300	200	134,800	90,500	800	260,600 2/
2030	53,400	600	314,900	106,100	2,100	477,100 3/

1/ USDS, CROP AND LIVESTOCK REPORTING SERVICE <69>
2/ STRAIGHT LINE INTERPOLATION
3/ USDA, SOIL CONSERVATION SERVICE <93>
4/ EXCLUDES ACREAGE ON WHEAT, VEGETABLES, ORCHARDS AND VINEYARDS, AND HAYLAND.

The projections made by ERS were evaluated on a statewide basis. In this analysis, it was assumed that the total acreage of cropland in the state would remain the same. Additional cropland projected in some basins would be offset by reversion of cropland to other uses in other basins. <93>

Irrigated acres projected statewide were allocated to the Lower Ouachita Basin and other basins primarily on the basis of the occurrence of soil groups that the model indicated would be used to produce irrigated crops. <93> As shown in Figure 2-3, this basin has a large percentage of prime farmland which indicates a high potential for increasing the amount of cropland in the basin; however, investigation of the land use in the basin reveals that forestland accounts for about 87 percent of the prime farmland that is available for conversion to cropland. <90> The cost of converting land in other uses to irrigated cropland was not specifically considered in developing the ERS projections. <93>

There are 327,000 acres of cropland in the basin according to NRI 82 data. <90> In order to meet the ERS projections for 2030 (477,100 irrigated acres), 150,100 acres must be converted from other land uses to cropland if all cropland is irrigated. If this projection is met, 90 percent of the land with a reasonable potential for conversion will be in cropland and all of the cropland will irrigated. This suggests that the projections made for irrigated cropland are maximum potential conditions with virtually all of the potential cropland being converted to cropland, and all cropland being irrigated. These maximum potential projections are valuable to the State Water Plan because the maximum potential for development of irrigated cropland has been quantified and may be used to determine water needs in a manner that will preserve plenty of water for agricultural uses in this basin.

SOIL RESOURCES

Major Land Resource Areas

The four major land resource areas in the basin are the Ouachita Mountains, Southern Mississippi Valley Alluvium, Coastal Plain, and Southern Mississippi Valley Silty Uplands. These major land resource areas are illustrated in Figure 2-4. A general description of each area is provided in the following paragraphs.

Ouachita Mountains

The Ouachita Mountains area consists of a series of east-west ridges and valleys in the northwest part of this basin. Common bedrock is shale, slate, quartzite, novaculite and sandstone. The rocks are generally steeply inclined, fractured and folded. Elevations range from about 500 to 1,000 feet above sea level. Soils are deep to shallow and moderately permeable to slowly permeable. Slopes range from level to gently sloping in the valleys to moderately sloping to very steep on the mountain sides. Most of this area is used for timber production. Some narrow valleys have been cleared and are used for pasture production. This area makes up about seven percent or 327,700 acres of this basin. <88, 89>

Southern Mississippi Valley Alluvium

This area consists of broad alluvial plains in the extreme eastern part of this basin. Elevations range from about 100 to 400 feet above sea level. Soils developed from deep alluvial sediments. The soils are deep and rapidly permeable to very slowly permeable. Slopes are dominantly level to nearly level and some areas are undulating. Most of this area is used for production of cultivated crops. Some areas remain forested and are important for hardwood production and wildlife habitat. This area makes up approximately six percent or 324,000 acres of this basin. <88, 89>

Coastal Plain

The Coastal Plain area consists of rolling terrain broken by stream valleys. Elevations range from about 100 to 500 feet above sea level. The deep soils developed from marine sediments and are rapidly to slowly permeable. Slopes are level to nearly level on flood plains and terraces and nearly level to moderately sloping on uplands. This area is used extensively for timber production and pasture. Seventy-seven percent or 3,782,800 acres of this basin are located within this resource area. <88, 89>

Southern Mississippi Valley Silty Uplands

This area consists of broad level to nearly level areas and gently to moderately sloping areas in the southeastern part of the basin. Elevations range from 150 to 500 feet above sea level. Soils developed from deep loess deposits that in some areas have

CHAPTER III

SURFACE WATER

INTRODUCTION

The principle streams in the Lower Ouachita Basin are the Ouachita River and Bayou Bartholomew. Other major streams in the basin include Hurricane Creek, Smackover Creek, Moro Creek and Saline River. Generally, the stream patterns are very irregular and meandering. Many of the streams have relatively flat slopes which contribute to the sluggish streamflow in many parts of the basin.

There are approximately 290 impoundments with a surface area of 5 acres or more in the Lower Ouachita Basin. There are also an estimated 8,700 impoundments in the basin which are less than 5 acres in size. The total capacity for all impoundments in this basin is approximately 144,000 acre feet. <11>

The average annual runoff in the Lower Ouachita Basin ranges from about 12.5 inches in the southwestern part of the basin to about 20.5 inches in the northern part of the basin. <40> Runoff varies seasonally as well as annually, with the area subject to extremes of both flood and drought. The seasonal variability is characterized by low flows which usually occur during June through December each year. It is important to note that this period of lowest streamflow includes the agricultural growing season which is a period of significant water use from some streams in the basin, such as Bayou Bartholomew. Therefore, optimum development of surface-water resources in the Lower Ouachita Basin requires storage of the high winter and spring flows to meet the summer and fall demands.

The suitability of streamflow for most uses depends on the flow characteristics of a stream and the chemical, physical and biological properties of the water. These streamflow characteristics vary with time, with location and with manmade changes, and exert a major influence on the economics of the water development.

According to Speer and others <72>, many streams in the Lower Ouachita Basin are affected by manmade changes such as diversion of water to and from the streams, dredging of channels, and construction of levees. The effects of these manmade changes, however, are not necessarily permanent. For example, sediment may partially fill dredged channels, or the channels may erode deeper due to increased velocity of flow. On the other hand, major reservoirs created on streams have significant and permanent effects on downstream flows. Flow of the Ouachita River is affected by the Felsenthal Lock and Dam which is located near the state line. Flow in the Ouachita River is also significantly affected by Lakes Catherine, Hamilton, Greeson, Ouachita and DeGray which are located in the Upper Ouachita Basin.

This section of the report presents an inventory of the surface-water resources of the Lower Ouachita Basin. Present water use and estimated future water needs are also quantified. In addition, problems affecting existing water resources are outlined and solutions and recommendations to solve existing problems are suggested. This information will provide a guide for the future use, management, and development of the water resources of the Lower Ouachita Basin.

SURFACE-WATER INVENTORY

Surface-water data collection network

Gage-height, streamflow, and water-quality data are collected in the Lower Ouachita Basin primarily by the U. S. Geological Survey, the Arkansas Department of Pollution Control and Ecology, and the U. S. Army Corps of Engineers. Locations of 27 streamflow and (or) water-quality data collection sites are shown in Figure 3-1. Five sites in Louisiana were included in this report to provide additional information on streams in southern Arkansas. There are many more sites in the basin where surface-water data have been collected, however, the 27 stations selected have relatively long-term records available for study.

Additional information on the data collection sites in Figure 3-1 is summarized in Table 3-1. Streamflow data for the gaging station on the Ouachita River at Camden, which is outside the basin, are used in several sections of this report because there are limited streamflow data available for stations on the Ouachita River. However, the gaging station at Camden is located in the Upper Ouachita Basin, therefore, information on the data collection site was not included in the data collection network for the Lower Ouachita Basin.

The U. S. Army Corps of Engineers collects gage-height data at sites other than those listed in Table 3-1. Information on selected gaging stations operated by the Corps in the Lower Ouachita Basin is summarized in Table 3-2.

Streamflow characteristics

Distribution of streamflow is dependent upon climate, physiography, geology, and land use in the basin. Basins where these conditions are similar may have similar streamflow characteristics. Generally, the distribution of high flows is governed largely by the climate, the physiography, and the plant cover of the basin. The distribution of low flows is controlled mainly by the basin geology. Streamflow variability is the result of variability in precipitation as modified by the basin characteristics previously mentioned. The variability is reduced by storage, either on the surface or in the ground. <70>

To analyze the variability of streamflow in the Lower Ouachita Basin, flow-duration curves were developed for streams at gaging station locations. The flow-duration curve is a cumulative

figure 3-1

STREAMFLOW AND WATER-QUALITY DATA COLLECTION SITES

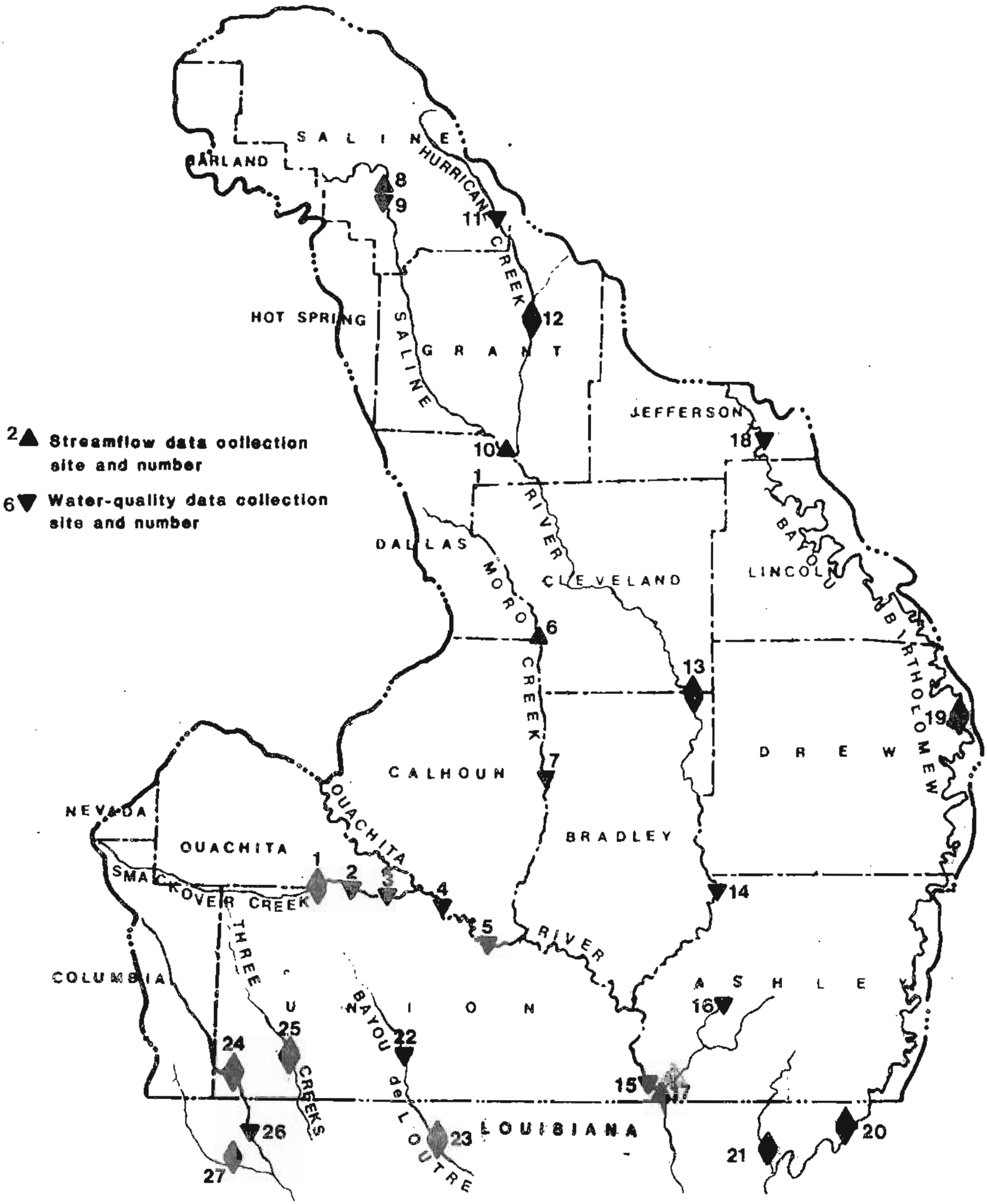


TABLE 3-1
SUMMARY OF SELECTED STREAMFLOW AND WATER-QUALITY DATA COLLECTION SITES.
(DATA COLLECTED BY U. S. GEOLOGICAL SURVEY UNLESS OTHERWISE NOTED.
SITE NUMBERS CORRESPOND TO THOSE IN FIGURE 3-1.)

SITE NO.	USGS STATION NO.	ADPC&E STATION NO.	NAME	DRAINAGE AREA (SQ.MI.)	PERIOD & TYPE OF RECORD	EXTREMES FOR PERIOD OF RECORD: MAXIMUM DISCHARGE (CFS) & DATE	EXTREMES FOR PERIOD OF RECORD: MINIMUM DISCHARGE (CFS) & DATE	AVG. DISHCARGE (CFS) FOR PERIOD OF RECORD
1	07362100	-	SMACKOVER CREEK NR. SMACKOVER	385	STREAMFLOW: 1962-83 WATER QUALITY: 1978, 1981	52,700 6-8-74	0 8-9-64	374
2	07362110	OUA 27	SMACKOVER CREEK NORTH OF SMACKOVER	411	WATER QUALITY 1/: APRIL 1974-83	-	-	-
3	07362200	-	SMACKOVER CREEK NR. NORPHLET	-	WATER QUALITY: 1953-55, 1960-71, 1981	-	-	-
4	07362390	-	OUACHITA RIVER AT CALION	-	WATER QUALITY 1/: 1950-54, 1971, 1981	-	-	-
5	07362400	OUA 07A	OUACHITA RIVER AT LOCK & DAM 8, NR. CALION	-	WATER QUALITY 1/: JAN. 1972-83	-	-	-
6	07362500	-	MORO CREEK NR. FORDYCE	240	STREAMFLOW: AUG. 1951-83	26,800 5-2-58	NO FLOW AT TIMES	238
7	07362550	OUA 28	MORO CREEK NR. BANKS	385	WATER QUALITY 1/: APRIL 1974-78, 1980-83	-	-	-
8	07363000	-	SALINE RIVER AT BENTON 2/	550	STREAMFLOW: 1951-79	100,000 1-30-69	NO FLOW AT TIMES DURING JULY AND AUGUST, 1954	784
9	07363002	OUA 26	SALINE RIVER WEST OF BENTON	550	WATER QUALITY 1/: APRIL 1974-83	-	-	-
10	07363200	-	SALINE RIVER NR. SHERIDAN	1123	STREAMFLOW: 1971-82	59,600 6-10-74	5.5 9-15-80	1601
11	07363270	OUA 31	HURRICANE CREEK NR. SARDIS	66.0	WATER QUALITY 1/: APRIL 1974-83	-	-	-

						EXTREMES FOR PERIOD OF RECORD		
SITE NO.	USGS STATION NO.	ADPC&E STATION NO.	NAME	DRAINAGE AREA (SQ.MI.)	PERIOD & TYPE OF RECORD	MAXIMUM DISCHARGE (CFS) & DATE	MINIMUM DISCHARGE (CFS) & DATE	AVG. DISHCARGE (CFS) FOR PERIOD OF RECORD
12	07363300	-	HURRICANE CREEK NR. SHERIDAN	204	STREAMFLOW: 1962-83 WATER QUALITY: 1950-55, 1968-71, 1978-80	18,100 4-24-64	NO FLOW AT TIMES	229
13	07363500	-	SALINE RIVER NR. RYE	2102	STREAMFLOW: AUG. 1937-83 WATER QUALITY: 1947,1949-55, NOV. 1957-1960, 1968-71, 1978-80	74,500 5-18-68	3.5 9-27,28-54	2587
14	07364012	OUA 10A	SALINE RIVER NR. FOUNTAIN HILL	-	WATER QUALITY 1/: JAN. 1972-83	-	-	-
15	07364080	OUA 08	OUACHITA RIVER NR. FELSENTHAL	-	WATER QUALITY 1/: 1950-80	-	-	-
16	07364088	OUA 11A	COFFEE CREEK NR. CROSSETT	-	WATER QUALITY 1/: JAN. 1972-83	-	-	-
17	07364100	-	OUACHITA RIVER NR. AR-LA STATE LINE 3/	10,787	STREAMFLOW: APRIL 1958-83 (DAILY GAGE HEIGHTS & DAILY DISCHARGES BELOW 19.0 FT. STAGE ONLY.)	3/	MINIMUM DAILY 190 9-13-71	-
18	07364115	OUA 33	BAYOU BARTHOLOMEW NR. LADD.	-	WATER QUALITY 1/: MAY 1974-83	-	-	-
19	07364150	-	BAYOU BARTHOLOMEW NR. MCGEHEE	576	STREAMFLOW: 1939-42, 1946-83 WATER QUALITY: 1960-72	6870 5-11-58	0.20 8-15,23-56	676
20	07364200	OUA 13	BAYOU BARTHOLOMEW NR. JONES, LA. 4/	1187	STREAMFLOW: 1958-83 WATER QUALITY 1/: 1957-58, 1964-77, 1981-83	6710 1 -2-83	27 9-31-83	1269
21	07364300	-	CHEMIN-A-HAUT BAYOU NR. BEEKMAN, LA. 5/	271	STREAMFLOW: 1956-79 WATER QUALITY 1/: 1971-74	29,500 4-26-58	NO FLOW AT TIMES IN 1956,1963, 1965,1966, & 1971.	294

SITE NO.	USGS STATION NO.	ADPC&E STATION NO.	NAME	DRAINAGE AREA (SQ.MI.)	PERIOD & TYPE OF RECORD	EXTREMES FOR PERIOD OF RECORD MAXIMUM DISCHARGE (CFS) & DATE	MINIMUM DISCHARGE (CFS) & DATE	AVG. DISHCARGE (CFS) FOR PERIOD OF RECORD
22	07364600	OUA 05	BAYOU DE LOUTRE NR. EL DORADO	-	WATER QUALITY 1/: 1971-83	-	-	-
23	07364700	-	BAYOU DE LOUTRE NR. LARAN, LA.	141	STREAMFLOW: 1956-1977 WATER QUALITY: 1958, 1968-71	23,900 6-9-74	1.0 7-21,25,26-64	185
24	07365800	-	CORNIE BAYOU NR. THREE CREEKS	180	STREAMFLOW: FEB. 1956-83 WATER QUALITY 1/: MAY 1950-62, 1971-74,1980-83	65,000 6-8-74	NO FLOW AT TIMES	175
25	07365900	-	THREE CREEKS NR. THREE CREEKS	50.3	STREAMFLOW: FEB. 1956-71 WATER QUALITY 1/: MAY 1950-62, 1971-74	11,300 4-6-58	NO FLOW AT TIMES IN MOST YRS.	49.5
26	07366000	-	CORNEY BAYOU NR. LILLIE, LA.	462	WATER QUALITY: 1944,1955-57, 1960-61,1968-73, 1981-83	-	-	-
27	07366200	-	LITTLE CORNEY BAYOU NR. LILLIE, LA.	208	STREAMFLOW: 1956-83 WATER QUALITY: 1957-58,1966-70, 1981-83	24,000 6-9-74	NO FLOW AT TIMES DURING AUG., SEPT. AND OCT., 1956; AND AUG. 11-14, 1964	186

1/ DATA COLLECTED BY ARKANSAS DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY.

2/ LITTLE ROCK DIVERTS ABOUT 35 CFS FROM LAKE WINONA ON ALUM FORK FOR MUNICIPAL USE. BENTON DIVERTS ABOUT 4.0 CFS FOR MUNICIPAL USE JUST UPSTREAM FROM STATION. AT TIMES, LOW FLOW IS AUGMENTED BY RELEASES FROM LAKE NORRELL.

3/ DISCHARGE COMPUTED FOR STAGES BELOW BANKFULL, ABOUT 19 FT. CONSIDERABLE REGULATION BY 5 RESERVOIRS IN ARKANSAS, AND A SERIES OF NAVIGATION LOCKS AND DAMS.

4/ SMALL DIVERSIONS ABOVE STATION FOR IRRIGATION. IN EXTREME FLOODS, CONSIDERABLE FLOW BY-PASSES STATION. MOST OF THE FLOW IS INTO THE BAYOU LAFOURCHE - BOEUF RIVER BASINS BY WAY OF INTERCONNECTING SYSTEM OF BAYOUS AND DRAINAGE DITCHES. OTHER FLOW BYPASSES STATION AND REENTERS THE BASIN 5 MILES DOWNSTREAM BY WAY OF OVERFLOW CREEK.

5/ SOME DIVERSIONS ABOVE STATION FOR IRRIGATION.

TABLE 3-2.
SUMMARY OF SELECTED GAGING STATIONS OPERATED BY THE U. S. ARMY CORPS OF ENGINEERS.

NAME	YEARS OF RECORD	DRAINAGE AREA (Sq.Mi.)	MAXIMUM STAGE (feet)	MINIMUM STAGE (feet)	REMARKS
SALINE RIVER NEAR WARREN	2	2,476	26.22	4.75	GAGE ZERO, 86.02 FEET
BAYOU BARTHOLOMEW NEAR WILMOT	52	1,170	26.3	0	GAGE ZERO, 85.17 FEET
BAYOU BARTHOLOMEW NEAR STAR CITY	36	215	26.29	6.09	GAGE ZERO, 153.25 FEET
HARDING DRAIN AT PINE BLUFF	4	-	19.70	12.30	GAGE ZERO, 185.00 FEET
OUACHITA RIVER NEAR CROSSETT	15	-	86.20	61.0	GAGE ZERO, at MSL
OUACHITA RIVER AT LOCK & DAM 8 (LOWER)	67	6,569	41.2	1.0	GAGE ZERO, 55.07 FEET
OUACHITA RIVER NEAR MORO BAY	15	-	89.95	61.35	GAGE ZERO, at MSL
OUACHITA RIVER AT LOCK & DAM 8 (UPPER)	67	6,569	41.2	1.4	GAGE ZERO, 56.07 FEET

SOURCE: U.S. ARMY CORPS OF ENGINEERS, 1977 <81>

frequency curve of daily mean flows that shows the percent of time which specified discharges were equaled or exceeded. The method outlined by Searcy <70> was used to develop the flow-duration curves and selected points from the curves are summarized in Table 3-3. It should be noted that the flow-duration curve applies only to the period for which data were used to develop the curve or to the period to which the curve is adjusted <70>. However, these data may be used to estimate the probability of occurrence of future streamflow if the period used is representative of the long-term flow of the stream.

Hydrologic and geologic characteristics of a drainage basin are generally the major factors that determine the shape of the flow-duration curve. Flow-duration curves for Moro Creek near Fordyce and Bayou Bartholomew near Jones were plotted in Figure 3-2 to illustrate the significant difference between the streamflow characteristics at the two sites. The flow-duration curve for Moro Creek has a steep slope throughout which denotes highly variable streamflow that is mainly from direct surface runoff. The curve for Bayou Bartholomew has a flat slope which indicates streamflow that is from delayed surface runoff and ground-water storage. The flat slope at the lower end of the curve for Bayou Bartholomew indicates sustained base flow, whereas the steep slope for the Moro Creek curve indicates a negligible base flow.

In the Lower Ouachita Basin, streamflow is generally highest during January through May because of the large amount of precipitation during this period. Similarly, streamflow is generally lowest during June through December due to a decrease in precipitation and an increase in evapotranspiration that occurs during the growing season. Mean monthly discharges at selected gaging stations are shown in Table 3-4.

Streamflow variability of the Saline River near Rye is illustrated in more detail by the streamflow distribution graph in Figure 3-3. The shaded area represents the central 50 percent of the monthly flows. The monthly discharge of the Saline River (for the period of record) has occurred 50 percent of the time within the shaded region. Similarly, 25 percent of the time the monthly discharge was above the shaded area and 25 percent of the time it was below the shaded area. Therefore, the streamflow distribution graph for the Saline River represents a range in flows that have a 50 percent probability of occurring in a given month. The graphs of annual mean discharge in Figure 3-3 illustrate the variation in discharge of the Saline River from year to year for the period of record.

Minimum streamflows generally occur during August through October of each year in the Lower Ouachita Basin. Management and development of surface-water supplies depend on the rate of sustained streamflow during these dry periods. Indices generally used to define low-flow characteristics of streams are the lowest mean discharges for seven consecutive days having recurrence

table 3-3

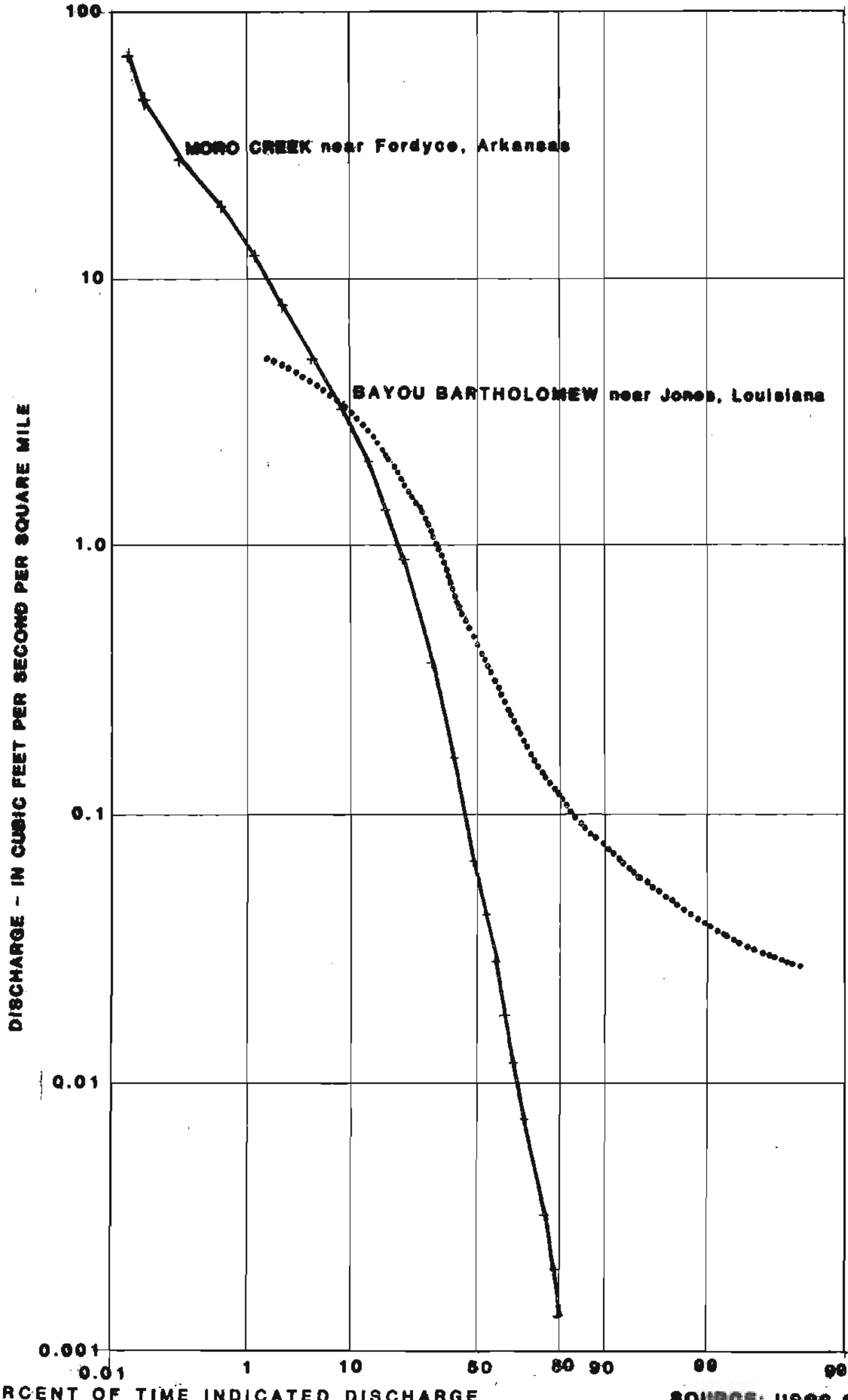
FLOW DURATION OF STREAMS AT SELECTED CONTINUOUS - RECORD GAGING STATIONS

STATION NUMBER & NAME	DRAINAGE AREA (MI2)	RECORDS USED (WTR. YRS)	99.9	99.5	99	98	95	90	80	70	60	50	40	30	20	10	5	2	1	0.5
			FLOW, IN CUBIC FEET PER SECOND, WHICH WAS EQUALED OR EXCEEDED FOR PERCENTAGE OF TIME INDICATED IN COLUMN SUBHEADS																	
07362000 OUACHITA RIVER AT CAMDEN	5357	1955-83	450	545	610	700	880	1080	1500	2040	2770	3560	4650	6450	10,300	17,800	26,000	39,000	51,000	67,500
07362100 SMACKOVER CREEK NEAR SMACKOVER	385	1962-83	0.1	0.5	0.9	1.5	2.6	5.0	14	29	50	82	128	217	435	1060	1720	2680	3720	5250
07362500 MORO CREEK NEAR FORDYCE	240	1952-83	0	0	0	0	0	0	0.3	1.5	5.1	14	38	100	260	665	1120	2100	3120	4260
07363000 SALINE RIVER AT BENTON	550	1951-79	0.3	1.8	6.0	11	19	31	55	88	136	210	320	495	800	1540	3000	6600	10,400	15,300
07363200 SALINE RIVER NEAR SHERIDAN 1/	1123	1951-79	-	-	14	22	36	56	96	160	263	425	670	1120	2090	4100	6600	10,300	14,800	19,000
07363300 HURRICANE CREEK NEAR SHERIDAN	204	1962-83	0	0	0.1	0.5	1.8	3.3	7.2	12	22	38	76	132	232	525	1050	1910	2970	4570
07363500 SALINE RIVER NEAR RYE	2102	1938-83	4.9	11	16	22	39	60	118	213	355	620	1230	2420	4230	7400	10,700	15,900	21,300	29,800
07364150 BAYOU BARTHOLOMEW NEAR MCGEHEE	576	1939-42 1946-83	0.4	4.5	10	16	25	35	56	85	138	227	415	730	1170	1980	2770	3680	4260	4820
07364200 BAYOU BARTHOLOMEW NEAR JONES, LA	1187	1958-83	33	41	47	54	69	90	141	217	330	515	855	1500	2420	3680	4800	5700	6000	6250
07364300 CHEMIN-A-HAUT BAYOU NEAR BEEKMAN, LA	271	1956-79	0	0	0.08	0.2	0.6	1.4	5.1	11	17	29	57	123	325	790	1360	2690	3920	5230
07364700 BAYOU DE LOUTRE NEAR LARAN, LA	141	1956-77	1.6	3.4	4.6	6.0	8.3	12	20	31	46	65	91	135	225	432	710	1200	1640	2270
07365800 CORNIE BAYOU NEAR THREE CREEKS	180	1957-83	0	0	0	0	0.3	1.4	4.6	9.7	18	30	48	87	200	440	710	1330	2120	3140
07365900 THREE CREEKS NEAR THREE CREEKS	503	1958-71	0	0	.06	0.1	0.3	0.5	1.4	2.3	3.5	5.5	8.3	14	29	108	247	477	735	1090
07366200 LITTLE CORNEY BAYOU NEAR LILLIE, LA	208	1956-83	0	0.2	0.4	1.1	2.6	4.3	9.6	19	31	46	68	117	255	490	740	1300	1790	2420

1/ FLOW-DURATION CURVE ADJUSTED USING INDEX-STATION METHOD DESCRIBED BY SEARCY <70>

figure 3-2

FLOW-DURATION CURVES FOR MORO CREEK NEAR FORDYCE AND BAYOU BARTHOLOMEW NEAR JONES LOUISIANA



SOURCE: USGS Streamflow Records

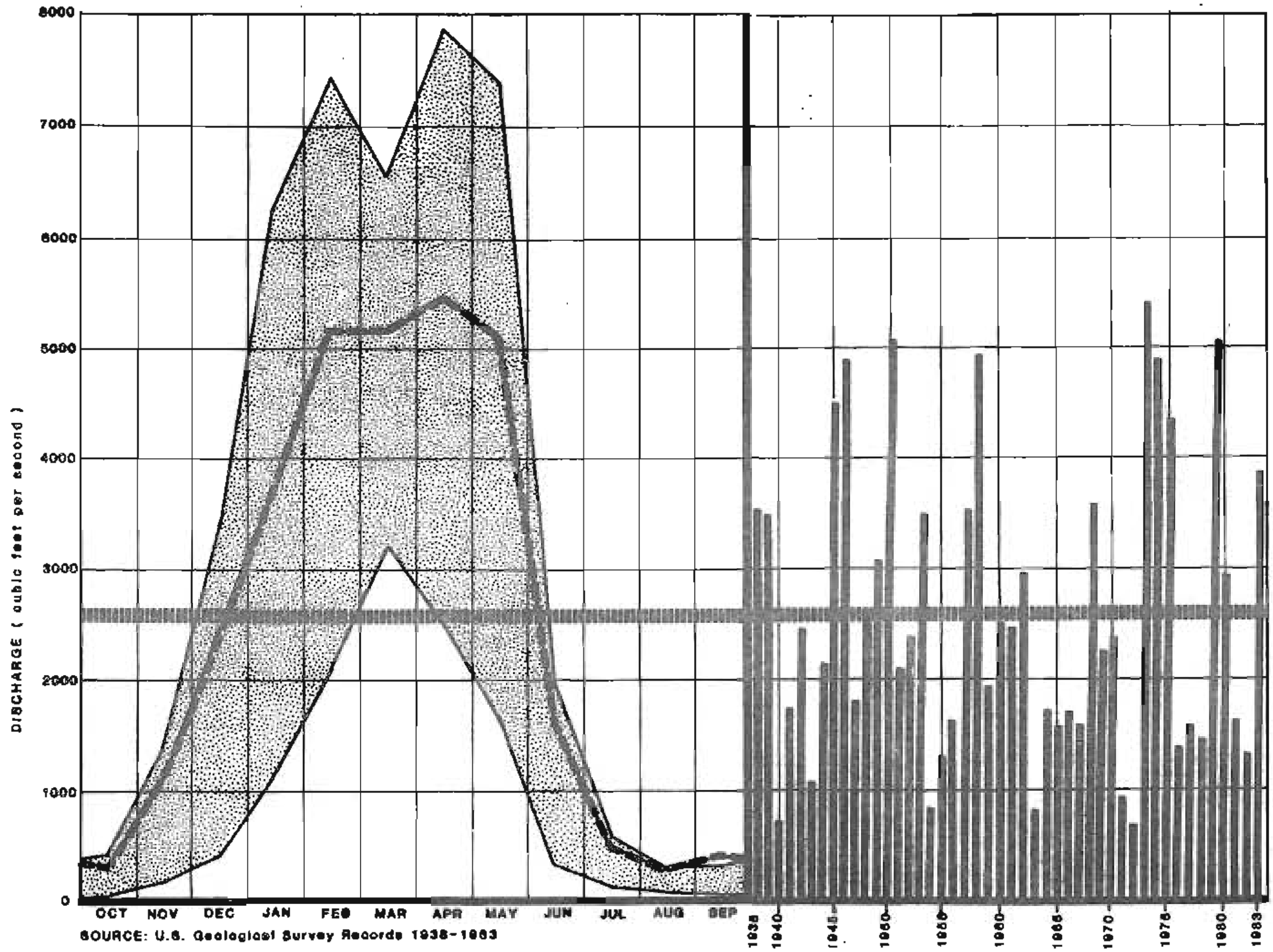
TABLE 3-4
MEAN MONTHLY DISCHARGES AT SELECTED GAGING STATIONS

STATION NUMBER	STATION NAME	DRAINAGE AREA (SQ.MI.)	YEARS USED FOR COMPUTATION	MEAN MONTHLY DISCHARGE (CUBIC FEET PER SECOND) OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
07362000	OUACHITA RIVER AT CAMDEN	5357	1955-83	2927	5978	9037	8373	10640	11060	12140	12990	6312	3243	2664	3100
07362100	SMACKOVER CREEK NR. SMACKOVER	385	1962-83	65.8	219	475	558	678	682	673	571	327	74.8	44.9	143
07362500	MORO CREEK NR. FORDYCE	240	1952-83	12.7	85.0	254	316	476	522	543	471	118	34.2	15.8	24.1
07363000	SALINE RIVER AT BENTON	550	1951-79	198	678	948	1101	1298	1480	1474	1289	472	161	139	204
07363200	SALINE RIVER NR. SHERIDAN	1123	1971-82	234	1756	2280	2165	2226	2855	3185	2089	1488	336	264	386
07363300	HURRICANE CREEK NR. SHERIDAN	204	1962-83	18.9	135	336	346	364	445	520	373	120	21.1	26.3	45.8
07363500	SALINE RIVER NR. RYE	2102	1938-83	331	1130	2472	3710	5161	5152	5459	5099	1596	506	281	398
07364150	BAYOU BARTHOLOMEW NR. MCGEHEE	576	1939-42, 1946-83	168	293	628	980	1393	1302	1246	1169	493	164	136	186
07364200	BAYOU BARTHOLOMEW NR. JONES, LA	1187	1958-83	383	451	1333	1914	2213	2381	2319	2064	1205	376	285	366
07364300	CHEMIN-A-HAUT BAYOU NR. BEEKMAN, LA	271	1956-79	28.9	184	295	453	555	540	652	494	157	47.2	33.8	116
07364700	BAYOU DE LOUTRE NR. LARAN, LA	141	1956-77	49.6	145	199	275	307	305	342	226	179	89.1	37.6	73.0
07365800	CORNIE BAYOU NR. THREE CREEKS	180	1957-83	28.0	105	187	261	306	299	400	254	156	48.0	16.5	46.9
07365900	THREE CREEKS NR. THREE CREEKS	50.3	1958-71	6.87	22.8	56.7	64.8	84.6	103	123	61.4	25.9	26.9	8.17	12.1
07366200	LITTLE CORNEY BAYOU NR LILLIE, LA	208	1956-83	33.2	125	221	291	339	326	376	254	150	60.5	24.1	45.4

SOURCE: U.S. GEOLOGICAL SURVEY STREAMFLOW RECORDS

figure 3-3

STREAMFLOW DISTRIBUTION OF SALINE RIVER NEAR RYE



SOURCE: U.S. Geological Survey Records 1936-1983

MEAN MONTHLY DISCHARGE

MEAN ANNUAL DISCHARGE

CENTRAL 80% OF MONTHLY FLOW

intervals of 2 and 10 years. For simplicity, these indices are referred to as the 7-day $Q_2(7Q_2)$ and 7-day $Q_{10}(7Q_{10})$ discharges, respectively. These discharges are taken from a frequency curve of annual values of the lowest mean discharge for seven consecutive days. Low-flow characteristics of selected streams are shown in Table 3-5. The $7Q_2$ and $7Q_{10}$ discharges per square mile are also shown in Table 3-5 for comparison purposes.

TABLE 3-5
SUMMARY OF LOW-FLOW CHARACTERISTICS
OF SELECTED STREAMS

NAME	PERIOD OF RECORD	$7Q_2$ (cfs)	$7Q_2$/mi2 (cfsm)	$7Q_{10}$ (cfs)	$7Q_{10}$/mi2 (cfsm)
OUACHITA RIVER AT CAMDEN 1/	1955-83	916	0.17	571	0.11
SMACKOVER CREEK NR. SMACKOVER	1963-83	3.3	0.009	0.3	0.001
MORO CREEK NR. FORDYCE	1953-83	0	0	0	0
SALINE RIVER AT BENTON	1952-79	21	0.04	3.6	0.006
SALINE RIVER NR. SHERIDAN	1972-82	37	0.03	12	0.01
HURRICANE CREEK NR. SHERIDAN	1963-83	0	0	0	0
SALINE RIVER NR. RYE	1939-83	41	0.02	13	0.006
OUACHITA RIVER NR. AR-LA STATE LINE 1/	1958-76; 1979-82	1150	0.10	660	0.06
BAYOU BARTHOLOMEW NR. MCGEHEE	1940-83	37	0.06	6.6	0.01
BAYOU BARTHOLOMEW NR. JONES, LA	1959-83	89	0.08	44	0.04

TABLE 3-5
SUMMARY OF LOW-FLOW CHARACTERISTICS
OF SELECTED STREAMS
(CONTINUED)

NAME	PERIOD OF RECORD	$7Q_2$ (cfs)	$7Q_2$/mi2 (cfsm)	$7Q_{10}$ (cfs)	$7Q_{10}$/mi2 (cfsm)
CHEMIN-A-HAUT BAYOU NR. BEEKMAN, LA	1957-79	0	0	0	0
BAYOU DE LOUTRE NR. LARAN, LA	1957-77	9.1	0.06	3.2	0.02
CORNIE BAYOU NR. THREE CREEKS	1957-83	0	0	0	0
THREE CREEKS NR. THREE CREEKS	1959-71	0	0	0	0
LITTLE CORNEY BAYOU NR. LILLIE, LA	1957-83	0.1	0.0005	0	0

1/ LOW-FLOW CHARACTERISTICS ARE APPLICABLE ONLY AS LONG AS THE EXISTING PATTERN OF REGULATION AND (OR) DIVERSION EXISTS.

The $7Q_2$ and $7Q_{10}$ values were determined using U. S. Geological Survey streamflow data and the log Pearson Type III probability distribution program <67>. This program mathematically fits a frequency curve to the discharge data, and the $7Q_2$ and $7Q_{10}$ values are then taken from the curve generated by the program. If a stream is dry during any part of the year, however, this procedure is not directly applicable and a graphical solution for determining the low-flow characteristics must be used.

It should be noted that extrapolation of the $7Q_2$ and $7Q_{10}$ indices in Table 3-5 to other reaches on the streams or to other streams in the basin should not attempted without knowledge of the basin characteristics and without knowledge of the effects of man-made practices. For example, the diversion of water at many locations along Bayou Bartholomew for irrigation purposes affects the low-flow characteristics throughout much of the stream reach. Low-flow characteristics of Bayou de Loutre are affected by several municipal and industrial effluent discharge points along the stream. According to a report on the low-flow characteristics of streams in this area by Speer and others <72>, heavy pumping of

Instream flow requirements

Instream flow requirements are generally defined as "the quantity of water needed to maintain the existing and planned in-place uses of water in or along a stream channel or other water body and to maintain the natural character of the aquatic system and its dependent systems". <83> Instream flow requirements are established at a level at which the flow regime best meets the individual and collective instream uses and off-stream withdrawals of water. Instream uses of water include uses of water in the stream channel for navigation, recreation, fisheries, riparian vegetation, aesthetics, and hydropower. Off-stream water withdrawals include uses such as irrigation, municipal and industrial water supplies, and cooling water.

Section 2 of Act 1051 of 1985 (see legal and institutional setting) requires the Arkansas Soil and Water Conservation Commission to determine instream flow requirements for: (1) water quality, (2) fish and wildlife, (3) navigation, (4) interstate compacts, (5) aquifer recharge, and (6) needs of all other users in the basin such as industry, agriculture, and public water supply. Determination of the amount of water required to satisfy instream needs in the Lower Ouachita Basin is necessary so that streamflow available for use within the basin as well as the amount of excess water available for interbasin transfer can be quantified.

In order to determine instream flow requirements for the categories mentioned above, information was obtained from other agencies such as the Arkansas Department of Pollution Control and Ecology, the Arkansas Game and Fish Commission, and the Corps of Engineers. The flows recommended for the different categories (as provided by the appropriate agencies) were then evaluated with respect to all other instream needs in order to determine the flow regime which best meets the collective instream uses and off-stream withdrawals. This resulted in a two-part solution for the process of determining instream flow requirements. The first approach was to determine the amount of water necessary to satisfy instream needs in the basin based on the flows recommended by other agencies before interbasin transfer of water could take place. The information compiled in the following sections on instream flow requirements pertains to this first approach. The second approach was to determine the amount of water necessary to satisfy minimum instream flow requirements in order to determine the streamflow available for use within the basin. This second approach is described in more detail in the minimum streamflow section of the report.

1. Water-Quality Requirements

The $7Q_{10}$ low-flow characteristic is a common criterion used by state and federal agencies to determine the permissible rate of waste disposal into a given stream since one of the most important factors influencing the concentration of dissolved solids in streamflow is the volume of water available for dilution. The Arkansas Department of Pollution Control and Ecology (ADPC&E) is responsible for the management of water-quality conditions in the Lower Ouachita Basin. The $7Q_{10}$ discharge for streams and rivers in the basin is the minimum flow at which the ADPC&E is responsible for maintaining streamflow contaminant concentrations at acceptable levels. The ADPC&E continues to monitor point-source discharges below the $7Q_{10}$ discharge and requires concentrations of certain pollutants to be maintained below critical levels. However, since sufficient water is not available at times during the year to dilute the effluent discharges, streamflow water quality may not meet the quality standards during all times of the year.

Streams that are affected by regulation are addressed by ADPC&E on a case-by-case basis to determine the minimum flow required to maintain streamflow contaminant concentrations at acceptable levels. The flow of the Ouachita River is significantly affected by reservoirs that are located in the Upper Ouachita Basin. To determine the $7Q_{10}$ low-flow characteristics for locations on the Ouachita River, only those streamflow records which represent the existing pattern of regulation were used in the computations. If significant changes are made in the methods of reservoir regulation in the Upper Ouachita Basin, the $7Q_{10}$ values determined for reaches on the Ouachita River downstream of the reservoirs should be recomputed.

The $7Q_{10}$ discharges were determined at 11 gaging station locations. The discharges required to meet water-quality standards at gaging station locations are as follows:

Bayou Bartholomew	- 6.6 cfs near McGehee	
Smackover Creek	- 0.3 cfs near Smackover	
Moro Creek	- no flow near Fordyce	
Hurricane Creek	- no flow near Sheridan	
Three Creeks	- no flow near Three Creeks	
Cornie Bayou	- no flow near Three Creeks	
Saline River	- 3.6 cfs at Benton 12 cfs near Sheridan 13 cfs near Rye	
Ouachita River	- 571 cfs at Camden 660 cfs at state line	($7Q_{10}$ discharges are applicable only as long as the existing pattern of regulation exists.)

The $7Q_{10}$ discharges at other ungaged locations on streams in the Lower Ouachita Basin can not be statistically quantified. As previously stated, extrapolation of the $7Q_{10}$ indices should not be attempted without knowledge of the basin characteristics and without knowledge of the effects of man-made practices. However, a range for the low-flow characteristics at ungaged locations can be estimated by using available low-flow information from other gaged locations. An example of the methodology that can be used to estimate a range in the $7Q_{10}$ discharge at an ungaged site is described for the Saline River at the mouth. The $7Q_{10}$ discharge for the Saline River near Rye (the most downstream gaging station on the Saline River) is 13 cfs. It is assumed that the minimum $7Q_{10}$ discharge at the mouth is at least equal to the $7Q_{10}$ discharge near Rye, or 13 cfs. The maximum $7Q_{10}$ discharge at the mouth is estimated by adjusting the $7Q_{10}$ discharge near Rye based on a ratio of the drainage areas. This results in an estimate of 20 cfs for the maximum $7Q_{10}$ discharge for the Saline River at the mouth.

The method previously explained was used to estimate the range in $7Q_{10}$ discharges for streams at ungaged locations at the mouth or at the state line with the results shown in Table 3-6. It should be emphasized that the discharge ranges in Table 3-6 are only estimates. However, the results do provide a general range in $7Q_{10}$ discharges for selected locations and can be compared with other instream flow requirements at these locations.

TABLE 3-6
ESTIMATED RANGE IN $7Q_{10}$ DISCHARGE AT SELECTED LOCATIONS IN THE LOWER OUACHITA BASIN

	ESTIMATED $7Q_{10}$ DISCHARGE RANGE (cfs)
BAYOU BARTHOLOMEW AT STATE LINE	6.6-44
SMACKOVER CREEK AT MOUTH	0.3-0.4
MORO CREEK AT MOUTH	no flow
HURRICANE CREEK AT MOUTH	no flow
CHEMIN-A-HAUT BAYOU AT STATE LINE	no flow
BAYOU DE LOUTRE AT STATE LINE	≤ 3.2
THREE CREEKS AT STATE LINE	no flow
CORNIE BAYOU AT STATE LINE	no flow
SALINE RIVER AT MOUTH	13-20
LITTLE CORNEY BAYOU AT STATE LINE	no flow

2. Fish and Wildlife Requirements

Several methods are currently available for determining instream flow requirements for fisheries. Some of these methods, however, require considerable field work to characterize fish habitats in a basin. On the other hand, Tennant <75> developed a method (often referred to as the "Montana Method") which requires limited field work and utilizes historic hydrologic records to estimate instream flow requirements for fish and other aquatic life by correlating the condition of the aquatic habitat with the percent of the average flow present in the stream. The Montana Method was tested by field studies which involved physical, chemical, and biological analyses conducted on 11 streams in three states. Additional analyses of hundreds of additional flow regimens in 21 different states substantiated the correlation between the condition of the aquatic habitat and the percent of the average flow present in the stream. Tennant's comprehensive study resulted in the following conclusions:

(A) "Ten percent (10%) of the average flow: This is a minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life forms. Channel widths, depths, and velocities will all be significantly reduced and the aquatic habitat degraded. The stream substrate or wetted perimeter may be about one-half exposed, except in wide, shallow riffle or shoal areas where exposure could be higher. Most side channels will be severely or totally dewatered. Most gravel bars will be substantially dewatered, and islands will usually no longer function as wildlife nesting, denning, nursery, and refuge habitat. Streambank cover for fish and fur animal denning habitat will be severly diminished. Many wetted areas will be so shallow they no longer will serve as cover, and fish will generally be crowded into the deepest pools. Riparian vegetation may suffer from lack of water. Large fish may have difficulty migrating upstream over many riffle areas. Water temperature may become a limiting factor, especially in the lower reaches of the stream in July and August. Invertebrate life will be severely reduced."

(B) "Thirty percent (30%) of the average flow: This is a base flow recommended to sustain good survival habitat for most aquatic life forms. Widths, depths, and velocities will generally be satisfactory. The majority of the substrate will be covered with water, except for very wide, shallow riffle or shoal areas. Most side channels will carry some water. Most gravel bars will be partially covered with water and many islands will provide wildlife nesting, denning, nursery, and refuge habitat. Streambanks will provide cover for fish and wildlife denning habitat in many reaches. Many runs and most pools will be deep enough to serve as cover for fishes. Riparian vegetation should not suffer from lack of water. Large fish should have no trouble moving over most riffle areas. Water temperatures are not expected to become limiting in most stream segments. Invertebrate life is reduced but not expected to become a limiting factor in fish production."

(C) "Sixty percent (60%) of the average flow: This is a base flow recommended to provide excellent to outstanding habitat for most aquatic life forms during their primary periods of growth and for the majority of recreational uses. Channel widths, depths, and velocities will provide excellent aquatic habitat. Most of the normal channel substrate will be covered with water, including many shallow riffle and shoal areas. Side channels that normally carry water will have adequate flows. Few gravel bars will be exposed, and the majority of islands will serve as wildlife nesting, denning, nursery, and refuge habitat. The majority of streambanks will provide cover for fish and safe denning areas for wildlife. Most pools, runs, and riffles will be adequately covered with water and provide excellent feeding and nursery habitat for fishes. Riparian vegetation will have plenty of water. Fish migration is no problem in any riffle areas. Water temperatures are not expected to become limiting in any reach of the stream. Invertebrate life forms should be varied and abundant."

Tennant's recommended flows are generally applicable for both cold and warm water streams. However, it is suggested that the recommended flow regimens be altered to fit different hydrologic cycles or to coincide with vital periods of the life cycle of fishes.

Filipek and others <39> have developed a new method, termed the "Arkansas method", which utilizes some of Tennant's basic principles. This new method was developed due to limitations in the application of the Montana method to Arkansas streams. The Arkansas method divides the water year into three seasons based on the physical and biological processes that occur in the stream. The three physical/biological seasons as well as the flow recommended for fisheries during each season are described in Table 3-7. The instream flow requirements, as determined by the Arkansas method, are those that apply to fish populations only and represent the point at which fisheries begin to be impacted. The method assumes that when instream flows meet the needs for fisheries, instream requirements for other wildlife forms are probably also satisfied.

The Arkansas method was applied to streamflow data from U.S. Geological Survey gaging stations in the Lower Ouachita Basin. Instream flow requirements for fisheries were first determined at three gaging station locations on the Saline River with the results compiled in Table 3-8. The instream flow requirements were computed as a percent of the mean monthly discharge required for each month of the year. The annual flows required to satisfy

TABLE 3-8
MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR THREE GAGING STATIONS ON THE SALINE RIVER.
(CONTINUED)

07363200 - SALINE RIVER NR. SHERIDAN, AR
(PERIOD OF RECORD: 1971-82)

MONTH	MEAN MONTHLY DISCHARGE (cfs)	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS (cfs)
OCTOBER	234	117
NOVEMBER	1756	1054
DECEMBER	2280	1368
JANUARY	2165	1299
FEBRUARY	2226	1336
MARCH	2855	1713
APRIL	3185	2230
MAY	2089	1462
JUNE	1488	1042
JULY	336	168
AUGUST	264	132
SEPTEMBER	386	193

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 1010 cfs

07363500 - SALINE RIVER NEAR RYE, AR
(PERIOD OF RECORD: 1938-83)

MONTH	MEAN MONTHLY DISCHARGE (cfs)	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS (cfs)
OCTOBER	331	166
NOVEMBER	1130	678
DECEMBER	2472	1483
JANUARY	3710	2226
FEBRUARY	5161	3097
MARCH	5152	3091
APRIL	5459	3821
MAY	5099	3569
JUNE	1596	1117
JULY	506	253
AUGUST	281	140
SEPTEMBER	398	199

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 1653 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

To determine instream flow requirements for the Saline River at the mouth, an ungaged location, the following procedure was used. Mean monthly discharges for the gaging station near Rye were adjusted based on a ratio of the drainage areas of the Saline River near Rye and the Saline River at the mouth. The Arkansas method was then applied to the estimated mean monthly flows to determine the instream flow requirements at the mouth of the Saline River (Table 3-9).

TABLE 3-9
ESTIMATED MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR THE SALINE RIVER AT THE MOUTH

MONTH	MEAN MONTHLY DISCHARGE (cfs) OF SALINE RIVER NEAR RYE	ESTIMATED MEAN MONTHLY DISCHARGE (cfs) OF SALINE RIVER AT MOUTH	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS AT MOUTH (cfs)
OCTOBER	331	512	256
NOVEMBER	1130	1747	1048
DECEMBER	2472	3822	2293
JANUARY	3710	5736	3442
FEBRUARY	5161	7980	4788
MARCH	5152	7966	4780
APRIL	5459	8440	5908
MAY	5099	7884	5519
JUNE	1596	2468	1728
JULY	506	782	391
AUGUST	281	434	217
SEPTEMBER	398	615	308

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 2556 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

Instream flow requirements were computed for the gaging station locations on Smackover, Moro, and Hurricane Creeks with the results compiled in Tables 3-10, 3-11, and 3-12, respectively. In addition, the drainage area ratio method (as previously explained) was used to estimate instream flow requirements for Smackover Creek at its confluence with the Ouachita River (Table 3-10), Moro Creek at its confluence with the Ouachita River (Table 3-11), and Hurricane Creek at its confluence with the Saline River (Table 3-12).

TABLE 3-15
MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR TWO LOCATIONS ON CORNIE BAYOU

07365800 - CORNIE BAYOU NR. THREE CREEKS, AR
(PERIOD OF RECORD: 1957-83)

MONTH	MEAN MONTHLY DISCHARGE (cfs)	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS (cfs)
OCTOBER	28.0	14.0
NOVEMBER	105	63.0
DECEMBER	187	112
JANUARY	261	157
FEBRUARY	306	184
MARCH	299	179
APRIL	400	280
MAY	254	178
JUNE	156	109
JULY	48.0	24.0
AUGUST	16.5	8.25
SEPTEMBER	46.9	23.4

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 111 cfs

CORNIE BAYOU AT AR-LA STATE LINE

MONTH	MEAN MONTHLY DISCHARGE (cfs) AT CORNIE BAYOU NR. THREE CREEKS	ESTIMATED MEAN MONTHLY DISCHARGE (cfs) AT CORNIE BAYOU AT STATE LINE	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS AT STATE LINE (cfs)
OCTOBER	28.0	29.2	14.6
NOVEMBER	105	110	66.0
DECEMBER	187	195	117
JANUARY	261	273	164
FEBRUARY	306	320	192
MARCH	299	312	187
APRIL	400	418	293
MAY	254	265	186
JUNE	156	163	114
JULY	48.0	50.1	25.0
AUGUST	16.5	17.2	8.60
SEPTEMBER	46.9	49.0	24.5

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 116 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

TABLE 3-16
ESTIMATED MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR CHEMIN-A-HAUT BAYOU AT THE AR-LA STATE LINE

MONTH	MEAN MONTHLY DISCHARGE (cfs) AT CHEMIN-A-HAUT BAYOU NR. BEEKMAN, LA	ESTIMATED MEAN MONTHLY DISCHARGE (cfs) AT CHEMIN-A-HAUT BAYOU AT STATE LINE	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS AT STATE LINE (cfs)
OCTOBER	28.9	27.5	13.8
NOVEMBER	184	175	105
DECEMBER	295	281	169
JANUARY	453	431	259
FEBRUARY	555	528	317
MARCH	540	514	308
APRIL	652	621	435
MAY	494	470	329
JUNE	157	149	104
JULY	47.2	44.9	22.4
AUGUST	33.8	32.2	16.1
SEPTEMBER	116	110	55.0

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 178 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

TABLE 3-17
ESTIMATED MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR BAYOU DE LOUTRE AT THE AR-LA STATE LINE

MONTH	MEAN MONTHLY DISCHARGE (cfs) AT BAYOU DE LOUTRE NR. LARAN, LA	ESTIMATED MEAN MONTHLY DISCHARGE (cfs) AT BAYOU DE LOUTRE AT STATE LINE	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS AT STATE LINE (cfs)
OCTOBER	49.6	44.3	22.2
NOVEMBER	145	130	78
DECEMBER	199	178	107
JANUARY	275	246	148
FEBRUARY	307	274	164
MARCH	305	272	163
APRIL	342	306	214
MAY	226	202	141
JUNE	179	160	112
JULY	89.1	79.6	39.8
AUGUST	37.6	33.6	16.8
SEPTEMBER	73.0	65.2	32.6

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 103 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

TABLE 3-18
ESTIMATED MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR LITTLE CORNEY BAYOU AT THE AR-LA STATE LINE

MONTH	MEAN MONTHLY DISCHARGE (cfs) AT LITTLE CORNEY BAYOU NR. LILLIE, LA	ESTIMATED MEAN MONTHLY DISCHARGE (cfs) AT LITTLE CORNEY BAYOU AT STATE LINE	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS AT STATE LINE (cfs)
OCTOBER	33.2	19.3	9.65
NOVEMBER	125	72.7	43.6
DECEMBER	221	128	76.8
JANUARY	291	169	101
FEBRUARY	339	197	118
MARCH	326	190	114
APRIL	376	219	153
MAY	254	148	104
JUNE	150	87.2	61.0
JULY	60.5	35.2	17.6
AUGUST	24.1	14.0	7.00
SEPTEMBER	45.4	26.4	13.2

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 68.2 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

TABLE 3-19
MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR OUACHITA RIVER AT CAMDEN.

MONTH	MEAN MONTHLY DISCHARGE (cfs)	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS (cfs)
OCTOBER	2927	1464
NOVEMBER	5978	3587
DECEMBER	9037	5422
JANUARY	8373	5024
FEBRUARY	10640	6384
MARCH	11060	6636
APRIL	12140	8498
MAY	12990	9093
JUNE	6312	4418
JULY	3243	1622
AUGUST	2664	1332
SEPTEMBER	3100	1550

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 4586 cfs

SOURCE: MEAN MONTHLY DISCHARGE FROM USGS STREAMFLOW RECORDS

TABLE 3-20
ESTIMATED MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR OUACHITA RIVER DOWNSTREAM OF SALINE RIVER.

MONTH	ESTIMATED MEAN MONTHLY DISCHARGE (cfs)	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS (cfs)
OCTOBER	3670	1835
NOVEMBER	8723	5234
DECEMBER	15040	9024
JANUARY	16860	10120
FEBRUARY	22190	13310
MARCH	22700	13620
APRIL	23930	16750
MAY	24090	16860
JUNE	10080	7056
JULY	4355	2178
AUGUST	3293	1646
SEPTEMBER	4285	2142

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 8314 cfs

TABLE 3-21
ESTIMATED MEAN MONTHLY DISCHARGE AND FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS FOR OUACHITA RIVER AT AR-LA STATE LINE.

MONTH	ESTIMATED MEAN MONTHLY DISCHARGE (cfs)	FISH AND WILDLIFE INSTREAM FLOW REQUIREMENTS (cfs)
OCTOBER	3723	1862
NOVEMBER	8962	5377
DECEMBER	15480	9288
JANUARY	17460	10480
FEBRUARY	22920	13750
MARCH	23420	14050
APRIL	24730	17310
MAY	24720	17300
JUNE	10350	7245
JULY	4426	2213
AUGUST	3339	1670
SEPTEMBER	4438	2219

ANNUAL INSTREAM FLOW REQUIREMENT FOR FISH AND WILDLIFE = 8564 cfs

The Arkansas method for determining instream flow requirements for fisheries is based on a percent of the mean monthly flows for the three seasons of November thru March, April thru June, and July thru October. The recommended flows for fisheries range from 50 percent of the mean monthly flow or median monthly flow (whichever is greater) during July thru October to 70 percent of the mean monthly flow during April thru June. Comparison of the instream flow requirements as determined by the Arkansas method with those determined by the Montana method indicates that the flow requirements using the Arkansas method would provide excellent to outstanding habitat for most aquatic life forms. Therefore, to protect stream fisheries and to satisfy water needs for fish and wildlife in the Lower Ouachita Basin, the instream flow requirements as determined by the Arkansas method represent an amount of water that is unavailable for interbasin transfer.

3. <u>Navigation Requirements</u>

The Ouachita River is the only federally-maintained navigation system in the Lower Ouachita Basin. According to discussions with the Corps of Engineers <78, 82>, specific flow requirements have not been designated for navigation on the Ouachita River since the operation of the locks and dams on the river provides sufficient depth of water in the channel for navigation purposes. However, according to the water control plan for the Felsenthal Lock and Dam on the Ouachita River <82>, a mean daily discharge of 100 cfs is required for operation of the lock and to account for losses from lockage, leakage, and evaporation. Therefore, 100 cfs of water should be maintained in the Ouachita River between Camden and the state line for navigation. There are no instream flow requirements for navigation on the other streams in the Lower Ouachita Basin.

4. <u>Interstate Compact Requirements</u>

The Lower Ouachita Basin is included in Reach IV of the Red River Compact. This compact is an agreement among the states of Arkansas, Oklahoma, Texas and Louisiana. The purpose of the compact is to promote comity among these participating states by cooperating in the equitable apportionment and development of the water in specific river basins as provided by the interstate compact agreements. The following information is from sections of the Red River Compact which is defined in "<u>Arkansas Water Law</u>" <10>.

ARTICLE VII

APPORTIONMENT OF WATER--REACH IV ARKANSAS AND LOUISIANA

Subdivision of Reach IV and allocation of water therein.

Reach IV of the Red River is divided into topographic subbasins, and the water therein allocated as follows:

SECTION 7.01, Subbasin 1--Intrastate streams--Arkansas, reads in part as follows:

(a) This subbasin includes streams and their tributaries above last downstream major dam sites originating in Arkansas and crossing the Arkansas-Louisiana state boundary before flowing into the Red River in Louisiana. The last major downstream damsite in the Lower Ouachita Basin, as designated in the Red River Compact, is Lake Winona (63,264 acre-feet), which is located on Alum Fork of the Saline River.

(b) Arkansas is apportioned the waters of this subbasin and shall have unrestricted use thereof.

SECTION 7.02. Subbasin 2--Interstate Streams--Arkansas and Louisiana.

(a) This subbasin shall consist of Reach IV less subbasin 1 as defined in Section 7.01 (a) above.

(b) The State of Arkansas shall have free and unrestricted use of the water of this reach subject to the limitation that Arkansas shall allow a quantity of water equal to forty (40) percent of the weekly runoff originating below or flowing from the last downstream major damsites to flow into Louisiana. Where there are no designated last downstream damsites, Arkansas shall allow a quantity of water equal to forty (40) percent of the total weekly runoff originating above the state boundary to flow into Louisiana. Use of water in this subbasin is subject to low flow provisions of subparagraph 7.03 (b).

SECTION 7.03. Special Provisions, reads in part as follows:

(a) Arkansas may use the beds and banks of segments of Reach IV for the purpose of conveying its share of water to designated downstream diversions.

(b) The State of Arkansas does not guarantee to maintain a minimum low flow for Louisiana in Reach IV. However, on the following streams when the use of water in Arkansas reduces the flow at the Arkansas-Louisiana state boundary to the following amounts:

(1) Ouachita - 780 cfs

(2) Bayou Bartholomew - 80 cfs

the State of Arkansas pledges to take affirmative steps to regulate the diversions of runoff originating or flowing into Reach IV in such a manner as to permit an equitable apportionment of the runoff as set out herein to flow into the State of Louisiana.

According to the provisions outlined in the Red River Compact for Reach IV, all streams in the Lower Ouachita Basin, except the reach of Alum Fork upstream of Lake Winona, are considered to be interstate streams and are subject to interstate compact requirements. To comply with Section 7.02(b) of the Compact, Arkansas shall allow forty percent of the total weekly runoff from these interstate streams to flow into Louisiana. The Engineering Advisory Committee to the Red River Compact Commission is in the process of determining each state's responsibilities for compliance with the compact. Although the compact compliance requirements have not been identified for Reach IV of the Red River Basin, requirements have been designated for Reach II, Subbasin 5. It is believed that similar procedures will be proposed for Reach IV.

At the present time, the amount of water required to satisfy interstate compact requirements can not be quantified for several reasons. The first reason is that compact compliance is based on a percentage of the total runoff in a basin. Runoff, as defined in the compact, includes flow in the streams and water that has been diverted from the streams for other uses. The amount of water that is diverted from streams is not accurately quantified, therefore, the amount of runoff in the basins is unknown. The second reason the interstate compact requirements can not be quantified is because the requirements are based on the previous week's streamflow and diversions. Therefore, the compact requirements change from week to week, depending on the runoff available in a basin the previous week. Using average weekly discharge for the period of record would give an idea of the weekly discharges that could be expected at a particular location. However, the compact requirements can not be determined using these data since the requirements are based on a percentage of the actual weekly runoff for a basin.

5. <u>Aquifer Recharge Requirements</u>

Recharge to the major aquifers in the Lower Ouachita Basin is primarily from precipitation and percolation in the outcrop area. High streamflows during the spring may also contribute to aquifer storage through lateral movement of flow from the streams to the aquifers. Conversely, when stream levels are lowest during the fall, the aquifers may discharge water to the streams for several months.

The instream flows that are required to recharge the aquifers in the basin are currently unknown because there is insufficient information available to define and quantify the stream-aquifer relationships. However, streams in the Lower Ouachita Basin that exhibit sustained baseflow during dry-weather conditions are evidence that formations in these drainage basins are not accepting recharge. The baseflow of these streams is sustained by water that is discharged from the formations. Therefore, in these basins, there would be no aquifer recharge requirements. However, if ground water levels were drawn down below the level of the streambed, the aquifer recharge requirements would then need to be considered.

Groundwater models of the Alluvial and Sparta Sand Aquifers are currently being developed by the U.S. Geological Survey. These investigations will provide information on groundwater-surface water relationships, which will contribute to quantification of the aquifer recharge requirements where applicable. Additional information describing the Alluvial and Sparta Sand Aquifer models is provided in the Groundwater Solutions and Recommendations section of this report.

6. Riparian Use Requirements

Section 2 of Act 1051 of 1985 (see legal and institutional setting) requires the Arkansas Soil and Water Conservation Commission to determine surface water needs of public water supplies, industry, and agriculture. In 1984, reported surface-water use for irrigation, industry, and public water supply totalled approximately 95,000 acre-feet of water in the Lower Ouachita Basin as determined from Arkansas Soil and Water Conservation Commission's records of registered diversions. Of the total amount of water diverted for these needs, 16,000 acre-feet were used for irrigation, 27,000 acre-feet were used for municipal supply, and 52,000 acre-feet were used for industry. These figures represent current riparian needs in the Lower Ouachita Basin.

The amount of water diverted from each of the four major streams in the Lower Ouachita Basin was not determined for this report. The purpose of defining and quantifying instream flow requirements for streams in the basin was to determine the amount of water available for other uses such as interbasin transfer. Since the water diverted for the uses mentioned above has already been removed from the streams and is not available, it was not included in the computations for total surface-water yield and excess streamflow of the basin.

Riparian water use requirements may vary considerably from year to year based on changing needs. Projected riparian water needs are accounted for in the water-use projections for irrigation, industry, and public water supplies.

7. Aesthetic Requirements

Instream flow requirements, as previously defined, include water that is necessary to maintain the existing in-place uses of water in or along a stream channel. Recreational activities, such as fishing and hunting, in the Lower Ouachita Basin represent another use of water in the streams in addition to those uses previously addressed. Instream flow requirements established for fish and wildlife should be adequate to maintain recreational activities in streams in the basin.

The Saline River has been designated a scenic river by Act 689 of 1985 from its confluence with the Ouachita River upstream to the Grant County line. Designation of a scenic river is for the purpose of protection of natural and scenic beauty, water quality, and fish and wildlife of aquatic systems. There are no provisions in Act 689 for prohibiting existing and future water withdrawals from designated scenic rivers. However, instream flow requirements which have been established for water quality and fish and wildlife should protect the natural character of the streams in the basin.

Current Available Streamflow

The flows required to satisfy the instream needs previously identified were compared with estimated average annual discharges for streams at the state line or at the mouth to determine the amount of streamflow that is currently available for determining excess streamflow from streams and rivers in the Lower Ouachita Basin. The information in Table 3-22 was compiled by stream to provide a generalized summary of the current water available on an average annual basis for many of the streams in the Lower Ouachita Basin. It should be noted that, for the purpose of this compilation, the instream flow requirements for the interstate compact were computed as 40 percent of the estimated average annual discharge. The actual interstate compact requirements, however, may be significantly different than those in the table since the actual requirements are determined from the previous week's streamflow and diversions.

The instream flow requirements for the different categories are not additive. The highest instream need represents the amount of water required to satisfy all the existing instream needs at the selected locations. The instream needs for fish and wildlife were the governing instream flow requirements for all streams listed in Table 3-22. Therefore, to determine the amount of water that is currently available at all locations, the flows required for fish and wildlife were subtracted from the estimated average annual discharges. The water currently available for other uses, on an average annual basis, ranged from 24.9 cfs for Three Creeks at the state line to 5136 cfs for the Ouachita River at the state line. These results may, however, be somewhat misleading. Due to the streamflow variability in the basin, most of the water is available during the winter and spring months with considerably less water available during the growing season and low-flow months of the year.

To illustrate the effect that streamflow variability can have on the determination of available streamflow, the streamflow available on an average annual basis was compared with the streamflow available on a monthly basis for the Saline River at the mouth (Table 3-23). The governing fish and wildlife instream requirements were subtracted from the estimated mean monthly

TABLE 3-22
STREAMFLOW AT SELECTED LOCATIONS IN THE LOWER OUACHITA BASIN THAT IS CURRENTLY AVAILABLE FOR OTHER USES

	ESTIMATED AVERAGE ANNUAL DISCHARGE (cfs)	INSTREAM FLOW REQUIREMENTS (cfs) WATER QUALITY	*FISH AND WILDLIFE	NAVIGATION	INTER-STATE COMPACTS	CURRENT AVAILABLE STREAM-FLOW (cfs)
SMACKOVER CREEK AT THE MOUTH	526	0.3-0.4	331	--	210	195
MORO CREEK AT THE MOUTH	567	NO FLOW	363	--	227	204
HURRICANE CREEK AT THE MOUTH	350	NO FLOW	222	--	140	128
SALINE RIVER AT THE MOUTH	4000	13-20	2556	--	1600	1444
BAYOU BARTHOLOMEW AT STATE LINE	1240	6.6-44	779	--	495	461
CHEMIN-A-HAUT BAYOU AT STATE LINE	280	NO FLOW	178	--	112	102
BAYOU DE LOUTRE AT STATE LINE	165	≤3.2	103	--	66.0	62.0
CORNIE BAYOU AT STATE LINE	183	NO FLOW	116	--	73.2	67.0
THREE CREEKS AT STATE LINE	67.2	NO FLOW	42.3	--	26.9	24.9
LITTLE CORNEY BAYOU AT STATE LINE	108	NO FLOW	68.2	--	43.2	39.8
OUACHITA RIVER AT STATE LINE	13,700	660	8564	100	5464	5136

*GOVERNING INSTREAM FLOW REQUIREMENT WHICH REPRESENTS THE AMOUNT OF WATER REQUIRED TO SATISFY EXISTING NEEDS AT SELECTED LOCATIONS.

discharges to determine the streamflow available on a monthly basis. The Saline River at the mouth has 1444 cfs of water available for other uses on an average annual basis. However, on a mean monthly basis, the available water ranged from 217 cfs in August to 3192 cfs in February. The data in Table 3-23 show that the majority of the current available streamflow of the Saline River at the mouth occurs during the period of December through May.

TABLE 3-23
STREAMFLOW AT SALINE RIVER
AT THE MOUTH THAT IS CURRENTLY AVAILABLE
FOR OTHER USES

INSTREAM FLOW REQUIREMENTS (cfs)

	WATER QUALITY	*FISH AND WILDLIFE	NAVIGATION	INTER-STATE COMPACTS	CURRENT AVAILABLE STREAMFLOW (cfs)
ESTIMATED AVERAGE ANNUAL DISCHARGE (cfs)=4000	13-20	2556	--	1600	1444
ESTIMATED MEAN MONTHLY DIS-CHARGE (cfs):					
OCTOBER = 512	13-20	256	--	205	256
NOVEMBER = 1747	13-20	1048	--	699	699
DECEMBER = 3822	13-20	2293	--	1529	1529
JANUARY = 5736	13-20	3442	--	2294	2294
FEBRUARY = 7980	13-20	4788	--	3192	3192
MARCH = 7966	13-20	4780	--	3186	3186
APRIL = 8440	13-20	5908	--	3376	2532
MAY = 7884	13-20	5519	--	3154	2365
JUNE = 2468	13-20	1728	--	987	740
JULY = 782	13-20	391	--	313	391
AUGUST = 434	13-20	217	--	174	217
SEPTEMBER = 615	13-20	308	--	246	307

*GOVERNING INSTREAM FLOW REQUIREMENT WHICH REPRESENTS THE AMOUNT OF WATER REQUIRED TO SATISFY EXISTING NEEDS.

The current available streamflows computed in Tables 3-22 and 3-23 do not represent the amount of water that is available for interbasin transfer. Before interbasin transfer of water can be considered, the projected water needs of the basin must be addressed. The previous determinations of current available streamflow do not account for the projected water needs of the basin. Data identifying the projected water needs for individual streams in the basin are not currently available. However, the projected water needs of the entire basin have been estimated and are accounted for in the excess streamflow section of the report for the determination of water available in the Lower Ouachita Basin for interbasin transfer.

Minimum Streamflow

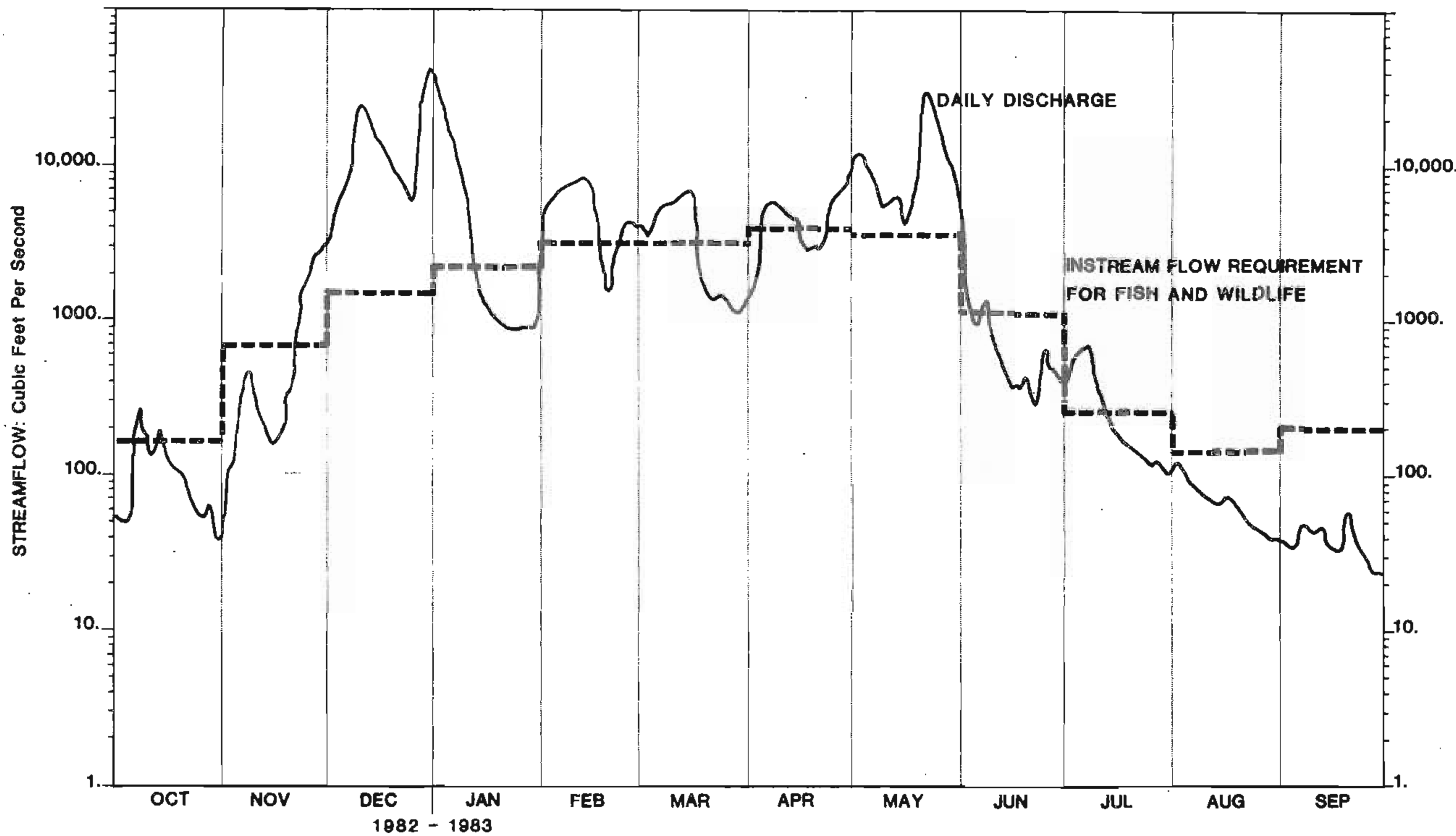
Section 2 of Act 1051 of 1985 (See Legal and Institutional Setting) requires the Arkansas Soil and Water Conservation Commission to establish minimum streamflows. Minimum streamflow is defined as the lowest daily mean discharge that will satisfy minimum instream flow requirements. A minimum streamflow is established to protect instream needs, particularly during low-flow conditions which may occur naturally or during periods of significant use from the stream. The minimum streamflow also represents a critical low flow condition below which some minimum instream need will not be met. The minimum streamflow is not a target level or a flow that can be maintained for an extended period of time without serious environmental consequences. Therefore, the minimum streamflow also represents the discharge at which all withdrawals from the stream will cease. Because of the critical low flow conditions which may exist at the minimum streamflow level, allocation of water based on the establishment of water-use priorities should be in effect long before this point is reached. Allocation of water should help to maintain streamflow above the established minimum discharge.

Minimum streamflows for streams in the Lower Ouachita Basin were determined based on the instream flow requirements as previously described in this report with the exception of fish and wildlife requirements. The instream flow requirements for fish and wildlife were re-evaluated to determine instream needs that represent minimum conditions. This was necessary because, as previously stated in the Instream Flow Requirements section of this report, recommended instream flow requirements for fish and wildlife using the Arkansas Method (Arkansas Game and Fish Commission) would provide excellent to outstanding habitat for most aquatic life forms. These recommended flows are viewed as representing desirable conditions and not minimum instream flow needs.

Recommended instream flow requirements for fish and wildlife as determined by the Arkansas Method were compared with daily mean discharge hydrographs for selected streams in the Lower Ouachita Basin. Hydrographs for Bayou Bartholomew near McGehee and Saline River near Rye for the 1983 water year were plotted for illustrative purposes and are shown in Figures 3-4 and 3-5,

figure 3-4

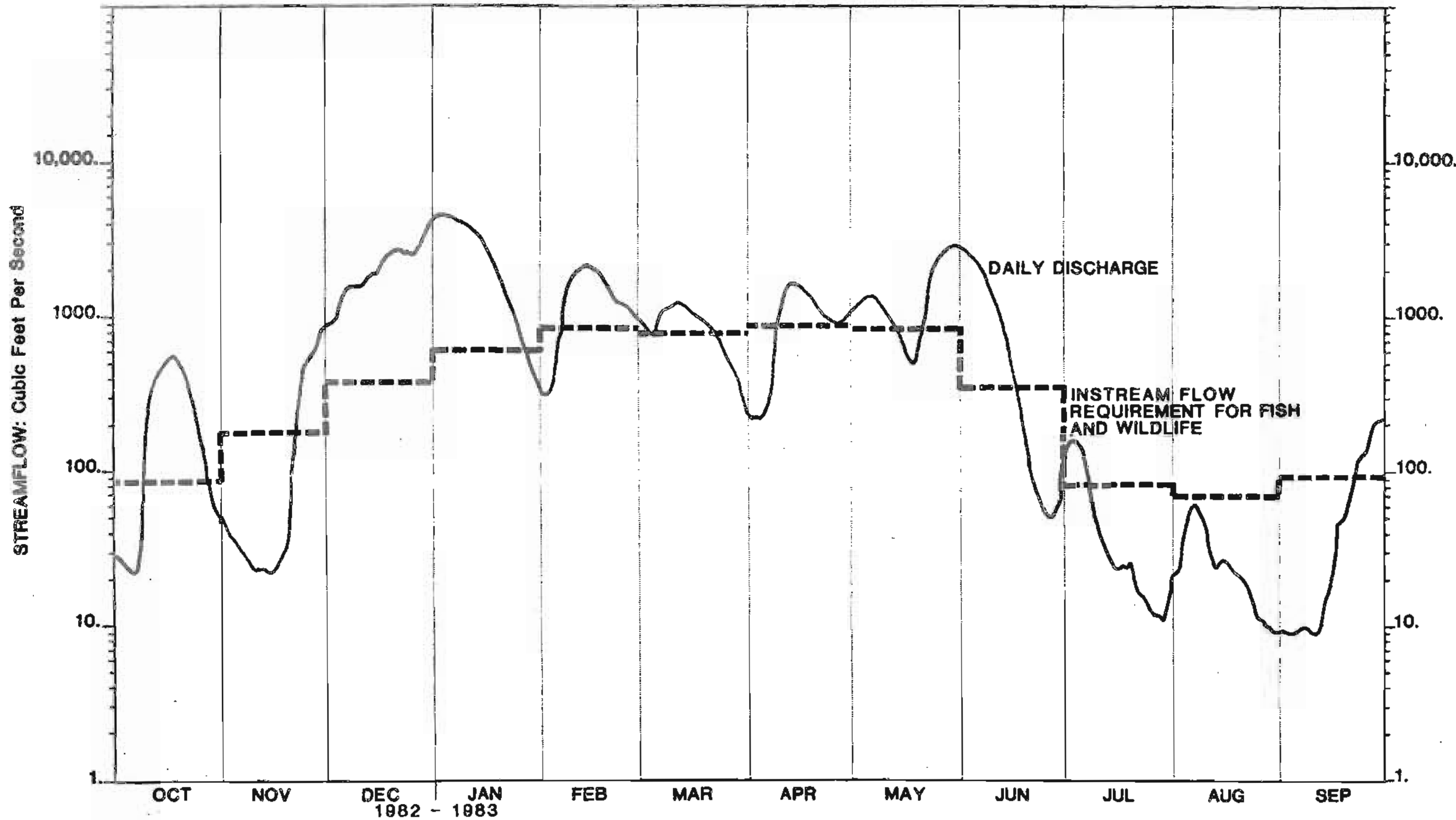
DAILY DISCHARGE AND INSTREAM FLOW REQUIREMENTS FOR FISH AND WILDLIFE AT THE SALINE RIVER NEAR RYE - 1983 WATER YEAR



SOURCE: DAILY DISCHARGE DATA FROM U.S. GEOLOGICAL SURVEY STREAMFLOW RECORDS.

figure 3-5

DAILY DISCHARGE AND INSTREAM FLOW REQUIREMENTS FOR FISH AND WILDLIFE AT BAYOU BARTHOLOMEW NEAR McGEHEE - 1983 WATER YEAR



SOURCE: DAILY DISCHARGE DATA FROM U.S. GEOLOGICAL SURVEY STREAMFLOW RECORDS.

respectively. The 1983 water year was selected for analysis because of the variation in climatic conditions during the year. The 1983 water year was wetter than normal during the winter months and drier than normal during the summer months. The hydrographs show the annual variability in discharge that exists for these two streams. The hydrographs also show that streamflow during the 1983 water year was inadequate to satisfy instream needs for fish and wildlife (as determined by the Arkansas Method) at times during most months of the year.

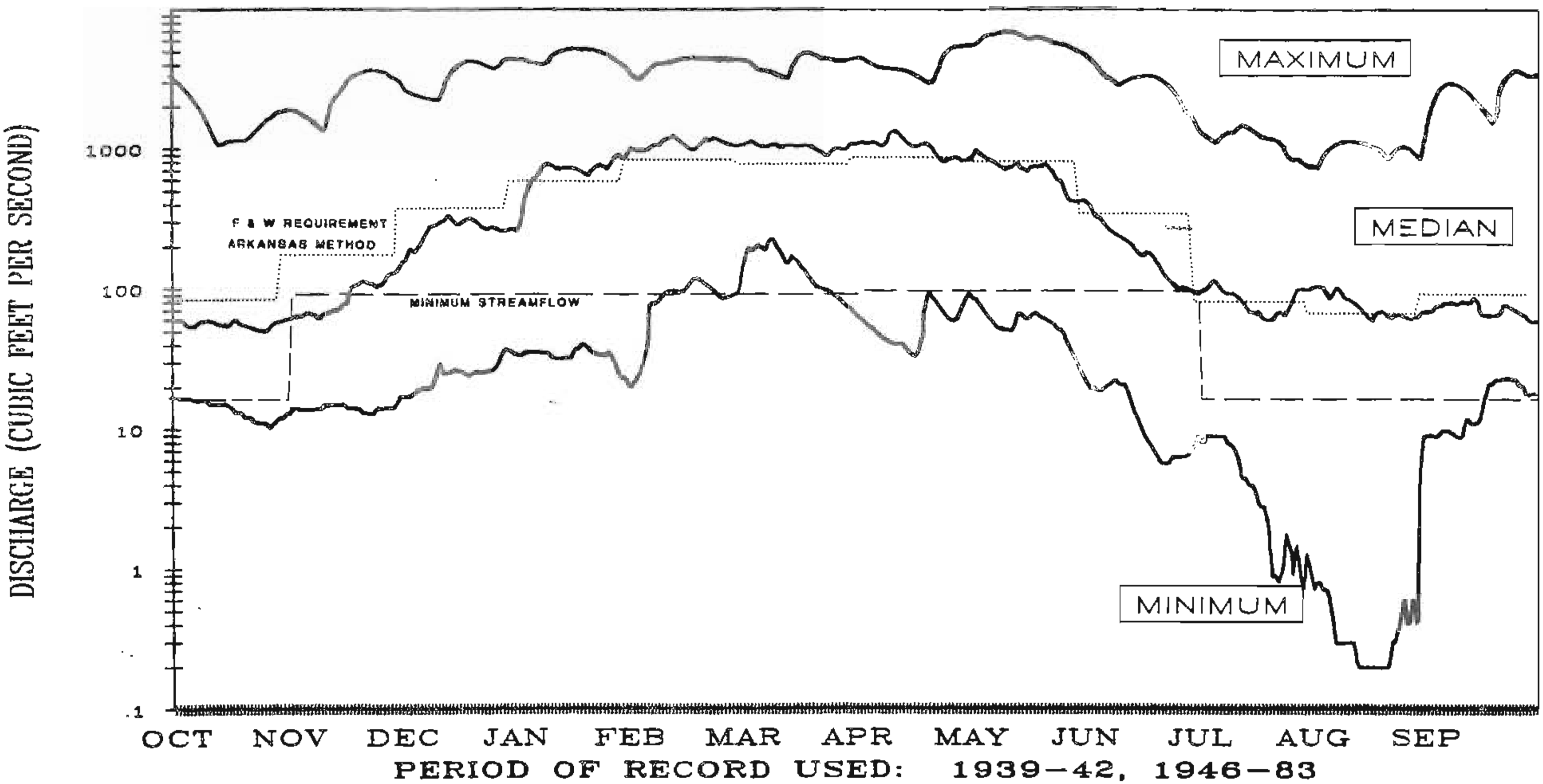
In addition to the previous analyses, maximum, median, and minimum daily discharges for Bayou Bartholomew near McGehee for the period of record (1939-42; 1946-83) were compared with instream flow requirements for fish and wildlife (Figure 3-6). This illustration shows that median daily discharges during May through December were frequently less than the instream needs determined using the Arkansas Method. Therefore, 50 percent of the time (for the period of record), streamflow in Bayou Bartholomew near McGehee has been insufficient during May through December to satisfy instream needs for fish and wildlife as determined by the Arkansas Method. These data support the conclusion that the recommended instream flow requirements for fish and wildlife as determined using the Arkansas Method represent desirable conditions and not minimum streamflow needs.

To determine minimum instream flow requirements for fish and wildlife, the following procedure was used. As previously stated in the Instream Flow Requirements section, Tennant concluded from his study that 10 percent of the average annual streamflow is the minimum flow required for short-term survival of most aquatic life forms. However, analysis of streamflow records for streams in the Lower Ouachita Basin showed that 10 percent of the average annual discharge was higher than the daily mean discharge at most times during the summer months. This is exemplified by the hydrographs for Bayou Bartholomew near McGehee (Figure 3-7) and Saline River near Rye (Figure 3-8). The daily mean discharge for Bayou Bartholomew at most times during the summer months for the 1983 water year was inadequate to meet Tennant's short-term survival flow. Daily mean discharges for the Saline River at Rye during the 1983 water year dropped below 10 percent of the average annual discharge during most of October, parts of November and July, and all of August and September. High streamflows that generally occur during January through May increase the average annual discharge which causes the flow recommended by Tennant for short-term survival (10 percent of the average annual discharge) to frequently exceed streamflow during the low-flow season.

To account for the seasonal variability of streamflow in the basin, the year was divided into three seasons as identified in the Arkansas Method <39>. The seasons are based on physical processes that occur in the stream and the critical life stages of the fish and other aquatic organisms inhabiting the stream. The minimum instream flow requirements for fish and wildlife were established by taking 10 percent of the average seasonal flows.

figure 3-6

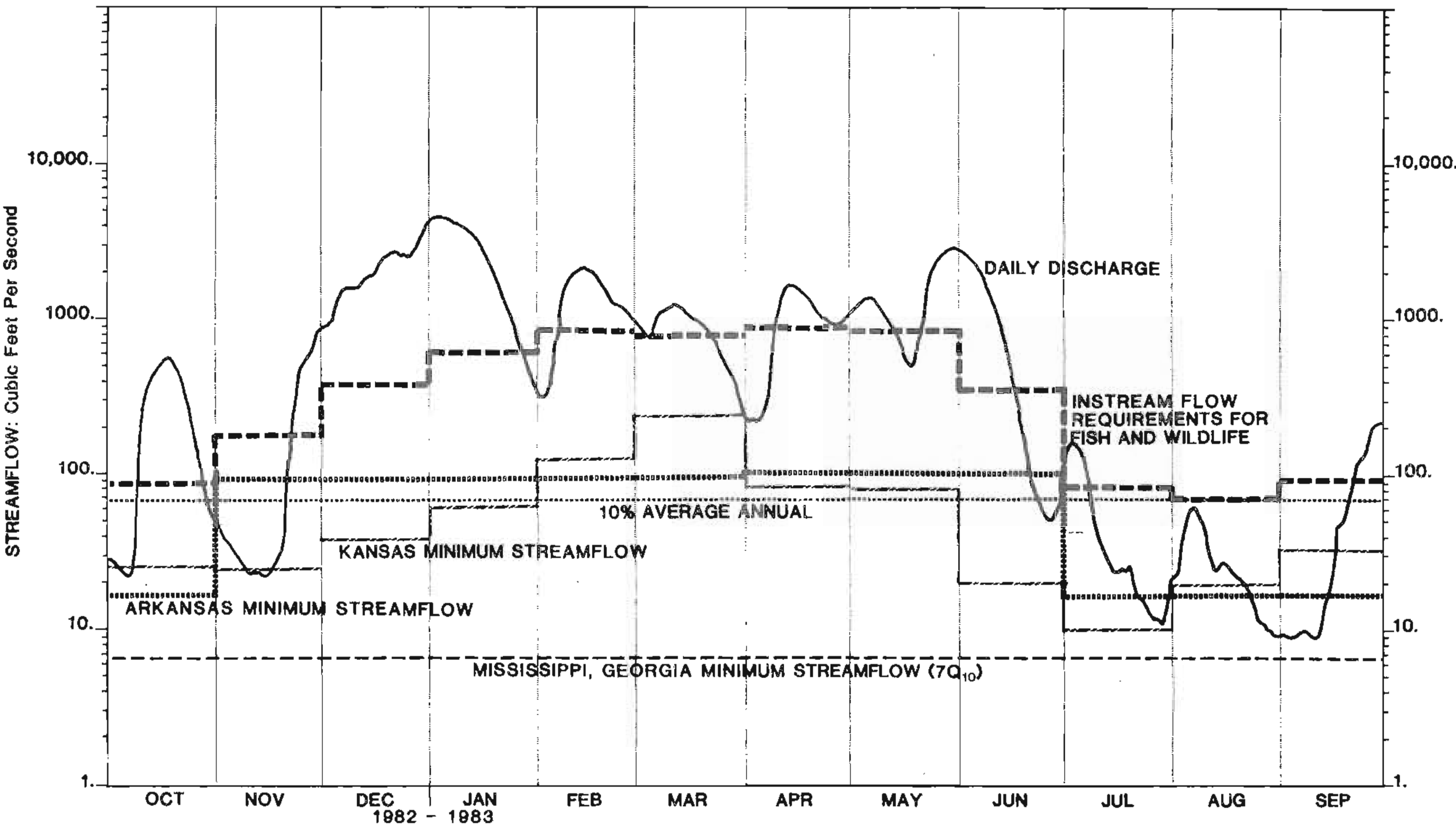
MAXIMUM, MEDIAN, and MINIMUM DAILY DISCHARGES, and SELECTED INSTREAM NEEDS for the PERIOD of RECORD at BAYOU BARTHOLOMEW NEAR McGEHEE



SOURCE: DAILY DISCHARGE DATA FROM U.S. GEOLOGICAL SURVEY STREAMFLOW RECORDS.

figure 3-7

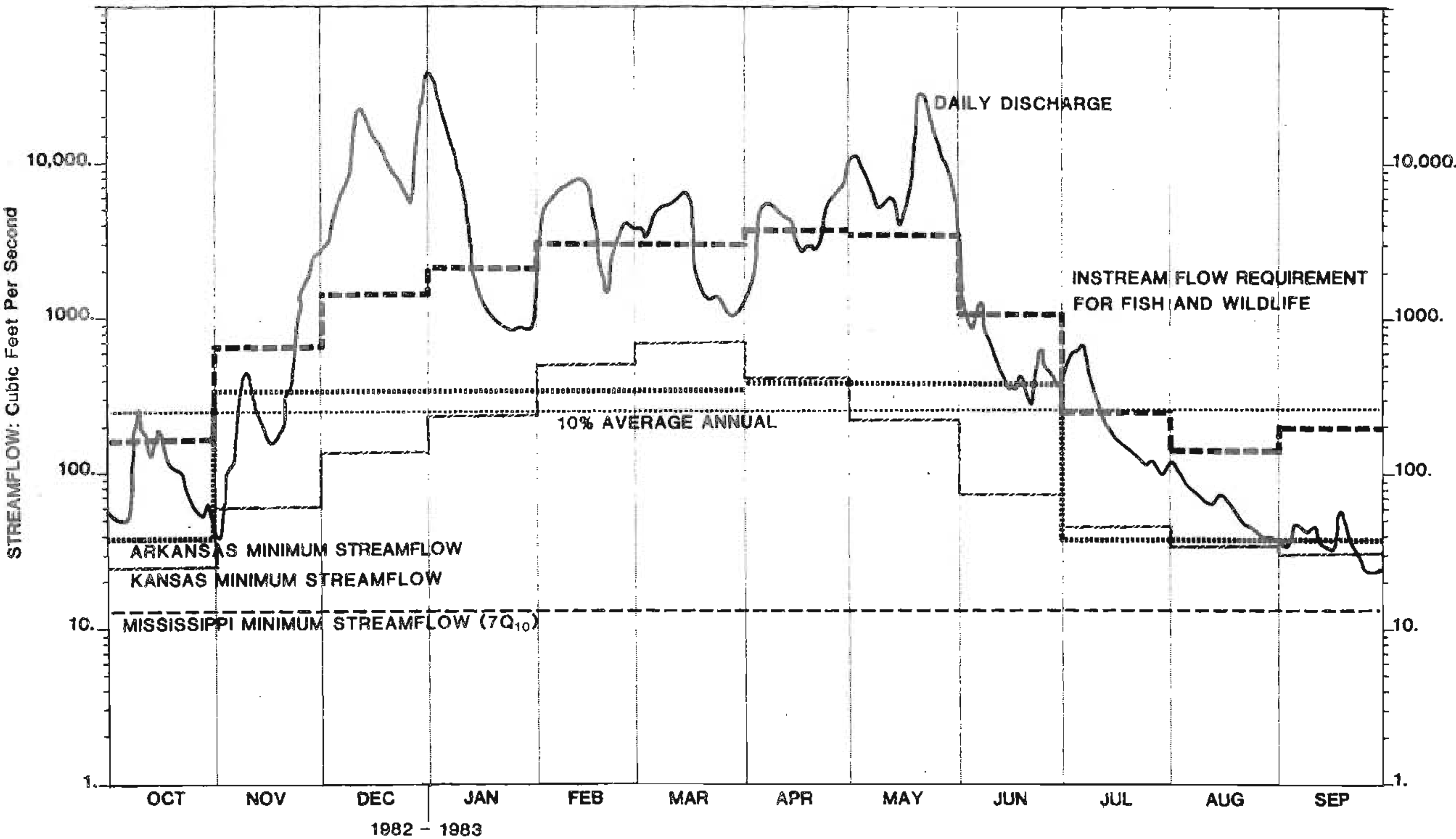
DAILY DISCHARGE, INSTREAM FLOW REQUIREMENTS FOR FISH AND WILDLIFE, AND ALTERNATIVE MINIMUM STREAMFLOWS AT BAYOU BARTHOLOMEW NEAR McGEHEE 1983 WATER YEAR



SOURCE: DAILY DISCHARGE DATA FROM U.S. GEOLOGICAL SURVEY STREAMFLOW RECORDS.

figure 3-8

DAILY DISCHARGE, INSTREAM FLOW REQUIREMENTS FOR FISH AND WILDLIFE, AND ALTERNATIVE MINIMUM STREAMFLOWS AT THE SALINE RIVER NEAR RYE – 1983 WATER YEAR



SOURCE: DAILY DISCHARGE DATA FROM U.S. GEOLOGICAL SURVEY STREAMFLOW RECORDS.

Minimum instream flow requirements for fish and wildlife have been established by other states. The states of Mississippi and Georgia have selected the $7Q_{10}$ discharge as the minimum streamflow necessary to provide for minimum instream needs <12, 58>. Although Kansas evaluates each stream independently, established minimum streamflows are generally the flows necessary for survival of approximately 60 percent of the fishery resource <52>. Generally, minimum streamflows in Kansas are flows that are equaled or exceeded 85 to 95 percent of the time on a monthly basis.

Comparisons of the previously described different minimum instream flow requirements for fish and wildlife are shown for Bayou Bartholomew near McGehee and Saline River near Rye with the hydrographs for the 1983 water year in Figures 3-7 and 3-8, respectively. The minimum instream flow requirements for fish and wildlife in Arkansas (10 percent of the average flow for each season) are higher than 10 percent of the average annual streamflow (Tennant's Method) for the seasons of November through March and April through June, and lower than 10 percent of the average annual streamflow for July through October in these illustrations. The Arkansas minimum instream flow requirements for fish and wildlife are considerably higher than the minimum instream needs established by Mississippi and Georgia ($7Q_{10}$ discharge). During most months of the year for both streams, the Arkansas minimum instream needs were higher than the minimum instream needs as determined by the Kansas Method.

In addition to requirements for fish and wildlife, instream flow requirements for water quality, navigation, interstate compacts, and aesthetics were also considered in the determination of minimum streamflows. Since the instream flow requirements are not additive, the highest instream need for each season was used to establish the minimum streamflow for each season. Minimum streamflows were established at gaging station locations and other selected sites and are presented in Table 3-24. It should be noted, however, that the instream flows required to satisfy the interstate compact were not quantified for the reasons previously explained in the Instream Flow Requirements section. Therefore, the minimum streamflows in the Lower Ouachita Basin are those flows that appear in Table 3-24 <u>or</u> 40 percent of the weekly runoff, whichever is greater. Preliminary investigation of historic streamflow data for streams in the Lower Ouachita Basin indicated that the instream flows required for interstate compact compliance may be the governing instream flow requirement throughout much of the year.

The establishment of minimum streamflows will have varying effects on different water users in the basin. Riparian users will, for example, be affected by the establishment of minimum streamflows. Industrial and agricultural riparian users must either conserve water or construct storage reservoirs in anticipation of the times when the flow of the stream falls below the minimum levels. Instream water users will also be affected by the establishment of minimum streamflows. Although some level of flow protection will be beneficial to fish and wildlife, minimum

TABLE 3-24
MINIMUM STREAMFLOWS IN THE LOWER OUACHITA BASIN 1/
BY SEASON

LOCATION	NOVEMBER - MARCH (cfs)	APRIL - JUNE (cfs)	JULY - OCTOBER (cfs)
OUACHITA RIVER AT CAMDEN	900	1050	570 2/
OUACHITA RIVER AR-LA STATE LINE	1760	1990	660 2/
SALINE RIVER AT BENTON	110	108	17.6
SALINE RIVER NEAR SHERIDAN	226	225	30.5
SALINE RIVER NEAR RYE	353	405	37.9
BAYOU BARTHOLOMEW NEAR MCGEHEE	91.9	96.9	16.4
BAYOU BARTHOLOMEW AR-LA STATE LINE	163	182	43.0 2/
BAYOU DE LOUTRE AR-LA STATE LINE	22.0	22.3	5.6
SMACKOVER CREEK NEAR SMACKOVER	52.2	52.4	8.2
MORO CREEK NEAR FORDYCE	33.1	37.7	2.2
HURRICANE CREEK NEAR SHERIDAN	32.5	33.8	2.8
CHEMIN-A-HAUT BAYOU AR-LA STATE LINE	38.6	41.3	5.4
CORNIE BAYOU NEAR THREE CREEKS	23.2	27.0	3.5
THREE CREEKS NEAR THREE CREEKS	6.6	7.0	1.4

1/ FISH AND WILDLIFE IS THE GOVERNING INSTREAM REQUIREMENT UNLESS OTHERWISE NOTED.
2/ WATER QUALITY IS THE GOVERNING INSTREAM REQUIREMENT.

streamflows are clearly not desirable conditions. Minimum streamflows will not, however, affect water uses that are non-consumptive (power generation).

For agricultural users, the irrigation season generally begins the middle of May with rice <14> and continues through the end of August. This overlaps with the low streamflow season which is generally during July through October. The minimum streamflows established are much higher during May and June than during July and August. Frequently, flow of streams in the Lower Ouachita Basin may be less than the established minimums during the low-flow season due to natural streamflow variability. This will result in less surface water available for irrigation.

Farmers will be forced to either produce crops that require less water, pump additional groundwater or construct reservoirs to store water for later use. As a general rule, the groundwater supply is limited and more expensive to pump than surface water. In the 1985 Legislative Session, recognition was made of the magnitude of groundwater problems in some areas by the passage of legislation to provide tax credits as an incentive to convert from groundwater to surface water use. If groundwater is not used to replace the reduction in available surface water, farmers will have to manage with less water. This reduction in available water for a specific crop will cause reduced yields, reduced irrigated acreage, or a change to less water-demanding crops. The establishment of minimum streamflows will not allow agricultural interests to utilize surface water with the freedom they have had in the past. This will negatively impact agriculture whether farmers pump more expensive groundwater or manage with less water.

The Arkansas Association of Conservation Districts has commented that the minimum streamflows established "would, in a number of instances, diminish certain riparian use rights that now exist." The Association added that mitigation to riparian land owners should be considered where minimum streamflows are established (See comments in the Appendix).

Low-flow conditions that are caused either by natural events or significant diversions impact fish and wildlife. The Arkansas Game and Fish Commission has stated that at the minimum streamflow level "extreme degradation to the fish and wildlife resource in a stream has already occurred. Water temperatures have significantly increased, mirrored by a substantial decrease in dissolved oxygen content in the water. Shoal or riffle areas are dewatered or essentially out of production. Spawning and survival of desirable fish types is greatly reduced. A shift to more tolerant and less diverse fish and invertebrate populations is occurring. Riparian vegetation and associated wildlife is greatly reduced. Flushing of sediment and septic wastes in the stream is essentially nil, magnifying the dissolved oxygen depletion, fish kills, pollution, and groundwater contamination. Waterfowl habitat is decimated and terrestrial wildlife dependent on the river become more susceptible to dependent limiting factors such as predation, disease, lack of reproductive success and starvation" (See comments in Appendix). The minimum streamflow is clearly not a desirable flow condition for fish and wildlife, nor one which should be maintained for any length of time.

Establishment of minimum streamflows will also have an impact on waterfowl habit. The use of surface water to flood green tree reservoirs may be restricted during the fall, especially November. For example, during the month of November, the minimum streamflow approximates the median daily streamflow for the period of record at Bayou Bartholomew near McGehee (Figure 3-6). Discharge may frequently be less than the minimum streamflow during November due to natural streamflow variability.

Finally, an important question to be addressed is the impact of minimum streamflows on priority of other users during allocation conditions. Under current law, the ASWCC has the authority to allocate water during periods of water shortage based on the following water-use priorities: 1) sustaining life, 2) maintaining health, and 3) increasing wealth. Additionally, in "Rules for Surface Water Diversion Registration and Allocation in the State of Arkansas" by ASWCC, the following are to be reserved prior to allocation:

1. Domestic and municipal-domestic use
2. Instream flow required to maintain stream ecosystems
3. All water requirements for support of those purposes previously authorized.

Other than the above uses, all other lawful uses of water are equal.

It would appear that the minimum streamflow for fish and wildlife would define the #2 reservation according to the rules. However, since the minimum streamflow is defined as a critical low flow condition, allocation should begin above this point. Two questions arise: 1) What is the point at which allocation should begin and should this be a fixed point? (i.e. what defines a shortage), and 2) What is the priority of competing uses in a shortage which has not reached the minimum flow conditions? Simply stated, where does fish and wildlife priority fall in relation to agriculture, industry, hydropower and other uses in allocation above the defined minimum flow? It would appear under current case law and rules and regulations all these uses have equal priority.

The point at which allocation should begin is a decision which should be made on a case by case basis taking into account the historical uses and values of each stream resource. This is envisioned as a judgement which will vary not only within the state but also vary in different reaches of individual streams.

Safe Yield

Section 2 of Act 1051 of 1985 (see legal and institutional setting) requires the Arkansas Soil and Water Conservation Commission to define the safe yield of streams and rivers in Arkansas. The safe yield of a stream or river is defined as the amount of water that is available on a dependable basis which could be used as a surface-water supply.

Seasonal and annual variability of streamflow affect the dependability of water available for development. Therefore, as previously described, flow-duration curves were developed to analyze the variability of streamflow in the Lower Ouachita Basin for streams at gaging station locations (Table 3-3). To quantify the safe yield of streams in the basin, the amount of water available on a dependable basis was designated as the discharge which has been equaled or exceeded 95 percent of the time for the available period of record. This flow represents the discharge which can be expected at selected stream locations on a dependable basis; however, not all of this flow is actually available for use. Minimum streamflows, which have been established for streams and rivers in the Lower Ouachita Basin and were previously defined in this report, represent discharge that is not available for use. Therefore, the safe yield of a stream or river is the discharge which can be expected 95 percent of the time minus the discharge necessary to maintain the minimum flow in the stream during the low-flow season (July-October).

The safe yield of streams at selected gaging stations is summarized in Table 3-25. The designation of safe yield for some streams is not applicable since the minimum streamflow is greater than the 95 percent flow. This indicates that, at times during the year, water is not available in some streams for other uses and some type of streamflow storage would be required at these locations to provide a sustained yield.

Potential For Development

Although streams in the Lower Ouachita Basin have very small safe yields, development of surface water storage impoundments could significantly increase dependable yields from streams in the basin. The seasonal variability in streamflow could be compensated for by storing water during high-flow periods and releasing it during low-flow periods.

TABLE 3-25
SAFE YIELD OF STREAMS AT SELECTED GAGING STATIONS

STREAM	FLOW (cfs) WHICH WAS EQUALED OR EXCEEDED 95 % OF THE TIME	MINIMUM STREAMFLOW July-October (cfs)	SAFE YIELD (cfs)
OUACHITA RIVER AT CAMDEN	880	570	310
SMACKOVER CREEK NR. SMACKOVER	2.6	8.2	N/A
MORO CREEK NR. FORDYCE	0	2.2	N/A
SALINE RIVER AT BENTON	19	17.6	1.4
SALINE RIVER NR. SHERIDAN	36	30.5	5.5
HURRICANE CREEK NR. SHERIDAN	1.8	2.8	N/A
SALINE RIVER NR. RYE	39	37.9	1.1
BAYOU BARTHOLOMEW NR. MCGEHEE	25	16.4	8.6
CORNIE BAYOU NR. THREE CREEKS	0.3	3.5	N/A
THREE CREEKS NR. THREE CREEKS	0.3	1.4	N/A

The potential development for streams in the basin is presented in Table 3-26. Article VII of the Red River Compact requires that "Arkansas shall allow a quantity of water equal to 40 percent of the weekly runoff originating below or flowing from the last downstream major damsites" to flow into Louisiana. In order to determine the potential development, a quantity of water equal to 40 percent of the mean annual discharge is estimated to be necessary to satisfy interstate compact requirements and other instream needs. Therefore, the remaining 60 percent of the mean annual discharge is potentially available for development.

Approximately 5,310 MGD is potentially available from the Ouachita River at the Arkansas-Louisiana state line. Mean annual discharges from streams crossing the state line were combined as described in Table 3-26 to obtain a potential development for the basin of 6,150 MGD. While this indicates that a large volume of water can be developed, specific impoundment locations have not been considered and may not be available.

Potential Site Locations

Studies have been made by the Soil Conservation Service and the Corps of Engineers locating flood control impoundments in the Bartholomew sub-basin. The SCS identified 56 potential sites for the construction of floodwater retarding structures <86>, and the Corps of Engineers studied the 10 largest of these 56 sites in more detail. The 56 sites are located on Ables Creek, Cutoff Creek and along the Bartholomew escarpment. Many of the sites have little to no potential to be constructed as floodwater retarding structures due to lack of interest or cost effectiveness (see USDA and Corps of Engineers Projects), but these sites are potential surface water development sites.

The total storage at the flood control pool elevation is 285,800 acre-feet (See Table 3-27) for the 10 Corps of Engineers' escarpment lakes, and 95,600 acre-feet for the 46 SCS impoundments. <77, 86> The total volume of storage for the 56 sites is approximately 380,000 acre-feet. The remainder of the Lower Ouachita Basin has water available for developing surface water storage as shown in the previous section, but there have been no studies to locate potential development sites.

TABLE 3-26
POTENTIAL DEVELOPMENT FOR STREAMS AT SELECTED LOCATIONS

STREAM	(1) MEAN ANNUAL DISHCARGE (cfs)	POTENTIAL DEVELOPMENT (2) 0.60X(1) (cfs)	(3) 0.6463X(2) (MGD)
OUACHITA RIVER AT CAMDEN	7,350	4,410	2,850
OUACHITA RIVER AR-LA STATE LINE	13,700 1/	8,220	5,310
SALINE RIVER AT BENTON	784	470	304
SALINE RIVER NEAR SHERIDAN	1,600	960	620
SALINE RIVER NEAR RYE	2,590	1,550	1,000
BAYOU BARTHOLOMEW NEAR McGEHEE	676	406	262
BAYOU BARTHOLOMEW AR-LA STATE LINE	1,240 1/	744	481
BAYOU DE LOUTRE AR-LA STATE LINE	165 1/	99	64
OVERFLOW CREEK AR-LA STATE LINE	90.4 1/	54	35
FRANK LAPERE CREEK AR-LA STATE LINE	35.3 1/	21	14
LITTLE CORNEY BAYOU AR-LA STATE LINE	108 1/	65	42
SMACKOVER CREEK NEAR SMACKOVER	374	224	145
MORO CREEK NEAR FORDYCE	238	143	92
HURRICANE CREEK NEAR SHERIDAN	229	137	89
CHEMIN-A-HAUT BAYOU AR-LA STATE LINE	280 1/	168	109
CORNIE BAYOU AR-LA STATE LINE	183 1/	110	71
THREE CREEKS AR-LA STATE LINE	67.2 1/	40	26
BASIN TOTAL 2/	15,870	9,520	6,150

1/ DISCHARGES AT THE AR-LA STATE LINE WERE ADJUSTED FROM GAGING STATION DATA BY METHODS OUTLINED IN THE INSTREAM FLOW REQUIREMENTS SECTION

2/ BASIN TOTAL ESTIMATED BY SUMMING DISCHARGES FOR THE OUACHITA RIVER BAYOU BARTHOLOMEW, BAYOU DE LOUTRE, OVERFLOW CREEK, FRANK LAPERE CREEK, LITTLE CORNEY BAYOU, CHEMIN-A-HAUT BAYOU, CORNIE BAYOU, AND THREE CREEKS AT THE AR-LA STATE LINE.

TABLE 3-27
CORPS OF ENGINEERS PLANNED ESCARPMENT LAKES

NAME	FLOOD CONTROL POOL ELEVATION (FT.)	FLOOD CONTROL POOL VOLUME (AC.-FT.)
BEECH CREEK	144.0	14,000
BEARHOUSE CREEK	143.0	63,000
WOLF CREEK	153.0	52,000
CUTOFF CREEK	149.0	98,000
ABLES CREEK	186.0	20,000
FLAT CREEK	182.0	6,300
TURTLE CREEK	199.0	11,200
BOGGY BAYOU	210.0	3,300
BAYOU BARTHOLOMEW LAKE	256.0	12,000
PRAIRIE CREEK	-	6,000 1/
		285,800

1/ OBTAINED FROM SOIL CONSERVATION SERVICE <86>
SOURCE: MODIFIED FROM CORPS OF ENGINEERS <77>

Water Use

In 1980, the ten county study area used 388.2 mgd of water, along with utilizing 43.3 mgd to produce electricity. <48> The 43.3 mgd used for electricity production is not considered as part of the water use because it essentially is returned to the stream in the same area as it was withdrawn. The water is available for reuse downstream of the power plant and can be used in computations of excess streamflow. The study area water use by category and source is listed in Table 3-28.

A portion of the total 388.2 mgd water use was consumed. This consumed portion was either evaporated, transpired, ingested, or incorporated into a product. Consumptive water use in the study area amounted to 272.1 mgd of the 388.2 mgd used. <48>

TABLE 3-28
1980 USE OF WATER IN THE 10 COUNTY STUDY AREA
(MILLION GALLONS PER DAY)

USE CATEGORY	GROUNDWATER	SURFACE WATER	TOTAL
PUBLIC SUPPLY	18.6	5.7	24.3
SELF-SUPPLIED IND.	22.6	46.6	69.2
RURAL USE:			
DOMESTIC	4.8	0.0	4.8
LIVESTOCK	1.2	1.8	3.0
SUBTOTAL	6.0	1.8	7.8
IRRIGATION:			
RICE	186.0	28.7	214.7
OTHER CROPS	35.0	7.5	42.5
SUBTOTAL	221.0	36.2	257.2
FISH & MINNOW FARMS	11.1	9.7	20.8
WILDLIFE IMPOUNDMENTS	0.0	8.9	8.9
TOTAL	279.3	108.9	388.2

SOURCE: HOLLAND AND LUDWIG <48>

Water Use Trends

Water use data from 1960, 1965, 1970, 1975 and 1980 for the various categories are plotted in Figure 3-9. Categories showing increases in total water use are:

PUBLIC SUPPLY	17.3 MGD INCREASE	1960-80
IRRIGATION	211.1 MGD INCREASE	1960-80

Only one category, fish farms, had a decreasing trend. From 1970-80 fish farms decreased use by 17.4 mgd. This was after a substantial increase in use from 1965-70 of 33.0 mgd.

Self-supplied industry and rural use have fluctuated with no apparent trend. Wildlife impoundment use was available on only one year, thus a trend cannot be established.

Potential Water Use

This basin has the potential to greatly increase its water use. A large acreage of favorable soil types that the SCS has identified as having a medium to high potential of being irrigated cropland exist in the basin. If all this area were converted, there would be nearly 1/2 million acres of irrigated cropland in the basin with water use of over 1,000 mgd. This is not a projection for the basin, but is what the basin has the potential of using should favorable agricultural economic conditions exist.

Industrial water use was previously the largest water user. With the addition of one or two large industries in the area, industry could once again be the leading water user. Since this is not projectable, the large agricultural potential water use is a buffer against large increases in water use by industry.

Other water uses are estimated based on straight line projections of past uses and population projections to the year 2030. These projections were combined with the agricultural potential and industrial use projection to estimate the maximum potential water use of the basin (See Table 3-29). This represents the amount of water that needs to be reserved for future basin needs before interbasin transfer of water is considered.

TABLE 3-29
WATER USE IN 1980 AND POTENTIAL WATER USE FOR 2030
MILLION GALLONS PER DAY

USE	1980 1/	2030 2/
PUBLIC SUPPLY	24.3	77
SELF-SUPPLIED INDUSTRY	69.2	268
RURAL USE	7.8	17
IRRIGATION 3/	286.9	1081 4/
TOTAL	388.2	1443

1/ HOLLAND AND LUDWIG, AR GEOLOGICAL COMMISSION <48>
2/ AR SOIL AND WATER CONSERVATION COMMISSION
3/ INCLUDES FISH AND MINNOW FARMS AND WILDLIFE IMPOUNDMENTS
4/ MAXIMUM POTENTIAL FOR BASIN

Excess Streamflow

Excess streamflow, defined in Section 5 of Act 1051 of 1985, is twenty-five percent of that amount of water available on an average annual basis above the amount required to satisfy the existing and projected water needs of the basin. In order to determine the excess streamflow in the Lower Ouachita Basin, the amount of water in the streams and rivers on an average annual basis was first calculated based on U.S. Geological Survey streamflow data. Mean annual discharge at the Arkansas-Louisiana state line was estimated for the Ouachita River and Bayou Bartholomew (Table 3-30). Mean annual flows from the gaging station closest to, or most representative of, the point in interest were adjusted based on a ratio of the drainage areas. If no gaging station data was available, mean annual discharge was estimated using runoff data from a nearby basin with similar surficial geology. Mean annual discharges at the state line were also estimated for Overflow Creek, Chemin-a-Haut Bayou, Frank Lapere Creek, Little Corney Bayou, Bayou de Loutre, Cornie Bayou, and Three Creeks using the same procedure with the results shown in Table 3-30. The sum of all estimated mean annual discharges at the state line indicated a surface-water yield of approximately 11 million acre-feet of water from the streams and rivers of the Lower Ouachita Basin on an average annual basis.

To determine the excess streamflow in the basin, the surface-water yield of 11 million acre-feet must be adjusted to account for the water needed to satisfy existing water needs for instream flow requirements. Since the instream flow requirements are not additive, the highest instream need represents the amount of water required to satisfy all the existing instream needs. The instream flow requirements for fish and wildlife were previously identified as the governing instream need for all streams investigated in the basin. Therefore, to determine the amount of water required to satisfy instream flow requirements in the basin, the annual instream flow requirements for fish and wildlife (as previously determined for Bayou Bartholomew, Three Creeks, Cornie Bayou, Chemin-a-Haut Bayou, Bayou de Loutre, Little Corney Bayou, and the Ouachita River) were totaled. On an average annual basis, approximately 7.1 million acre-feet of water is necessary to maintain instream flow requirements.

TABLE 3-30
ESTIMATED MEAN ANNUAL DISCHARGE AT SELECTED LOCATIONS IN THE LOWER OUACHITA BASIN

	ESTIMATED MEAN ANNUAL DISCHARGE	
	CFS	ACRE-FT/YR
OUACHITA RIVER AT AR-LA STATE LINE	13,700	9,926,000
BAYOU BARTHOLOMEW AT AR-LA STATE LINE	1,240	898,000
OVERFLOW CREEK AT AR-LA STATE LINE	90.4	65,500
CHEMIN-A-HAUT BAYOU AT AR-LA STATE LINE	280	203,000
FRANK LAPERE CREEK AT AR-LA STATE LINE	35.3	25,600
LITTLE CORNEY BAYOU AT AR-LA STATE LINE	108	78,200
BAYOU DE LOUTRE AT AR-LA STATE LINE	165	120,000
CORNIE BAYOU AT AR-LA STATE LINE	183	133,000
THREE CREEKS AT AR-LA STATE LINE	67.2	48,700
TOTAL ESTIMATED MEAN ANNUAL DISCHARGE =	15,870 cfs	11,498,000 ACRE-FT/YR

In order to determine excess streamflow in the Lower Ouachita Basin, projected surface-water needs must also be satisfied prior to the determination of water that is available for other uses. The surface-water needs in the Lower Ouachita Basin were projected to the year 2030 using the water use projections in Table 3-29 along with information pertaining to the trends in surface water and groundwater use in the area over the past 10 years. The projected surface-water needs in the Lower Ouachita Basin were estimated to be 1.2 million acre-feet of water.

The available surface water in the Lower Ouachita Basin was calculated by subtracting the flow necessary to satisfy instream flow requirements (7.1 million acre-feet) and projected surface-water needs (1.2 million acre-feet) from the 11 million acre-feet of water in the basin resulting in 2.7 million acre-feet of available water. According to Act 1051 of 1985, twenty-five percent of the 2.7 million acre-feet of available water, or 675,000 acre-feet, is excess surface water in the Lower Ouachita Basin which is available on an average annual basis for other uses, such as interbasin transfer. The majority of the excess surface water is available during the high-flow period of January through May.

Quality of Streamflow

Surface water quality has been addressed by the Arkansas Department of Pollution Control and Ecology in its published reports "Water Quality Inventory Report, 1984," <4> and "Nonpoint Source Pollution Assessment Summaries for the Ouachita River Basin, 1979" <9>. ADPC&E divides the Ouachita River Basin into segments 2A through 2G. The Lower Ouachita River Basin contains segments 2B, 2C, 2D and 2E. (See Figure 3-10). The boundary between the Upper and Lower Ouachita Basins used by ADPC&E is the same as the hydrologic unit division used in this report with one exception. The ADPC&E boundary includes a small part of the Ouachita River above and including Camden in segment 2D, as shown in Figure 3-10. Figure 3-10 also shows the ADPC&E water quality data collection sites in the basin. Stream monitoring data are collected within the basin as part of ADPC&E's routine stream monitoring program. An inventory of each segment is presented below. The water quality problems in each segment are addressed in the surface water quality problems section.

Segment 2B - Bayou Bartholomew and Tributaries

Segment 2B is located in the southeastern part of the Lower Ouachita Basin and includes parts of Jefferson, Lincoln, Drew and Ashley counties. The major streams in this segment are Bayou Bartholomew, Cutoff Creek, and Ables Creek. The total drainage area is approximately 996,800 acres. Land use is primarily forestland, accounting for 65.9 percent of the total area. <4, 9>

Two stream monitoring stations are located on Bayou Bartholomew, one in the upper part of the drainage area (OUA 33), and one at the Arkansas-Louisiana state line (OUA 13). Bayou Bartholomew is the only stream that is monitored in this segment. <9>

Impoundments

Inventory

The inventory of the lakes of the basin is taken from the Lakes of Arkansas publication of this agency. For the lakes over five surface acres, the data given will be for lakes within the hydrologic region (the basin). However, the information for lakes under five surface acres is only listed by county; therefore, the study area (10 counties) will be used in data compilation. There are 292 impoundments over 5 surface acres within the Lower Ouachita Basin. These impoundments have a total surface area of 17,280 acres and impound 123,320 acre-feet. (See Table 3-31). <11> Also, within the study area there is estimated to be over 8,700 impoundments under five surface acres covering over 7,200 acres and impounding over 21,000 acre-feet of water. (See Table 3-32). <11>

TABLE 3-31
INVENTORY OF LAKES OVER 5 SURFACE ACRES

COUNTY		NUMBER	AREA (ACRES)	CAPACITY (ACRE-FEET)
ASHLEY*		16	4019	18339
BRADLEY*		8	228	2033
CALHOUN*		16	1253	13122
CLEVELAND*		19	210	1836
COLUMBIA		20	195	2614
DALLAS		8	73	672
DREW*		46	2925	12902
GARLAND		6	433	4554
GRANT*		18	478	2937
HOT SPRING		2	40	443
JEFFERSON		22	768	4554
LINCOLN*		23	1133	4745
OUACHITA*		28	596	4743
SALINE*		29	2633	38355
UNION*		31	2296	11471
	TOTAL	292	17280	123320

* 10 COUNTY STUDY AREA
SOURCE: ASWCC <11>

TABLE 3-32
INVENTORY OF LAKES UNDER 5 SURFACE ACRES
IN THE 10-COUNTY STUDY AREA

COUNTY		NUMBER	AREAS (ACRES)	CAPACITY (ACRE-FEET)
ASHLEY		470	405	1205
BRADLEY		1162	1104	4192
CALHOUN		500	250	500
CLEVELAND		859	854	2611
DREW		1299	580	1063
GRANT		1234	1950	3900
LINCOLN		776	543	2173
OUACHITA		937	562	2248
SALINE		839	418	1672
UNION		626	600	1800
	TOTAL	8702	7266	21364

SOURCE: ASWCC <11>

Impoundment Water Quality

Limited water quality data exist for the major impoundments. Available data indicate that Lake Winona, a water supply for the Central Arkansas metropolitan area, is being affected by soil erosion due to silviculture activities. Calion Lake has had fish kills caused by oil field brine. Lake Georgia-Pacific, which is used as a water supply by the Georgia-Pacific Corporation, has no history of any problems. The same is true of Seven Devils Lake. <9, 48>

Impoundment Water Use

Total storage of all impoundments in the basin is 144,320 acre-feet. Reported withdrawals from impoundments totaled 29,865 acre-feet in 1984. This use represents 21 percent of the total storage and is 31 percent of the total surface-water use in the basin. 27,093 acre-feet of this use was for public water supply.

USDA (SCS) and Corps of Engineers Projects

The Watershed Protection and Flood Prevention Act, Public Law 83-566, was approved on August 4, 1954. This Act authorizes the Secretary of Agriculture to cooperate with local organizations having authority under State law to carry out, maintain, and operate works of improvement for flood prevention or for the conservation, development, utilization, and disposal of water in watersheds or sub-watershed areas. Technical and financial assistance to prevent or reduce flood damages is provided under the PL 83-566 program. According to the Soil Conservation Service, there are 82 watersheds designated in the Lower Ouachita Basin. Only two of these watersheds (Overflow Creek and Bartholomew-Cousart-Deep Bayou) have the potential to be viable flood prevention watershed projects. (See Figure 3-11). The Garrett Bridge watershed has been deauthorized, and planning has been suspended on the Ables Creek watershed. The remaining 78 watersheds in the basin have no potential for single purpose flood prevention projects because they are not cost effective, there is no local interest, or there are no flooding problems. <91> There is, however, potential within the Bartholomew sub-basin for irrigation projects (See Water Quantity Recommendations) and watershed protection projects (See Water Quality Recommendations).

The Corps of Engineers have done a considerable amount of work in this basin regarding flood protection, drainage and navigation. The major projects of the Corps in the Lower Ouachita Basin are shown in Figure 3-12 and the status of each project is listed in Table 3-33. In the following paragraphs the numbers preceding the project name correspond to those in Figure 3-12. <79, 80>

TABLE 3-33
MAJOR PROJECTS OF THE CORPS OF ENGINEERS
(VICKSBURG DISTRICT)

PROJECT 1/	PROJECT NAME	STATUS
1	PINE BLUFF LOCAL PROTECTION	COMPLETED
2	BAYOU BARTHOLOMEW & TRIBS.	NOT STARTED
3	CALION LOCAL PROTECTION	COMPLETED
4	CALION LOCK AND DAM	COMPLETED
5	FELSENTHAL LOCK AND DAM	COMPLETED
6	OUACHITA AND BLACK RIVERS NINE-FOOT NAVIGATION PROJECT	OPEN

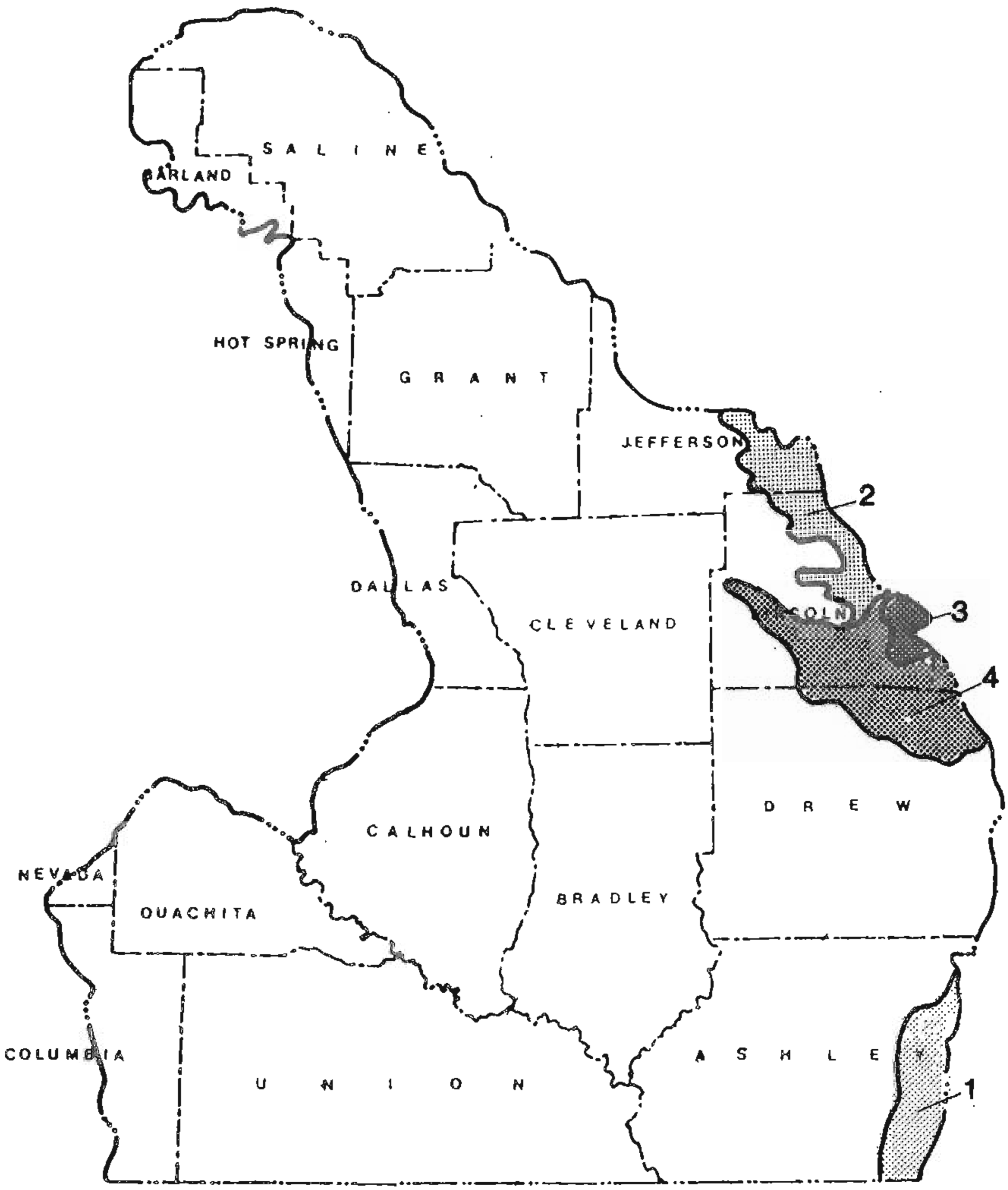
1/ REFER TO FIGURE 3-12, MAJOR PROJECTS OF CORPS OF ENGINEERS
SOURCE: U.S. ARMY CORPS OF ENGINEERS <79, 82>

1 The River and Harbor Act of 1950 provided for flood protection, through drainage improvement, at Pine Bluff. The project involved construction of an intercepting canal, improvement of the existing Pine Bluff outlet canal and improvement of more than four miles of Bayou Bartholomew. These improvements were completed in 1954.

2 The purpose of the Bayou Bartholomew and tributaries project was to provide for reduced flooding of croplands, to improve recreational opportunities in the area, and to enhance fish and wildlife environments. The project provided for channel improvements and closing of high water outlets on the main channel of Bayou Bartholomew, enlargement of Deep Bayou, and clearing and

figure 3-11

LOCATION AND STATUS OF POTENTIAL PL83-566 WATERSHED PROJECTS

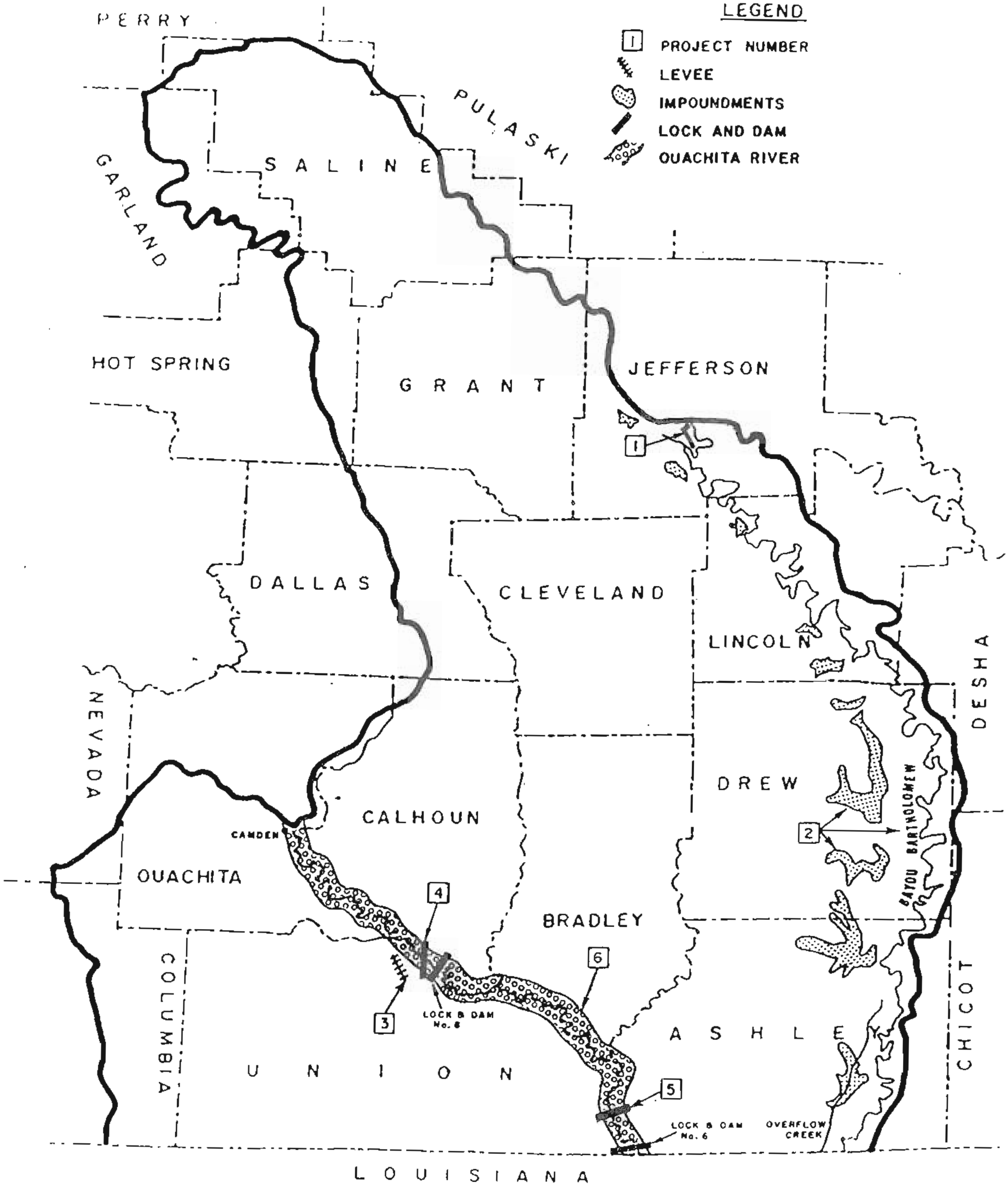


NO.	WATERSHED	STATUS
1	OVERFLOW CREEK	POTENTIAL
2	BARTHOLOMEW-COSART-DEEP BAYOU	POTENTIAL
3	GARRETT BRIDGE	DEAUTHORIZED
4	ABLES CREEK	SUSPENDED

SOURCE: USDA - Soil Conservation Service, State of Arkansas Watershed Data Listing and Hydrologic Data, 1982.(91)

figure 3-12

MAJOR PROJECTS OF THE CORPS OF ENGINEERS



SOURCE: U.S. Army Corps of Engineers ⟨79⟩

enlargement of Overflow Creek. Amendments to the original authorization added ten flood retention lakes on the western escarpment of Bayou Bartholomew and authorized purchase of 3,200 acres of land to offset any fish and wildlife losses resulting from the project construction. The project was placed in the inactive category of civil works projects in December, 1979.

3 The Calion project is part of the Ouachita River development program. The purpose of the project was to provide flood protection for the city of Calion and provide drainage necessary as a result of the levees. Work that has been completed as part of this program includes levees, floodwalls, and floodgates as well as a pumping plant. The project was completed in 1959, with additional levee work completed in 1970.

4, 5, & 6 Development of the Ouachita River for navigation was first authorized in 1871. The project in 1871 consisted of channel clearing and snagging of the Ouachita River from Arkadelphia, Arkansas to its confluence with the Black River in Louisiana. A navigation project was authorized by the River and Harbor Act of 1902. This project was completed in 1926 and involved a series of locks and dams to provide a 6.5 foot navigation depth. The River and Harbor Acts of 1950 and 1960 provided for modification of the original project to increase the navigation depth to nine feet from the mouth of the Ouachita River to Camden. This project involved the construction of 4 locks and dams to replace six obsolete structures. The construction of the locks and dams is complete but channel alignment, enlargement and dredging has been delayed. The two new locks and dams in Arkansas are located at Felsenthal and Calion. Fish and wildlife mitigation involved in the Ouachita River Project includes the 65,000 acre Felsenthal National Wildlife Refuge located along both banks of the Ouachita River in Ashley, Bradley, and Union counties. The refuge has been transfered to the United States Fish and Wildlife Service for operation and management. The navigation pool will be raised in the winter months to provide an enlarged wetland area for waterfowl. <79>

The Vicksburg District of the Corps of Engineers is currently preparing a comprehensive study for the Ouachita River Basin. The study which is to be released in 1988 will address such items as flood protection, water quality, hydroelectric power, erosion, and water supply. <22>

Legal and Institutional Setting

Surface Water in Federal Law

Federal laws exist that relate to surface water in this basin. The Clean Water Act was passed to improve or maintain water quality throughout the Nation; the Water Resource Planning Act was passed to provide coordinated planning of water and related land resources; and the Watershed Protection and Flood Prevention Act was passed to prevent damages caused by erosion, floodwaters, and sediment.

Water Pollution Control Act: This law was set up primarily to keep the pollution of water at a minimum, and is a direct descendant of the Refuse Act, which was set up to give the Corps of Engineers control of navigable streams. The Refuse Act generally prohibits the discharge of refuse into navigable waters of the United States, and prohibits discharges into tributaries of navigable waters, if the refuse floats or is washed into navigable waters. Further, the Refuse Act prohibits deposits on the banks of navigable waters and on the banks of tributaries, if the material is likely to be washed into the navigable water, either by ordinary high tide, storms, floods or otherwise, if navigation would thereby be impeded or obstructed. <10>

With the passage of the Water Pollution Control Act, Amendments of 1972 (P.L. 92-500, 33 U.S.C., Sec. 1251.), the mission of regulation of water quality by the Environmental Protection Agency was greatly enhanced. In short, the Federal Water Pollution Control Act enabled the Environmental Protection Agency to further carry out the provisions of the Refuse Act by attempting to rid our streams and navigable waters of pollution deposited there by industry and non-point pollution. The objectives of the 1972 amendment were to eliminate the discharge of all pollutants into the navigable waters of the United States by 1985. As a result of the passage of this Act, the Environmental Protection Agency was the administrator of our Nation's water quality programs and charged with the responsibility of enforcing existing laws and issuing additional regulations as needed to insure that our waters would remain unpolluted. <10>

Clean Water Act of 1977: Congress recognized the need to amend the Federal Water Pollution Control Act and did so with the Clean Water Act in 1977 (P.L. 95-217, 91 Stat. 1566, 33 U.S.C. 1251). This amendment extends the appropriations as set out in the original act and requires the Environmental Protection Agency to enter into written agreements with the Secretaries of Agriculture, Army and Interior to provide maximum utilization of the laws and programs to maintain water quality. It also deals with the processing of permits for dredged or fill material in any navigable waters of the United States. <10>

Water Resources Planning Act: Congress passed the Water Resources Planning Act, (P.L. 89-90, 79 Stat. 244, 42 U.S.C. 1962), as amended by P.L. 94-112, with the intention of providing for the optimum development of the Nation's natural resources through the coordinated planning of water and related land resources. This was achieved, partially, by the establishment of a Water Resources Council in this act. Additionally, financial assistance was to be afforded to the individual states in order to increase their participation in all phases of water resources planning. <10>

The responsibilities of the Water Resources Council, composed of the Secretary of the Interior, the Secretary of Agriculture, the Secretary of the Army, the Secretary of Health, Education and Welfare and the chairman of the Federal Power Commission, includes various assessments and reports to be made periodically. These reports, to be submitted biennally, are to report on and assess the adequacy of water supplies necessary to meet the water requirements in each water resource region in the United States. Another responsibility of the council is to assess regional or river basin plans and programs to meet the requirements of larger regions of the Nation and administrative and statutory means for the coordination of the water and related land resources policies and programs of the several Federal agencies. Recommendations are to be made to the president of the United States with respect to the Federal policies and programs that are being studied. <10>

<u>Watershed Protection and Flood Prevention Act</u>: This act, (P.L. 83-566, 1954) declared the intention of Congress to be that a cooperative program should be in effect between the Federal government and the states, their political sub-divisions, soil or water conservation districts, and other local public agencies for the purpose of preventing such damages caused by erosion, floodwaters and sediment in the watersheds of the rivers of the United States. It allows and directs the Secretary of Agriculture to cooperate with the previously mentioned entities in flood prevention matters. This act was passed to diminish damages in watersheds causing loss of life and damage to property, and for the purpose of furthering the conservation, development, utilization, and disposal of water and conservation and utilization of land. <10>

<u>Surface Water in State Law</u>

<u>Water Rights</u>: Arkansas water law is based on the old English common law as is the case in most of the humid Eastern States. Under the common law, the right to use water is incidental to ownership of riparian land - land adjacent to surface water.

Initially, the legal use of surface water was limited by the "natural flow" rule that each riparian landowner had the right to insist that the water in the stream continue to flow unimpared in quality or quantity.

The courts have generally decided disputes over water according to a "reasonable use" test which allows each owner to use the water for his own purposes having due regard for the effect of that use upon other riparian owners and on the public in general. What is or is not deemed to be a reasonable exercise of riparian rights, of course, depends upon the circumstances of the case and the philosophy of the courts in the various jurisdictions.

Generally, the following criteria test the "reasonableness" of a given use:

1. The purpose of the use must be lawful and beneficial to the user and suitable to the stream involved;
2. The social utility of a proposed or existing use should be considered;
3. Use of the water must be made on riparian land (used by the riparian owner on land adjacent to the stream or lake);
4. The quantity of water diverted to the exclusive use of the riparian user must be viewed in light of the total flow;
5. The use must not pollute the water so as to significantly harm downstream riparian users;
6. The manner of flow must not be appreciably altered.

Specifically, the Arkansas Supreme Court has declared the following general rules and principles with regard to the reasonable use of water which is subject to riparian rights:

a. The right to use water for strictly domestic purposes--such as for household use--is superior to many other uses of water, such as for fishing, recreation and irrigation.
b. Other than the use mentioned above, all other lawful uses of water are equal (Some recognized lawful uses are fishing, recreation, and irrigation).
c. When one lawful use of water is destroyed by another lawful use, the latter use must yield or it may be enjoined.
d. When one lawful use of water interferes with or detracts from another use, then a question arises as to whether, under all the facts and circumstances of that particular case, the interfering use shall be declared unreasonable and, as such, enjoined, or whether a reasonable and equitable adjustment should be made having due regard to the reasonable rights of each.

Arkansas statutory law authorized the Arkansas Soil and Water Conservation Commission to allocate surface water during periods of shortage and delineates priority of use during times of scarcity as (1) sustaining life; (2) maintaining health, and (3) increasing wealth.

Water Quality Management: The Arkansas Water Quality Management Plan provides tools by which water quality can be more effectively and efficiently managed. The provisions of the Federal Water Pollution Control Act, as amended, set forth requirements for the establishment of comprehensive statewide water quality planning programs. These programs are marked by three distinct phases of development. Phase I plans were completed in 1976 and provide, for each major river basin in Arkansas, identification of existing water quality problems, programs to control or eliminate those problems and an identification of major sources of water pollution within each basin. The Phase I Basin plans are often referred to as 303(e) plans and are available for review at the Department of Pollution Control and Ecology.

Phase II is defined as the planning, which occurred between 1976 and May 29, 1979, and focused upon the requirements of Section 208 of the Federal Water Pollution Control Act. Phase II planning is often referred to as the initial 208 planning effort. Phase III refers to the continuation of planning initiated under Phase II, including revisions of the initial 208 plan. Phase III planning was authorized by the 1977 amendments to the Federal Water Pollution Control Act (Clean Water Act).

Section 208 of the Clean Water Act directs the governor of each state to identify each area within the state which, as a result of urban industrial concentrations or other factors, has substantial water quality control problems. Section 208 of the Act provides for the designation of areas with substantial water quality control problems which are located in two or more states by the governors of the respective states. If an area fulfills the requirements for designation and the governor (or governors) fail to act, either by designating or determining not to make a designation, Section 208(a)(4) of the Act provides that the chief elected officials of local governments in the area may designate the area by agreement.

The governor of Arkansas subsequently designated the following agencies and areas in this basin:

1. May, 1976 - Southeast Arkansas Regional Planning Commission, Jefferson Co.
2. July, 1976 - Metroplan, Saline and Pulaski Co.

All of the areas designated by the Governor have been approved by the EPA and funded for study. The Arkansas Department of Pollution Control and Ecology has been designated by the Governor of Arkansas as the agency responsible for water quality management planning in the non-designated areas of the state.

Institutional Setting

Federal and State agencies, as well as local organizations have various responsibilities in water resource management. The following sections describe the responsibilities and objectives of several of these organizations.

Federal Agencies: 1. The Soil Conservation Service (SCS) was established in the United States Department of Agriculture by Congress in 1935 to plan and carry out a national program to conserve and develop our soil and water resources. The mission of the SCS is to provide national leadership in the conservation and wise use of soil, water, and related resources through a balanced cooperative program that protects, restores, and improves these resources. SCS directs efforts toward two national priorities:

A. Reduce excessive erosion on crop, range, pasture, and forest lands.

B. Conserve water used in agriculture, and reduce flood damages in small upstream watersheds.

Specific programs of the SCS relating to surface water include technical assistance which is provided to individuals and groups through conservation districts to conserve soil and water resources; water resources activities including watershed projects; river basin investigations; resource conservation and development; technical assistance for the Water Bank Program; and emergency conservation measures.

2. The Corps of Engineers, established in 1779 by Congress, has been assigned a broad range of civil works projects to develop, manage, and conserve the Nation's water resources. The Corps is involved with water resource planning and development. Activities of the Corps include commercial navigation, hydroelectric power development, flood reduction, land and water recreation, irrigation, water supply, shore and beach erosion protection, hurricane protection, water quality management, and studies of urban area problems including wastewater management. In developing and managing water resources, the Corps seeks to balance the developmental and environmental needs of our country. <79>
3. The U.S. Geological Survey was established through legislation of 1879. In 1888 and 1894, legislation authorized the U.S.G.S. to survey irrigable lands in arid regions and provided funds for gaging streams and determining the water supply of the Nation. The mission of the U.S. Geological Survey is to provide hydrologic information needed by others and to appraise the Nation's water resources. The water resources activities of the U.S.G.S. are diverse ranging from collecting data on the quantity, quality, and use of surface and groundwater to conducting hydrologic and water-related research. The Survey conducts water-resources investigations and also acquires information useful in predicting and delineating water-related natural hazards from flooding, volcanoes, mudflows and land subsidence.
4. The Environmental Protection Agency: In 1970, executive action, termed Reorganization Plan #3, brought together several environmental programs and formed the Environmental Protection Agency (EPA). Enactment of new laws and important amendments to older laws in the 1970's greatly expanded EPA's responsibilities. The Agency now administers nine comprehensive environmental protection laws as follows:
   1. Clean Air Act;
   2. Clean Water Act;
   3. Safe Drinking Water Act;
   4. Comprehensive Environmental Response, Compensation, and Liability Act (superfund);
   5. Resource Conservation and Recovery Act;
   6. Federal Insecticide, Fungicide, and Rodenticide Act;
   7. Toxic Substance Control Act;
   8. Marine Protection, Research, and Sanctuaries Act;
   9. And the Uranium Mill Tailings Radiation Control Act.

Through the administration of these laws, EPA is accomplishing its mission to protect human health and the environment. <102>

<u>State Agencies</u>: 1. The Arkansas Department of Pollution Control and Ecology (ADPC&E) has powers of regulation and enforcement over waters of the state through the authority of Act 472 of 1949. The activities of ADPC&E as they relate to water include making basin surveys, reviewing and approving waste treatment designs, administering funds for the construction of municipal treatment plants, monitoring streams for the construction of municipal treatment plants, monitoring streams to determine water quality, and conducting and sponsoring research. ADPC&E also has the responsibility of the state-level administration of the Clean Water Act mentioned previously. <10>

ADPC&E has developed regulations to protect the waters of the State, and two of these regulations relate to surface water. Regulation #1 was developed for the prevention of pollution by saltwater and other oil field wastes produced by wells while Regulation #2 was developed to establish water quality standards for the surface waters of the state.

2. Arkansas Act 81 of 1957 established the Arkansas Water Conservation Commission, now the Arkansas Soil and Water Conservation Commission. Primary functions given the Commission by this act were:
    1. regulate construction of facilities by permit to store surplus streamflow;
    2. inspection of permitted dams annually for safety and maintenance;
    3. allocation of water between persons taking water from streams during periods of shortage;
    4. gather data from time to time, on the use of surface water and the need of it;
    5. review petitions for the formation of regional water districts to utilize water stored in federal reservoirs; and
    6. register water diverted from streams, lakes, or ponds to assure proper allocation of water during periods of shortage.

Act 217 of 1969 authorized the Commission to develop the Arkansas State Water Plan that would serve as the state water policy for the development of water and related land resources in the state of Arkansas. All reports, studies and related planning activities were required to take the State Water Plan into consideration. In 1975, the first State Water Plan was published. In 1980, work on revising the 1975 plan began.

Act 1051 of 1985 outlined many variables that needed to be quantified or delineated and included in the State Water Plan, expected to be released by late 1986. Some requirements of the Act were: (a) determine current and projected needs of public water supplies, industry and agriculture, (b) define and quantify the safe yield of all streams, reservoirs and aquifers, and (c) quantify requirements of fish and wildlife, navigation, riparian rights and minimum stream flows. In addition, the act authorized interbasin transfer and non-riparian use contingent upon guideline development by the Commission and required all groundwater users to report the quantity of groundwater withdrawn on an annual basis. The Commission will now collect and compile groundwater use data in addition to surface water use data collection that was authorized by Act 180 of 1969.

Act 417 of 1985 will provide incentives for construction of surface reservoirs in the form of a state tax credit not to exceed 50% of the total construction cost or a maximum of $33,000 over an 11 year period. Any applicant that converts to surface water from groundwater sources may receive a tax credit equal to 10% of the total conversion cost. Persons seeking eligibility for the tax breaks must apply to Arkansas Soil and Water Conservation Commission for evaluation and acceptance.

3. The basin, like all others within the State, is entirely within the boundaries of conservation districts. These districts are legal entities of State Government and are funded in part from funds administered from the various quorum courts and from state funds administered by the Arkansas Soil and Water Conservation Commission. The major function of these districts, organized under authority of Act 197 of the General Assembly of the State of Arkansas in 1937, as amended, is to assist the owners and farm operators in developing individual land use plans on their farms. These plans show necessary corrective methods, works of improvement and best management practices necessary to control soil erosion, improve surface water quality, lower floodwater and sediment damages, and further the conservation, development and utilization of soil and water resources. Each conservation district has entered into a memorandum of understanding with the U.S. Department of Agriculture and a supplemental memorandum of understanding with the Soil Conservation Service to provide them with the technical assistance. The Department of Agriculture administers a cost sharing program for certain on-farm conservation practices through county offices of the Agricultural Stabilization and Conservation Service.

Local Organizations: Irrigation, drainage, and watershed improvement districts are generally formed to provide facilities for irrigation, drainage, flood control, recreation, fish and wildlife, and to prevent soil erosion and sediment damages. These irrigation, drainage, and watershed improvement districts, through their boards, may assess damages and benefits to all lands within that particular district. <10> Following is a narrative of the local organizations in this basin.

1. Drainage districts were formed to construct and maintain works of improvement. Many of the smaller districts have gone out of existence. Those remaining maintain works of improvement constructed by the Vicksburg District Corps of Engineers. At present, there are two drainage districts which are listed below:
   (A) Lincoln Drainage District - Inactive
   (B) Dermott Drainage District - Dermott
2. After the Soil Conservation Service's small watershed program (PL 83-566) was created, watershed improvement districts were formed to sponsor and maintain watershed projects within their district. In some cases the watershed improvement district absorbed the drainage district and in other cases, watershed improvement districts lie within active drainage districts. The 6 districts in the basin are:
   (A) Camp Bayou Watershed Improvement District - Wilmot
   (B) Canal 18 Watershed Improvement District - McGehee
   (C) Chicot, Desha and Drew Watershed Improvement District - McGehee
   (D) Grady-Gould Watershed Improvement District - Gould
   (E) Fleschman Bayou Watershed Improvement District - McGehee
   (F) Ables Creek Watershed Improvement District - Star City

SURFACE WATER RESOURCE PROBLEMS

To insure future productivity and economic growth, adequate water supplies must be available. The overriding policy of the Arkansas Soil and Water Conservation Commission in the area of water management is to insure Arkansans with sufficient water quantity of a quality satisfactory for the intended beneficial use. This basin is a highly productive region of a diverse economic base, and includes agriculture, forestry, mining, and oil and gas production. Without adequate quantities of satisfactory quality water, these economic activities will suffer setbacks in current levels of production and increases in production could be impossible.

A series of public meetings were held within each conservation district to determine the public perception of and concerns with problems associated with soil, water and related resources. These meetings fulfilled the requirements of the Soil and Water Resources Conservation Act (RCA) passed by Congress in 1977. This Act directed the secretary of Agriculture to conduct a continuing appraisal of the status and condition of our soil, water and related resources. The purpose of RCA is to insure that programs administered by the Secretary of Agriculture for the conservation of soil, water, and related resources shall respond to the nation's long term needs. Broad based participation in the RCA effort by groups, organizations, and the general public is a primary objective of the Act and is necessary to ensure that programs respond to the public needs. Included in the following list are those concerns and problems voiced by the public and various state and federal agencies. The catagories of expressed concern within the basin were as follows: <66>

MINING	FORESTRY (NON-FEDERAL LAND)
SOIL EROSION	WATER QUALITY (POINT SOURCES)
FLOODING	WATER QUANTITY (SURFACE WATER)
DRAINAGE	FOOD AND FIBER
WATER SUPPLY	FISH AND WILDLIFE
WATER MANAGEMENT	RECREATION

This basin has the potential to tremendously increase water use. With straight line increases in water use by public supply and industry along with the maximum development of irrigated cropland, this basin could use almost 1,500 mgd. The maximum conversion of land to irrigated cropland would require over 1,000 mgd of this total potential need of the basin.

To increase profit margins and to insure against complete crop failure, land owners and operators are expected to increase investments for irrigation systems. Based on 1980 prices, investment cost for irrigation systems in this basin was $261.68 per acre. This is $89.00 more than the average for the state. <93> The conversion to irrigation of major crops has the potential to increase from 116,200 acres in 1980 to as much as 477,100 acres in 2030. <69, 93>

Present problems within the basin are discussed, by problem, on the following pages.

Surface-Water Quantity Problems

Availability

The Lower Ouachita River Basin would appear to have no problems with water availability on an average annual basis. However, the average annual flow is based upon high winter-spring flows and low summer-fall flows. The conversion to an average flow throughout the year is limited in its use for planning purposes because this average doesn't reflect the periods of low flow that cause availability problems. This could occur only seasonally during a year or could be a year long event as was noted in the streamflow characteristics section. It is these low flow periods and their recurrence intervals that need to be the focus of planning efforts.

The Saline River is the source of water for industry and public supply. The streamflow characteristics are such that a dependable year-round supply is not available. Users have overcome this problem by developing instream and offstream storage to sustain water supplies during low flows. Currently, there is no evidence of a water availability problem. However, additional development along the Saline River would probably require offstream storage to supplement the water supply during periods of insufficient streamflow.

Shortages of available surface water are primarily a problem in the agricultural region of the Basin. This is the case in the Bayou Bartholomew watershed. Bayou Bartholomew and its tributaries are used extensively as an irrigation source at a time that it historically has its lowest flows of the year. The flows are reduced to levels that threaten equitable distribution to users and leave little room for development by landowners who are not currently exercising their riparian right. Because of this, Bayou Bartholomew is a critical water area. An in-depth review of the problem, including computations, is in the critical surface water area section.

The Ouachita River has no registered use other than navigation; therefore, availability problems are not addressed.

Flooding

There are about 1,407,600 acres located within the floodplain of this basin. Land use within the floodplain consists of about 249,100 acres of cropland, 1,051,500 acres of forestland, and about 107,000 acres of grassland. <88> The 100-year frequency flood would inundate and cause severe losses on the entire 1,407,600 acres. Portions of the cropland located within the floodplain are flooded on a somewhat regular basis. <88>

Flooding and drainage problems which are due to excessive runoff from high intensity or long duration rainfalls, occur on cropland throughout the agricultural region of the basin. An estimated 28,900 acres of cropland flood once every two years. An additional 21,300 acres of cropland flood once every five years, and about 37,500 additional acres flood once every ten years. <87>

An estimated 13.6 million dollars (1977 price base) in damages occur annually to crop, pasture, and forestland within the floodplain. Total damages which include damages to roads and bridges, urban areas, and other agricultural properties, are estimated to be about 21.5 (1977 price base) million dollars annually. <88>

Surface-Water Quality Problems

As mentioned in the water quality inventory section, water quality has been addressed by the Arkansas Department of Pollution Control and Ecology. Water-quality problems in segments 2B, 2C, 2D and 2E (as shown in Figure 3-10) are discussed in the following paragraphs.

Segment 2B - Bayou Bartholomew and Tributaries

Water quality in Segment 2B is impacted by nonpoint sources of agricultural runoff. Soil erosion is causing turbidity at the lower station in this basin to exceed the 50 NTU water quality standard most of the time. High pesticide and fertilizer applications along with excessive erosion rates are the primary sources of water quality degradation. <4, 9>

An estimated 637,400 tons of sediment are being delivered to the watershed outlets in segment 2B annually. This includes the delivery of 121,600 tons of sediment to the Bartholomew-Cousart-Deep Bayou outlet, and 116,600 tons of sediment to the Ables Creek outlet. According to the Soil Conservation Service, the total erosion in this segment is approximately 2,089,000 tons per year (See Table 3-34). Sheet and rill erosion accounts for more than 92 percent of the erosion in this segment. <9>

TABLE 3-34
SUMMARY OF EROSION BY SOURCE
SEGMENT 2B

EROSION SOURCE	TONS/YEAR	PERCENT OF TOTAL
ROAD SURFACE EROSION	56,600	2.7
ROAD BANK EROSION	59,900	2.9
GULLY EROSION	800	-
STREAMBANK EROSION	42,300	2.0
SHEET AND RILL EROSION	1,929,000	92.4
TOTAL	2,088,600	100.0

SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

Table 3-35 shows sheet and rill erosion by land use. While cropland makes up only 26.5 percent of the total land use in this segment, more than 91 percent of the sheet and rill erosion is occurring on cropland. The highest average cropland erosion rate of 14.2 tons/acre/year is occurring on Turtle Creek. <9>

TABLE 3-35
SHEET AND RILL EROSION BY LAND USE
SEGMENT 2B

LAND USE	PERCENT OF TOTAL LAND USE	AVG. EROSION RATE (TONS/ACRE/YEAR)	PERCENT 1/ OF TOTAL EROSION
CROPLAND	26.5	6.67	91.4
GRASSLAND	5.2	0.94	2.5
FORESTLAND	65.9	0.18	6.1
URBAN & BUILT-UP	1.0	2/	-
WATER, MINES, AND OTHER	1.4	2/	-
SEGMENT 2B	100.0	1.94	100.0

1/ TOTAL = TOTAL SHEET AND RILL EROSION
2/ NOT COMPUTED
SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

The intensive agriculture in the eastern half of the segment has a significant effect on streamflow water quality. After a rain, runoff flows through drainage ditches and into streams. This runoff carries with it silt, fertilizers, herbicides, and pesticides. Fish kills due to misuse of pesticides have occurred along the entire length of Bayou Bartholomew. <9>

A 1976-77 survey from the monitoring program indicates several violations of the Arkansas Water Quality Standards (e.g., total phosphorus and turbidity). Several constituents also exceeded levels recommended by Quality Criteria for Water <98>, especially pesticides and heavy metals. (See Table 3-36). Additional information in Table 3-36 shows results of the biological monitoring program. <9>

An inventory of the water quality conditions in 1984 by ADPC&E <4> showed that dissolved oxygen concentrations were, at times, below water-quality standards. Also, copper, lead, and zinc concentrations exceeded water-quality standards at times.

Segment 2C - Saline River and Tributaries.

Water quality in Segment 2C is being degraded by both point and nonpoint sources of pollution. Primary point sources of pollution are the discharges from aluminum mining and processing industries, while a major nonpoint source is erosion occurring on forestland. <9>

The nonpoint sources of discharge affecting the Saline River watershed are those resulting from silvicultural, mining, and urban development activities. These activities may cause an increase in sediment yield to streams, as well as an increase in concentrations of pesticides, heavy metals, and nutrients. <9>

table 3-36

SUMMARY OF PARAMETERS NOT MEETING RECOMMENDED LEVELS

SEGMENT 2B

	IRON	MANGA-NESE	TOTAL PHOS-PHORUS	TURBI-DITY	CAD-MIUM	COP-PER	DISS. OXY-GEN	ZINC	MER-CURY	LEAD	PH	DDT DDE DDD	METHYL PARA-THION	END-RIN	DIEL-DRIN	ALA-CHLOR	TOXA-PHENE	FECAL COLI-FORM
OUA 13	21/21	21/21	20/21	10/21	3/6	1/20	1/22	1/20		5/19		1/10	3/10	4/10	3/10	3/10	8/10	1/21
OUA 33	20/20	20/20	20/21	5/22	2/5	2/19	9/22	1/20		2/8			2/10	4/8	3/8	1/8	4/8	2/21

OUA 13 BAYOU BARTHOLOMEW NEAR JONES, LA
OUA 33 BAYOU BARTHOLOMEW NEAR LADD, AR

X : Y

X = SAMPLES EXCEEDING RECOMMENDED LEVELS.
Y = TOTAL NUMBER OF SAMPLES TAKEN IN 1976 AND 1977.

BIOLOGICAL MONITORING DATA

CORRECTED CHLOROPHYLL a: YEARLY AVERAGE

	1975	1976	1977	1978
OUA 13			45.22	4.07
OUA 33		14.15	26.52	12.35

CHLOROPHYLL a IS A GOOD GENERAL INDICATOR OF THE AMOUNT OF NUTRIENTS PRESENT IN A STREAM. A YEARLY AVERAGE LESS THAN 10 INDICATES CLEAR, CLEAN WATER. AVERAGES GREATER THAN 10 INDICATE VARYING DEGREES OF DEGRADATION.

BENTHIC DIVERSITY INDEX

	1976	1977
OUA 13	-	1.8
OUA 33	2.6	1.4

IN GENERAL, THE BENTHIC DIVERSITY INDEX FOR STREAMS IN ARKANSAS MAY BE ASSESSED AS FOLLOWS:

> 2.5: GOOD
2.0 - 2.5: AVERAGE
< 2.0: POOR

SOURCE: ARKANSAS SOIL AND WATER CONSERVATION COMMISSION (9)

An estimated 1,250,800 tons of sediment are being delivered to Segment 2C watershed outlets annually. This includes the delivery of 214,300 tons of sediment to the Lower Alum Fork and Middle Fork outlet, 166,600 tons of sediment to the South Fork of the Saline River outlet, and 133,600 tons of sediment to the upper Alum Fork outlet. According to the Soil Conservation Service, the total erosion in this segment is approximately 3,977,200 tons per year (See Table 3-37). Sheet and rill erosion accounts for about 74 percent of the total erosion in this segment, while roadbank and streambank erosion accounts for 11.2 and 10.6 percent, respectively. The highest average total erosion rate of 13.3 tons/acre/year is occurring on the Upper Alum Fork. <9>

TABLE 3-37
SUMMARY OF EROSION BY SOURCE
SEGMENT 2C

EROSION SOURCE	TONS PER YEAR	PERCENT OF TOTAL
ROAD SURFACE EROSION	163,600	4.11
ROADBANK EROSION	443,100	11.20
GULLY EROSION	6,300	0.10
STREAMBANK EROSION	421,300	10.60
SHEET AND RILL EROSION	2,942,900	73.99
TOTAL	3,977,200	100.00

SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

Table 3-38 shows that forestland accounts for more than 78 percent of the total sheet and rill erosion. <9>

TABLE 3-38
SHEET AND RILL EROSION BY LAND USE
SEGMENT 2C

LAND USE	PERCENT OF TOTAL LAND USE	AVG. EROSION RATE (TONS/ACRE/YEAR)	PERCENT 1/ OF TOTAL EROSION
CROPLAND	1.1	11.33	7.00
GRASSLAND	11.9	2.02	14.76
EXTRACTIVE	0.3	0.34	0.20
FORESTLAND	85.6	1.61	78.04
URBAN & BUILT-UP	0.9	2/	-
SEGMENT 2C	100.0	2.33	100.00

1/ TOTAL = TOTAL SHEET AND RILL EROSION
2/ NOT COMPUTED
SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

While erosion is a primary nonpoint source of pollution which contributes to water quality degradation in this segment, the mining industry is also a nonpoint source of pollution in this segment. There are approximately 4800 acres of land which are mined for bauxite in this segment. About 3400 acres of these mines occur in the Upper Hurricane Creek Watershed while most other mines are located in the Lost Creek Watershed. The major problem associated with the mines is acid mine drainage caused by the oxidation of exposed pyritic materials. <9>

Hurricane Creek has shown general improvements over the past acid water situtaton; however, it appears that the opposite condition is occurring in Hurricane Creek downstream from Sardis. High pH waters containing lime from the aluminum extraction process has increased the pH of the water in Hurricane Creek. The mean pH value for 22 samples collected during 1982-83 on Hurricane Creek near Sardis was 7.7. <4>

Although the major water quality problems in this segment are related to mining and silvicultural activities, the rapid increase in urbanization in recent years has compounded the problems resulting from urban runoff. All of these problems combined have severely affected some streams in this segment. Lost Creek and Hurricane Creek are unfit for most beneficial purposes. The Saline River and tributaries such as the Middle, South, and Alum Forks generally support beneficial uses but are affected by urban runoff and the forestry industry. <9>

The major point source discharges in Segment 2C include approximately 45 industrial sites, 8 municipal sites, and 20 non-municipal domestic waste sites. Many of the industrial discharge sources are from the aluminum mining and processing industries in Saline County. The major water quality problems caused by point sources are: excessively high levels of fecal coliform bacteria (due to inadequate sewage treatment), high turbidity (from mining and silvicultural operations), and low pH and high concentrations of heavy metals (from mining and processing industries). <9>

A 1976-77 survey from the ambient monitoring program indicates several violations of the Arkansas Water Quality Standards. Also there were several constituents that exceeded levels recommended by Quality Criteria for Water <98>. A summary of parameters exceeding recommended levels is presented in Table 3-39. Additional information in Table 3-39 shows results of the biological monitoring program conducted at the three sites. <9>

A study of the water quality conditions in 1984 by ADPC&E <4> showed that dissolved oxygen, pH, total dissolved solids, chloride, and fecal coliform bacteria exceeded water quality standards, at times, in this segment. The Hurricane Creek station (OUA 31) has shown an increase in the concentrations of chloride, sulfate, and total dissolved solids.

table 3-39

SUMMARY OF PARAMETERS NOT MEETING RECOMMENDED LEVELS

SEGMENT 2C

	IRON	MANGA-NESE	TOTAL PHOS-PHORUS	TURBI-DITY	CAD-MIUM	COP-PER	DISS. OXY-GEN	ZINC	MER-CURY	LEAD	PH	DDT DDE DDD	METHYL PARA-THION	END-RIN	DIEL-DRIN	ALA-CHLOR	TOXA-PHENE	FECAL COLI-FORM
OUA 10A	18/21	21/21	11/21		4/6	2/20	1/22	1/20	1/1	4/19			1/10				1/10	
OUA 26	13/20	10/19	5/21	8/24	1/3	20/20		7/20		1/6								4/21
OUA 31	15/15	14/14	8/19	2/20	3/7	2/16		7/17	1/1	3/7	10/20							1/19

OUA 10A SALINE RIVER NEAR FOUNTAIN HILL, AR
OUA 26 SALINE RIVER NEAR BENTON, AR
OUA 31 HURRICANE CREEK NEAR SARDIS, AR

X/Y : X = SAMPLES EXCEEDING RECOMMENDED LEVELS.
Y = TOTAL NUMBER OF SAMPLES TAKEN IN 1976 AND 1977.

BIOLOGICAL MONITORING DATA

CORRECTED CHLOROPHYLL a: YEARLY AVERAGE

	1975	1976	1977	1978
OUA 10A			15.72	3.39
OUA 26	1.60	1.35	2.67	0.74
OUA 31	1.80	1.16	4.73	1.85

A YEARLY AVERAGE LESS THAN 10 INDICATES CLEAR, CLEAN WATER. AVERAGE GREATER THAN 10 INDICATE VARYING DEGREES OF DEGRADATION.

BENTHIC DIVERSITY INDEX

	1976	1977
OUA 10A	-	2.1
OUA 26		
OUA 31	2.1	1.0

IN GENERAL, THE BENTHIC DIVERSITY INDEX FOR STREAMS IN ARKANSAS MAY BE ASSESSED AS FOLLOWS:

> 2.5: GOOD
2.0 - 2.5: AVERAGE
< 2.0: POOR

SOURCE: ARKANSAS SOIL AND WATER CONSERVATION COMMISSION(9)

Segment 2D - Lower Ouachita River and Tributaries

This segment is affected by a number of nonpoint sources of pollution. An estimated 125,600 tons of sediment are being delivered to Segment 2D watershed outlets annually. This includes the delivery of 53,400 tons of sediment to the Brushy Creek outlet, 37,100 tons of sediment to the Lower Freeo and Chapel Creek outlet, and 27,400 tons of sediment to the Tulip Creek outlet. According to the Soil Conservation Service, the total erosion in this segment is approximately 1,614,600 tons per year (See Table 3-40). Sheet and rill erosion accounts for about 66 percent of the total erosion in the segment, while road bank and road surface erosion accounts for almost 24 percent of the total erosion. <9>

TABLE 3-40
SUMMARY OF EROSION BY SOURCE
SEGMENT 2D

EROSION SOURCE	TONS/YEAR	PERCENT OF TOTAL
ROAD BANK & SURFACE EROSION	383,500	23.8
GULLY EROSION	8,600	0.5
STREAMBANK EROSION	151,900	9.4
SHEET & RILL EROSION	1,070,600	66.3
TOTAL	1,614,600	100.0

Source: USDA, SOIL CONSERVATION SERVICE <87>

Sixty-four percent of the sheet and rill erosion is occurring on forestland as shown in Table 3-41. Cropland accounts for 27 percent of the sheet and rill erosion even though it makes up just over one percent of the land use. <9>

TABLE 3-41
SHEET & RILL EROSION BY LAND USE
SEGMENT 2D

LAND USE	PERCENT OF TOTAL LAND USE	AVG. EROSION RATE (TONS/ACRE/YEAR)	PERCENT 1/ OF TOTAL EROSION
CROPLAND	1.1	11.9	27.0
GRASSLAND	5.5	.8	9.0
FORESTLAND	90.7	.3	64.0
URBAN & BUILT-UP	2.1	2/	-
MINES	0.1	2/	-
WATER & OTHER	0.5	-	-
TOTAL	100.0	.50	100.0

1/ TOTAL = TOTAL SHEET AND RILL EROSION
2/ NOT COMPUTED
SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

Cropland and forestland account for 91 percent of the sheet and rill erosion. (Table 3-41) Erosion rates are excessive on cropland. The steep slopes that are predominant in this segment are the major cause of high erosion rates. <9> Erosion on forestland amounts to 64 percent of the sheet and rill erosion; however, the average erosion rate is only 0.3 tons/acre/year on forestland. Erosion from forestland in this segment does not appear to cause any significant water quality problems.

Segment 2D contains a relatively large number of municipal and industrial discharges. These include sewage treatment plants, and oil field wells, including injection wells, that produce varying amounts of water, oil, and/or gas. <9>

An estimated 2,210,000 pounds per day of dry salt equivalent leave the State of Arkansas by way of the Ouachita River. At least 57 percent of this load enters the Ouachita River between Camden and Lock and Dam Number 6. Of this 57 percent, about 14 percent is naturally occurring, while 86 percent is generated within the oil fields of the area. From these percentages, approximately 50 percent of the total salt load carried by the Ouachita River comes from the production of oil and gas. <9>

Saltwater and petrochemical residuals have damaged an estimated 20,000 acres of land in this segment. A high water table with high concentrations of sodium and total dissolved salts is characteristic of low lying flats. Soil pH of damaged areas is often in the 3.5 to 4.5 range. Sodium chloride concentrations of water in some streams are frequently higher than that found in ocean water. Salting of the land has resulted in a constant source of salt pollution to streams. Plants, microorganisms, and soil animals do not survive under these adverse conditions. The major problem area is the Smackover Creek area north of El Dorado, but salt problems are evident in other areas of this segment. <9>

A 1976-77 survey from the monitoring program indicates several violations of the Arkansas Water Quality Standards including fecal coliform bacteria, total phosphorus, and dissolved oxygen (See Table 3-42). Also, several constituents exceeded levels recommended by Quality Criteria for Water <98>, especially pesticides. Additional information in Table 3-42 shows results of the biological monitoring program.

An inventory of the water quality conditions in Segment 2D in 1984 by ADPC&E <4> showed that water quality problems at the Felsenthal station on the Ouachita River included low dissolved oxygen concentrations, and heavy metal and chloride concentrations which exceeded water quality standards. In Coffee Creek, dissolved oxygen concentrations of zero have been recorded. The major flow from Coffee Creek comes from the Georgia Pacific and Crossett sewage treatment plant. Samples collected from Smackover Creek are periodically low in dissolved oxygen and pH. The headwaters of Smackover Creek receive wastewater from a sewage treatment plant and industrial sources which contribute to the low dissolved oxygen

table 3-42

SUMMARY OF PARAMETERS NOT MEETING RECOMMENDED LEVELS

SEGMENT 2D

	IRON	MANGA-NESE	TOTAL PHOS-PHORUS	TURBI-DITY	CAD-MIUM	COP-PER	DISS. OXY-GEN	ZINC	MER-CURY	LEAD	PH	DDT DDE DDD	METHYL PARA-THION	END-RIN	DIEL-DRIN	ALA-CHLOR	TOXA-PHENE	FECAL COLI-FORM
OUA 05	20/21	20/20	20/21		12/17	3/21	8/22		1/1	6/19		1/2					1/2	2/20
OUA 07A	21/21	19/19	8/21	1/22	4/9	1/21		1/21	1/1	5/18	3/22							
OUA 08	18/20	18/19	11/20		2/5	3/19		1/19		2/18								1/22
OUA 11A	18/20	18/18	16/18	8/18	6/8	6/17	18/18	4/17	1/1	13/15								16/17
OUA 27	19/20	17/17	7/22		6/9	3/20	4/23	2/20	1/1	2/8	3/23							
OUA 28	5/5	3/3	13/21		1/3		3/22		1/1		1/22							1/20

OUA 05 BAYOU DE L'OUTRE NEAR EL DORADO, AR
OUA 08 OUACHITA RIVER NEAR FELSENTHAL, AR
OUA 27 SMACKOVER CREEK NEAR SMACKOVER, AR
OUA 07A OUACHITA RIVER AT LOCK AND DAM 8
OUA 11A COFFEE CREEK NEAR CROSSETT, AR
OUA 28 MORO CREEK EAST OF HAMPTON, AR

X/Y : X = SAMPLES EXCEEDING RECOMMENDED LEVELS.
Y = TOTAL NUMBER OF SAMPLES TAKEN IN 1976 AND 1977.

BIOLOGICAL MONITORING DATA

CORRECTED CHLOROPHYLL a: YEARLY AVERAGE

	1975	1976	1977	1978
OUA 05	8.25	88.26	89.70	23.46
OUA 08			10.20	3.84
OUA 27	3.40	4.53	10.61	10.25

CHLOROPHYLL a IS A GOOD GENERAL INDICATOR OF THE AMOUNT OF NUTRIENTS PRESENT IN A STREAM. A YEARLY AVERAGE LESS THAN 10 INDICATES CLEAR, CLEAN WATER. AVERAGES GREATER THAN 10 INDICATE VARYING DEGREES OF DEGRADATION.

BENTHIC DIVERSITY INDEX

	1976	1977
OUA 05	0.89 -	0.08
OUA 08		1.7
OUA 27	2.1	2.7

IN GENERAL THE BENTHIC DIVERSITY INDEX FOR STREAMS IN ARKANSAS MAY BE ASSESSED AS FOLLOWS:

> 2.5: GOOD
2.0 - 2.5: AVERAGE
< 2.0: POOR

SOURCE: ARKANSAS SOIL AND WATER CONSERVATION COMMISSION (9) content found below these sources. This low dissolved oxygen concentration continues for the entire length of Smackover Creek. Dissolved oxygen and pH are measurably low on Moro Creek.

Segment 2E - Upper Cornie Bayou and Tributaries

Nonpoint sources of pollution affect water quality in this segment. An estimated 54,600 tons of sediment are delivered to the watershed outlets each year; however only 49,100 tons of sediment are delivered to the Louisiana state line from Segment 2E. This includes the delivery of 22,700 tons of sediment to the Upper Big Cornie Creek outlet and 22,300 tons of sediment to the Middle Big Cornie Creek outlet. According to the Soil Conservation Service, the total erosion in this segment is approximately 180,000 tons per year (See Table 3-43). Sheet and rill erosion accounts for about 64 percent of the total erosion in this segment.

TABLE 3-43
SUMMARY OF EROSION BY SOURCE
SEGMENT 2E

EROSION SOURCE	TONS PER YEAR	PERCENT OF TOTAL
ROAD SURFACE EROSION	13,500	7.5
ROAD BANK EROSION	30,400	16.9
GULLY EROSION	4,100	2.3
STREAMBANK EROSION	17,700	9.8
SHEET AND RILL EROSION	114,200	63.5
TOTAL	179,900	100.0

SOURCE: USDA, SOIL CONSERVATION SERVICE <87>

Most of the erosion is occurring on forestland, the principal land use in Segment 2E. (See Table 3-44). Orchards and vineyards account for only 0.4 percent of the land use, but cause over 25 percent of the sheet and rill erosion.

Data Base Problems

Irrigated Cropland

Information on irrigated cropland is necessary for planning purposes. Since about 60 percent of the total water use in this basin is for irrigation, the total irrigated acreage of each crop, should be known to determine the amount of water needed for irrigation.

Information on irrigated cropland is difficult to obtain. The Agricultural Stabilization and Conservation Service (ASCS) reports rice acreages, and the Crop and Livestock Reporting Service reports estimates of irrigated crops from sampling procedures. This information is only available by county. For planning purposes, information should be reported by hydrologic boundaries (basins). The Soil Conservation Service reported irrigated cropland figures by basin for 1980 in its publication "Agricultural Water Study, Phase V, Arkansas Statewide Study" <93>; however, irrigated cropland was only reported for one year.

Reports on irrigated cropland in the Lower Ouachita Basin vary considerably. In 1980, SCS reported 32,052 total irrigated acres in the Lower Ouachita Basin. <93> Crop and Livestock Reporting Service figures were combined for a total of 116,200 acres of irrigated cotton, soybeans, and rice in the basin. <69> With such a variation in reporting of irrigated cropland, and the difficulty in obtaining information, there is a need for accessibility and consistency in the reporting of irrigated cropland.

Streamflow Data

Streamflow data are collected in the Lower Ouachita Basin by the monitoring of gaging stations in the area. Information for fourteen continuous streamflow gaging stations in southern Arkansas and northern Louisiana was used in this report as the data base from which many of the mathematical computations were determined. Extrapolation of the gaging station data to other reaches on gaged streams and to other ungaged streams was necessary to determine streamflow characteristics, instream flow requirements, and excess streamflow for the Lower Ouachita Basin. Error may be introduced into the computations when data are extrapolated, particularly if knowledge of the basin characteristics and the effects of man-made practices are limited.

Streamflow characteristics for some streams in the basin, such as the Saline River, are reasonably well defined from the gaging station information that has been collected. However, streamflow characteristics for other streams, such as Bayou Bartholomew, are not well defined. Data for only two gaging stations on Bayou Bartholomew were available for the computations in this report, and streamflow characteristics are significantly different between the two stations.

Streamflow in reaches of the Ouachita River is also not well defined. Data for the gaging station on the Ouachita River at Camden are used in several computations, however, these data are not representative of the streamflow characteristics downstream to the state line. Limited streamflow information is available at a gaging station near the Arkansas-Louisiana state line, but only the stages below 19.0 feet are gaged because conventional streamflow gaging techniques are not applicable to high streamflow conditions on the Lower Ouachita River. In this report, data from the gaging station at Camden were extrapolated to other reaches on the Ouachita River with some modifications. However, as previously stated, extrapolation of data may introduce error into the computations.

Diversion Reporting

Annual registration of surface water diversions has been required since the passage of Act 180 of 1969 to amend Act 81 of 1957. All surface water diversions are included except those diversions from lakes or ponds owned exclusively by the diverter. Diversion registration is a necessary tool in the planning process for maximum development of the state's water resources along with being beneficial should periods of shortage make allocation necessary. There is no penalty for non-registration other than being non-preferential should allocation become necessary.

Registration does not constitute a water right. This misconception could be the cause of some extremely high reported use rates. Should a period of allocation become necessary, the portion of the available water to be allowed each registered riparian user would be based upon need and not exclusively on past water use reports. More care should be taken to give an accurate report of water use.

Some diverters choose not to report. This could be because they are not familiar with the diversion registration requirements, or they disregard the law because of the lack of a penalty (other than during allocation). Additionally, there are those that initially report but then fail to report water use in subsequent years even though reporting is required annually.

Determining Instream Flow Requirements

The Arkansas Soil and Water Conservation Commission has been mandated by Act 1051 of 1985 to determine the instream flow requirements for water quality, fish and wildlife, navigation, interstate compacts, aquifer recharge, and other uses such as industry, agriculture, and public water supply in the state of Arkansas. When these needs and future water needs are determined for each basin, the water available for other uses can be determined.

At the present time, there is limited information available to quantify instream flow requirements for streams in the Lower Ouachita Basin. In addition to the problem of limited data available, the methods used in establishing instream flow requirements should be flexible so that the historic instream and off-stream uses of water from each stream are considered. For example, instream flow requirements for the Saline River should be established at a high level of protection for the fisheries since it is designated as a scenic river and other current and historic uses of water from the Saline River are not significant. On the other hand, water needs for agricultural purposes from Bayou Bartholomew are very significant and should be considered in the establishment of instream flow requirements for all categories.

Additional problems in determining instream flow requirements for the major categories are described below:

(1) Water quality - The $7Q_{10}$ stream discharge has been established as the instream flow requirement for water quality by the Arkansas Department of Pollution Control and Ecology. The $7Q_{10}$ low-flow characteristic is a relatively simple statistic to compute if the streamflow data are available. However, data are available to determine the $7Q_{10}$ discharge for only a few continuous gaging stations and partial-record stations in the Lower Ouachita Basin. At selected ungaged locations in the basin, a range for the $7Q_{10}$ discharge was estimated. These estimated ranges may not accurately represent the low-flow characteristics at the ungaged sites.

(2) Fish and wildlife - A new method, called the Arkansas method, has been developed by Filipek and others <39> to determine instream flow requirements for fish and wildlife. The Arkansas method utilizes some of the basic principles from Tennant's Montana method <75> which is a method often used for the determination of fish and wildlife instream needs. However, in the Arkansas method, the selection of the percent of the seasonal flow which is required for fish and wildlife is not supported by field data collection or documentation from other studies. Comparison of the percentages used in the Arkansas method with the percentages used in the Montana method indicates that the instream needs for fish and wildlife using the Arkansas method would provide excellent to outstanding fisheries habitat. Therefore, the instream flow requirements determined by the Arkansas method were not applicable for use in determining minimum streamflows in the basin.

(3) Navigation - The Ouachita River is the only Federally-maintained navigation system in the Lower Ouachita Basin. Specific flow requirements have not been designated for navigation on the Ouachita River. This does not pose a problem, however, since the operation of the locks and dams on the river provides sufficient depth of water in the channel for navigation purposes.

(4) Interstate compacts - Two major problems exist in the determination of instream flows which should be reserved in order to satisfy the interstate compact requirements. The first problem is that the total runoff in a basin must be computed prior to the determination of the amount of water that needs to remain in the streams for Louisiana's use. Runoff, as defined in the compact, includes flow in the streams and water that has been diverted from the streams for other uses. The amount of water that is diverted from the streams is not accurately quantified, therefore, the amount of runoff in the basins is unknown.

The second problem that exists in the determination of instream flow requirements for the interstate compact is that compact compliance requirements are based on the previous week's streamflow and diversions. Therefore, the instream flow requirements are dependent on the runoff available in a basin the previous week and may change from week to week.

To get an idea of the weekly discharge that could be expected to occur at a particular location, average weekly discharge for the period of record could be computed. However, the compact requirements can not be determined using these data since the requirements are based on a percentage of the actual weekly runoff for a basin. It is important that the interstate compact requirements are quantified since preliminary analysis of historic data indicated that the instream flows required for the interstate compact could be the governing instream need at times during the year.

(5) Aquifer recharge - Instream flow requirements necessary to recharge the aquifers in the Lower Ouachita Basin are currently unknown. This is not a problem in this basin, however, since most of the streams exhibit sustained baseflow during dry-weather conditions which is evidence that formations in these drainage basins are not accepting recharge.

(6) Riparian use - Riparian use is recorded in the Arkansas Soil and Water Conservation Commission files of registered diversions. As previously stated, there are some problems with water use reporting. It is very important that the water used by riparian landowners be accurately quantified. Accurate riparian use information is necessary for planning purposes such as the allocation of water during times of shortage and the quantification of runoff in a basin for determining instream flow requirements.

(7) Aesthetics - Instream flow requirements necessary for aesthetic purposes have not been determined. This is not a problem in this basin, however, since instream flow requirements for water quality and fish and wildlife should be adequate to maintain recreational activities such as fishing and hunting and to protect the natural character of the streams in the basin.

Critical Surface Water Areas

Section 2 of Act 1051 of 1985 (see legal and institutional setting) requires the Arkansas Soil and Water Conservation Commission to define critical water areas and to delineate areas which are now critical or which will be critical within the next thirty years. A critical surface water area is defined as any area where current water use, projected water use, and (or) quality degradation have caused, or will cause, a shortage of useful water for a period of time so as to cause prolonged social, economic, or environmental problems.

Streamflow in Bayou Bartholomew has been reduced to levels low enough at times to cause economic and environmental problems. During the month of August, streamflow has been below acceptable levels three of the years in the period of 1980-84. The flow in the Bayou was reduced by irrigation pumpage and short-term drought to the point that it was too low to be used as an irrigation source, threatened water quality, and harmed fisheries. For these reasons, Bayou Bartholomew is considered a critical water area.

Many people consider 1980 a benchmark year for drought. The average flow of Bayou Bartholomew near Jones, LA (near the state line) was 69 cubic feet per second during August of that year. The lowest daily average streamflow at Jones, LA during the (1980) irrigation season was 51 cfs on August 28. However, the 1983 irrigation season proved to be drier than 1980, despite the 1983 water year having above average streamflow and fewer acres reported to have been irrigated from the Bayou. The streamflow for August 1983 averaged 47 cfs with a low daily average flow of 27 cfs, the lowest flow of record.

There are nearly 1/2 million acres in the Lower Ouachita River Basin that, because of soil type, have the potential to be irrigated cropland. The 1982 National Resources Inventory developed by the Soil Conservation Service <90> shows that within the basin Ashley, Drew, Lincoln, and Jefferson Counties have more than 57,000 acres that have at least a medium potential to be converted to cropland. Currently, twenty percent of the cropland is irrigated from surface-water sources, primarily Bayou Bartholomew. However, flow in Bayou Bartholomew could not support the irrigation of 20% of the potential 57,000 additional acres of farmland.

The current utilization of Bayou Bartholomew as an irrigation source is shown for the period of 1980-84 in the following tables. Water used for each crop was computed for each month from information received during telephone contacts with Dr. James Ferguson, Associate professor of Agricultural Engineering at the University of Arkansas. Dr. Ferguson provided a percentage of total water use per month for each crop. The percentages were converted to applications as shown:

CROP	MONTH	APPLICATION (DEPTH IN INCHES)	TOTAL
RICE	JUNE	17	36 INCHES
	JULY	10	
	AUGUST	9	
SOYBEANS	JUNE	0.5	18 INCHES
	JULY	6.5	
	AUGUST	9	
	SEPTEMBER	2	
COTTON	JUNE	3.5	18 INCHES
	JULY	9	
	AUGUST	5.5	

Total applications are on the high side of a range of water requirements. They were used because diversion records were used for irrigated acreage totals. Non-reporting of diversions is a problem, therefore, the application rates used should offset the lower than actual acreage totals. Crop acreage totals from the diversion records are shown in Table 3-45.

TABLE 3-45
REPORTED ACREAGES IRRIGATED FROM
BAYOU BARTHOLOMEW AND ITS TRIBUTARIES
1980-83

	1980	1981	1982	1983
RICE	12,450	11,805	11,655	9,340
COTTON	12,595	8,872	7,630	9,665
SOYBEANS	14,110	7,825	6,215	8,925
OTHER	620	10	865	1,675

SOURCE: ASWCC SURFACE WATER DIVERSION RECORDS

The acreage totals and applications per month were computed as a constant demand over each month. This was added to the gaged streamflow to obtain an approximate streamflow that would have occurred had there not been any use. The total was then divided into the use rate for each month and was expressed in Table 3-46 as a use percentage of the total runoff.

TABLE 3-46
BAYOU BARTHOLOMEW IRRIGATION USE PERCENTAGE

MONTH	YEAR	FLOW 1/ (cfs)	USE 2/ (cfs)	TOTAL (cfs)	USE (% OF TOTAL)
JUNE	80	1600	370	1970	19
	81	1407	330	1737	19
	82	201	324	525	62
	83	2399	278	2677	10
JULY	80	134	453	587	77
	81	588	338	926	37
	82	269	324	593	55
	83	133	339	472	72
AUGUST	80	69	420	489	86
	81	63	303	366	83
	82	338	288	626	46
	83	47	311	358	87

1/ USGS STREAMFLOW RECORDS, BAYOU BARTHOLOMEW NEAR JONES, LA
2/ COMPUTED FROM ASWCC SURFACE WATER DIVERSION RECORDS

There is a good possibility that actual acreages irrigated from Bayou Bartholomew should be higher because of non-reporting. Therefore, the use rate is probably higher even though the application rate is inflated. This would mean that the use percentage shown in August could top 90%. The Bayou Bartholomew basin currently is a critical area and will probably become more critical as more land is irrigated in the basin.

The Saline River Basin is not designated as a critical surface water area in the Lower Ouachita Basin. Streamflow at times during most years will be less than the minimum flow previously established in this report. If these low flows were caused by use, the basin could be classified as a critical surface water area. However, low flow of the Saline River is a result of the natural streamflow variability caused by variability of precipitation as modified by basin characteristics. Because of the streamflow variability of the Saline River, surface water diverters have implemented off-stream storage to alleviate prolonged social and economic problems during the low-flow periods each year.

Based on water-use projections, it is anticipated that the Saline River Basin will not become a critical water area within the next thirty years. Industrial water use from the Saline River is projected to increase within the next thirty years, however, it is expected that new industries will also provide off-stream storage to supplement use during the low-flow periods.

The Ouachita River Basin has not been designated as a critical surface water area. The major use of the Ouachita River is for navigation with no reported surface-water diversions in the basin. The operation of the locks and dams on the river provides sufficient depth of water in the channel for navigation purposes. However, if navigation of the Ouachita River is affected during low-flow periods, the flow can be supplemented through regulation of upstream reservoirs.

SOLUTIONS AND RECOMMENDATIONS

Arkansas has an abundance of water. However, water is not always available when needed, or of the quality necessary for our needs. Increases in population, industrial activity, and irrigation have resulted in significant increases in water demand. In addition, the potential exists for a dramatic increase in water use during the next 50 years.

As mentioned earlier, there are 11 million acre-feet of surface water available in the basin on an annual basis. Even with this amount of water available, this valuable resource is not inexhaustible nor is it exempt from misuse or poor management. Every possible effort must be made to protect and enhance the surface water in this basin.

Surface water quantity and quality problems need to be addressed. Solutions and recommendations for surface water quantity problems include: (1) alternate water sources, such as the construction of water storage reservoirs and the transfer of Arkansas River water to Bayou Bartholomew, (2) accurate reporting of water use, (3) flood prevention and floodplain management, (4) additional informaton on instream flow requirements, and (5) more gaging station information. Best management practices (BMP's) can be used to reduce the water quality problems in this basin, and watershed protection projects can help implement BMP's in agricultural areas. Water conservation, if practiced throughout the basin, should provide more water of a higher quality in the basin.

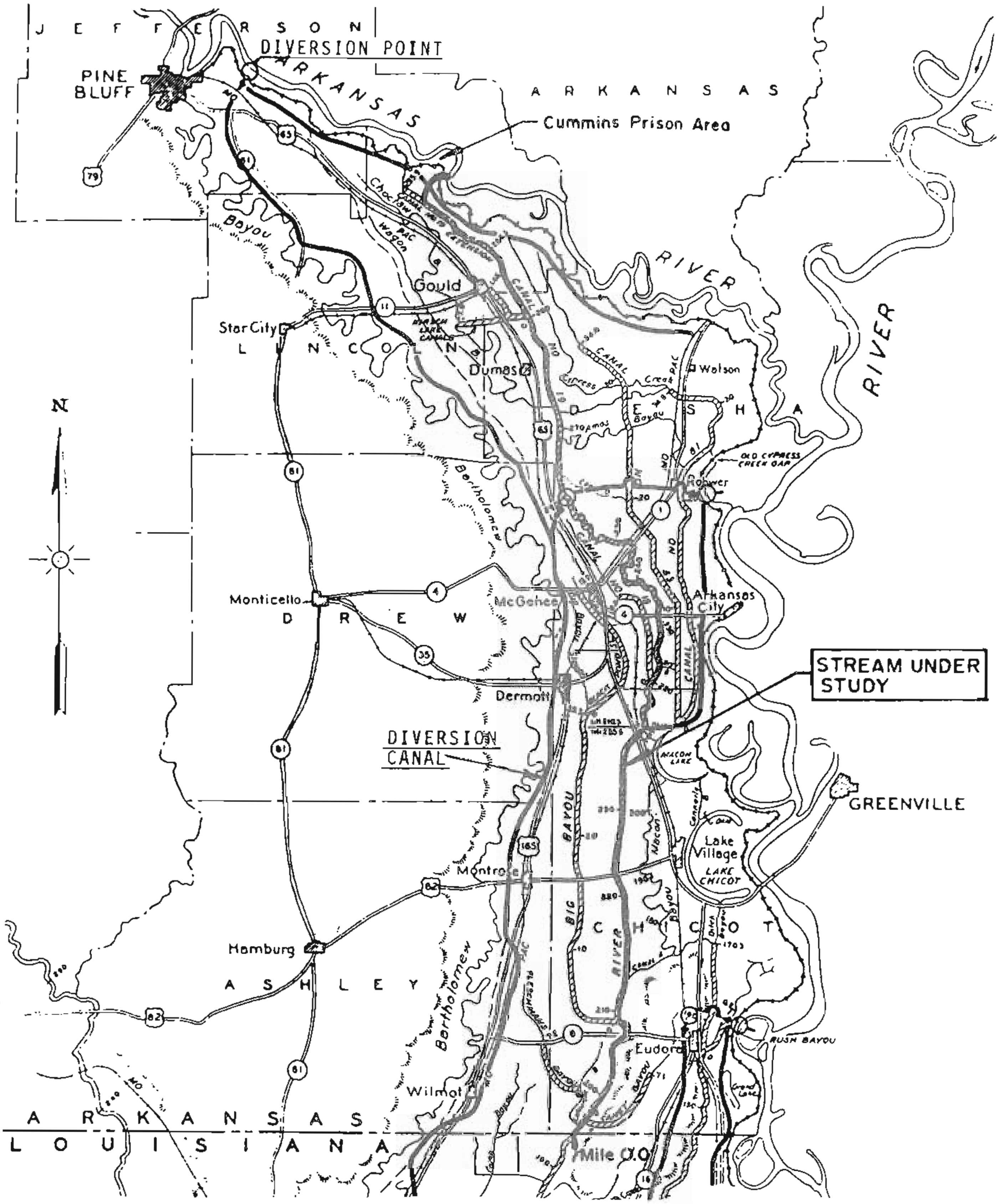
Surface Water Quantity

Availability

The continued use of water from Bayou Bartholomew at the current rate will not allow increases in irrigated acreage, and during low-flow periods, Bayou Bartholomew could be over-utilized as an irrigation source. Structural alternatives have been proposed to address this problem. These alternatives are: the impounding of tributaries along the western escarpment of Bayou Bartholomew, on farm storage impoundments, and the transfer of Arkansas River water into Bayou Bartholomew. Additionally, conservation measures and best management practices would reduce water use.

figure 3-15

ARKANSAS RIVER DIVERSION TO BAYOU BARTHOLOMEW



SOURCE: Environmental Technical Consultants, Inc., "Boeuf River Water Diversion Projects" water quality, flood reduction, fish and wildlife enhancement, recreational opportunities, and watershed protection. The preferred alternative should be proposed as a project to be planned, designed, and constructed.

Governmental Assistance

Act 81 of 1957 gave the Arkansas Soil and Water Conservation Commission the power to allocate surface water during periods of shortage. This is an emergency measure to be used to uniformly distribute surface water to riparian land owners.

Act 1051 of 1985 allows the Arkansas Soil and Water Conservation Commission to authorize the transportation of excess surface water to nonriparians of such surface water for their use. The ASWCC is also authorized to contract, with participants in a transfer project, a specific quantity of water for a specific period of time at a reasonable price to cover the transportation of the water. This new law will allow projects such as the transfer of water from the Arkansas River to Bayou Bartholomew. The increase in flow during the summer months would allow more use as well as improve the quality of water in Bayou Bartholomew by dilution of nonpoint pollutants. An increase in flow and quality will probably also improve the fish habitat in the stream.

The construction of additional on-farm storage reservoirs would be another water supply alternative to reduce the demand on Bayou Bartholomew. Reservoir storage capacity in the basin for irrigation use listed in Lakes of Arkansas is 16,164 acre-feet. To meet the projected surface water demand for the year 2030, an estimated 200,000 acres of land would need to be converted to reservoirs, depending on the average depth. Act 417 of 1985, as amended, allows a tax credit for the construction or restoration of water impoundments or control structures of twenty acre-feet or more designed for the purpose of storing water to irrigate to produce food and fiber as a business, excluding aquaculture, or for domestic purposes, or for industrial purposes. This credit is allowed as a maximum of $3,000 per year for a maximum of 11 years or until 50% of the cost is recovered. To qualify, a taxpayer must obtain a construction permit from the ASWCC, or provide proof of exemption from the permit as per the requirements of Act 81 of 1957 as amended. Guidelines have been developed by the ASWCC.

Flooding

Flooding and drainage problems can be solved by either structural or non-structural measures. Structural solutions include such measures as channel improvement and flood water detention dams. Non-structural solutions relate to land treatment measures and floodplain management. Non-structural solutions are probably the most viable alternatives in most areas of this basin due to the fact that there are only two watersheds in this basin that are considered to be potential structural watershed projects. (See USDA and Corps Projects).

The United States Congress established the National Flood Insurance Program with the "National Flood Insurance Act of 1968". The program is administered by the Federal Insurance Administration (FIA) within the Federal Emergency Management Agency (FEMA) with the Arkansas Soil and Water Conservation Commission being the coordinating agency for Arkansas. Act 629 of 1969, enacted by the Arkansas General Assembly, authorizes the cities, towns, and counties, where necessary, to enact and enforce floodplain management which will curtail losses in flood prone areas.

This insurance is available from private insurance firms at reasonable rates. Rural residences within the basin who reside in Ashley, Bradley, Desha, Jefferson, Lincoln, Ouachita, Saline, Union and Pulaski counties, have the opportunity to participate in this program. Urban residents, who reside in towns that have been identified as having flood hazard areas, with the exception of Rison, may also insure their property.

Quality of Surface Water

Surface water quality is generally satisfactory for agricultural purposes in this basin, except for the salt content of the water in the Smackover Creek area north of El Dorado. Pollution by sediment, plant nutrients, pesticides, and industrial wastes render the stream flows unsuitable for other beneficial uses without extensive treatment.

ADPC&E has developed its Regulation #1 for the prevention of pollution by saltwater and other field wastes produced by wells in new fields or pools. This regulation attempts to prevent the brine (saltwater) from polluting the "waters of the state". For more information regarding salt contamination from the oil and gas industry, see the groundwater section of this report (Chapter IV).

Best Management Practices

Best Management Practices (BMP's) can be used effectively to reduce the major water-quality problems in the basin. Agricultural BMP's, if implemented on Bayou Bartholomew, should reduce erosion and conserve water. Mining BMP's can reduce acid mine drainage and erosion on the mined lands near Lost Creek and Hurricane Creek. The salt problem north of El Dorado can be diminished by using BMP's for saltwater contamination.

The following Best Management Practices for each of the nonpoint sources are recommended by the local conservation districts. These practices may or may not be considered as all inclusive.

TABLE 3-47
BEST MANAGEMENT PRACTICES
AGRICULTURAL BMP'S

1. Conservation Tillage (minimum till - no till).
2. Proper disposal of pesticide containers.
3. Proper use of pesticides.
4. Irrigation water management.
5. Crop Rotation.
6. Cover crops.
7. Irrigation system tailwater recovery.
8. Grass cover on turn rows and ditches.
9. Underground irrigation pipelines.
10. Crop residue management.
11. Land Leveling.
12. Contour Cultivation.
13. Rotation grazing.
14. Terraces.
15. Field drains.
16. Waste Management systems.
17. Establish and manage permanent pasture and hayland.
18. Farm ponds.
19. Grassed waterways.
20. Proper Fertilization.

FORESTRY BMP'S

1. Proper construction and maintenance of roads.
2. Limited clear cutting on steeper slopes.
3. Stream side management zones.
4. Correct pesticide application.
5. Minimized mechanical damage.
6. Livestock exclusion.
7. Firebreaks.
8. Critical area planting.
9. Traffic barriers.
10. Clearing on contour.
11. Skid logs on contour.
12. Temporary vegetative cover.

TABLE 3-47
BEST MANAGEMENT PRACTICES (CONTINUED)

CONSTRUCTION BMP'S

1. Mulching.
2. Traffic Barriers.
3. Limited soil disturbance.
4. Site planning and proper timing of operation.
5. Temporary vegetative cover.
6. Conservation of natural vegetation.
7. Diversions.
8. Water control structures.
9. Hard surface heavy use areas.
10. Roadside stabilization.

SUBSURFACE DISPOSAL BMP'S

1. Proper installation.
2. Provide sewer service.
3. Sanitary landfills.
4. Recycling.
5. Alternate systems for sewage disposal.
6. Limited housing density.

SALTWATER CONTAMINATION AND URBAN RUNOFF BMP'S

1. Grade stabilization structures.
2. Grassed waterways.
3. Sediment basins.
4. Flood water control structures.
5. Mulching.
6. Diversions.
7. Ponds.
8. Plug salt producing wells.
9. Holding pits.
10. Critical area treatment.
11. Lined waterways.

MINING BMP'S

1. Reclamation of mined lands.
2. Grassed waterways.
3. Diversions.
4. Revegetation.
5. Sediment basins.
6. Spread, smooth, and vegetate spoil lands.

TABLE 3-47
BEST MANAGEMENT PRACTICES (CONTINUED)

MINING BMP'S (CONTINUED)

7. Proper fertilizing and use of lime.
8. Fencing.
9. Tree planting.
10. Access roads.
11. Reshaping strip mines.
12. Mandatory reclamation plans for new mines.

HYDROLOGICAL MODIFICATIONS BMP'S

1. Grade Stabilization structures.
2. Dikes.
3. Streambank protection.
4. Surface drainage.
5. Revegetation after construction.
6. Spoil spreading.
7. Water control structures.
8. Dams.
9. Rock lined waterways.
10. Designing of side slopes to facilitate revegetation and maintenance.
11. Floodways.
12. Construction of irrigation reservoirs.
13. Irrigation return systems.
14. Levees to prevent flooding.
15. Low water weirs.
16. Clearing and snagging.

DISPOSAL SITES BMP'S

1. Diversions.
2. Filter strips.
3. Fencing.
4. Sites for disposal of pesticide containers.
5. Solid waste collection systems.
6. County wide refuse disposal plan.
7. Daily processing: Cover and vegetate abandoned dumps.

TABLE 3-47
BEST MANAGEMENT PRACTICES (CONTINUED)

ROAD BMP'S

1. Topsoiling ditch banks.
2. Paving.
3. Diversions.
4. Critical area planting.
5. Mulching.
6. Lined waterways.
7. Water conveyance structures.
8. Limited road grading.
9. Rip Rap.
10. Proper site selection for new road construction.

STREAMBANK BMP'S

1. Grade control structures.
2. Streambank vegetation including trees.
3. Reshaping banks.
4. Rock Rip Rap
5. Concrete mats.
6. Lined waterways.
7. Controlled grazing.
8. Revetments and Jetties.
9. Buffer zones.
10. Snagging.

GULLY BMP'S

1. Terraces.
2. Diversions.
3. Critical area shaping.
4. Mulching.
5. Critical area planting.
6. Fencing.

Anticipated reductions in nonpoint pollution sources will enhance the environment by improving water quality throughout the region. It is expected that fish habitat and the opportunities for swimming will be significantly improved. Wildlife habitat will be enhanced because of improved cover and diversity throughout the region.

In addition to enhancing the environment, implementation of the BMP's is expected to result in economic and social benefits. The resource base (land and water) will be protected. It is anticipated that agricultural income will be increased, additional recreational activities will become available, area residents will take more pride in their community, and social consciousness will be increased.

Watershed Protection

Erosion is a significant nonpoint source of pollution in the Lower Ouachita Basin. In this basin, there are more than 6,000,000 tons of sheet and rill erosion occurring each year. In Segments 2C, 2D, and 2E, approximately 70 percent of the sheet and rill erosion is occurring on forestland; however, more than 90 percent of the sheet and rill erosion in Segment 2B is occurring on cropland. <87> On cropland, watershed protection projects establish land treatment measures to reduce erosion, sediment and runoff. <94>

The Watershed Protection and Flood Prevention Act, PL 83-566, provides for the technical, financial and credit assistance by the Department of Agriculture to local organizations representing the people living in small watersheds. A watershed protection plan includes only on-farm land treatment practices for sustaining productivity, conserving water, improving water quality and reducing off-site sediment damages. <94> Practices might include such BMP's as conservation tillage, terraces, or even land use conversion. Participation within the watershed is voluntary and federal funds are available.

For practices sustaining agricultural productivity and reducing erosion and sediment damages, cost share rates may be up to 65 percent of the cost of the enduring practices installed, or the existing rate of ongoing conservation programs, whichever is less. Payments for management practices such as conservation tillage, based on 50 percent of the cost of adoption are limited to a one-time payment not to exceed $10,000 per landowner. No more than $100,000 of cost-shared PL 83-566 funds may be paid to any one individual. <94>

The Soil Conservation Service completed its first watershed protection plan in 1986 which is in St. Francis County on Crow Creek. Currently, watershed protection plans are being developed for five other watersheds in Arkansas. Areas with potential for watershed protection projects are watersheds containing fragile soils that are highly erodible and are eroding at excessive rates. <92>

The fragile soils in this basin are in Segment 2B. The major land resource area that accounts for most of Segment 2B is the Southern Mississippi Valley Upland Region (Loessial Plains and Hills). When these highly erodible soils are cropped, there is potential for excessive erosion rates, and watersheds in these areas may qualify for watershed protection. <92>

From the NRI 82 <90>, there are about 49,000 acres of subclass e (erosion hazard) cropland in this basin. There are 27,000 acres of this erodible cropland in Segment 2B alone. Erosion rates obtained from the RIDS data <87> indicate that several watersheds in Segment 2B are potential watershed protection projects. Turtle Creek, Boggy Bayou, Cousart-Deep Bayous, Ables Creek, Garrett Bridge, Four Mile Creek, and Bearhouse Creek are all potential watershed protection projects.

Conservation

Water conservation has not been overly emphasized in this basin because of the high average annual rainfall as observed at the three selected recording stations (Benton, 52.45 inches; Warren, 51.71 inches; and Crossett, 53.70 inches). As mentioned earlier in this report, an average of 388.2 million gallons of water are used in the study area each day for all purposes and the demand for water continues to escalate.

Water conservation is essential to the future well being of all Arkansans. Although not sufficient in itself, conservation does offer, at least in part, a means of helping to alleviate some of the basic problems.

Drought periods within the basin emphasize the need for conservation. While the average annual rainfall in the area is high, the erratic monthly rainfall patterns at times cause some streams to cease flowing and storage reservoirs to dry up or become dangerously low for most purposes. Conservation practiced during dry periods and the sense of emergency that prevails during droughts are soon forgotten in times of plentiful rainfall.

Agriculture

Only six percent of the land in this basin is cropland; however, irrigation accounts for about 75 percent of the total water use within the basin. (See Table 3-29). Rice accounted for almost 69 percent of the total irrigated acreage in 1980 within this basin. (See Table 2-4). Without adequate water for irrigation, farmers would be forced to produce different crops requiring smaller amounts of water. On-farm profits would be lowered and the economy of the basin would be adversely affected.

Since agriculture is the largest user of water in this basin, conservation efforts should be concentrated on agricultural water use. The East Arkansas Water Conservation Project is being administered by the Soil Conservation Service and the Arkansas Soil and Water Conservation Commission. Information from this 5-year project, which will continue through 1989, will promote irrigation water management. Irrigation water management includes maintaining high infiltration rates, using efficient delivery systems, choosing proper application methods, achieving high application efficiencies, employing irrigation scheduling, and obtaining sound engineering planning. These water conservation practices are discussed in the following paragraphs.

Infiltration Rates: Water is conserved for agricultural use when rainfall infiltrates the soil and is stored for plant use at a later date. High infiltration rates increase the amount of water that can be stored in the soil. Infiltration of water into the soil may be increased by two methods: (1) practices that keep soil pore space to a maximum, and (2) practices that alter the soil surface to allow more time for infiltration.

Vegetative cover on the soil surface absorbs raindrop impact to keep soil pores open. Stubble mulch tillage and no-till planting keep plant residues on the soil surface to increase infiltration and decrease evaporation. Cover crops, when planted, are also effective in maintaining high infiltration rates.

The soil surface may be altered to allow for more time for infiltration. With proper management, runoff can be minimized and more infiltration will occur. The construction of terraces and the practice of farming on the contour are two methods of surface alteration that allow more time for infiltration.

Delivery Systems: Delivery systems used in the basin consist of about 30 miles of earthen irrigation canals, 25 miles of underground pipelines, 40 miles of above ground pipes (gated pipe), and about 4 miles of temporary ditches. <93>

There are advantages of replacing earthen canals with pipelines. The typical earthen canal will lose from 10 to 40 percent of the total volume of water pumped through the canal; however, an underground pipeline should have virtually no water losses. (See Table 3-48). Replacing canals with pipelines will eliminate seepage and evaporation losses, while also reducing labor and system maintenance. Pipelines also require less land area than canals and allow more positive control in water management. Irrigation water supplied through pipelines will be available for use at the precise time and location it is needed. As delivery systems are upgraded to conserve water, effective methods of applying irrigation water should be chosen to obtain high efficiencies.

TABLE 3-48
ESTIMATED WATER LOSSES IN AGRICULTURAL SYSTEM COMPONENT

COMPONENT	ESTIMATED RANGE OF WATER LOSS -----PERCENT-----
DELIVERY SYSTEM	
CANAL-MAIN	40 - 10
PIPE-MAIN	5 - 0
FIELD CANAL	40 - 10
PORTABLE PIPE	10 - 0
UNDERGROUND PIPELINE	0 - 0
APPLICATION METHOD	
FURROW (WITHOUT RETURN)	70 - 15
FURROW (WITH RETURN)	20 - 5
LEVEE (WITHOUT RETURN)	60 - 20
LEVEE (WITH RETURN)	20 - 5
TRAVELING SPRINKLER	25 - 10
CENTER-PIVOT SPRINKLER	25 - 10
SOLID SET OR PORTABLE SET	25 - 10
DRIP IRRIGATION	15 - 5

SOURCE: USDA, Soil Conservation Service <84>

Application Methods: The greatest single on-farm saving of water can be accomplished by selecting the most suitable irrigation method. Contour levee irrigation and furrow irrigation are the two most common methods of applying water to crops in this basin. In 1980, about 57 percent of irrigated acreage in the basin was irrigated by contour levee irrigation, and about 35 percent of the irrigated acreage was irrigated by furrow irrigation. Other methods and approximate percentages of total irrigated acreages are as follows: Sprinkler methods - 2%, drip irrigation - 1%, level border - 1%, and other methods - 4%. <93>

Factors to consider when choosing an application method include slope, soil type (infiltration and permeability), crop, water availability and labor availability. Choosing the proper application method is the first step in obtaining high application efficiencies.

Application Efficiency: Application efficiency depends on the uniform application of the water at a proper rate at the proper time. Application efficiencies for furrow and contour levee irrigation average about 50 percent, with a range of 30 to 85 percent efficiency. Water losses from furrow irrigation without return systems range from 15 to 70 percent. With return systems, losses range from 5 to 20 percent. Losses from contour levee irrigation without return systems range from 20 to 60 percent, while losses from contour levee methods with return systems range from 5 to 20 percent. (See Table 3-48). <93>

Application efficiency can be increased if the water is applied at a uniform depth over the entire field. Over-application to the upper end of the field causing water loss by deep percolation is a common problem with furrow irrigation; however, methods such as furrow diking and surge irrigation help to obtain uniform applications. Precision land leveling and land smoothing are practices that modify the soil surface to allow for a more uniform application increasing application efficiencies. Water can be saved on contour levee irrigation of rice by shallow flooding. Shallow flooding of rice is practical on a relatively flat precision leveled field where a minimum depth of flood will cover the entire field.

As mentioned earlier, only about two percent of the irrigated acreage was irrigated using sprinkler methods of application. Sprinkler methods of irrigation are more efficient than gravity methods without return systems, ranging from 75 to 90 percent efficiency. <14, 93> Evaporation losses from sprinklers are normally 5 to 10 percent of the total discharge. High efficiencies are dependent upon climatic factors such as wind and heat. The most popular type of sprinkler irrigation is the center-pivot system, and its use is on the increase. Water savings may result when gravity methods of irrigation are replaced with sprinkler methods of irrigation; however, the high cost of conversion must be considered.

Application efficiencies can be increased significantly on gravity methods of irrigation by installing tailwater recovery systems (return systems). As shown in Table 3-48, both furrow and contour levee irrigation are much more efficient with return systems. The reuse of irrigation water captured in tailwater recovery systems not only conserves water, but keeps chemically concentrated water from degrading receiving streams.

Irrigation Scheduling: Regardless of the method of application, irrigation water must be applied in the proper amounts and at the proper time to obtain high efficiencies. Irrigation scheduling allows the irrigator to apply water only when the crop needs it, but in sufficient quantities to satisfy crop requirements.

Important factors in irrigation scheduling are soil properties, plant characteristics, weather, and management practices. Important soil properties include texture, depth to a restricting layer, available water holding capacity, infiltration, and permeability. The type of crop, drought tolerance, and root depth are important plant characteristics while temperature, wind, relative humidity, and rainfall are important climatic factors. Management practices or the farming practices the operator employs include planting dates, short or long season crop varities, and row spacing. If all factors are considered, an efficient irrigation schedule may be developed.

Some specific equipment is needed in irrigation scheduling. Moisture monitoring equipment is used to determine how much and when water is needed. Tensiometers, gypsum blocks, feel methods, speedy moisture testers, and nuclear moisture gauges are the most popular moisture monitoring techniques. Flow meters, flumes, or weirs are installed to determine how much total water is and can be pumped onto the field. With this equipment, an irrigation schedule may be developed, implemented, and application efficiency may be determined.

Engineering Planning: An overall engineering plan can make maximum use of available water and be very economical. Irrigation and drainage of individual fields must be carefully planned to fit in the complete irrigation and drainage system. Engineering planning can help determine the size of fields, slopes needed on precision leveled fields, location of drainage ditches, location of underground pipelines and their outlets, location and size of pipes for water control, and location of wells.

With groundwater levels declining, surface water sources are very desirable. A portion of the least productive land can be converted into a reservoir to recover tailwater, and an irrigation reservoir will be developed. Water will be conserved by recovering tailwater and additional water will be available for irrigation by storing winter runoff in the reservoir. Pumping costs will be significantly reduced in most areas by pumping from surface reservoirs rather than wells. Although the initial construction is expensive, state tax credits are now available through Act 417, "The Water Resource Conservation and Development Incentives Act of 1985".

Public Supply

This basin used about 24 million gallons of water per day for public supply purposes in 1980. (Table 3-29) While this use represents only 6 percent of the total water use in the study area, significant amounts of water can be conserved by individuals if water conservation is practiced at home. Several water-saving techniques include installing water-use restrictors, checking for leaks and watering lawns during the coolest part of the day. There are many conservation measures that can save water in your home.

Self-supplied industries

Self-supplied industries used a total of 69.2 million gallons per day of water in 1980. (Table 3-29) Some industries may be able to reduce the amounts of water they use by substituting or altering their production procedures. The water used by industries in this basin shows a decreasing trend over the past 10 years. Industries will respond to the increasing cost of treating water after it has been used by practicing conservation methods. This response to conserving water is expected to increase as technology improves and the cost of treatment continues to escalate. <60>

Wastewater reuse and recycling

Wastewater or sewage effluent discharged by municipalities and industries should be recognized as a valuable resource that can be reused or recycled to help meet growing water requirements.

Proponents list as pluses for reuse savings in money and energy, particularly in the cost of treating wastewaters to make them acceptable for discharge. <60> However, due to the availability of high quality water, most municipalities thus far have not sought to develop a market for treated wastewater, simply disposing of it as quickly as possible. <60>

Water pricing

As with any other commodity, increasing the price is a proven and effective means of reducing water consumption. Pricing techniques to encourage the conservation of water rely primarily on the premise that as the price increases, the quantity purchased decreases. The effect of such a price change on quantity is called demand elasticity.

There is substantial elasticity in the demand for water. The price affects the amount consumers will demand; if the price goes up, consumers will use less water. <60>

Data Bases

Irrigated Cropland

The U.S. Department of Agriculture has three agencies that are involved with reporting irrigated cropland. The Agricultural Stabilization and Conservation Service reports rice acreages while the Crop and Livestock Reporting Service reports irrigated cropland based on sampling procedures. Water resource management is a major function of the Soil Conservation Service, and the SCS has published a report entitled "Agricultural Water Supply, Phase V, Arkansas Statewide Study". <93> A joint effort is needed between these three agencies to accurately report irrigated cropland periodically for planning purposes. Through such an effort, accurate and consistent information will be developed which will enhance water resource planning in the state.

Streamflow Data

One solution to the lack of streamflow gaging station data in the Lower Ouachita Basin would obviously be to install more gaging stations on streams in the basin. Additional gages on Bayou Bartholomew, for example, would be particularly helpful to define streamflow characteristics at other locations on the stream, and to quantify the amount of water diverted from the stream during the agricultural growing season.

Construction of additional gages would not however be an appropriate solution for the limited streamflow data available for the Ouachita River. Due to the channel and floodplain characteristics of the Ouachita River Basin in southern Arkansas, streamflows above bankfull stage on the lower reaches of the Ouachita River can not be accurately determined by present streamflow gaging techniques. However, the U.S. Geological Survey has developed a digital model, called the "BRANCH" model, which may be applicable for determining streamflow in the lower reaches of the Ouachita River. The model is capable of computing the discharge at any point on a reach of stream using input hydrographs from continuous gaging stations at each end of the reach along with cross section information at selected points within the reach. It may be possible to use the "BRANCH" model with hydrograph data from the gaging stations at Camden, AR and Sterlington, LA to more accurately determine streamflow at other ungaged points on the Lower Ouachita River.

Another solution to the problem of limited streamflow data would be to develop a regionalization technique for statistically estimating discharges for sites on streams where data are limited. Development of a regionalization technique for determining low-flow characteristics of streams would be extremely helpful since extrapolation of low-flow information to ungaged areas can result in unreliable estimates of low-flow discharges. Low-flow information is necessary for use in the State Water Plan for determining safe yield of streams, instream flow requirements for water quality, minimum streamflows, and critical use areas. A suitable regionalization technique has not been developed for Arkansas at this time. A report by Hines <47> provides an alternative to a regionalization method, however, this technique is limiting since it requires several low-flow discharge measurements at each ungaged site to estimate the low-flow characteristics. A regionalized low-flow investigation would provide a method to determine low-flow characteristics of streams in Arkansas through the use of regression equations which would extend the usefulness of the present gaging-station network.

Diversion Reporting

Surface water diversion registration was required by Act 180 of 1969. The diversion reports have been useful to determine water use in the state. The importance of the report was magnified by Act 1051 of 1985 that required the Arkansas Soil and Water Conservation Commission to determine the water requirements of riparian land owners. Without diversion registrations this determination would prove costly and time consuming. The determination of water used by riparians is necessary to insure that an over-utilization of a stream or lake does not occur, or, if currently over-utilized, to what degree. Additionally, the registrations could be utilized when studying areas that could be aided by an interbasin transfer for irrigation projects.

One solution to the reporting problems is to amend Act 180 of 1969. Strengthen the law to insure, rather than suggest, exclusion of non-reporters during allocation of surface water. Also, allow the ASWCC staff to amend reports that appear in error. Public education of the law also will help to insure more complete diversion reporting. Continued coordination with Conservation Districts will also get the message out, as well as, newspaper, TV, and radio advertising.

Determining Instream Flow Requirements

One major problem with the methods that have been used in this report for determining instream flow requirements is that the methods are not flexible. The historic instream and off-stream uses of water from each stream are not considered on a quantitative basis.

One solution to this problem could be the development of a prioritization of the historic and current instream and off-stream uses of water from each stream in the basin. A matrix could be established to include all uses of water for the streams in the basin (water quality, fish and wildlife, municipal and industrial water supply, agriculture, navigation, etc.). Each use category might have several designated priorities. For example, a comparison of the streams that are used for irrigation could be made and the streams would then be ranked as far as their importance for irrigation. Similarly, streams could be ranked regarding the water-quality conditions that exist (high, medium, low). Each stream in the basin would then be assigned a ranking for each use category. The composite score for each stream would indicate the stream protection level which should be maintained. Since there is considerable variation in uses of the state's surface waters, the priority matrix would attempt to consider all uses and recommend an appropriate level for protection of these uses.

Problems have also been identified with the methods used to determine the instream flow requirements for water quality, fish and wildlife, interstate compacts and riparian use. Quantification of the amount of water in the Lower Ouachita Basin that is available for other uses is not possible until these instream flow needs are identified.

The criteria for water-quality flow requirements have been established by ADPC&E, but the low-flow characteristics have been determined for only a relatively small number of sites in the Lower Ouachita Basin. One possible solution to this problem would be the development of a regionalization technique for statistically estimating low-flow discharges for sites on streams where data are limited.

The instream flow requirements for fish and wildlife have been addressed by Filipek and others <39> using the Arkansas method. The accuracy of the Arkansas method and verification of the selection of an appropriate percent of seasonal flow required to satisfy fish and wildlife needs could be determined using two different methods. The accuracy of the Arkansas method could be verified by a study of instream flow requirements using the Instream Flow Incremental Methodology (IFIM) developed by the U.S. Fish and Wildlife Service. However, since this type of study can be very cost prohibitive and results in a site-specific determination of instream needs, an investigation similar to Tennant's study <75> could be conducted on streams in Arkansas. Field data collection correlating the condition of the aquatic habitat with the percent of the average flow present in the stream would provide the information necessary to determine the flow required for instream needs of fish and wildlife.

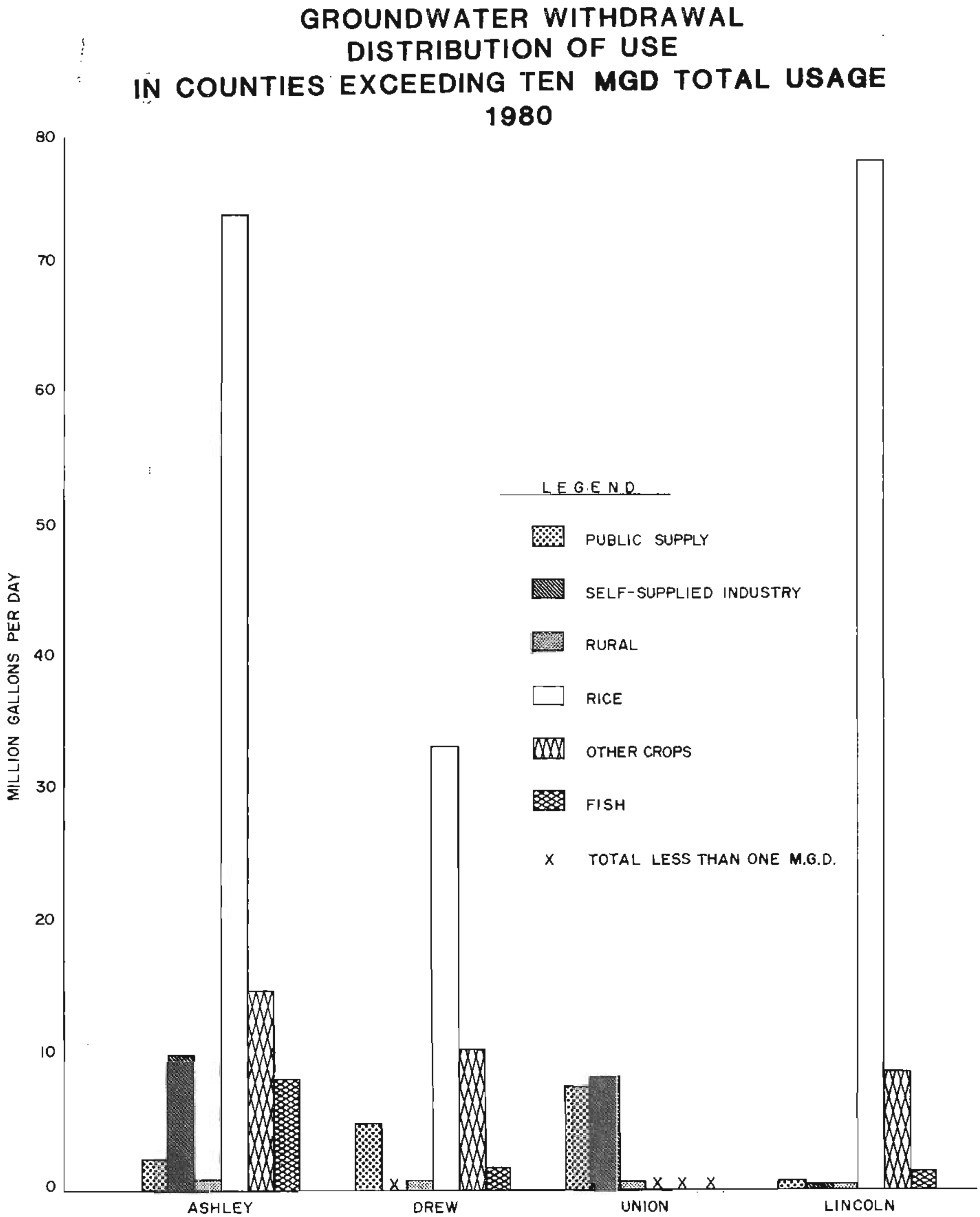
Accurate reporting of the amount of water diverted from the streams in the basin would significantly reduce the problems in determining instream flow requirements for the interstate compact and riparian use categories. In order to obtain water use data from all riparian land owners, it has been suggested, in a previous section of the report, that the current law be modified to include a penalty which would be imposed on individuals who fail to report water use to the ASWCC. The accuracy of the reported water use may be improved by a field reconnaissance study to measure the amount of water withdrawn from streams at selected critical locations.

It is also necessary to accurately determine the streamflow present in the interstate streams to determine runoff in order to comply with the interstate compact requirements. This will require additional continuous and partial-record gaging stations in the basin. Since the interstate compact requirements are based on the previous week's streamflow and diversions, it will also be necessary to equip the continuous-record gaging stations with data-collection platforms. This equipment will provide the planning staff with instantaneous discharge information which can be used in the determinaton of runoff in the basin.

CHAPTER IV

GROUNDWATER

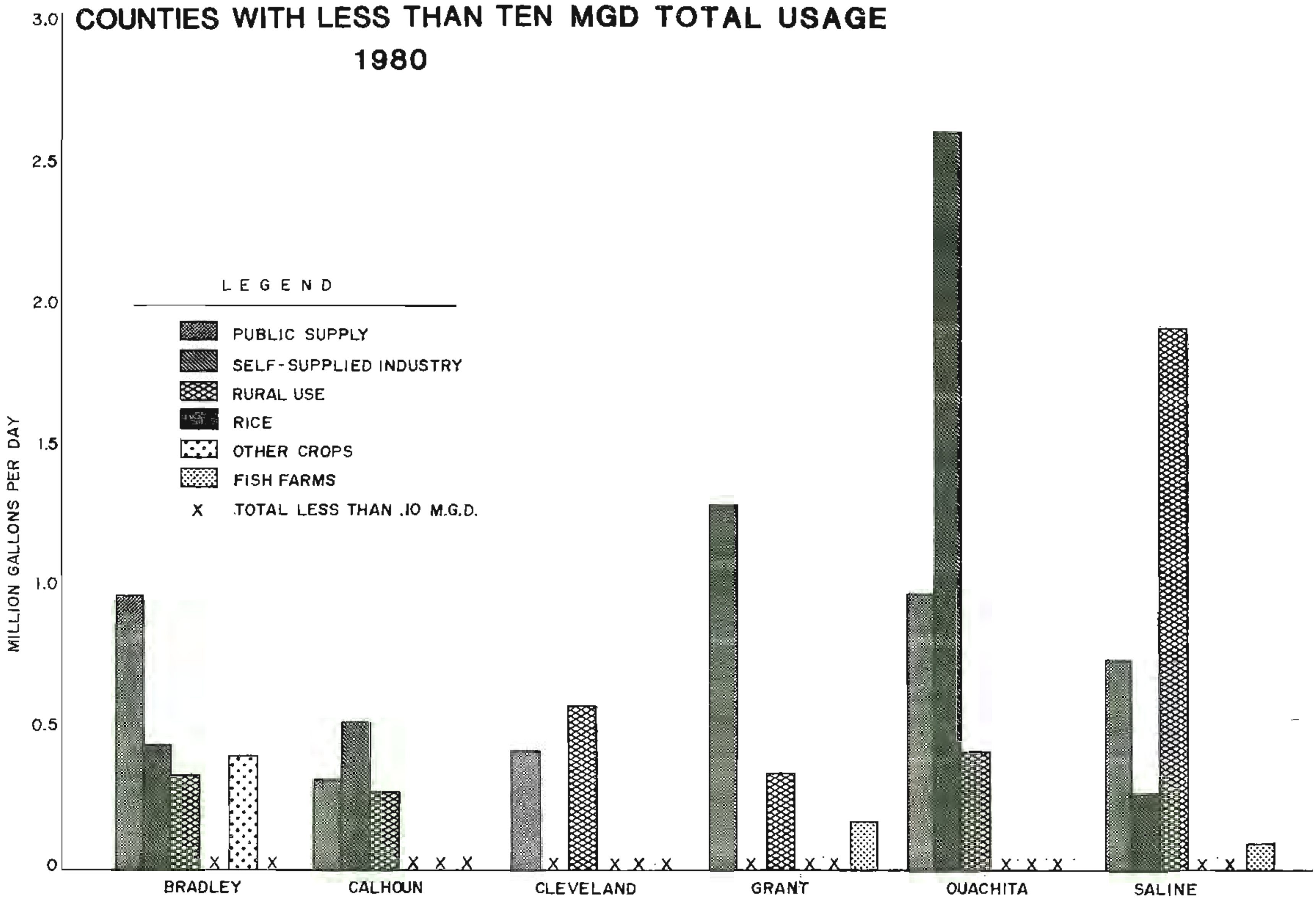
figure 4-4



SOURCE: U.S.G.S. - Water Use of Water in Arkansas-1980 Ref #48

figure 4-5

GROUNDWATER WITHDRAWAL
DISTRIBUTION OF USE IN
COUNTIES WITH LESS THAN TEN MGD TOTAL USAGE
1980



SOURCE: U.S.G.S.-Use of Water in Arkansas-1980 Ref #48

TABLE 4-2
GROUNDWATER WITHDRAWALS
BY USE - 1980 - STUDY AREA
MGD - % OF COUNTY TOTAL

COUNTY	PUBLIC SUPPLY	SELF SUPPLIED INDUSTRY	RURAL & DOMESTIC USE	RICE	OTHER CROPS	FISH & MINNOW FARMS	TOTALS
ASHLEY	2.27 - 2.0	10.03 - 9.1	.75 - <1.0	74.09 - 66.9	15.1 - 13.6	8.33 - 7.5	110.57
BRADLEY	.98 - 43.9	.45 - 20.2	.33 - 14.8	-	.40 - 17.9	.07 - 3.1	2.23
CALHOUN	.31 - 28.7	.51 - 47.2	.26 - 24.1	-	-	-	1.08
CLEVELAND	.41 - 41.0	.01 - 1.0	.58 - 58.0	-	-	-	1.0
COLUMBIA*	2.66 - 34.3	2.87 - 37.0	1.1 - 13.7	-	.07 - 1.0	1.1 - 14.2	7.76
DREW	2.82 - 5.8	.01 - <1.0	.49 - 1.0	33.51 - 69.2	10.5 - 21.7	1.11 - 2.3	48.44
GRANT	1.3 - 69.1	.07 - 3.7	.34 - 18.1	-	-	.17 - 9.0	1.88
JEFFERSON*	11.63 - 5.5	45.45 - 21.4	.6 - <1.0	132.64 - 62.4	14.98 - 7.0	7.24 - 3.4	212.54
LINCOLN	.88 - 1.0	.40 - <1.0	.31 - <1.0	78.34 - 87.0	9.01 - 10.0	1.22 - 1.4	90.16
OUACHITA	.98 - 24.0	2.64 - 64.5	.41 - 10.0	-	.02 - <1.0	.04 - 1.0	4.09
SALINE	.75 - 24.0	.27 - 8.7	1.93 - 61.9	.06 - 1.9	.01 - <1.0	.10 - 3.2	3.12
UNION	7.88 - 47.1	8.2 - 48.9	.56 - 3.3	-	-	.10 - 1.0	16.74
TOTALS	18.58	22.59	5.96	186.0	35.04	11.14	279.31
% OF TOTAL	6.6	8.1	2.1	66.6	12.5	3.9	

*COUNTIES OUTSIDE STUDY AREA - DATA EXCLUDED FROM TOTALS.

SOURCE: USGS - USE OF WATER IN ARKANSAS (1980). REF. #48

TABLE 4-3
GROUNDWATER QUALITY
MEAN VALUES BY FORMATION
LOWER QUACHITA BASIN

FORMATION	# OF SAMPLES	PERIOD OF RECORD	TEMP.	COLOR	S.C.	Ph	HCO-3	CO-3	CaCO-3	N.C.H.	Ca	Mg
QUATERNARY	(145)	46-64	19.2	5.6	320.5	7.1	96.6	.93	92.2	17.3	16.7	6.8
JACKSON	(62)	49-65	18.6	4.8	947.9	6.2	93.7	.05	305.7	129.9	66.9	28.3
COCKFIELD (MUNICIPAL WELLS)	(13)	71-80	-	-	-	8.0	-	-	-	-	12.9	6.6
COCKFIELD (NON MUN.)	(83)	49-66	19.1	11.5	429.4	7.4	149.1	.86	52.9	8.8	12.7	2.9
TOTAL COCKFIELD	(96)	49-80	-	-	-	7.7	-	-	-	-	12.8	4.8
COOK MTN.	(26)	59-66	18.8	4.7	234.3	6.1	35.1	0.00	52.6	31.3	8.6	3.8
SPARTA (MUNICIPAL WELLS)	(72)	71-79	-	-	-	7.8	-	-	-	-	6.9	3.6
SPARTA (NON MUN.)	(49)	46-65	21.3	8.8	335.8	7.6	179.2	.90	16.1	2.4	8.5	1.1
TOTAL SPARTA	(121)	46-79	-	-	-	7.7	-	-	-	-	7.7	2.4
CANE RIVER	(7)	45-64	19.0	9.0	283.6	6.9	159.1	.60	20.9	1.0	5.1	2.5
CARRIZO	(9)	59	18.5	14.0	174.0	7.7	100.0	0.00	20.0	0.0	5.6	1.5
WILCOX	(4)	63-64	19.3	1.8	94.8	6.8	55.5	0.00	33.5	.8	8.8	2.7
MIDWAY (MUNICIPAL WELLS)	(12)	71-79	-	-	-	8.1	-	-	-	-	42.6	21.4

FORMATION	# OF SAMPLES	PERIOD OF RECORD	Na	S.A.R.	K	Cl	SO-4	F	SiO-2	Fe	T.D.S	NO-3
QUATERNARY	(145)	46-64	28.8	1.67	3.6	38.5	17.0	.15	27.3	0.647	181.5	13.70
JACKSON	(62)	49-65	86.6	2.90	16.4	76.6	317.8	.40	34.7	0.839	546.7	9.90
COCKFIELD (MUNICIPAL WELLS)	(13)	71-80	140.9	-	-	58.6	24.4	.46	-	0.260	334.3	.25
COCKFIELD (NON MUN.)	(83)	49-66	58.8	7.30	3.5	17.1	42.0	1.40	18.6	2.055	218.3	1.80
TOTAL COCKFIELD	(96)	49-80	99.9	7.30	3.5	37.9	33.2	.93	18.6	1.160	276.3	1.03
COOK MNT.	(26)	59-66	30.6	.97	3.4	286.6	5.9	.10	21.6	1.862	132.4	18.54
SPARTA (MUNICIPAL WELLS)	(72)	71-79	66.4	-	-	15.3	33.1	.28	-	0.800	190.3	.25
SPARTA (NON MUN.)	(49)	46-65	74.4	12.40	3.9	13.0	6.4	.14	12.3	0.458	218.1	5.60
TOTAL SPARTA	(121)	46-79	70.4	12.40	3.9	14.2	19.8	.21	12.3	0.630	204.2	2.90
CANE RIVER	(7)	45-64	63.0	5.40	2.5	28.5	3.1	.30	15.2	0.472	119.0	.90
CARRIZO	(9)	59	35.0	25.00	2.0	7.3	4.9	-	.3	-	134.0	.90
WILCOX	(4)	63-64	7.7	.40	2.7	4.7	2.4	.05	12.7	0.078	67.3	.95
MIDWAY (MUNICIPAL WELLS)	(12)	71-79	22.6	-	-	8.1	16.3	.63	-	.490	235.0	.21

LEGEND

TEMP. - DEGREES - CENTIGRADE
COLOR - PLATINUM-COBALT UNITS
S.C. - SPECIFIC CONDUCTANCE (umhos)
HCO-3 - BICARBONATE mg/L
CO-3 - CARBONATE mg/L
CaCO-3 - HARDNESS mg/L

N.C.H. - NON-CARBONATE HARDNESS mg/L
Ca - CALCIUM DISSOLVED mg/L
Mg - MAGNESIUM DISSOLVED mg/L
Na - SODIUM DISSOLVED mg/L
S.A.R. - SODIUM ABSORPTION RATIO
K - POTASSIUM DISSOLVED mg/L
Cl - CHLORIDE DISSOLVED mg/L

SO-4 - SULFATE DISSOLVED mg/L
F - FLUORIDE DISSOLVED mg/L
SiO-2 - SILICA DISSOLVED mg/L
Fe - IRON DISSOLVED mg/L
T.D.S. - TOTAL DISSOLVED SOLIDS mg/L SUM OF CONSTITUENTS
NO-3 - NITRATE DISSOLVED AS N
- - NO READING

SOURCE: USGS FILE DATA AND ARKANSAS DEPARTMENT OF HEALTH (1982) REF. #3

SELECTED GEOLOGIC UNITS
Quaternary Deposits

Geology.

These deposits occupy the flood plains of all but the smallest streams or occur as a veneer 20 to 40 feet thick capping the hills in upland areas. Approximately half of the surface area in the Lower Ouachita Basin is underlain by deposits of the Quaternary System. The surface distribution of these deposits is shown in Figure 4-7. <16, 24, 25, 76>

The Quaternary System can be divided into the Holocene (recent alluvium) and the Pleistocene (terrace) Series. The terraces are older but usually are located at higher elevations than the alluvium. The process of alluvial deposition continues today along the Saline and Ouachita Rivers, as well as all streams in the basin. In some areas the alluvium and terraces are at different elevations, highly dissected and function as independent aquifers. In other areas, the two units are indistinguishable, and with a basal zone connection, can be treated as one hydrologic unit. <16, 24, 25, 76>

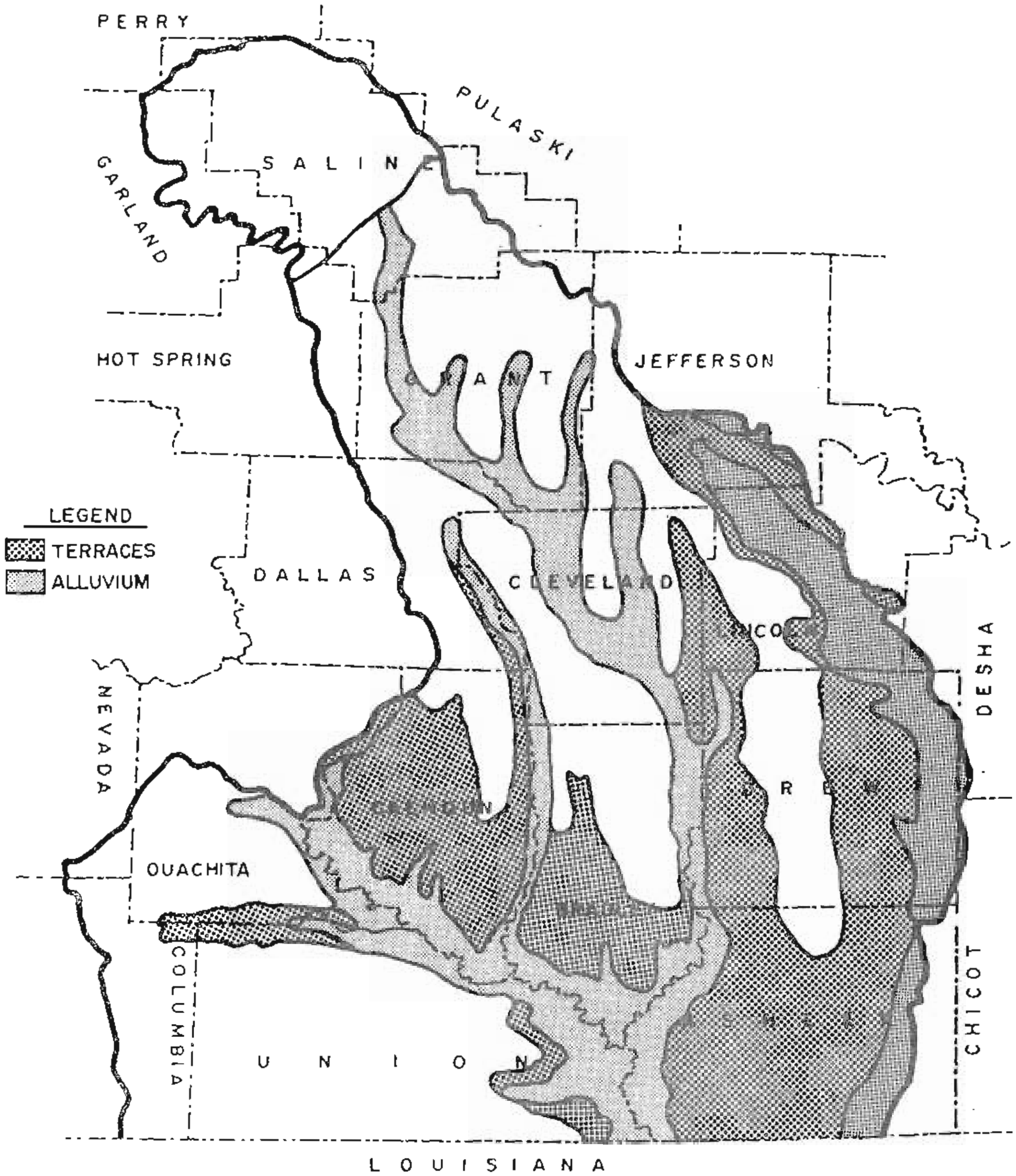
The terraces in the basin are a result of several periods of glaciation and melting which were illustrated in many alternating cycles of erosion and alluviation. During times of glacial melting, rising sea levels decreased stream gradients causing deposition of gravel, sand, silt and clay, in that order. During times of glacial building and receding sea levels, the terraces were eroded and dissected to be alluviated on an irregular surface during the following cycle of rising sea levels. This resulted in well sorted and semi-stratified beds in some areas with highly interfingered wedges and lenses in others. The unit generally grades upward from coarse sand and gravel at the base to silt and clay at the top. Gravel and sand may compose as much as fifty percent of the total thickness of the unit in small areas. <15, 46, 61>

Alluvial deposits are generally composed of gravel, sand, silt and clay. Stratification in the alluvium is similar to zones in the terrace deposits. There is a progressive change from gravel and coarse sand in the basal section to fine grained materials near the top. Composition of the alluvial surface deposits is controlled by mode of deposition, which may be one of the following: Point bar, swales, channel fill, natural levees or backswamps. These distinctions are important because they delineate areas of different permeabilities, recharge potential, topographic expression, mode of deposition and lithologic character. <1, 15, 46>

Point bars are deposits on the inside of the convex bank of a stream meander and are usually the most permeable of all alluvial deposits. They are composed of fine and very fine sand grading downward into coarser materials. Swales occur as depressions

figure 4-7

QUATERNARY DEPOSITS SURFACE DISTRIBUTION



SOURCE: - Modified from E.H.Boswell, E.M.Cushing and R.L.Hosman, 1968 Ref #16 between stages of point bar building and generally are composed of finer materials. Channel fill refers to oxbows that have been cut off from the mainstream of the river. Silts and clays from occasional floods fill the channel resulting in a relatively impermeable clay plug which hinders recharge. The overall thickness of the aquifer is usually reduced in those areas by the thickness of the clay plug. <1, 15, 46>

Natural levees form along the banks of streams during floods due to reduced velocity and carrying capacity when the water leaves the channel. They are relatively permeable, being composed mainly of sandy and silty material. The finer materials are deposited in the backswamps. Backswamps are the areas between the natural levees and the edge of the floodplain that are commonly flooded and filled with relatively impermeable silts and clays. All of the processes previously described result in alluvium that is complexly layered with lenses, wedges, plugs, and fingers of materials of different particle sizes. <1, 15, 46>

Thickness of the Quaternary Alluvium and Terraces was controlled by the topography of the Eocene surface. Considerable time elapsed following Eocene deposition and prior to the Pleistocene series of deposition. During this interval, the Eocene surface was eroded and developed stream patterns similar to the present day dendritic and yazoo pattern. The terrace and alluvial deposits were laid down on the irregular, eroded Eocene surface. The deposits were relatively flat on top; consequently, they are thickest over the Pre-Pleistocene depressions and thinnest over the higher, interstream areas. Generally, the terrace and alluvium deposits are less than 100 feet thick. (See Figure 4-8). However, the alluvium along smaller tributaries probably does not exceed 25 feet in thickness. Some of the thickest deposits (about 150 feet) are located in eastern Lincoln, Drew and Ashley Counties, where regional dip in the embayment and erosion on the Eocene surface resulted in thick deposits. The thickest deposits are in two small areas of Drew and Ashley counties where deposits are in excess of 150 feet. These locations could possibly be remnants of an ancestral Bayou Bartholomew. <15, 16, 17, 25, 46, 57, 61, 76>

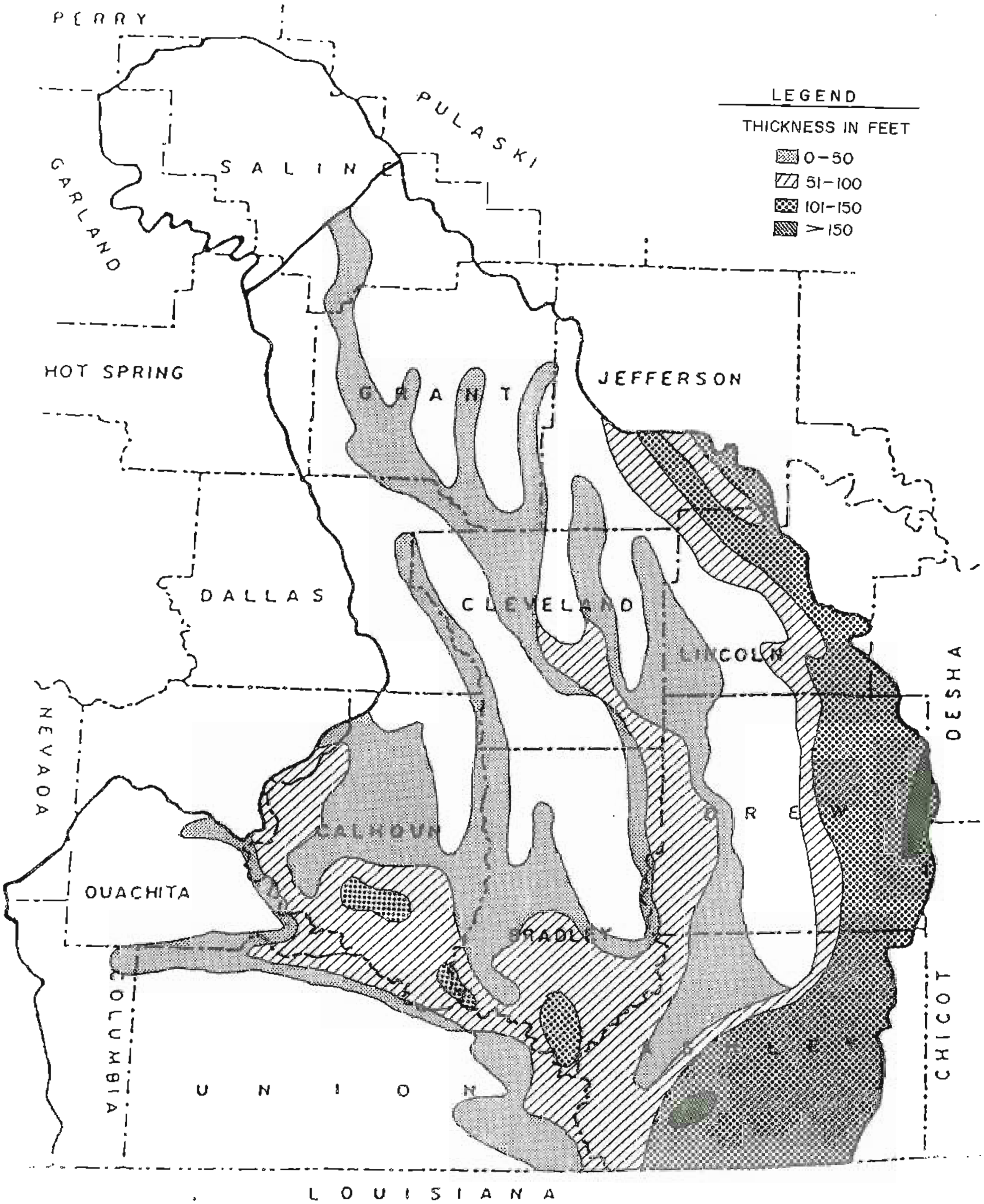
Hydrology

The Quaternary Aquifer is the single most important aquifer in the basin and in the State. Almost 87% of the groundwater used in the study area in 1980 was withdrawn from Quaternary Deposits. The quantity used within the study area was more than eight times the quantity withdrawn from the second most important aquifer, the Sparta Sand. Withdrawals from the Quaternary in 1980 equaled 242.3 MGD, an increase of 72.7 MGD since 1975. From 1965 to 1980, the average increase in use was 4.1 MGD per year. <41, 42, 43, 48>

Ninety-nine percent of the Quaternary withdrawals in the study area were from Ashley, Lincoln and Drew Counties. In 1980, 110.0 MGD or 45% of Quaternary withdrawals in the study area were in

figure 4-8

QUATERNARY DEPOSITS THICKNESS



SOURCE: U.S.G.S. - Modified from E.H.Boswell, E.M.Cushing and R.L.Hosman, 1968 Ref #16

Ashley County. Use has increased in the County on the average of 5.8 MGD every year since 1965. Withdrawals have also increased in Drew and Lincoln Counties, but at slower rates of 2.3 MGD and 4.2 MGD (per year) respectively. (See Figure 4-9a and 4-9b). <41, 42, 43, 48>

Approximately 80% of the total groundwater withdrawn from all formations in 1980 (221 MGD) was used for irrigation. Sixty-seven percent (186 MGD) was used to irrigate rice and 12.5% for other crops. The percentage of Quaternary withdrawals used for irrigation is unknown. However, if 87% of groundwater withdrawals in the study area was from the Quaternary and 80% of the total withdrawn was used on cropland, then it can be assumed that a large portion of the Quaternary withdrawals was used to irrigate crops. Another factor is that the water quality is usually not suitable for uses other than irrigation without treatment. <41, 42, 43, 48>

The importance of this aquifer is mainly due to the high yields of fresh water that can be obtained at relatively shallow depths due to high rates of transmissivity and recharge. Yields vary considerably over the Lower Ouachita basin, depending on permeability, saturated thickness, porosity and the storage coefficient of the deposit. Transmissivity is a product of permeability and thickness of the aquifer. Transmissivity in the basin ranges from less than 13,000 cubic feet per day to over 40,000 cubic feet per day, as shown in Figure 4-10. <16, 17, 46, 61>

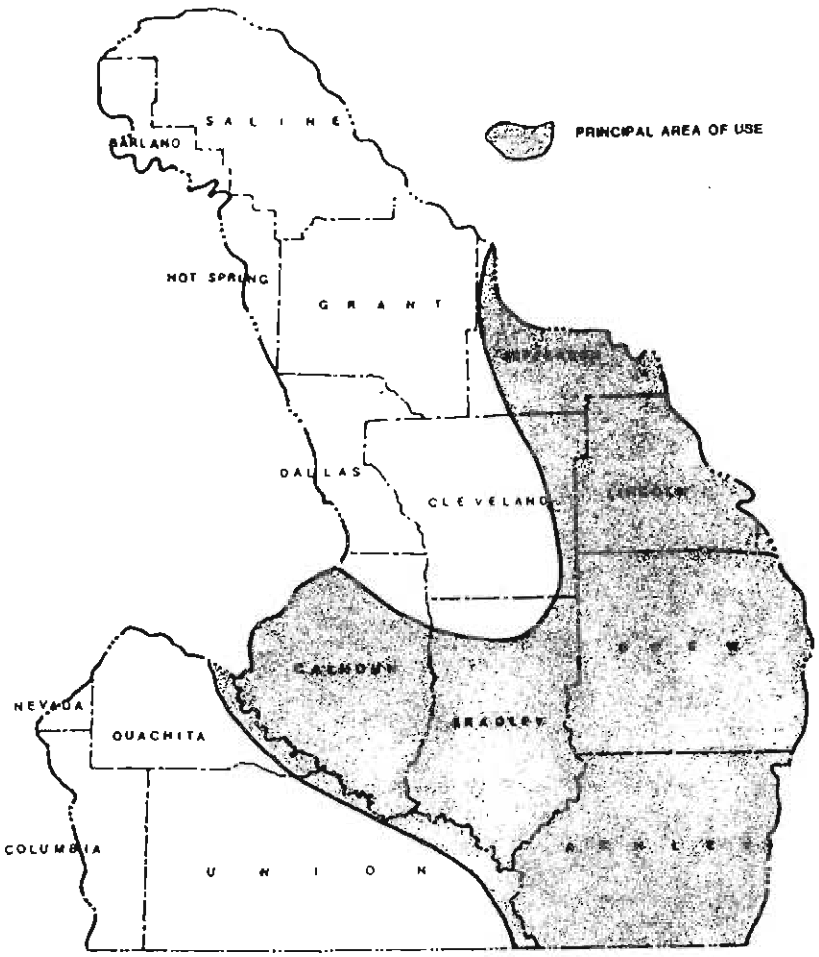
Movement within the Quaternary is regionally controlled by the gentle southeastward slope of the Mississippi River Alluvial Plain. Locally, movement is away from or toward streams depending on the season, and toward areas of large withdrawal. Yields in the northern part of the basin along the Saline River, and in the southern part along the Ouachita River range from 25 GPM to 50 GPM, due to the fine-grained character and thinness of the deposits. The highest yields are obtained in the thick deposits of eastern Lincoln, Drew and Ashley Counties where yields of 5000 GPM have been reported, while 2000 GPM is common. In this area, probably the single most important factor in obtaining a high yield is locating a well in the deepest deposits where the basal sections of gravel are thickest along ancestral Eocene Rivers. These areas have greater saturated thickness and appear to receive adequate recharge from precipitation and lateral flows along ancient watercourses. Several other high yield areas exist of small areal extent, where surface permeabilities are high and sufficient recharge is available. <16, 46, 61>

Recharge to the Quaternary Aquifer can occur in several ways. In most areas, the upper portion of the formation contains silt and clay averaging 5 to 20 feet thick, which allows percolation of water to occur at extremely slow rates. In some limited areas, gravel and sand is exposed which allows precipitation to infiltrate the soil and percolate relatively rapidly into the basal section of

QUATERNARY DEPOSITS

figure 4-9a

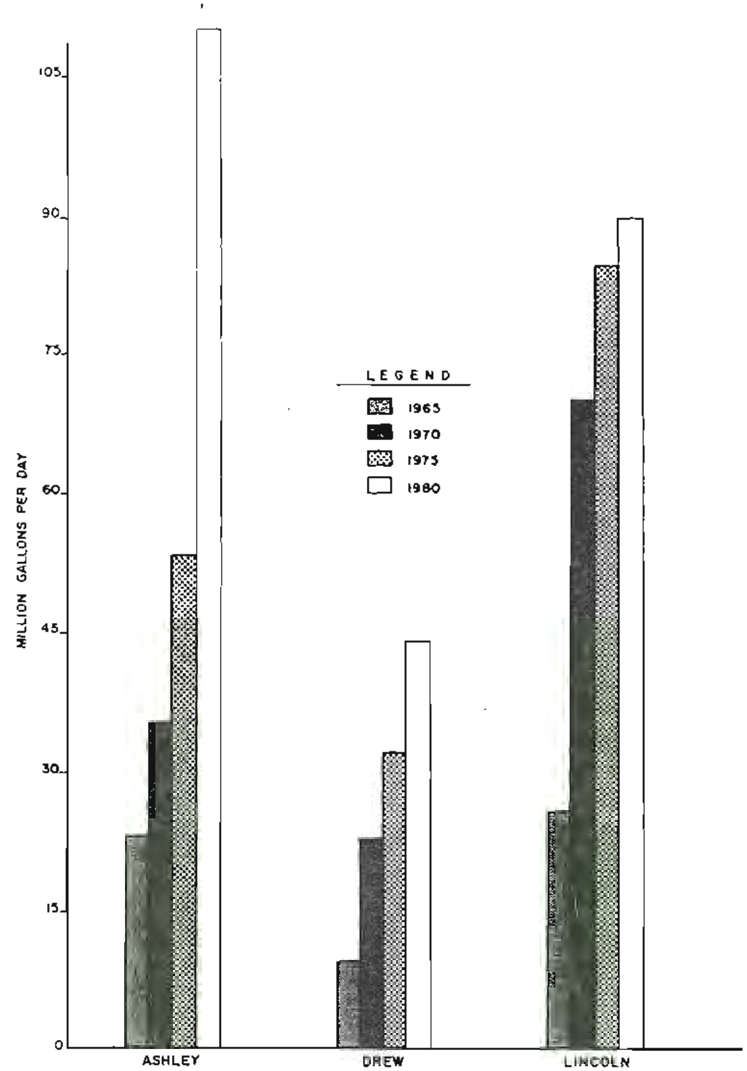
AREAS OF USE



SOURCE: Various Publications. Ref. 1, 15, 16, 46, 53, 76.

figure 4-9b

GROUNDWATER WITHDRAWAL 1965-80



SOURCE: USGS File Data, Ref #41, 42, 43, 48

Claiborne Group

The Claiborne Group of Middle Eocene age outcrops over 60% of the Lower Ouachita Basin and is extensive in the subsurface of the Mississippi Embayment. The Group has been divided into the Cockfield, Cook Mountain, Sparta Sand, Cane River and Carrizo Sand Formations. These formations were near shore deposits and consist of variable amounts of clay, sand and silt. Generally, the beds are not well defined due to lateral gradations in lithology. The resulting lenticularity makes identification of individual beds difficult. <1, 15>

Cockfield Formation

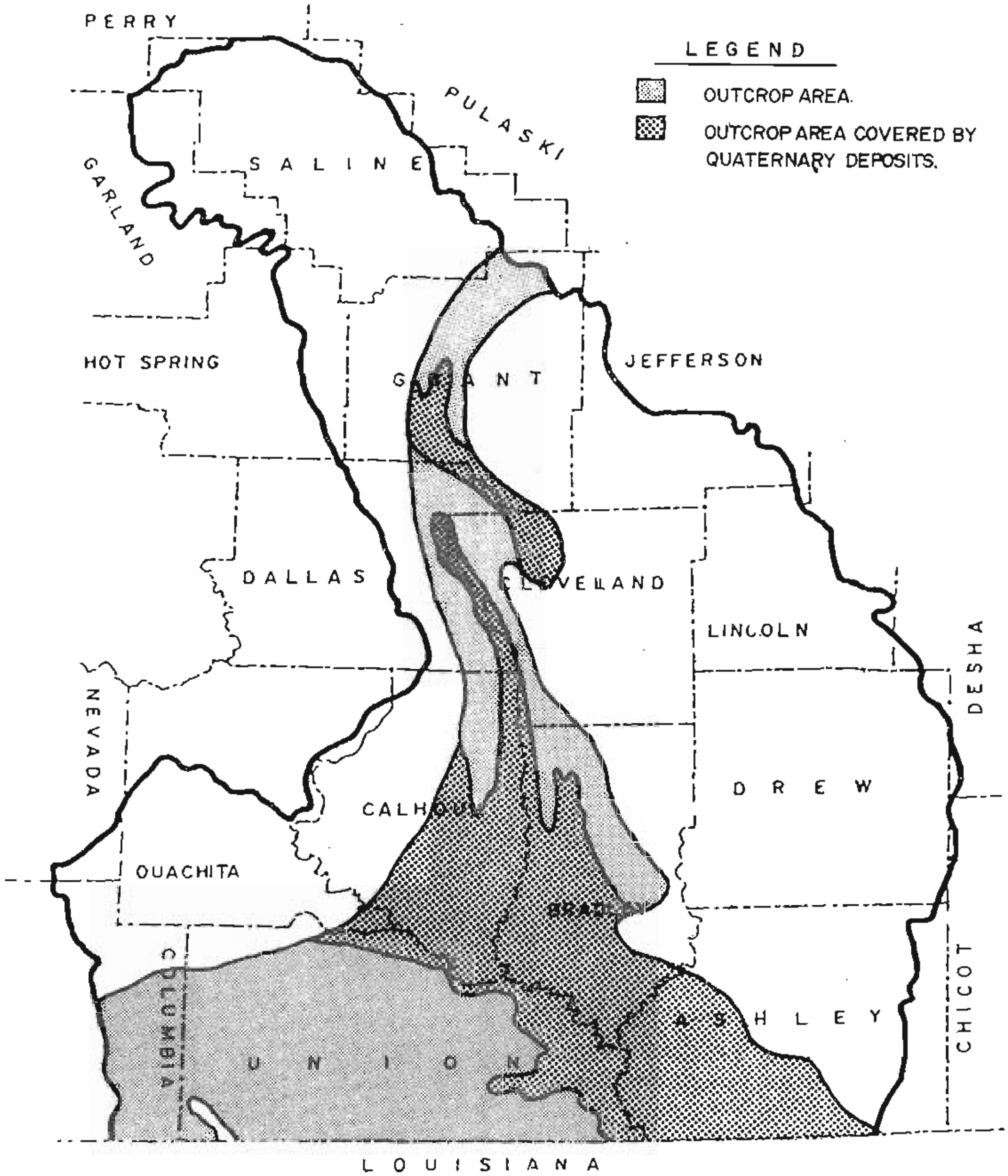
Geology. The Cockfield is the uppermost and youngest formation in the Claiborne Group. The formation is generally gradational in character, therefore, the contact between the overlying Jackson Group and the underlying Cook Mountain Formation is difficult to distinguish in many areas of the basin. The unit outcrops or subcrops under Quaternary Deposits, in a band across Grant, Dallas, Cleveland, Calhoun, Bradley and Ashley Counties including the southern half of Columbia and most of Union County. (See Figure 4-15). Thickness of the formation ranges from 200 to 400 feet with 300 feet common. Dip of the beds is generally eastward, oriented toward the axis of the Desha Basin at a rate of 20 to 25 feet/mile. Composition of the Cockfield Formation changes laterally with lenticular beds of sand, silt, clay and thin lignite interbeds. Most of the sand is fine to medium grained, gray and brown, reaching a maximum thickness of approximately 100 feet in the basal part of the formation in Union County. In most areas of the basin, the sand beds range from 20 to 40 feet thick and are discontinuous lenticular bodies interspersed with clay layers. The sands in Ashley County are clear quartz with light gray to colorless mica speckled with black minerals resulting in a salt and pepper appearance. The clays are usually dark brown, dark gray or green with thin lignitic layers. The presence of lignite, absence of fossils, and silt free sand lenses indicate subaerial beach deposition of deltaic or continental origin. <1, 13, 15, 44, 46, 61, 76>

Hydrology. The Cockfield Formation is the third most important source of groundwater in the basin based on withdrawals in 1980. This is primarily due to the relatively large yields of good quality water that can be obtained from shallow depths. <48>

Withdrawal of water from the Cockfield Formation within the study area in 1980 amounted to 3.86 million gallons per day. This quantity represented approximately 1.4% of the total groundwater withdrawn in the study area and 54% of the total withdrawals from

figure 4-15

COCKFIELD FORMATION OUTCROP



SOURCE: (1) U.S.G.S.-Modified from J.E.Terry,C.T.Bryant, A.H.Ludwig and J.E.Reed, 1979 Ref #76

(2) U.S.G.S.-Modified from Hosman and others, 1968 Ref #49

the Cockfield Formation statewide. Withdrawals from 1965 to 1975 remained approximately the same, but pumpage from the aquifer increased 32 percent from 1975 to 1980. <35, 36, 37, 42>

In 1980, Ashley County withdrew 1.01 MGD or 26.2 percent of the total Cockfield withdrawals in the study area in 1980, as shown in figure 4-16. Union County was the second largest user with 0 .67 MGD or 17.4 percent of total withdrawals, followed by Cleveland (0.65 MGD - 16.8 percent); Drew (0.45 MGD - 12.4 percent); Calhoun (0.39 MGD - 10.1 percent) and Bradley (0.38 MGD - 9.8 percent). The three highest use counties accounted for 2.3 MGD or 60.4 percent of Cockfield withdrawals in the study area. (See Figure 4-16). <41, 42, 43, 48>

Most of the water withdrawn from the Cockfield Formation is used for domestic or public supplies and self-supplied industry. In Ashley County where the deeper aquifer (Sparta Sand) is saline, the Cockfield is the principle aquifer for public supplies. In Union County, 47.1 percent of groundwater withdrawals is used for public supplies and 48.9 percent is used by self-supplied industry. In Cleveland County (the third largest user) 41 percent of withdrawals is used for public supplies and 58 percent for rural use. Water from the Cockfield is used for these purposes because it requires only limited treatment before use. Figure 4-17 illustrates the spatial distribution of municipalities that use Cockfield water. Most of the municipalities are in the extreme southeastern portion of the basin. Six of twelve cities using Cockfield water are in Ashley County with six others distributed throughout the basin. The largest user in 1978 was North Crossett (0.357 MGD), followed by Wilmot at 0.2 MGD. Water quality appears to be the most important factor in determining the pattern of municipal well distribution. <8>

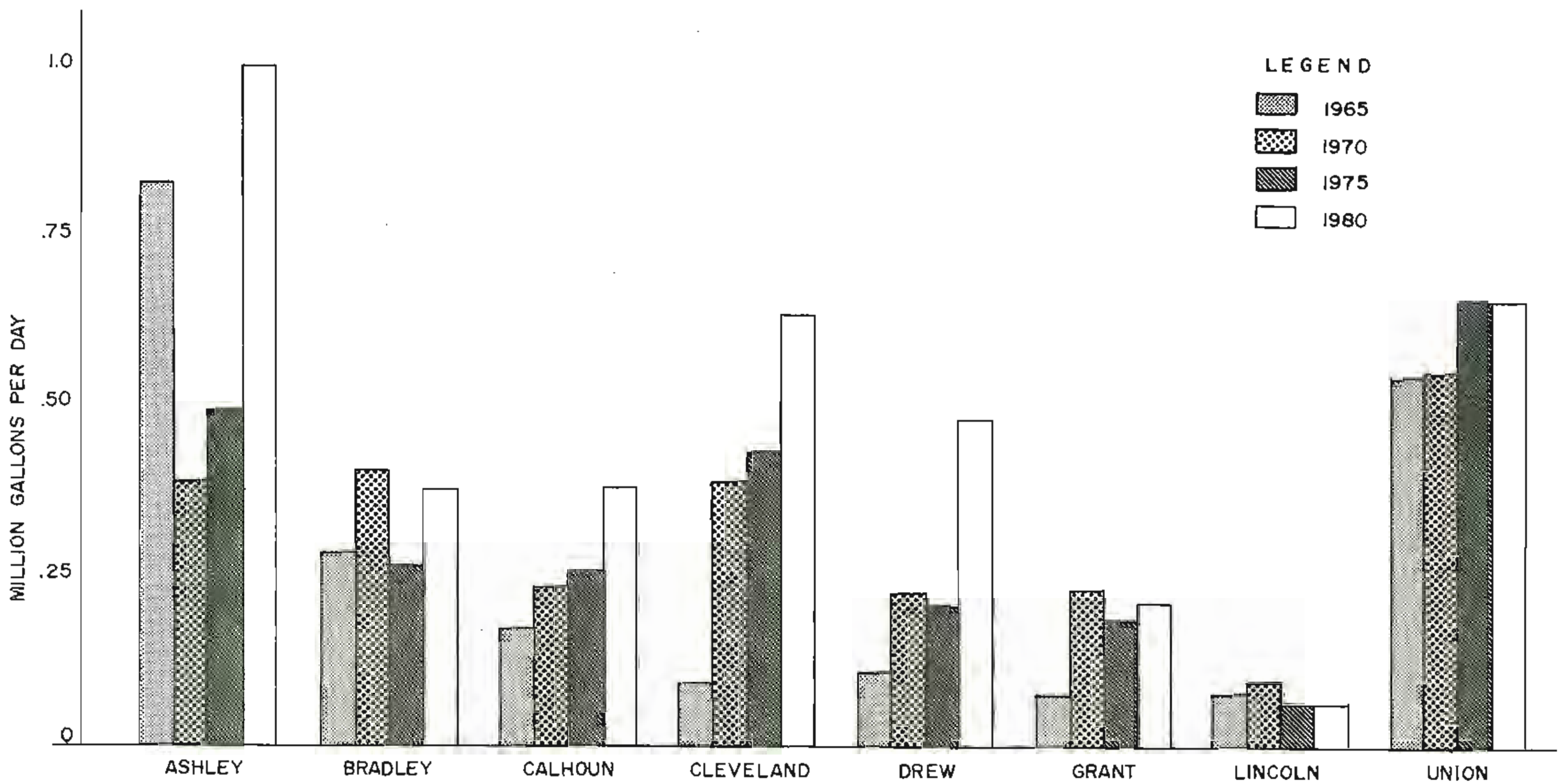
Yields from the Cockfield commonly range from a few gallons per minute to 400 GPM with one report of 1,000 GPM in Union County. The two most important variables affecting well yields appear to be the thickness of the unit and the percent of sand in the formation. Figure 4-18 illustrates that most of the formation contains sand beds that compose 41 to 60 percent of the unit. Three areas located in Bradley and Cleveland Counties contain percentages of sand from 61 to 80 percent. The thickness of the sand beds is very important because the nature of the deposit is commonly fine grained and not highly permeable. While the formation is composed of many individual lenticular beds, the unit has one potentiometric surface due to the hydraulic connection. <1, 13, 46, 65, 76>

Movement within the Cockfield on a large scale is generally southeastward or downdip from the recharge area. Recharge is mostly from precipitation falling on the outcrop area. Rainfall percolating into the Cockfield moves downdip under artesian conditions due to the confinement between clay layers (Jackson Group and Cook Mountain Formation). Locally, movement is toward the streams (Saline, Moro and Ouachita) as illustrated by the potentiometric contours in Figure 4-19. <1, 15, 46, 76>

figure 4-16

COCKFIELD FORMATION
GROUNDWATER WITHDRAWAL
1965-1980

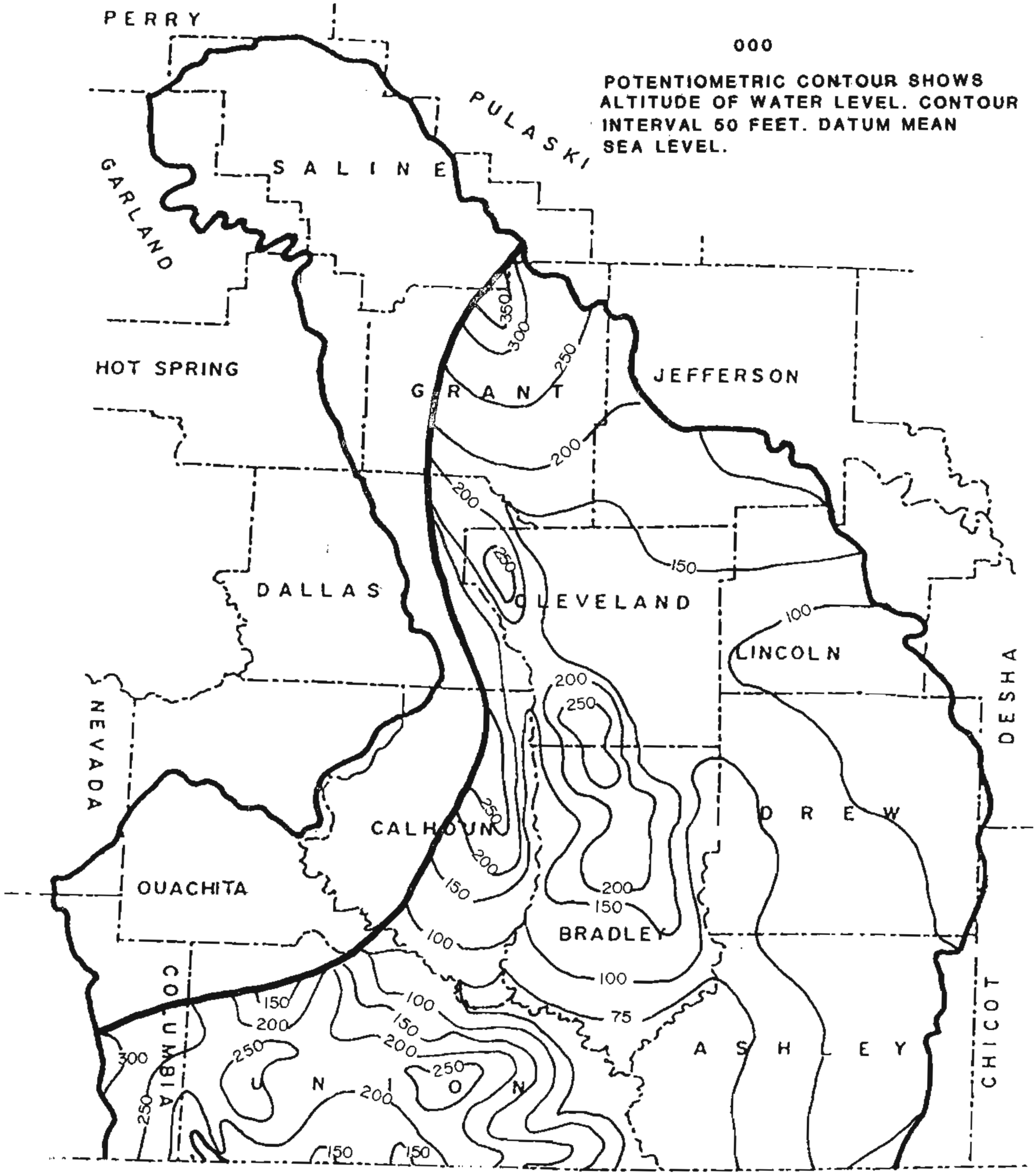
MILLION GALLONS PER DAY IN STUDY AREA



Source: U.S.G.S.-Use of Water in Arkansas (1965-1980)
Ref #41, 42, 43, 48.

figure 4-19

COCKFIELD FORMATION POTENTIOMETRIC SURFACE 1979



Source: USGS - Modified from J.E.Terry, C.T.Bryant, A.H.Ludwig and J.E.Reed, 1979. Ref #76

The average depth to water across the basin in the Cockfield Formation was approximately 74 feet below land surface. The depth ranged from 116 feet in Cleveland County to 21 feet in Calhoun County. The depth of wells was greatest in Lincoln County (530 feet below land surface), followed by Drew (413 feet) and Bradley (410 feet). The depth of wells tapping the Cockfield generally increases eastward from the outcrop area corresponding to the dip of the formation. (See Figure 4-20). <1, 13, 15, 25, 27, 28, 29, 30, 31, 32, 45, 46, 61, 65, 76>

Quality. Water quality within the Cockfield Formation is suitable for most purposes without treatment. Quality generally decreases southeast from the outcrop area. Water quality data for public supply wells and non-municipal wells in the Cockfield Formation are summarized in Tables 4-10 and 4-11, respectively. The water is generally soft. Hardness as CaCO-3 ranged from 105 mg/L in Grant County to 11 mg/L in Dallas County with a mean of 53 mg/L for non-municipal wells. Hardness of water from public supply wells was slightly higher at 73 mg/L. Specific conductance ranged from 622 umhos in Drew County to 42 umhos in Dallas County with a mean of 429 umhos (non-municipal wells). Two areas of high specific conductance are located in east-central Calhoun County and western Drew County as illustrated in Figure 4-21. Iron concentrations were high for non-municipal wells with a mean value of 2.0 mg/L. Total dissolved solids averaged 218 mg/L (non-municipal wells) and 334.3 mg/L (public supply wells). <34, 46, 76>

Cook Mountain

The Cook Mountain Formation outcrops in a narrow band from southeastern Saline County to Columbia County crossing parts of Grant, Dallas, Calhoun and Ouachita Counties. The formation is underlain by the Sparta Sand and overlain by the Cockfield Formation from the Claiborne Group. <44, 74>

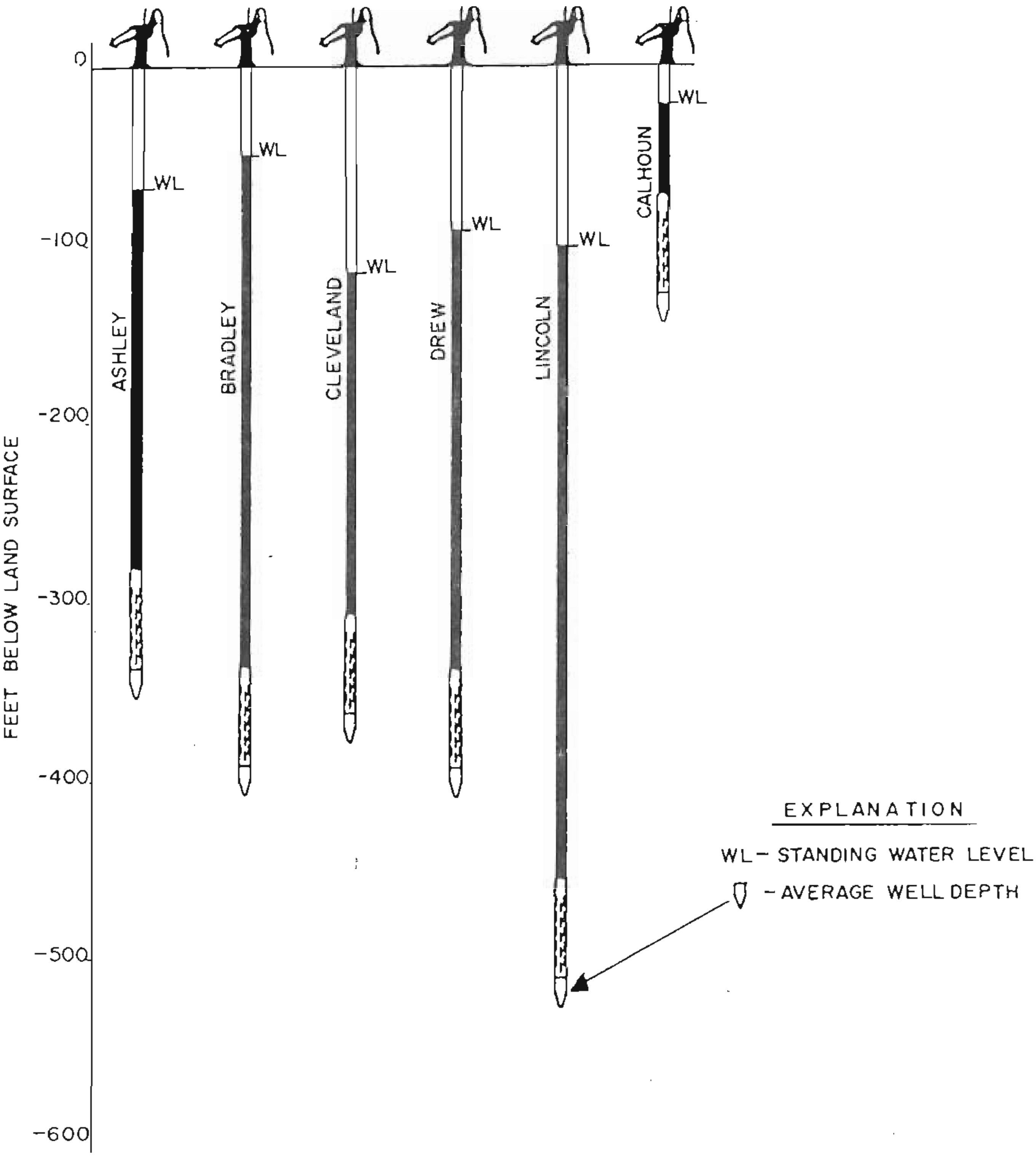
The formation is primarily composed of carbonaceous clay, lignite and lenticular beds of sand with the amounts varying considerably depending on the mode of deposition. A bed of fine sand 10 to 20 feet thick near the middle of the formation is fairly uniform in the southeastern part of the basin and the formation generally becomes sandier to the north and near the outcrop area. Thickness of the formation ranges from zero to 280 feet thick but typically is about 100 to 150 feet thick. Dip of the beds is generally oriented east and southeastward. <15, 44, 46, 61, 74, 76>

The Cook Mountain Formation is relatively impermeable due to the fine grained character of the deposits and is only of minor importance as a source of groundwater in the basin. The formation does however serve an important function because the confining character of the bed retards vertical movement between the Sparta

figure 4-20

COCKFIELD FORMATION AVERAGE DEPTH TO WATER 1983

WITHIN THE BASIN



SOURCE: Various. Ref #1, 15, 46, 61, 65, 76

TABLE 4-10
COCKFIELD FORMATION
QUALITY - PUBLIC SUPPLY WELLS
WITHIN THE BASIN

COUNTY	# OF SAMPLES	YEAR	pH	TOTAL SOLIDS	NA	TOTAL ALK.	TOTAL HARD.	CA	MG	FE	MN	CL	SO-4	F	NO3 (N)
ASHLEY	(7)	71-79	7.96	383.8	166.3	233.6	65.4	17.0	5.8	.23	.06	90.7	29.10	.35	.31
UNION	(2)	71-73	7.9	515.5	313.0	285.5	7.0	1.8	0.6	.308	.045	85.3	.25	.46	.20
BRADLEY	(3)	77-79	7.7	234.0	36.3	95.1	155.3	17.7	12.8	.160	.327	47.3	6.17	.10	.03
CLEVELAND	(1)	1980	8.5	204.0	48.0	150.0	63.0	15.0	6.0	.070	.03	11.0	13.00	.10	.02
MEAN			8.0	334.3	140.9	191.1	72.7	12.9	6.3	.19	.117	58.6	12.1	.25	.14

ALL DATA IN Mg/L

Na - SODIUM DISSOLVED AS Na
Ca - CALCIUM DISSOLVED AS Ca
Mg - MAGNESIUM DISSOLVED AS Mg
Fe - IRON DISSOLVED AS Fe
Mn - MANGANESE DISSOLVED AS Mn
Cl - CHLORIDE DISSOLVED AS Cl
SO-4 - SULFATE DISSOLVED AS SO-4
F - FLUORIDE DISSOLVED AS F
NO-3 - NITRATES DISSOLVED AS N
- - NO READING

SOURCE: ARKANSAS DEPARTMENT OF HEALTH, 1982. REF. #3.

and Cockfield formations and limits Sparta recharge to the Sparta outcrop area. The Cook Mountain does yield sufficient quantities of fresh water for domestic uses in the outcrop area and downdip for a distance of 10 to 15 miles. <1, 15, 46, 74, 76>

Sparta Sand Formation

Geology. The Sparta Sand is overlain by the Cook Mountain Formation and underlain by the Cane River formation. The Sparta outcrops in a semi-continuous north-south meandering band approximately 25 miles wide, interrupted only by Quaternary Alluvium deposits of recent age and terraces. The middle sections of the band lie just outside the Lower Ouachita basin in northern Ouachita and western Dallas Counties but were included in Figure 4-22 for a better understanding of the recharge-use area relationship. The formation is present in the entire study area south of the fall line as an outcrop, as a subcrop under Quaternary Deposits or buried beneath younger Tertiary beds. <18>

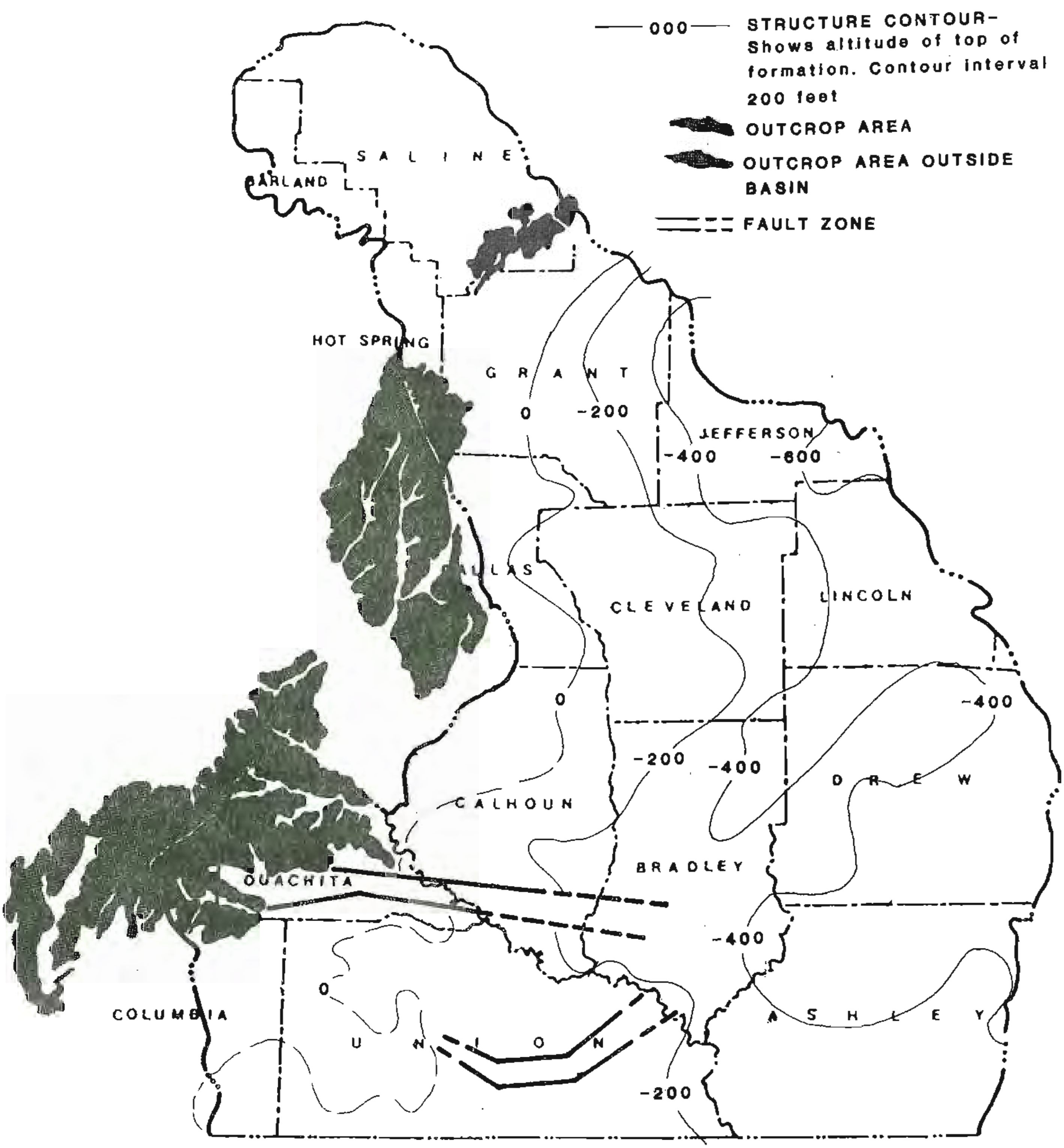
Eastward from the outcrop area, the Sparta becomes progressively buried under younger formations. Dip of the beds is generally eastward in the northern half of the basin toward the Mississippi Embayment and northeasterly in the southern half due to the influence of the Desha Basin Downwarp and the Monroe Uplift. The rate of descent in Grant and Jefferson Counties is approximately 20 feet per mile. Across Union and Ashley Counties, the rate is approximately eleven feet per mile and is interrupted by a graben near El Dorado and many minor faults in southern Calhoun, Bradley and Union Counties. The maximum depth to the top of the Sparta Sand in the basin is approximately 600 feet below mean sea level in Jefferson and Lincoln Counties near the Desha Basin. <18>

Thickness of the Sparta Sand is highly variable over the basin, but generally becomes thicker downdip or eastward from the outcrop area. The unit varies from 200 to 300 feet thick near the outcrop zone to over 900 feet in northern Drew and southern Lincoln Counties. <17> These larger, general thickness variations occurred due to structural features that were developing, or had completed development, during the period of Sparta deposition such as the Mississippi Embayment, Desha Basin, Monroe uplift, faulting and the smaller trough and dome-like folded structures of Ouachita, Bradley and Union Counties. Thickness may also vary on a small scale due to the alternating cycle of downcutting and deposition that occurred in channels of the lower Sparta and upper Cane River Formation. (See Figure 4-23). <44, 61, 63, 76>

Composition of the Sparta Sand varies considerably in the basin, both laterally and vertically over short distances due to the depositional environment of the formation. The Sparta is mostly sand of continental origin, being deposited by rivers as they meandered over long periods of time. The result was lenticular, overlapping and interfingered thick bodies of sand interspersed with thin beds of sandy to silty clay, shale and lignite. (See Figure 4-24). <13, 15, 44, 46, 63, 74, 76>

figure 4-22

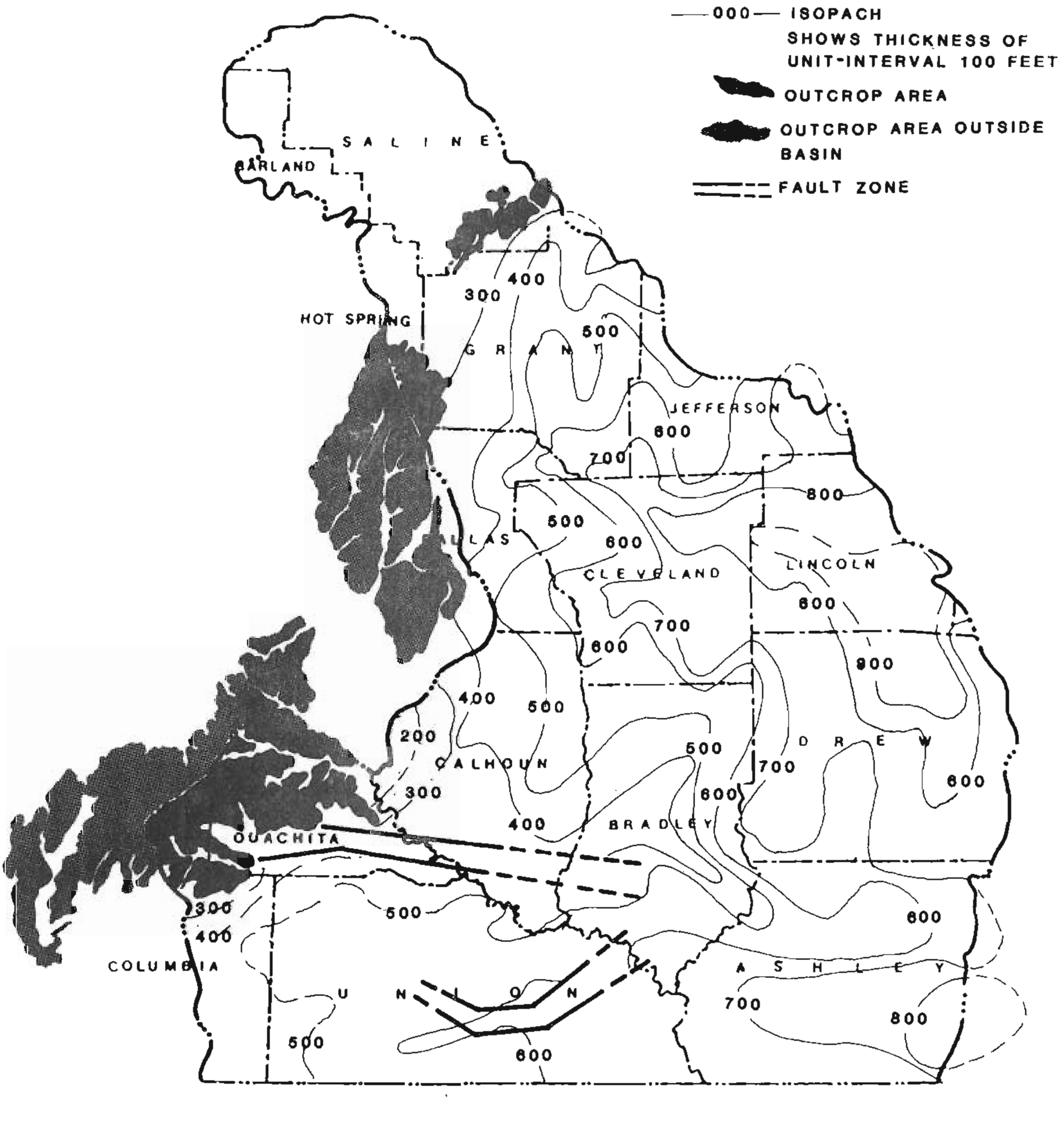
SPARTA SAND STRUCTURAL CONTOURS



SOURCE: Modified from J. C. Peterson and M. E. Broom (USGS), M. V. Bush (Ark Geol Comm), 1985. Ref #18

figure 4-23

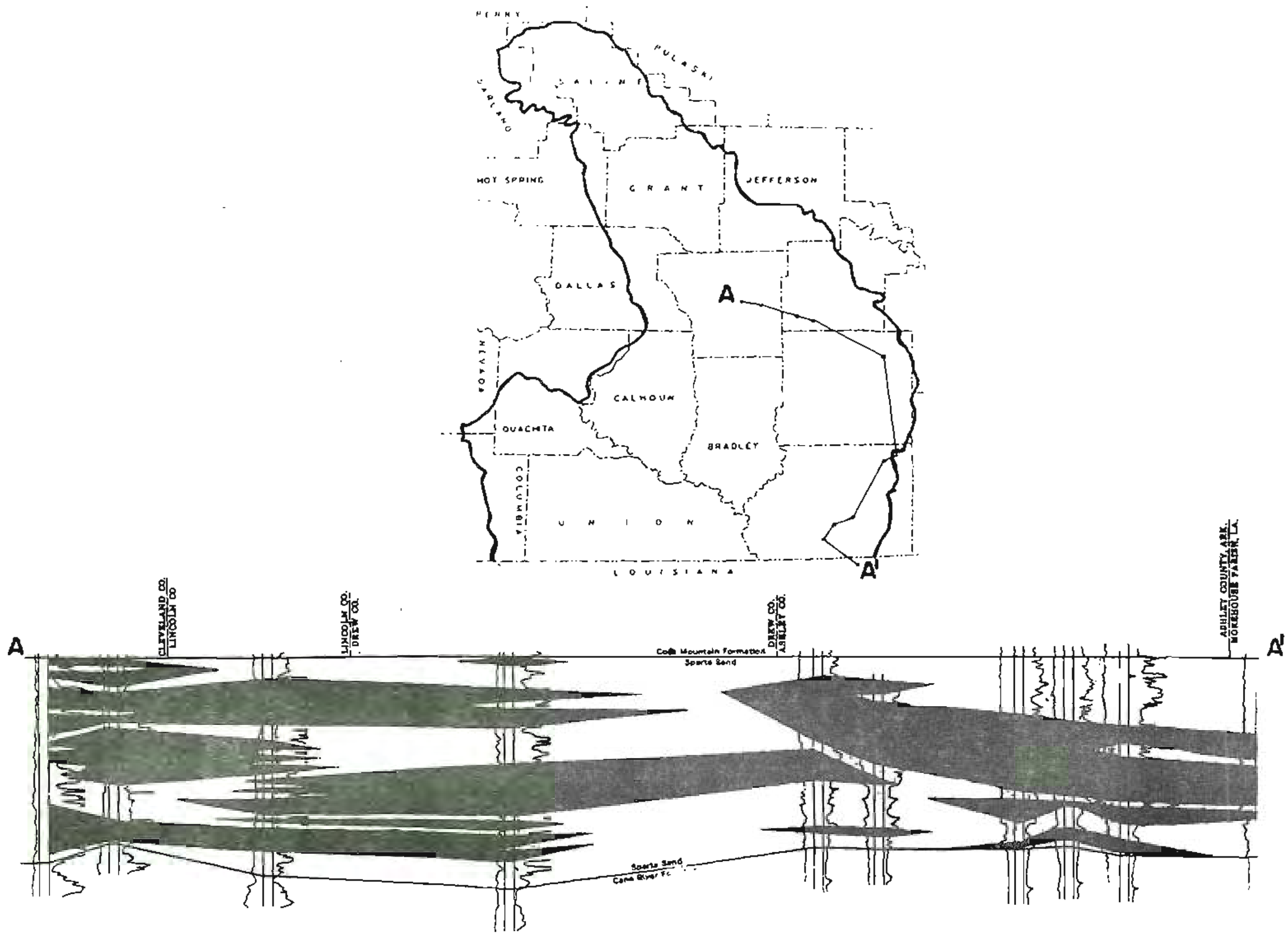
SPARTA SAND ISOPACH



SOURCE: Modified from J. C. Peterson and M. E. Broom (USGS), W. V. Bush (Ark Geol Comm) 1985. Ref #18

figure 4-24

SPARTA SAND
VARIABLE THICKNESS OF CONTINUOUS SAND UNITS



SOURCE: USGS - Modified from J.N.Payne Ref #83

In Union County, the Sparta can easily be divided into an upper and lower unit. The upper unit generally comprises about one-third of the total formation thickness and consists of very fine-grained sand layers interbedded with lenses of brown, gray or greenish lignitic, silty shale and sandy to silty clay. While the thickness of the sand beds varies considerably, they are relatively thin compared to the shale and clay lenses and rarely exceed 35 feet in individual sand bed thickness. These sands are commonly referred to as the "Greensands" due to their color and are believed to be of marine origin, due to brief, local invasions of the sea that repeatedly covered low lying areas of the land mass. The lower Sparta sands comprise about one-half of the total thickness of the formation. The lower unit contains massive beds of well-sorted sand interbedded with a few thin, lenticular clay beds and thin stringers of lignite. Commonly, the sand beds comprise 80 percent of the thickness of the lower unit. Between the "Greensand" and the "Lower Sparta" (El Dorado Sands), is a layer of relatively impermeable shale and clay that comprises approximately 15 percent of the total formation thickness. <13, 19, 46, 63, 74>

Hydrology. Based on withdrawals, the Sparta Sand is the second most important source of groundwater in the basin. This is primarily due to the large yields of good quality water that can be obtained from the formation almost everywhere in the basin. <48, 76>

Withdrawals from the Sparta Formation within the study area in 1980 amounted to 30 million gallons per day. This quantity represented 10.6 percent of the total groundwater withdrawn from all aquifers in the study area and 16.4 percent of total Sparta withdrawals statewide. Withdrawals increased 30 percent from 1965 (25 MGD) to 1970 (33 MGD), then declined in 1975 to 29 MGD. From 1975 to 1980, withdrawals showed a one percent increase throughout the study area. <41, 42, 43, 48>

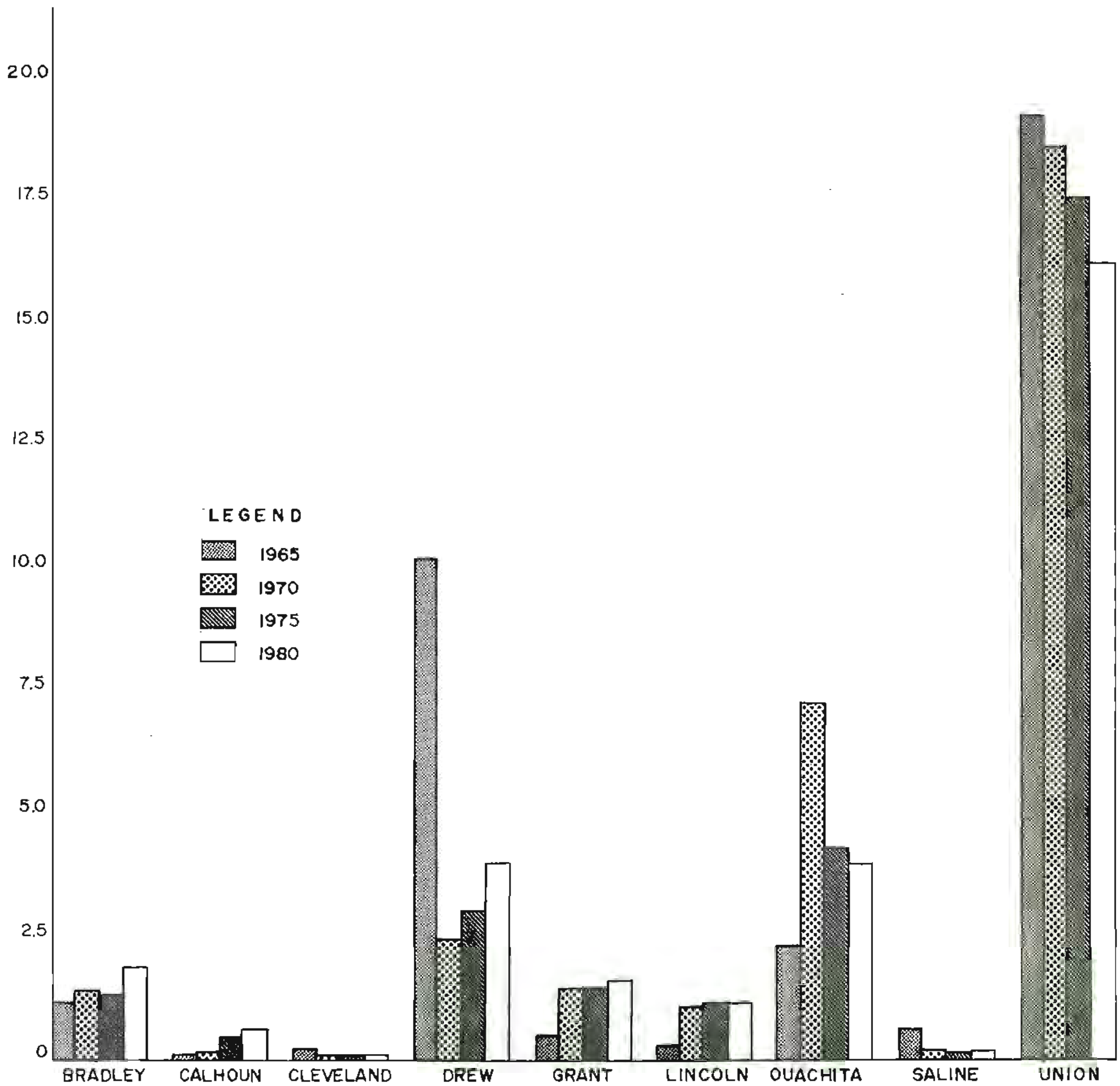
Union County alone withdrew 16 MGD from the Sparta in 1980 which amounted to 54 percent of the total quantity withdrawn from the Sparta in the study area. Ouachita County was second with 13 percent (3.89 MGD) and Drew was third with 13 percent (3.88 MGD). The three counties combined, withdrew 24 MGD or 80 percent of the Sparta withdrawals in the study area. (See Figure 4-25). <41, 42, 43, 48>

These statistics are somewhat deceptive because a large part of Jefferson and Columbia Counties are outside the basin and both counties are outside the study area. While withdrawals from the two counties have a significant impact on groundwater levels in the basin, their totals are not included in the withdrawal figures. Withdrawals from Jefferson and Columbia Counties in million gallons per day for 1965, 1970, 1975 and 1980 are as follows:

figure 4-25

SPARTA SAND
GROUNDWATER WITHDRAWAL
1965-1980

MILLION GALLONS PER DAY - IN STUDY AREA



SOURCE: USGS - Use of Groundwater in Arkansas (1965-1980) Ref #41, 42, 43, 48

WITHDRAWALS - MGD

YEAR	JEFFERSON	COLUMBIA
1965	44.36	3.03
1970	59.30	5.84
1975	53.82	6.02
1980	71.13	7.22

If these figures were included, withdrawals from the Sparta would increase from 29.7 MGD in the study area to 108.0 MGD. These figures more accurately illustrate the importance of the Sparta Sand Aquifer in the basin, compared to Quaternary withdrawals of 242.26 MGD in 1980, as shown in Figure 4-3. These data would also change the impression of Figure 4-25. Compared to Union County (the largest withdrawals in the study area), Jefferson County withdrew 4.5 times as much water from the Sparta. <41, 42, 43, 48>

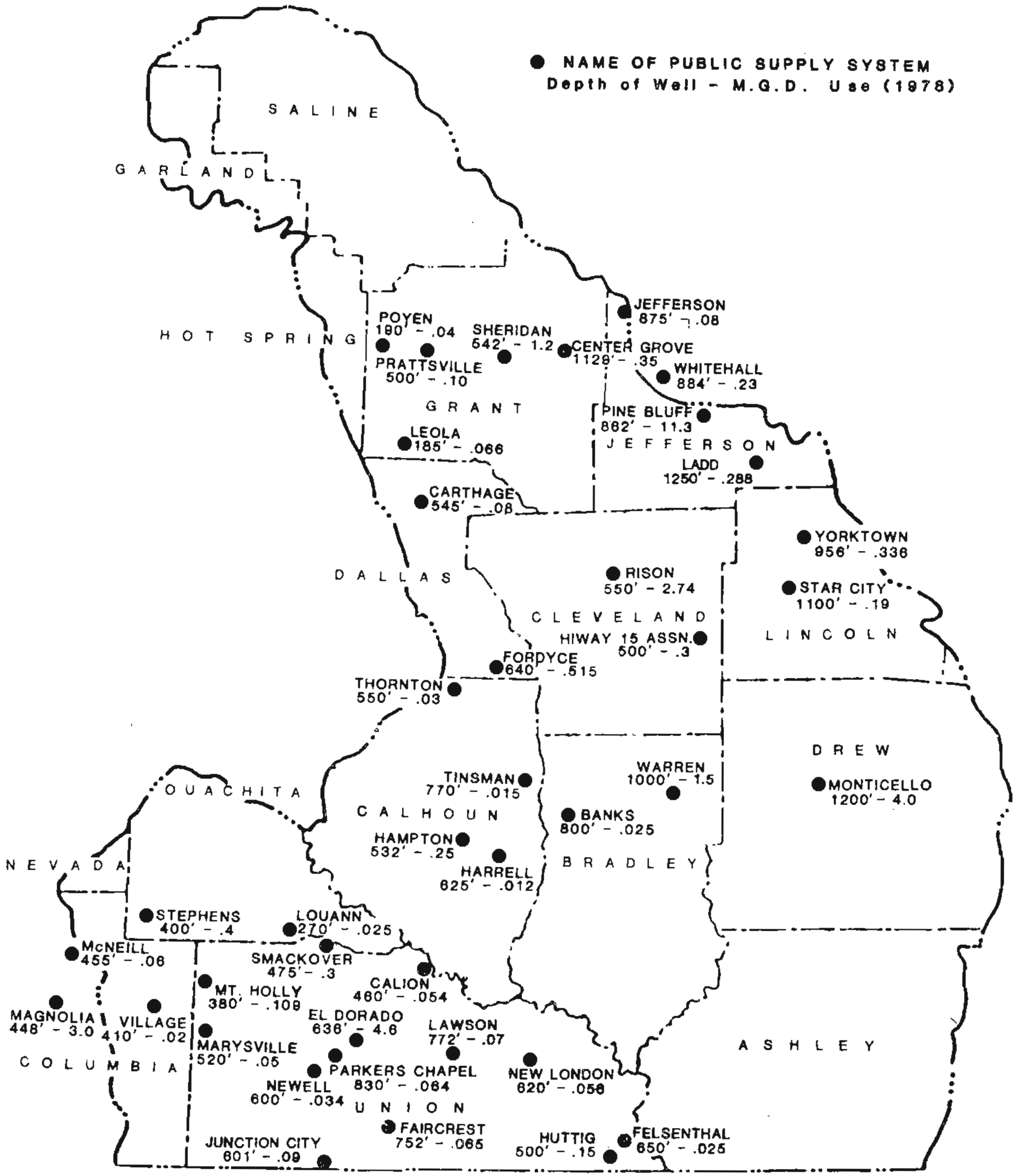
Withdrawals from the Sparta Sand are used primarily for public supply and self-supplied industry. In Union County, 47.1 percent of the groundwater withdrawn from all formations, was used for public supply and 48.9 percent for self-supplied industry in 1980. Ouachita County was the second largest user of Sparta water, where 64.5 percent was for self-supplied industry and 24 percent for public supply. Water from the Sparta Sand is used for these purposes because of the high yields and high quality that requires little or no treatment before use. Figure 4-26 illustrates the spatial pattern of municipalities that use Sparta water. Most of the municipalities are in a meandering, 50 mile wide band that roughly parallels the outcrop area. This is affected by several variables such as depth of wells and depth to water, with quality being the most important. In general, water quality decreases with increased distances from the recharge area. This principle holds true for the Sparta Sand and most of the artesian aquifers in the Lower Ouachita Basin. <8, 41, 42, 43, 48>

The largest use by any municipality in 1978 was Pine Bluff where withdrawals equalled 11.3 MGD from an average well depth of 862 feet. El Dorado was second with 4.6 MGD and Magnolia was third at 3.0 MGD. Heavy use by self-supplied industry in addition to withdrawals for public supply, exacerbates the problem of declining water levels in these areas. Most of the water used by self-supplied industry from the Sparta is for oil and paper processing. <8>

Yields average 600 GPM in the basin and commonly range from about 300 GPM near the outcrop area to as much as 2,000 GPM in the southern and eastern parts of the basin. Many variables affect yields to wells penetrating the Sparta Sand. The three most important are the percentage of sand, size of sand grains in the formation and thickness of the unit. <15, 44, 63, 76>

figure 4-26

SPARTA SAND PUBLIC SUPPLY SYSTEMS



SOURCE: Arkansas Soil and Water Conservation Commission 1978 Ref #6

The percentage of sand in the formation varies considerably over the basin due to the nature of deposition. As stated earlier, the Sparta was primarily deposited by meandering rivers resulting in lenticular sand bodies. Numerous areas of high sand content are visible in Figure 4-27. Several of these appear to have a meandering pattern that probably represented areas of channel development at different periods during Sparta time. One of these areas is located on a northwest-southeast line crossing Bradley and Ashley Counties; another is near the confluence of Ouachita, Columbia and Union Counties. These areas represent ancestral flow-ways where thick, clean, well sorted and somewhat coarser sand beds were deposited due to the persistent flow and higher stream velocities. Areas of lower sand percentages represent interchannel swamps, marshes or lakes where finer sediments accumulated. Significantly different yields are commonly obtained from closely spaced wells due to permeability changes that occur over short distances because of variations in sand grain size, compaction and sorting. While it is generally accepted that the sand beds in the Sparta are hydraulically connected due to overlapping, and have one potentiometric surface, many beds may act as independent aquifers for short distances. Locating ancestral channels where the percentage of sand and thickness of the unit is large, appears to be the key to higher yielding wells tapping the Sparta Sands. Despite lateral variations in lithology, the Sparta is generally a reliable and predictable aquifer. Some exceptions are along the Monticello Ridge in Drew County and in small areas of Eastern Union County. <13, 53, 63>

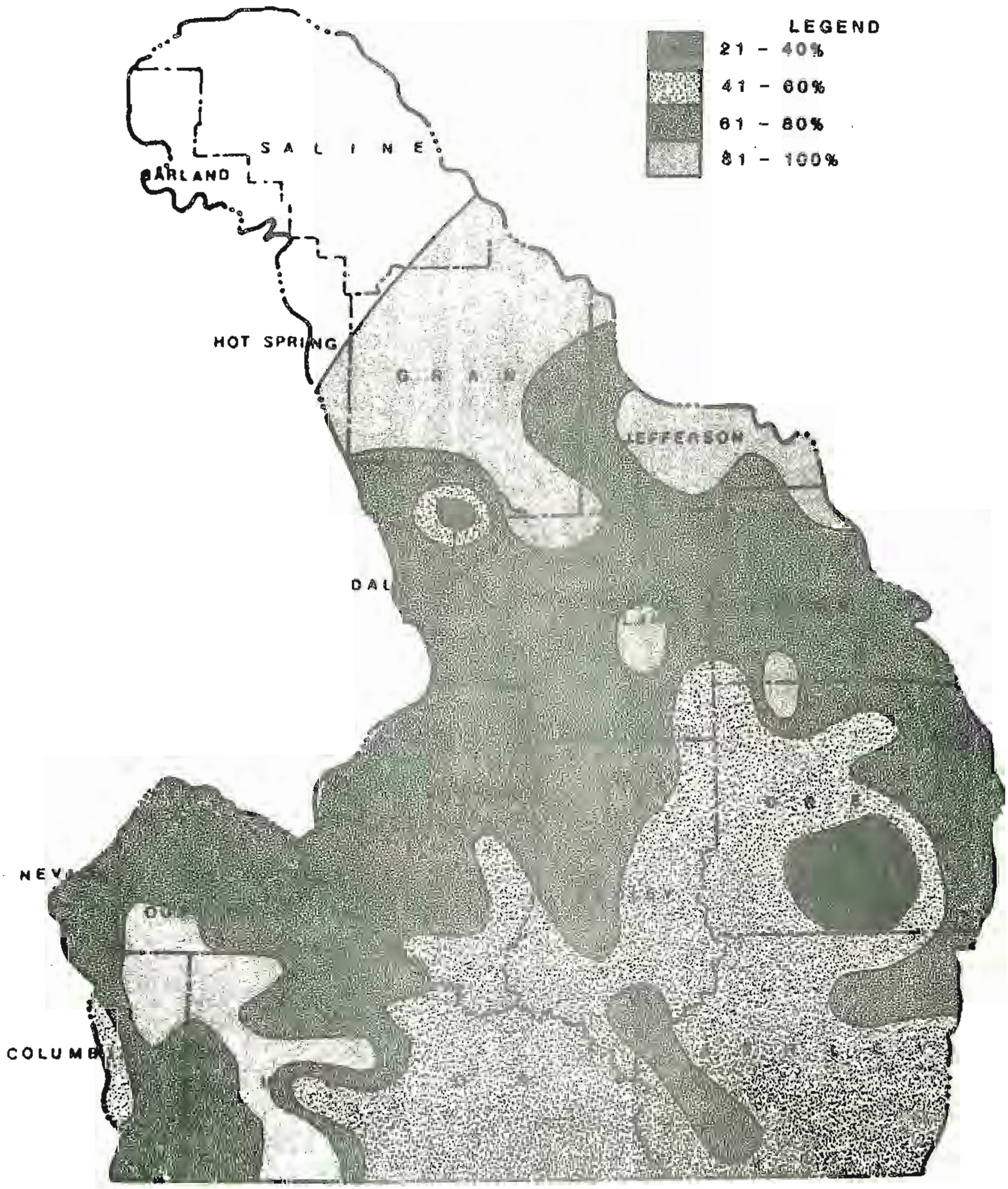
Movement on a large scale within the Sparta is generally southeastward and downdip. Recharge is primarily from precipitation and percolation in the outcrop area. When precipitation enters the Sparta, it proceeds downdip between the confining layers of the Cook Mountain Formation and the Cane River Formation. This results in a completely saturated formation downdip from the recharge or outcrop areas except in those areas of heavy withdrawal. When wells tap the formation, the water level in the well rises above the top of the formation and is termed artesian. On a smaller scale, movement is along ancestral flow-ways, down gradient and toward areas of large withdrawal. <63, 76>

The average well depths and the average depth to water vary considerably over the basin depending on many factors discussed previously. The largest average depths to the potentiometric surface occur in Union County at 330 feet below land surface. Dallas County was second at 315 feet and Columbia third at 270 feet. The average depth to Sparta water in the basin was 190 feet below land surface. <27, 28, 29, 30>

The average well depth varies primarily with the depth of the formation and the vertical section of the formation being tapped. The deeper wells are generally in the eastern part of the basin.

figure 4-27

SPARTA SAND
PERCENTAGE OF SAND CONTENT



SOURCE: U.S.G.S. - Modified from Hosmam, R.L. and Others, 1968 - Ref #49

Lincoln County wells were deepest, averaging 1028 feet below land surface. Jefferson County was second with an average of 996 feet and Bradley County was third at 900 feet. These were followed by Drew (686 feet), Calhoun (620 feet), Union (610 feet) and Dallas at 593 feet. These numbers represent county averages and should not be used in attempts to predict well depths to reach the Sparta. (See Figure 4-28).<1, 8, 13, 15, 27, 28, 29, 30, 44, 53, 61, 63, 64, 65>

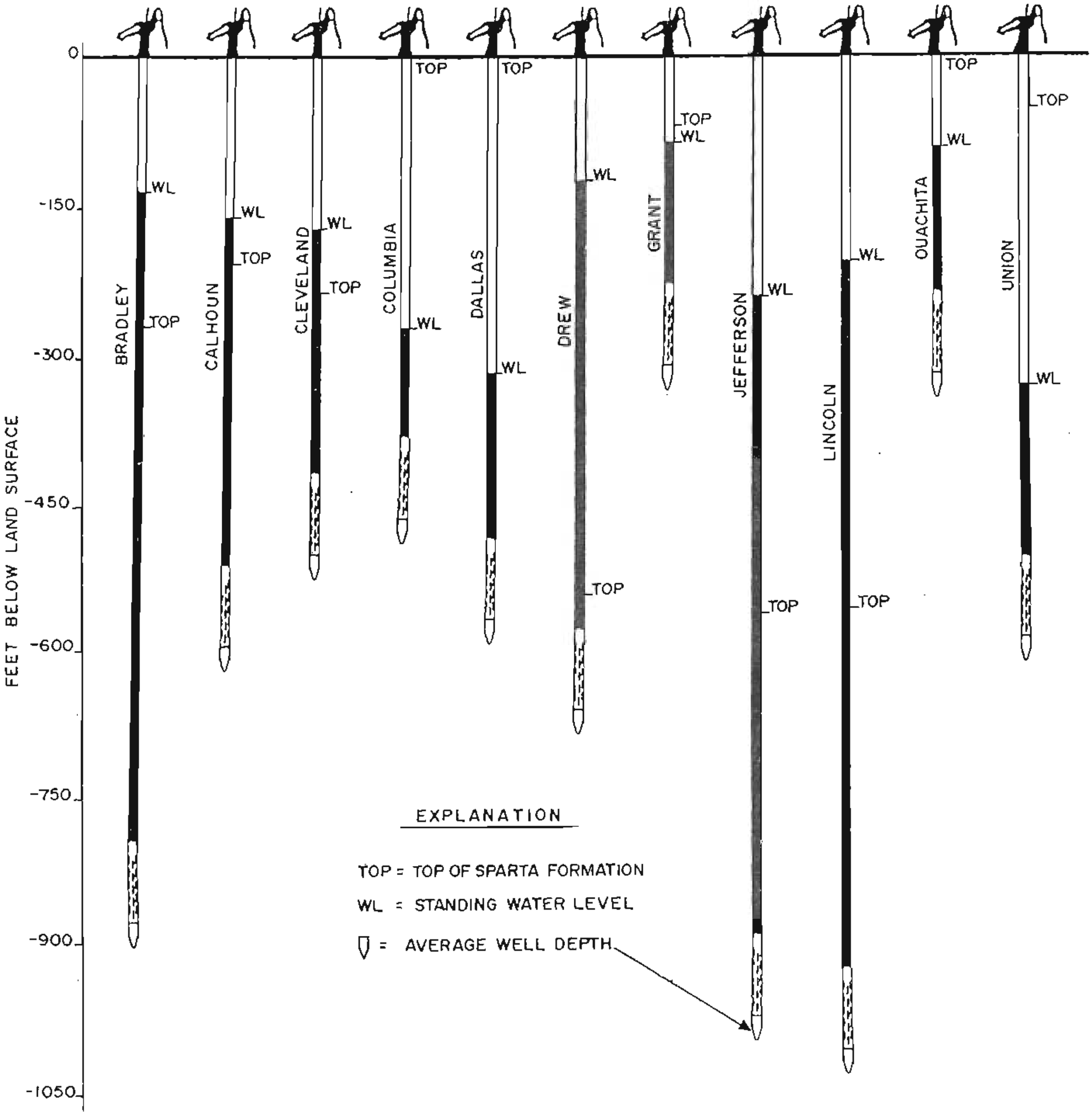
The "water level-formation top" relationship is important because when the water level is below the top of the tapped aquifer, the aquifer may become dewatered and the reduced head pressure can allow saline waters to intrude and pollute the aquifer being used. In addition, yields decrease with decreasing saturated thickness and subsequent formation compaction can make the situation permanent. Five of the ten counties studied had average water levels below the top of the formation. Water levels in Dallas, Grant and Ouachita Counties are below the top of the formation because they are in or near the outcrop zone and some degree of aquifer dewatering can be expected. The relatively large withdrawals in Union County have lowered levels below the top of the formation. Portions of Columbia County are in the outcrop area and also have large withdrawals resulting in water levels below the top of the formation. Considering the quantity of withdrawals and the declining levels, recharge in most areas has been sufficient to maintain water levels above the top of the formation. In six of eight counties studied where the Sparta is under artesian conditions, water levels averaged 200 feet above the top of the Sparta Sand. <27, 28, 29, 30, 31>

<u>Quality</u>. Water from the Sparta Sand is generally suitable for most purposes with only minimal or no treatment required. Quality tends to deteriorate downdip from the outcrop zone. Water from Ashley County in the southeastern corner of the basin is not suitable for most purposes because it is saline and total dissolved solids are estimated to exceed 1000 mg/L. <17> (See Figure 4-29, Tables 4-12 and 4-13). Generally the water from the Sparta is soft. Hardness values ranged from 6 mg/L (Drew County) to 45 mg/L (Ouachita County) with a basin mean of 16 mg/L as CaCO-3 for non-municipal wells. Water from public supply wells averaged 26 mg/L in total hardness. Specific conductance ranged from 557 umhos in Bradley County to 138 umhos in Grant County with a basin mean of 336 umhos. (See Figure 4-30). Total dissolved solids concentrations ranged from 97 mg/L (Grant County) to 324 mg/L (Bradley County) with a basin mean of 218 mg/L. Sodium concentrations averaged 74 mg/L in the basin (non-municipal wells) and iron concentrations averaged 0.460 mg/L (non-municipal wells). Refer to the Problem Section for more details. <1, 3, 13, 15, 46, 53, 61, 65, 74, 76>

figure 4-28

SPARTA SAND
AVERAGE DEPTH TO WATER LEVEL
1983

WITHIN THE BASIN



SOURCE: Ref #1, 13, 15, 32, 46, 63, 65, 74.

Cane River

The Cane River Formation is underlain by the Carrizo Sand and overlain by the Sparta Sand. The formation tentatively outcrops in a narrow band trending northeast-southwest across Saline and Pulaski counties, alternately exposed and buried by Quaternary Deposits, and is present in the subsurface thoughout most of the basin. Generally the formation is composed of beds of sand, clay and sandy clay but varies considerably from north to south and east to west within the basin, depending on the depositional environment. <15, 18, 44, 61, 64, 74, 76>

The Cane River Formation is not an important source of groundwater in the basin. Most of the formation contains between 21 and 60 percent sand with the exception of a small area in eastern Hot Spring and western Grant county where a bed of sand up to 125 feet thick is present, and percentages exceed sixty. In this Grant-Hot Spring County area, the Cane River is potentially an important aquifer for domestic uses, irrigation and small industrial and municipal supplies. <15, 18, 44, 61, 64>

In the area of use, the quality of water from the Cane River Formation is low in total dissolved solids, specific conductance and sodium, generally soft with a common problem of excess iron. Most parameters increase in concentration southeast of the outcrop area or downdip. Specific conductance ranged from 32.3 umhos in Hot Spring County to 509.5 umhos in Columbia County with a basin mean of 283.6 umhos. <1, 44, 65, 74, 76>

Carrizo Sand

The Carrizo Sand is the basal formation of the Claiborne Group, overlain by the Cane River and resting on the Wilcox Group. The Carrizo outcrops or subcrops in a narrow band across Saline and Hot Spring counties trending northeast-southwest as inferred from updip projections using electric log data. Dip of the beds is eastward in the northeastern two-thirds of the basin and southeastward in the southwest, ranging from 50 feet/mile to 15 feet/mile, respectively. The formation averages about 100 feet thick but ranges from zero in Union county to 300 feet in Central Cleveland county and in the Desha Basin. Composition of the Carrizo is more than 80 percent sand, usually gray and brown, very fine to medium fine with lignite and shallow water clay.
<1, 65, 76>

The Carrizo Sand is not used extensively as an aquifer in the Lower Ouachita Basin. Most of the wells are for small domestic supplies and have low discharges. With few wells, there are no significant cones of depression. The potential for the Carrizo, however, may be significant. From the thick sand beds in and near the outcrop, yields commonly in the 30 to 100 gallon/minute range could be expected which would be sufficient for some municipal, industrial and irrigation sources. One exploratory well near Pine Bluff, tapping a 150 foot thick sand bed at a depth of 1950 feet below land surface, yielded 102 gallons/minute with a drawdown of 15 feet. The aquifer is artesian and the standing water level in the well was 15 feet below the land surface. Some wells may flow in Columbia County. <24, 44, 76>

Water quality in the Carrizo is suitable for most purposes without treatment in Saline, Hot Spring, Grant, Dallas and Cleveland Counties. The water is generally soft, low in specific conductance and total dissolved solids in these counties. In Bradley and Calhoun County samples, specific conductance averaged 194 umhos and total dissolved solids averaged 134 mg/L. <1, 76>

Wilcox Group

The Wilcox Group is the lowermost unit of Eocene Age and occurs at the surface or in the subsurface in most of the basin. A narrow outcrop band crosses Saline and Pulaski Counties trending northeast-southwest. Dip of the beds varies from a south-southeast orientation in the northern part of the basin to a north-northeasterly trend in southern Bradley and Ashley counties, generally toward the axis of the Desha Basin. The group generally becomes thicker downdip from the outcrop area. <1, 15, 18, 44, 46, 65, 76>

The interbedding characteristic of the group hinders prediction of depth to a fresh water sand at any specific site. Most of the sands were deposited in a deltaic environment, alternately inundated and exposed with rapid shore line movement preventing the development of a widespread beach deposit. The resulting thin sand beds of the Wilcox are not a principle aquifer in the basin but are of local importance in and near the outcrop zone for household supplies and other small domestic needs. <1, 65>

Midway Group

Geology.

The Midway Group of Paleocene Age outcrops in small irregular patches in a narrow band across Northeastern Hot Spring and Central Saline Counties. The band varies from about ten miles wide just north of Benton to more than thirty miles wide near the town of Reyburn and trends northeast-southwest. The group is present in the subsurface south and east of the outcrop area, overlain by the Wilcox Group of Eocene Age and resting on Paleozoic Rocks. Dip of the beds varies from a south-southeast orientation near the outcrop area to north-northeastward in Drew and Ashley Counties, reflecting the influence of the downwarping in the Desha Basin. Thickness of the group ranges from about fifty feet in the northern part of the basin to 500 and 600 feet in Columbia and Ashley Counties, respectively, reaching a maximum in Lincoln County of approximately 850 feet. <15, 24, 46, 64, 76,>

Two formations have been differentiated within the Midway Group due to their lithologic character; the Porters Creek Clay and the Clayton Formation. The Porters Creek Clay (upper unit) consists of noncalcareous, dark gray to blue to black clay in the northern and northeastern part of the basin grading into a bluish, silty, micaceous shale southwestward in Columbia County. This portion of the unit makes the Midway one of the best confining beds in the basin. <15, 44, 46, 74>

The Clayton Formation constitutes the lower unit of the Midway Group. It consists mainly of limestone beds, calcareous sand and sandstone in the north and northeastern part of the basin, gray to white limestone, marl and calcareous clay in Ashley County, grading into dark blue to brown, glauconitic, limy shale in Columbia County. Throughout the basin, the formation is fossiliferous due to its marine origin. <46,74>

Hydrology.

The Porters Creek Clay is too fine grained and shaly to yield water to wells in the basin, but serves an important function in the area by retarding vertical movement of highly saline waters into producing formations of Tertiary Age. <18>

The Clayton Formation is not an aquifer in the basin. Locally, however, the formation contains up to twenty percent sand along a narrow band in Saline County near the outcrop area and commonly yields sufficient quantities of fresh water for household purposes from shallow wells in that area. The maximum yield in and near the outcrop area has been reported to equal 350 gallons/minute, but yields less than 20 gallons/minute are more common. <44, 76>

Four municipal wells in Saline County withdraw water from the Clayton Formation. The City of Bryant withdrew the largest quantity at 0.2 MGD, followed by Haskell (0.125 MGD), Ranchette (0.11 MGD) and Indian Springs at 0.065 MGD in 1978. (See Figure 4-31). <8>

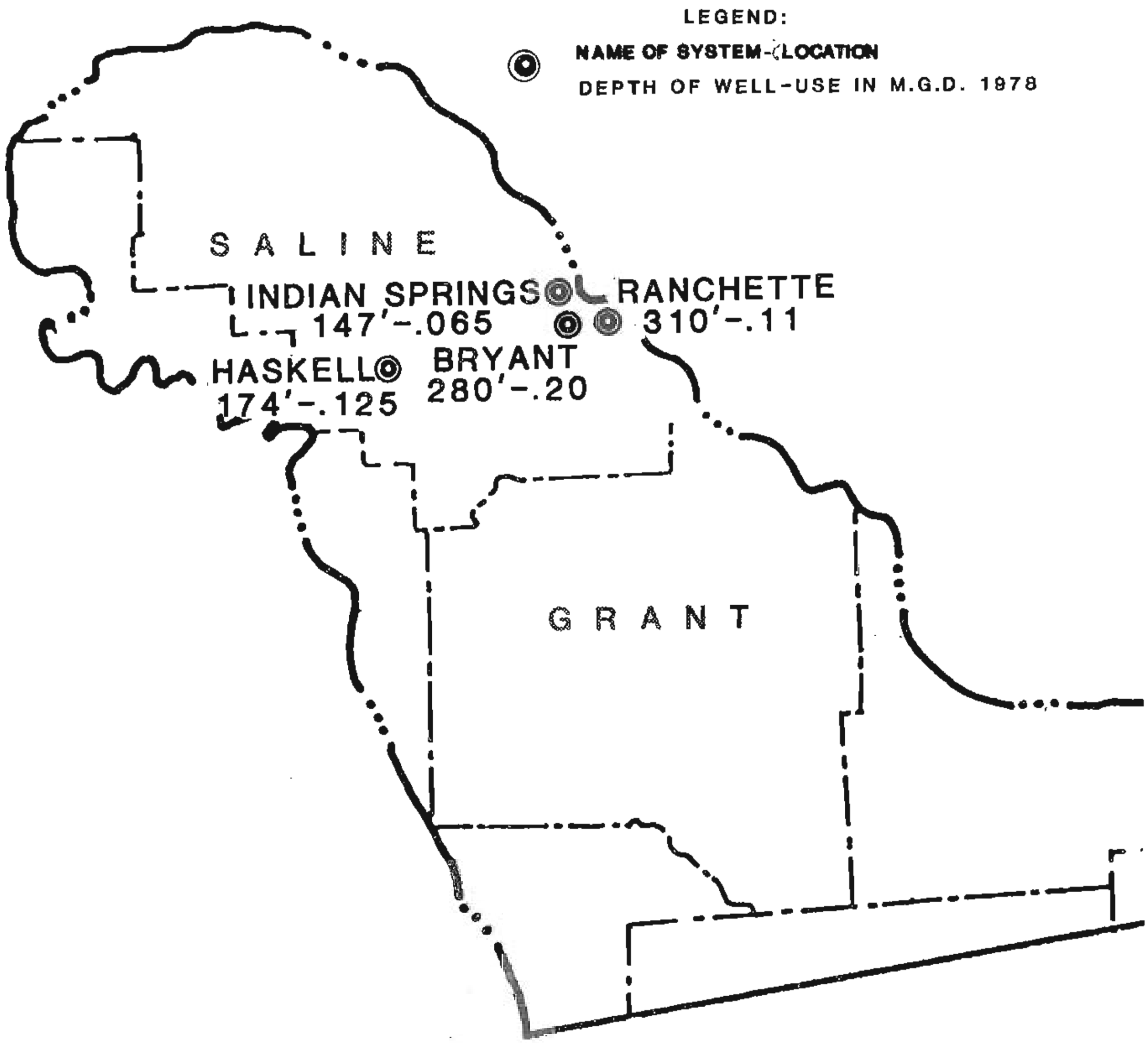
The quantity withdrawn from the Clayton Formation has steadily increased since 1965. In 1965, 0.23 MGD was withdrawn from the Clayton Formation. In 1980, 1.18 MGD or approximately six times the 1965 quantity was withdrawn. Over the fifteen year period, use has increased an average of 165 gallons a day. (See Figure 4-32). <41, 42, 43, 48>

Quality.

Water from the Clayton Formation is generally of good quality in Saline County, however, increases in concentrations of total dissolved solids render the water unusable downdip from the outcrop area. (See Table 4-14). Only minimal treatment is required before use in Saline County. Bryant, Haskell and Ranchette chlorinate and Indian Springs filters and aerates for iron removal in addition to chlorination. Twelve samples were analyzed from Saline County.

figure 4-31

CLAYTON FORMATION OF MIDWAY GROUP DISTRIBUTION OF PUBLIC SUPPLY SYSTEMS



Source: Arkansas Soil and Water Conservation Commission, 1978 #8

Total dissolved solids concentrations ranged from 351 mg/L (Haskell well) to 194 mg/L at Indian Springs with an average of 235 mg/L. Iron concentrations were relatively high with a mean of 0.49 mg/L. One well at Bryant and four wells at Indian Springs exceeded the 0.3 mg/L secondary drinking water standard. The pH ranged from 7.7 units to 8.6 units with a mean of 8.1 units. Fluoride concentrations averaged 0.54 mg/L with a maximum of 1.64 mg/L at Ranchette. <3, 44, 64, 76>

Paleozoic Rocks

Geology.

Formations within the Interior Highland Province of the basin range in age from Ordovician (Mazarn Shale) to Pennsylvanian (Jackfork Sandstone). Ten formations are commonly delineated in the area and consist primarily of shale, sandstone, chert and novaculite. (See Figure 4-33). These formations outcrop in the Highland Province but are deeply buried in the Coastal Plain under younger formations. The erosional surface of Paleozoic Rocks dip to the southeast at an average rate of 80 feet per mile. <18, 44, 64>

Hydrology.

In 1980, withdrawal of groundwater from Paleozoic Rocks (Saline County) amounted to 1.0 MGD which was only 1.5% of the Paleozoic withdrawals statewide and less than one percent of the withdrawals from all formations within the study area. The rate of withdrawal more than doubled from 0.43 MGD in 1965 to 1.0 MGD in 1980. (See Figure 4-34). <41, 48>

Formations in the Highland Province are relatively impermeable due to compaction from deep burial. Groundwater usually occurs within twenty feet of the land surface in fractured rocks, soil and loose particles created by weathering. Below the weathered zone, groundwater movement and storage occurs in secondary openings such as joints, fractures, and open bedding planes created by structural deformation. Yields, therefore, are primarily controlled by the pattern, distribution and density of fractures within the formation being tapped. Fracture linaments are generally oriented east-west due to the folded pattern in the Ouachita Mountains from north-south compression. Therefore, wells located north and south of each other may have quite different yields while east-west aligned wells commonly have similiar yields. All of the formations in the area are fractured to some degree and yield water to wells, but the Bigfork Chert, Jackfork Sandstone, Stanley Shale and the Arkansas Novaculite appear to be the most important aquifers. The Bigfork Chert is the single most important because it is the most highly fractured of the four formations. <2, 44, 64>

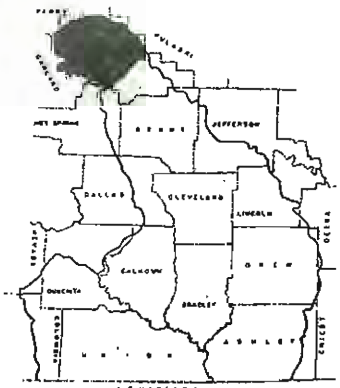
Yields in the area are generally less than 10 GPM, which restricts the supply to small demand uses such as rural, domestic or livestock. <44, 64>

figure 4-33

OUTCROPPING PALEOZOIC UNITS

LEGEND

- JACKFORK SANDSTONE.
- STANLEY SHALE.
- ARKANSAS NOVACULITE, MISSOURI MOUNTAIN SHALE, BLAYLOCK SANDSTONE.
- POLK CREEK SHALE, BIGFORK CHERT, WOMBLE SHALE.
- BLAKELY SANDSTONE, MAZARN SHALE
- QUATERNARY.
- LAKE WINONA



ENLARGED ABOVE

SOURCE: USGS - Modified from Haley, B.R., and others, 1976. Geologic Map of Arkansas. Ref# 46

LEGAL AND INSTITUTIONAL SETTING

Groundwater in Federal Law

No comprehensive federal groundwater law exists comparable to the legislation covering surface water or ocean pollution. This may reflect a federal view that groundwater quality problems are susceptible to local or state resolution and do not affect "interstate commerce" as directly as do surface waters. Federal measures for the control of groundwater pollution are listed in several different laws that are not primarily concerned with groundwater. These are:

Clean Water Act of 1977 - Congressionally delegated authority to the U.S. Environmental Protection Agency over surface water and groundwater; however, the scope of EPA authority over groundwater pollution has been ambiguous, partly because of the phrasing of Section 309 which refers to "navigable waters", which limits its applicability to groundwater.

Safe Drinking Water Act of 1974 - protects groundwater through its Underground Injection Control Program; and sets limits on some substances that may occur in public water supplies.

Section 1424 (e) - The Gonzales Amendment - provides state agencies with a legal mechanism to protect the recharge zones of special or "sole source" aquifers. In such areas, federally assisted projects which are found to endanger the quality of the water as set forth in the maximum contaminant levels set by the Safe Drinking Water Act, could have their funding halted by EPA.

Once designated as a "sole source" aquifer, section 3004 and 4002 of the Resource Recovery and Conservation Act (1976) come into play which allows state agencies to prohibit facilities in the recharge areas, require a leachate monitoring system, design specification for landfills and surface impoundments, thus giving the state legal support in restricting or prohibiting waste facilities within the recharge zone.

Resource Conservation and Recovery Act of 1976 (RCRA) - through which the EPA recently promulgated approximately 2,000 pages of regulations involving the classification, handling, testing, and disposal of hazardous substances, sets standards for the construction and monitoring of RCRA sites, including the digging of monitoring wells;

Toxic Substances Control Act of 1976 (TOSCA) - which overlaps with RCRA in some respects, also deals with toxic substances, particularly polychlorinated biphenyls (PCBs).

Surface Mining Control and Reclamation Act of 1977 - which deals with the release and disposal of mine water.

National Environmental Policy Act - forces consideration of the effects of federal action on groundwater in the writing of environmental impact statements. The federal reservation of water rights doctrine has been expanded to include groundwaters (1 Harv. Env. L. Rev. 173). In Cappaert vs. United States (426 U.S. 128, 1976), the U.S. Supreme Court held that "since the implied reservation-of-water doctrine is based on the necessity of water for the purpose of the federal reservation....the United States can protect its water from subsequent diversity, whether the diversion is of surface or groundwater." The court cited no cases to support this holding, relying instead on two National Water Commission publications and simple logic.

The federal government seems reluctant to tackle the socio/economic and technical problems involved in preparing a comprehensive groundwater resource management policy. There is no groundwater legislation equivalent to the Clean Water Act.

In September of 1984, EPA released its long awaited groundwater protection strategy. Consistent with its past pronouncements on groundwater, EPA's current strategy lays the economic burden of protection on the states. It calls upon them to build their groundwater programs using existing appropriations. New funds are to be used mainly for "information gathering and planning," with implementation reserved for those states who have completed their basic planning.

To assist the states, EPA has recently set up a new office on groundwater to coordinate programs. New regulations concerning the formerly unregulated underground storage tanks and surface impoundments will be promulgated along with further specifications for the protection and cleanup of aquifers.

Aquifers will be protected according to their "highest and best use", according to three classifications:

A. Special aquifers - those that are vulnerable to surface contamination, i.e. karst formations, sand and gravel aquifers. Those that are defined as ecologically vital, irreplaceable, or essential to the public.

B. Drinking water sources - currently used or potential sources.

C. All other aquifers.

Special aquifers will receive special attention; i.e., superfund sites over special aquifers will be cleaned up first, more stringent regulations for the storage, and disposal of chemicals will be applied over special aquifers, and special casing will be needed for disposal wells that are drilled through them. Further rules for land applications of nutrients and for new facilities over these aquifers will be applied.

Drinking water sources will have the same protection now in place. If a contaminant enters an aquifer used as a source of drinking water, it will be cleaned up with the best available technology, or, if that is not possible, the contaminant plume will be monitored.

Aquifers too salty to be used as drinking water sources will be monitored so that as little contamination as possible escapes from them into cleaner aquifers that are or could be used as drinking water.

EPA's recommendation for monitoring systems called for the utilization of monitoring already in place. They did agree that some selected monitoring could be funded if it fit within the general framework of the state strategy for groundwater. Monitoring that fell within the routine structure of the state system would not be eligible for funding.

Landfills, surface impoundments, and leaking storage tanks will be given special attention by EPA through programs designed to study the threat to groundwater presented by these sources of contamination. The first study which will deal with leaking underground storage tanks is already underway under the direction of the Office of Pesticides and Toxic Substances (OPTS).

Most of the actions to be taken by EPA involve the further use of existing regulations such as: FIFRA, the Federal Insecticide, Fungicide, and Rodenticide, Act., which will be used to control pesticides that may leach into the groundwater, TOSCA, (Toxic Substances Control Act), guidelines will be used to regulate new chemicals.

Groundwater in State Law

Groundwaters are generally subject to the same treatment as that given to watercourses and it follows that the Arkansas position, with respect to groundwaters, conforms to the riparian doctrine. Therefore, groundwaters also come within the framework of the reasonable use theory as applied to watercourses. Disputes over water have generally been decided according to a reasonable use test which allows each owner to use the water for his own purposes having due regard for the effect of that use upon other riparian owners and on the public in general.

Arkansas Case Law

A leading case which deals with the questions of groundwater use, Jones vs. Oz-Ark-Val Poultry Company, was a case of conflict between the industrial use of groundwater and domestic wells. The court held that industry interference with the groundwater was unreasonable and an injunction was issued to prevent excessive pumping by the industrial users. The court applied the "reasonable use doctrine" to resolve the conflict. The court recognized that under our law, the domestic use of groundwater prevail. The court further stated that, where two or more tracts of separately-owned land join with a common underground reservoir, each owner has common and correlative right to the use of the water on his land if the common supply is sufficient. However, if the supply is limited and one use interferes with another use, then each person is limited to a reasonable share in order not to hamper the use of the other party.

The Arkansas Supreme Court has not rigidly defined reasonable use. The court has ruled "that we are not necessarily adopting all the interpretations given it by the decisions of other states, and that our own interpretation will be developed in the future as occasions arise."

[Harris vs. Brooks, 225 Ark. 436, 283 S.W. 2d 129 (1955)]. Clearly, the definition of reasonable use is evolving as the court addresses more complex water problems. The court recently reversed a previous ruling requiring riparian owners to use water on riparian lands and demonstrated a willingness to adapt to changing needs. In Lingo vs. the City of Jacksonville, [258 Ark. 63, 522 S.W. 2d 403, 1975] the court ruled that the city of Jacksonville could legally buy land, drill wells, remove the water to a distant point and sell it to its customers. The Arkansas high court has consistently tried to guarantee maximum beneficial use of the State's water resources. The court concludes:

> "In all our consideration of the reasonable use theory, as we have attempted to explain it, we have accepted the view that the benefits accruing to society in general from a maximum utilization of our water resources should not be denied merely because of the difficulties which may arise in its application." [Harris vs. Brooks, 225 Ark. 436, 283 S.W. 2d 129, 1955].

Domestic use is preferred over other uses of ground and surface water. In times of scarcity, surface water use is allowed in the following order: (1) sustaining life, (2) maintaining health and (3) increasing wealth. The correlative rights rule (giving overlying owners a proportionate or prorated share) governs groundwater use during times of scarcity.

The courts decide which uses are reasonable or unreasonable on a case by case basis as conflicts arise. The Arkansas high court has modified the common law on several occasions in order to allow maximum beneficial use of the state's water resources and seems willing to make further changes as needed.

To summarize, Arkansas Water Law is based on a riparian/reasonable use rule for both surface and groundwater (whether percolating or flowing). Riparian owners are allowed to make reasonable beneficial use of the water "with due regard to the rights of others similarly situated."

Agency Regulations and Authority

A. Arkansas Department of Pollution Control and Ecology

1. Act 472 of 1949 as amended; Arkansas Water and Air Pollution Control Act

Under the authority of Act 472 of 1949, the ADPC&E has broad powers of regulation and enforcement over "waters of the state", both "surface and underground". Hence, it follows that all the kinds of monitoring, classifying and regulating that have been done for surface water, can be done for groundwaters (given, of course, the physical limitation imposed by geology).

2. Regulation #1, ADPC&E November 1, 1958.

The regulation was for the prevention of pollution by saltwater and other field wastes produced by wells in new fields or pools.

This attempted to prevent brine from the oil fields from polluting the "waters of the state". It applied only to wells established after July 1, 1957. It provided for underground injection whenever possible and outlawed holding ponds over porous or gravelly soils and was supplemented by Safe Drinking Water Act's Underground Injection Control Program.

3. Regulation #2, ADPC&E as amended, September, 1981. Arkansas Water Quality Standards

The regulation deals mostly with surface water, but refers occasionally to groundwater protection, as in Section 4, Part E (2C), as related to ephemeral and intermittent streams. There is not any legal reason why the classification of groundwater could not be included within this framework in the same comprehensive manner surface water is addressed.

4. Regulation #3 Underground Injection Control Code, March, 1982.

The regulation adopts by reference, most of the federal regulations dealing with the construction and control of injection wells.

5. Act 134 of 1979 as amended by Act 647 of 1979.

The program, in regard to groundwater, consists of a permit system which would allow for the assessment of the effect a mining activity might have on the groundwater resources, either quality or quantity. Again, this is accomplished on a case by case basis, only in the areas of proposed activity. The Department does have authority to prevent a given activity if adverse impacts warrant such action.

B. Arkansas Soil and Water Conservation Commission

1. Act 217 of 1969 authorized the Commission to develop the Arkansas State Water Plan that would serve as the state water policy for the development of water and related land resources in the state. All reports, studies and related planning activities were required to take the State Water Plan into consideration. In 1975, the first State Water Plan was published. In 1980, work on revising the 1975 plan began.

2. Act 1051 of 1985 outlined many variables that needed to be quantified or delineated and included in the State Water Plan, expected to be released by late 1987. Some requirements of the Act were: (a) to define current and projected needs of public water supplies, industry and agriculture, (b) define and quantify the safe yield of all streams, reservoirs and aquifers, (c) quantify requirements of fish and wildlife, navigation, riparian rights and minimum stream flows. In addition, the act authorized interbasin transfer and non riparian use contingent upon guideline development by the Commission and required all groundwater users to report the quantity of groundwater withdrawn on an annual basis. The Commission will now collect and compile groundwater use data in addition to surface water use data authorized by Act 180 of 1969.

3. Act 417 of 1985 provided incentives for construction of surface reservoirs in the form of a state tax credit not to exceed 50% of the total construction cost or a maximum of $33,000 over an eleven year period. Any applicant who converts to surface water from groundwater sources may receive a tax credit equal to 10% of the total conversion cost. Persons seeking eligibility for the tax breaks must apply to the Arkansas Soil and Water Conservation Commission for evaluation and acceptance.

C. Arkansas Geological Commission - Act 16 of 1963, charges the Commission with the collection and dissemination of data regarding water and other natural resources. This Act also states that the Commission will engage in cooperative agreements with the U.S. Geological Survey to perform investigations concerning water resources, which includes quantitative and qualitative analysis of groundwater.

D. Arkansas Oil and Gas Commission - Act 105 of 1939. This program consists of a permitting system for the underground injection of any industrial waste into existing aquifers. The permits are considered on a case-by-case basis in regard to means and level of injection, quality of water injected, use of groundwater in area, etc. An informal agreement exists between this Commission and the Department of Pollution Control and Ecology which indicates the Commission will deal with all impacts from the well head down and the Department of Pollution Control and Ecology will deal with problems related to surface water pollution (in execution of the Department Reg. 1). The Department of Pollution Control and Ecology will, in instances of hazardous waste inspections, work with potential subsurface impacts.

E. Arkansas Health Department - Act 402 of 1977.
The program pertains primarily to the permitting of waste treatment systems for individual dwellings, with the limitation being the quantity of wastewater treated. Permits are considered on a case by case basis, with the exception being that certain requirements are particularly applied to certain areas of the state to protect groundwater sources, specifically. The Department has authority to prevent and/or stop groundwater contamination sources by declaring them "public health nuisances". The Department is also authorized by Act 71 of 1973 to control septic tank pumpers and the disposal of sludge. Septic tank installers are also permitted by the Health Department. The Department not only considers septic tanks but any accepted method of waste treatment. Numerous alternatives are available and considered by the Health Department whenever physical conditions and economic justifications warrant.

F. University of Arkansas - Act 737 of 1977 - calls for research funds to be appropriated for septic tank design at the University's Agricultural Experiment Farms. This work is ongoing and is currently funded as a line item in the University's budget.

G. Water Well Construction Committee - Act 641 of 1969, as amended, gives the Committee the authority to issue water well contractor's licenses, test and register water well drillers, register and issue rig permits. The Committee insures that proper construction and abandonment standards are followed and investigates complaints against contractors. The Committee maintains files of well completion reports submitted by drillers.

H. Related Legislation

Mining Legislation:

The Arkansas Open Cut Land Reclamation Act, Act 336 of 1977, as amended by Act 824
- regulates reclamation of land disturbed by open cut mining; requires a permit for open cut mining.

The Arkansas Surface Coal Mining and Reclamation Act, Act 134 of 1979, as amended by Act 647
- establishes a program for coal mining and reclamation of mining areas.

Solid Waste Legislation:

Arkansas Solid Waste Management Act, Act 237 of 1971
- requires proper and permitted disposal of solid waste management plans; authorizes county courts to provide solid waste management systems.

Solid Waste Facilities and finance Authorization Act, Act 238 of 1971

- authorizes counties and municipalities to use available revenues for establishment of solid waste disposal systems, to impose rates and discharges, to issue bonds, and to prescribe regulations for refuse disposal.

Arkansas Hazardous Waste Act, Act 406 of 1979

- establishes a program of regulation over the generation, storage, transportation, treatment and disposal of hazardous wastes.

Joint County and Municipal Solid Waste Disposal Act, Act 699.

- authorizes counties and municipalities to participate in the joint construction, operation, and maintenance of facilities for disposal of solid waste.
- authorizes the creation of sanitation authorities to issue bonds for financing costs of solid waste management systems.

GROUNDWATER PROBLEMS

The major groundwater problems in the Lower Ouachita River Basin are as follows: (1) Quaternary Aquifer - Declining water levels and quality degradation; (2) Cockfield Formation-Declining water levels and quality degradation (3) Sparta Sand Aquifer - Declining water levels and quality degradation (4) Low yields from Paleozoic Rocks.

Potential hazards to groundwater include: 7000 tons of hazardous waste generated and stored in the basin, 2800 impoundments (most without liners), landfills and abandoned oil and gas wells. <20>

SELECTED GEOLOGIC UNITS

Quaternary Aquifer

Major problems in the Quaternary Aquifer include:

(a)Averge annual groundwater level declines of .32 feet (1975-1985) in the basin

(b)Areas with less than 50% saturated thickness remaining in Ashley and Drew Counties

(c)Areas exceeding 500 mg/L dissolved solids in Ashley, Drew, Calhoun, Lincoln and Jefferson Counties

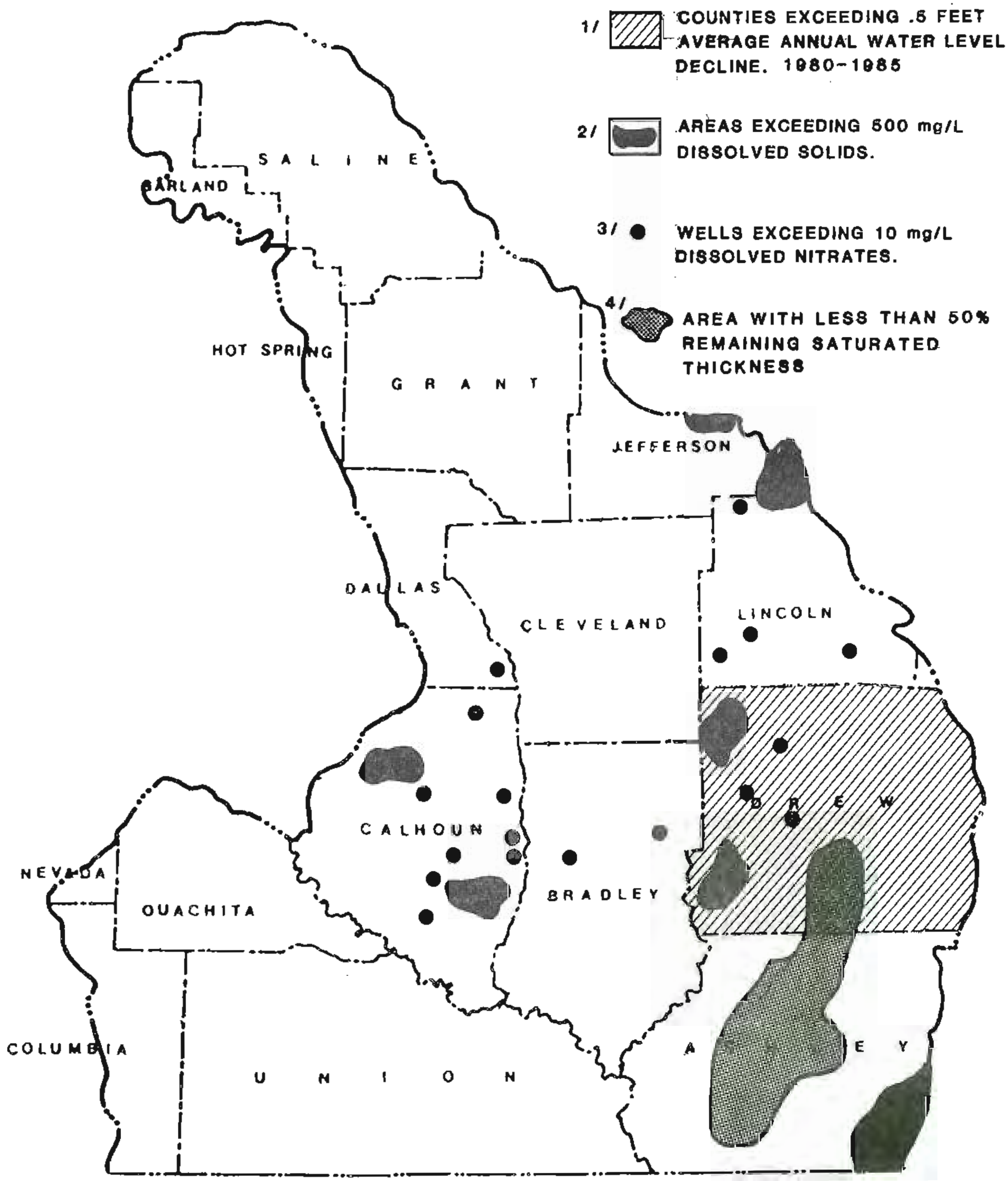
(d)Many areas with excessive nitrate concentrations. (See Figure 4-35)

Declining Water Levels

Large groundwater withdrawals are resulting in lowered water levels in the Quaternary Aquifer. Figure 4-36 illustrates the spring water levels in selected wells in the Quaternary System for Jefferson, Lincoln, Drew and Ashley County. The well selected for Ashley County is in the Crossett well field and shows an overall decline of approximately 19 feet from 1946 to 1983 with a slight rebound from 1983 to 1985. The well selected in Drew County is located in the southeastern part of the county in an agricultural area. The water level in the well has only declined approximately two feet from 1954 to 1985. Jefferson County also shows a small change (1.2 feet during the period of record) similar to the Drew County well with an overall gain. This well is located in an agricultural area south of the Arkansas River and east of Pine Bluff. The well selected for Lincoln County is located east of Yorktown in an agricultural area. From 1962 to 1985, the water level in the well has dropped over 19 feet. In summary, water levels in Quaternary wells in Ashley and Lincoln Counties have declined substantially over the long term, while levels in Jefferson and Drew Counties are highly variable but have remained at approximately the same level. The correlation coefficients of +.79 (Jefferson) and +.64 (Drew) for precipitation and water level change suggest that recharge is primarily from precipitation in

figure 4-35

QUATERNARY DEPOSITS GROUNDWATER PROBLEMS



1/ USGS - Groundwater Levels in Arkansas, 1980-1985, Ref #29, 36

2/ USGS - Modified from E.H. Boswell, E.M. Cushing and R.L. Hosman, 1968, Ref #16

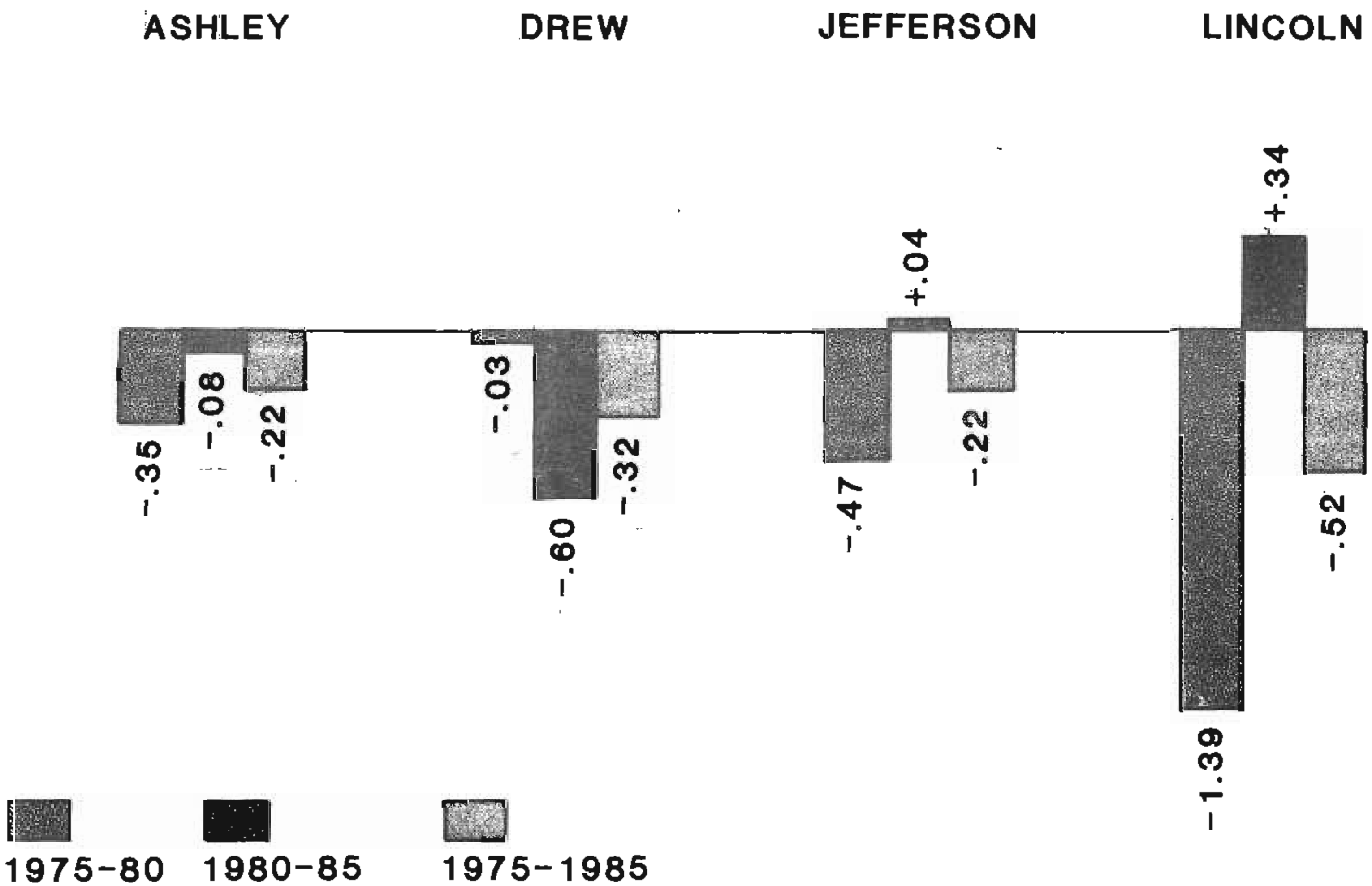
3/ USGS - Modified from C.T. Bryant, A.H. Ludwig and E.E. Morris, 1985, Ref # 20

4/a Water Well Construction Committee File Data, 1970-1985, Ref #107
4/b USGS Water Level Measurement File Data, 1985 106

figure 4-37

QUATERNARY DEPOSITS
AVERAGE ANNUAL GROUNDWATER LEVEL CHANGE
(WITHIN LOWER OUACHITA BASIN)

1975-1985



UNITS ARE IN FEET

SOURCE:USGS - Ref #29, 36, 103

TABLE 4-15
WATER LEVEL CHANGES IN THE QUATERNARY DEPOSITS
(FEET - WITHIN THE BASIN)

	# OF WELLS	1975-1980 NET	1975-1980 ANNUAL	1980-1985 NET	1980-1985 ANNUAL	1975-1985 NET	1975-1985 ANNUAL
ASHLEY	(6)	-1.73	-.35	-.41	-.08	-2.15	-.22
DREW	(5)	-.14	-.03	-3.02	-.60	-3.16	-.32
JEFFERSON	(2)	-2.37	-.47	+.22	+.04	-2.15	-.22
LINCOLN	(4)	-6.96	-1.39	+1.72	+.34	-5.24	-.52
MEAN CHANGE			-.56		-.08		-.32

SOURCE: USGS - GROUNDWATER LEVELS IN ARKANSAS 1975-1985.
REF. # 29, 36, 103.

persons (1980 data) are dependent on the aquifer, total dissolved solids are averaging 522.9 mg/L (before treatment) in Crossett and Hamburg wells and storage capacity at Hamburg is less than one day's demand on the system. Based on this information, the area will be more critical in thirty years than it is now.

Recharge from precipitation, lateral flow, and vertical flow upward from the Cockfield formation is not sufficient to maintain equilibrium with the quantity withdrawn from the Quaternary at this time. If withdrawals continue at the present rate of increase, declining water levels in the Quaternary will continue until quality degradation renders the water unusable or very costly to treat, or the saturated thickness of the Quaternary Aquifer will be inadequate to meet the demand.

None of these possibilities are desirable but are probable based on available data assuming no changes in water resource planning management activities in the basin and trends of use.

Cockfield Formation

Problems within the Cockfield use area include severe water level declines in Cleveland, Lincoln and Union Counties, high specific conductance in Drew, Ashley and Union Counties and excessive iron in Grant, Jefferson and Bradley Counties. (See Figure 4-39). <27, 28, 29, 30, 31, 76>

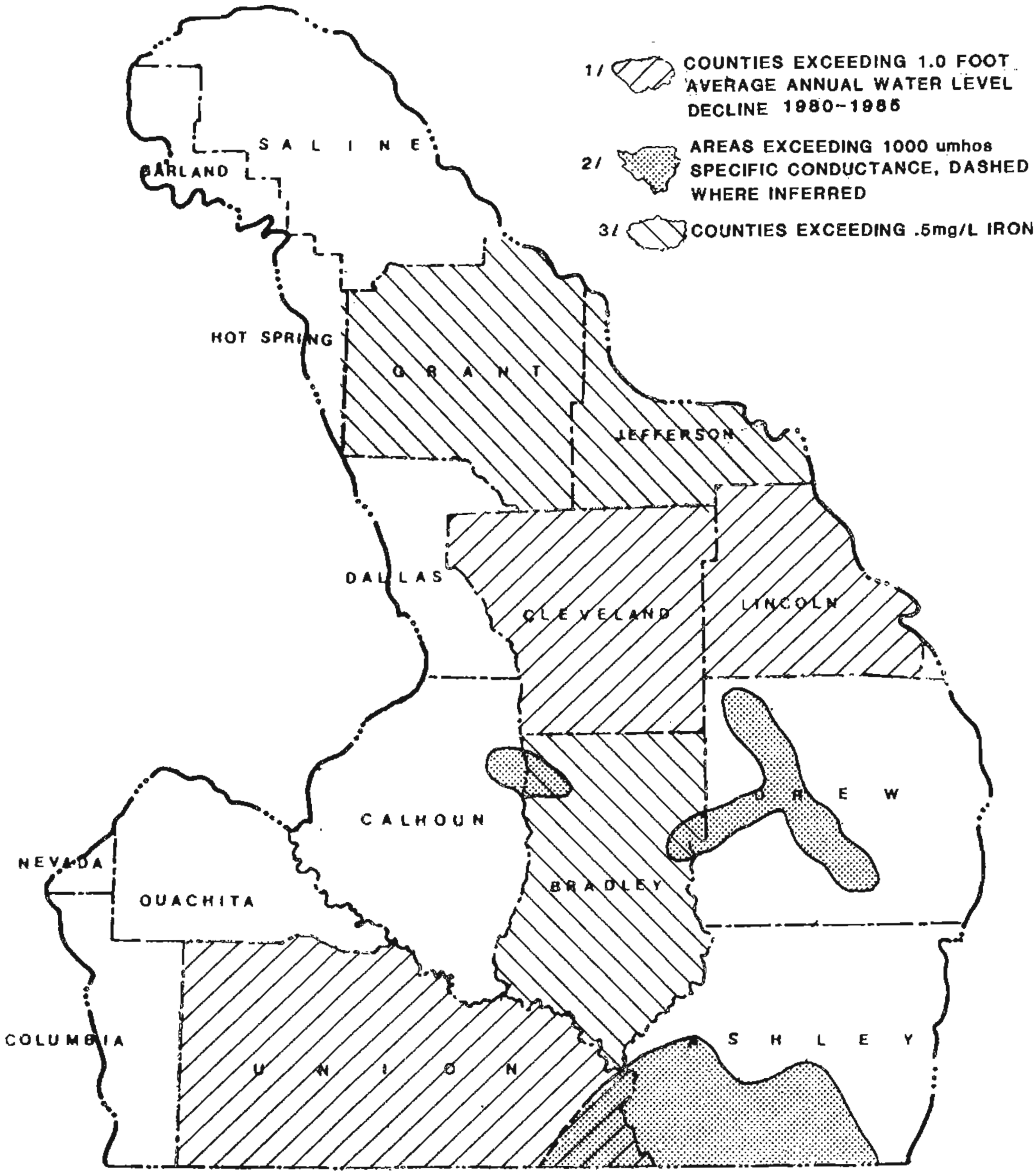
Declining Water Levels.

Water levels in the Cockfield have declined approximately .7 feet per year across the basin between 1975 and 1985. (See Figure 4-40 and Table 4-16). In a five year period from 1975 to 1980, water levels in Ashley, Bradley, Drew and Lincoln declined at the average rate of approximately 1.5 feet per year. Levels in Cleveland and Union Counties rebounded during the same period. In the five year period from 1980 to 1985, levels in Cleveland, Lincoln and Union Counties declined at a rate exceeding 1.0 foot per year. Over all, declines average .63 feet per year for 1980-1985 and .74 feet per year from 1975 to 1980. While levels continue to decline, the rate of decline has lessened in the last five year period of analysis. <29, 36, 103>.

The order of largest withdrawing Counties (Ashley, Union, Cleveland, Drew) does not match perfectly with the counties having the largest declines (Union, Cleveland, Lincoln, and Drew) but a positive correlation exists. While withdrawals in Lincoln and Drew Counties were modest compared to Ashley and Union, the rate of recharge in Lincoln and Drew is extremely slow due to the overlying clays of the Jackson Group. Ashley and Union Counties had the largest withdrawals and small declines in the water table because the Cockfield is on the surface and exposed to precipitation or is covered by Quaternary Deposits such as in Northeast Ashley County. Recharge rates are high where the Cockfield is exposed on the surface and where percolation from overlying Quaternary Deposits allows infiltration to occur. <27, 28, 29, 30, 31>

figure 4-39

COCKFIELD FORMATION GROUNDWATER PROBLEMS



SOURCES:

1/ USGS - Groundwater Levels in Arkansas, 1978-1983. Ref #32, 40

2/ USGS - Modified from J.E. Terry, C.T.Bryant, A.H.Ludwig and J.E.Reed. 1979 ,Ref #76

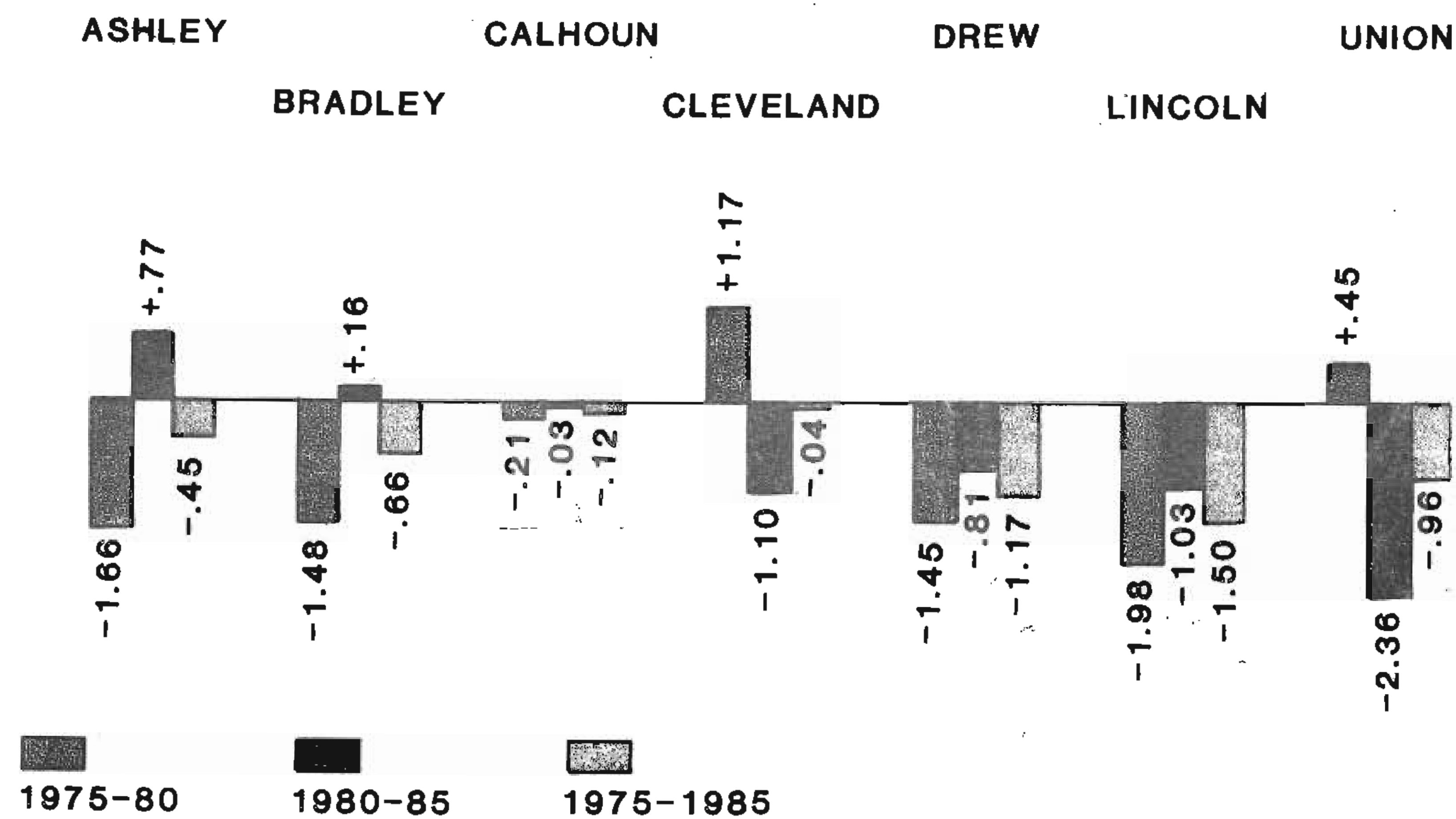
3/ USGS - Various Sources Ref #1, 15, 44, 53, 61, 65.

figure 4-40

COCKFIELD FORMATION
AVERAGE ANNUAL GROUNDWATER LEVEL CHANGE

(WITHIN THE LOWER OUACHITA BASIN)

1975-1985



UNITS ARE IN FEET

Ref #29, 36, 103

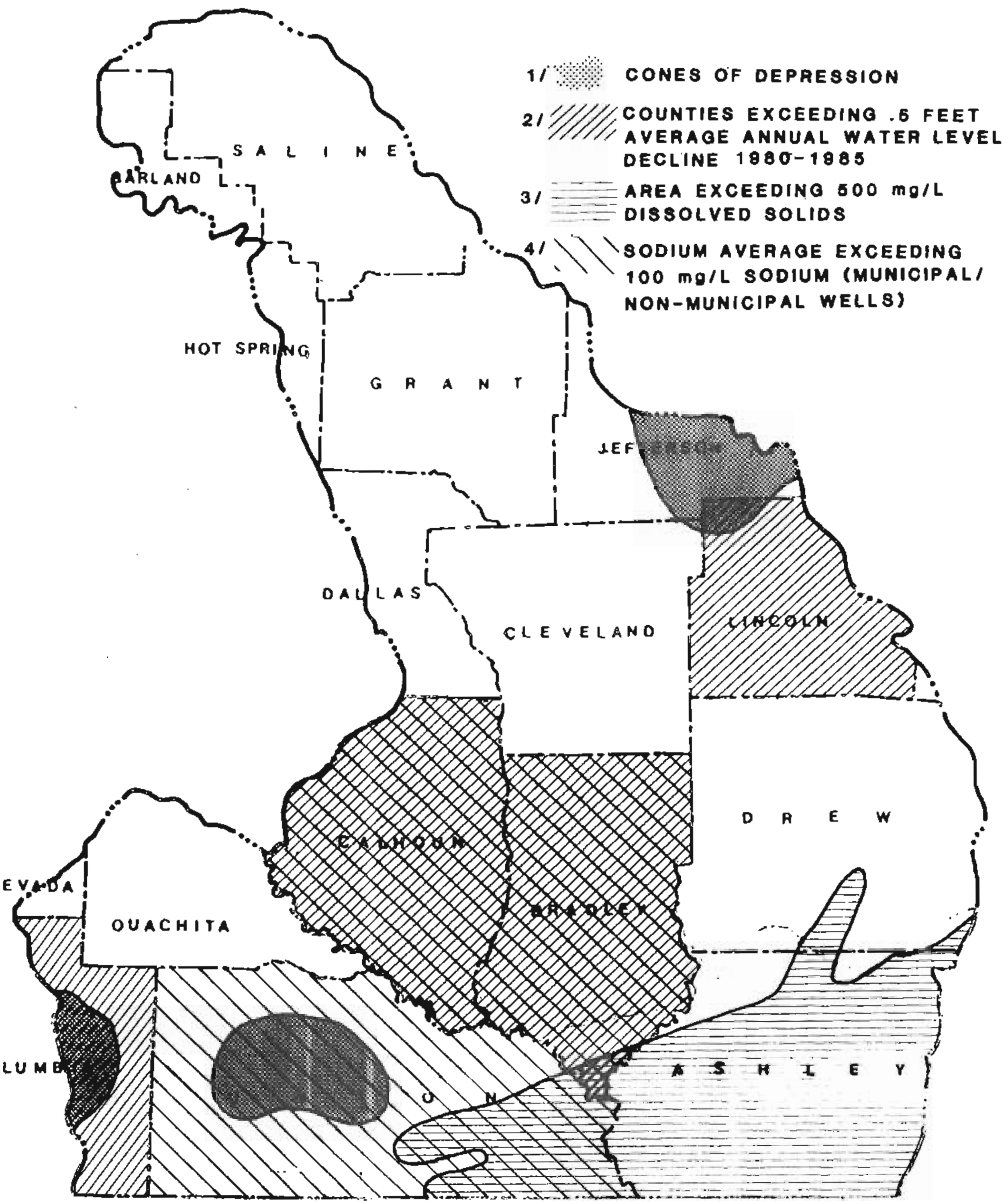
TABLE 4-16
WATER LEVEL CHANGES IN THE COCKFIELD FORMATION
(FEET - WITHIN THE BASIN)

	# OF WELLS	1975-1980 NET	1975-1980 ANNUAL	1980-1985 NET	1980-1985 ANNUAL	1975-1985 NET	1975-1985 ANNUAL
ASHLEY	(3)	-8.29	-1.66	+3.84	+.77	-4.45	-.44
BRADLEY	(5)	-7.41	-1.48	+.79	+.16	-6.62	-.66
CALHOUN	(1)	-1.06	-.21	-.17	-.03	-1.23	-.12
CLEVELAND	(1)	+5.86	+1.17	-5.49	-1.10	+.37	-.04
DREW	(3)	-7.24	-1.45	-4.05	-.81	-11.74	-1.17
LINCOLN	(1)	-9.90	-1.98	-5.14	-1.03	-15.04	-1.50
UNION	(1)	+2.23	+.45	-11.80	-2.36	-9.57	-.96
MEAN CHANGE			-.74		-.63		-.70

SOURCE: USGS - GROUNDWATER LEVELS IN ARKANSAS 1975-1985.
REF. #29, 36, 103

figure 4-41

SPARTA SAND
GROUNDWATER PROBLEMS



Source:

1/ U.S.G.S. - Modified from Edds, J. and Fitzpatrick, J. 1984, Ref #30

2/ U.S.G.S. - Groundwater Levels in Arkansas, 1976-1985. Ref #29, 39, 108

3/ Modified from J.C. Peterson and M.E. Broom(USGS) W.V. Bush (Ark Geol Comm) 1985 Ref #18

4/ (A) Arkansas Department of Health, 1982 Ref #3
(B) U.S.G.S. - Various Sources - Ref # 1, 15, 44, 74, 79

Quality Degradation

Specific conductance and iron concentrations are severe enough in some areas to require extensive treatment before use. Three areas located in Drew, Ashley, Calhoun, Bradley and Union Counties exceed 1000 umhos (specific conductance). Water from the Cockfield in these areas is mineralized enough to limit use for domestic wells and require extensive treatment for public supplies. Iron concentrations exceeded the .3 mg/L drinking water standard in Grant, Jefferson and Bradley Counties. Treatment for iron removal would be necessary in many areas within these counties. <76>

Critical Use Area

No areas were designated as critical groundwater use areas in the Cockfield Aquifer use area due to insufficient data. The Cockfield is under water table conditions in portions of Union, Cleveland, Dallas, and Grant Counties. No mapping activities are underway to determine the elevation of the base and top of the aquifer, thus, saturated thickness information can not be derived. Without this information, the potentiometric surface cannot be related to the top of the aquifer in areas where the aquifer is artesian. Water levels in Lincoln, Union and Cleveland Counties exceeded the C.U.A. criteria of one foot decline (1980-85) and are of significant concern, but these data were based on one well in each county and are insufficient to delineate critical use areas. A minimum of five wells per county in one aquifer with good spatial distribution would be necessary to have confidence in delineating C.U.A.s based solely on this criteria.

Sparta Sand

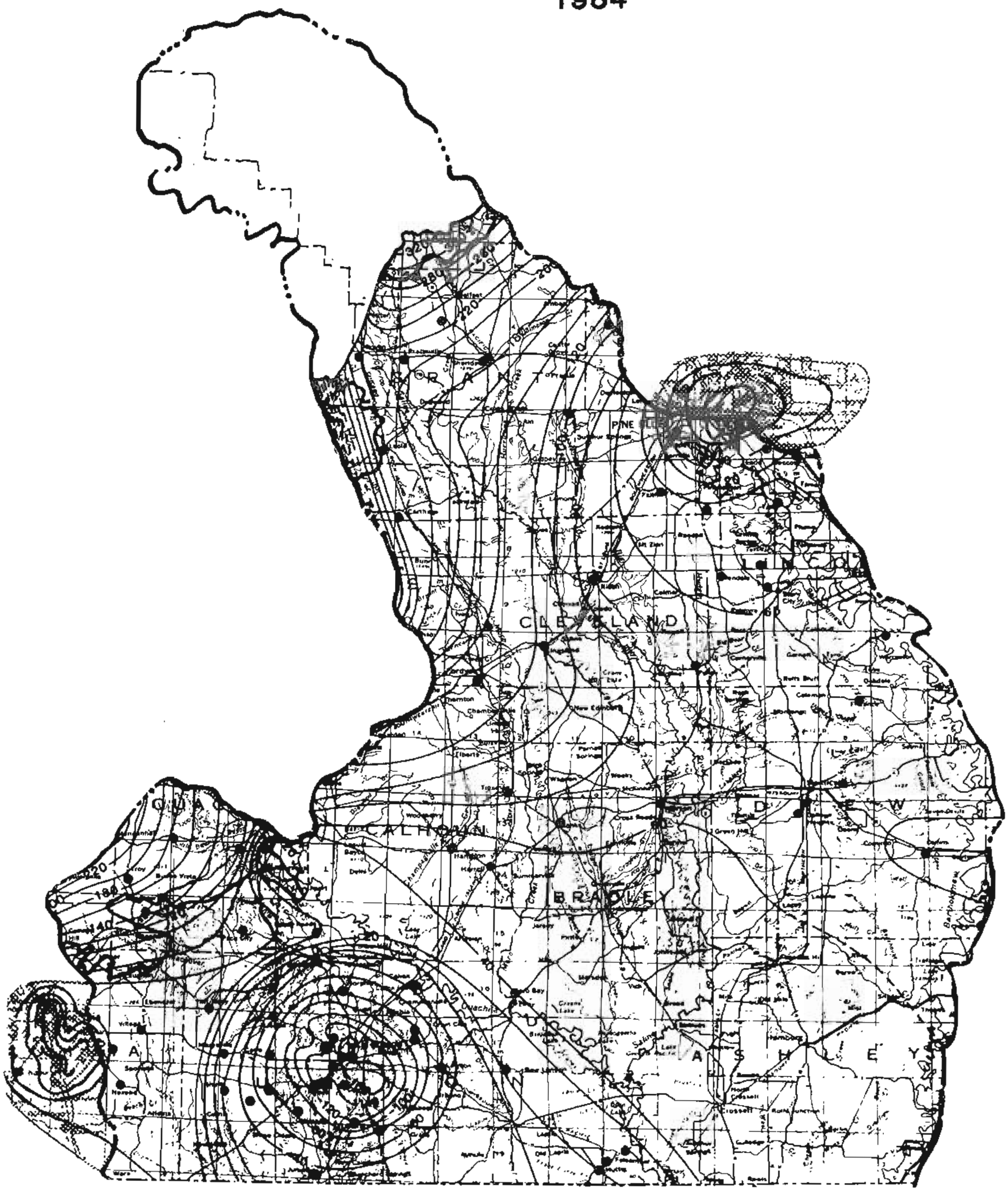
Water levels in the Sparta Sand around El Dorado have exceeded three feet of average annual decline since about 1920 when development began in the area. Pre-development levels were 320 feet higher than todays levels at El Dorado and 240 feet higher at Magnolia. In addition to declining water levels, several areas in the Sparta Sand use area contain excessive iron, sodium, chlorides and exceed 500 mg/L total dissolved solids. (See Figure 4-41). <20>

Declining Water Levels.

In the last decade, water levels in the Sparta Sand have been declining in excess of a foot a year. Three areas of large withdrawals are readily apparent in Figure 4-42 which are cones of depression represented by tightly spaced, closed contour lines. The cones are a result of the withdrawal rate exceeding the recharge rate which increases the gradient of the potentiometric surface by lowering the water level adjacent to the well. Increased gradients also increase the rate of recharge to the aquifers and subsequent rate of movement toward wells. However,

figure 4-42

SPARTA SAND POTENTIOMETRIC SURFACE 1984



Basin Boundary.

Outside Basin.

——250——

POTENTIOMETRIC CONTOUR.

Shows altitude at which water level would rise in tightly cased wells. Contour interval is 20 Feet.

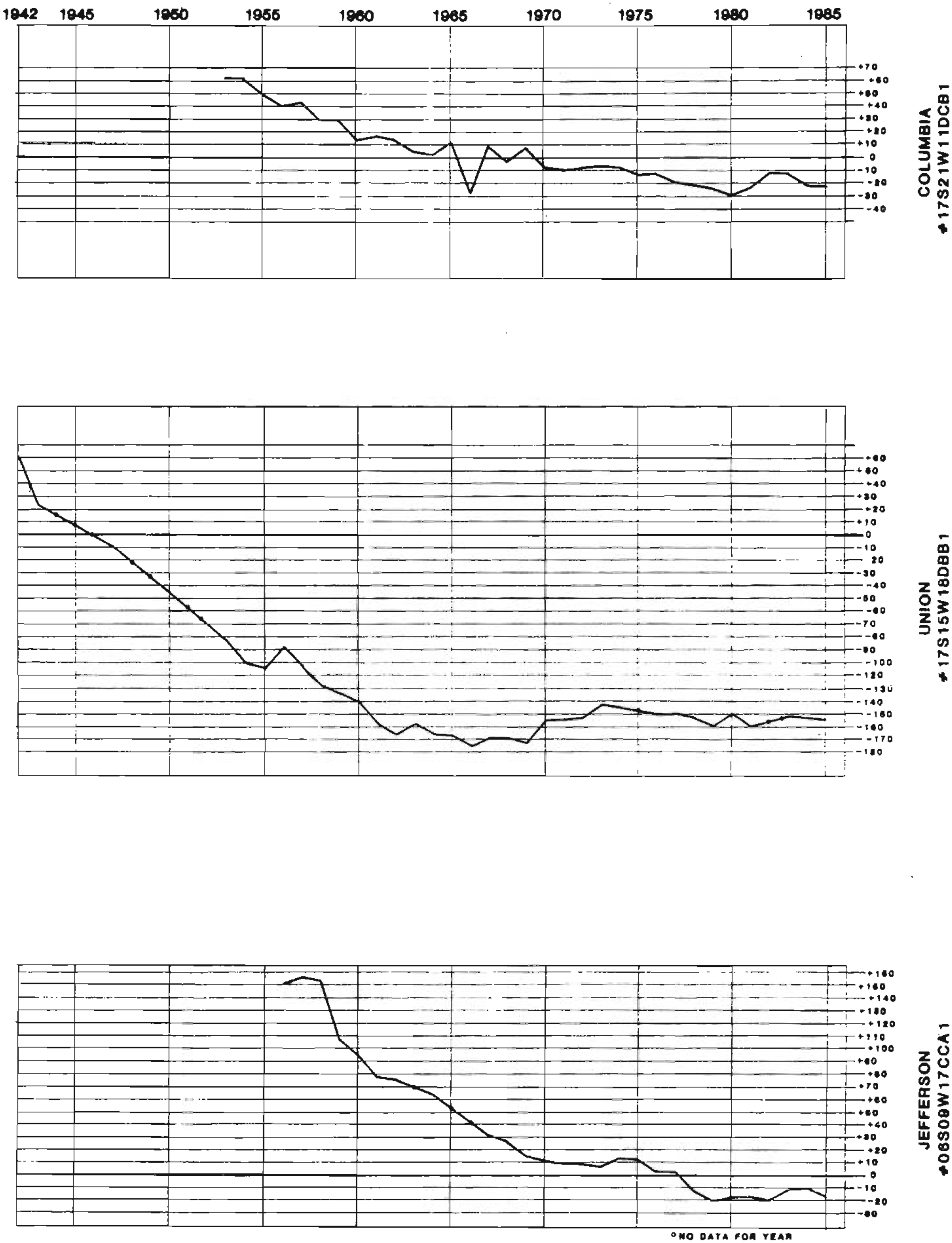
SOURCE: U.S.G.S. Modified from Edds J. and Fitzpatrick J., 1984. REF #34 when the transmissivity of the aquifer material is inadequate, flows toward the cone cannot maintain equilibrium with withdrawals. The result is lowered water levels, increased pumping lifts, higher pumping costs and the potential for quality degradation. The cones of depression are centered around the concentrated pumping areas of Pine Bluff, El Dorado and Magnolia. The cones are coalescing and appear to be affecting water levels over the entire basin. Contour lines on the potentiometric map are influenced or curved in response to the three cones. Subliminally, the figure shows direction of flow, which is perpendicular to the contour lines, down gradient, and toward the centers of each depression. When a deficit between withdrawals and recharge exist over a period of time, the safe yield of the aquifer is being exceeded and a decline in water levels and yields is the result. <63, 76>

Figure 4-43 represents three hydrographs for selected wells in Jefferson, Columbia and Union Counties in the Sparta Sand Aquifer. These wells were selected because of their long term record and location near Pine Bluff, Magnolia and El Dorado. The potentiometric surface of the Magnolia well has declined approximately 85 feet since 1954. Considerable variability in the level has occurred in the last five years. The El Dorado well has declined approximately 205 feet since 1942. Between 1960 and 1985 the levels have varied but have remained within a 30 foot range of decline and rebound. The well at Pine Bluff has declined approximately 170 feet since 1956. The potentiometric surface has shown a steady decline since 1956 except for two brief periods of rebound in 1974-75 and 1983-84. All three wells illustrate the exceedance of the safe yield of the Sparta Sand. Withdrawals have exceeded recharge for several decades.

Average annual change in the potentiometric surface of the Sparta Sand is illustrated in Figure 4-44 and listed in the table 4-17. Information was compiled from water level publications of the U.S. Geological Survey based on a network of many wells in each county. The overall rate of water level change for the ten year period from 1975 to 1985 for all counties using the Sparta in the basin was 1.1 foot of decline per year. The rate was almost two feet per year between 1975 and 1980, and .52 feet of decline per year for the period, 1980-1985. Overall, levels are declining but not at the rate they once were. In other words, levels are still going down but not as fast as they once were. Between 1975 and 1980, Jefferson, Cleveland, Lincoln and Columbia had the greatest change with declining rates of 3.65, 3.63, 2.17 and 2.06 feet per year, respectively. All ten counties showed a decline in the elevation of the potentiometric surface for the period. Between 1980 and 1985, the rate of decline had lessened in most counties and some had rebounded. The greatest rate of decline (1980-85) was in Lincoln County at 1.22 feet of decline per year followed by

figure 4-43

SPARTA SAND
HYDROGRAPHS FOR SELECTED WELLS

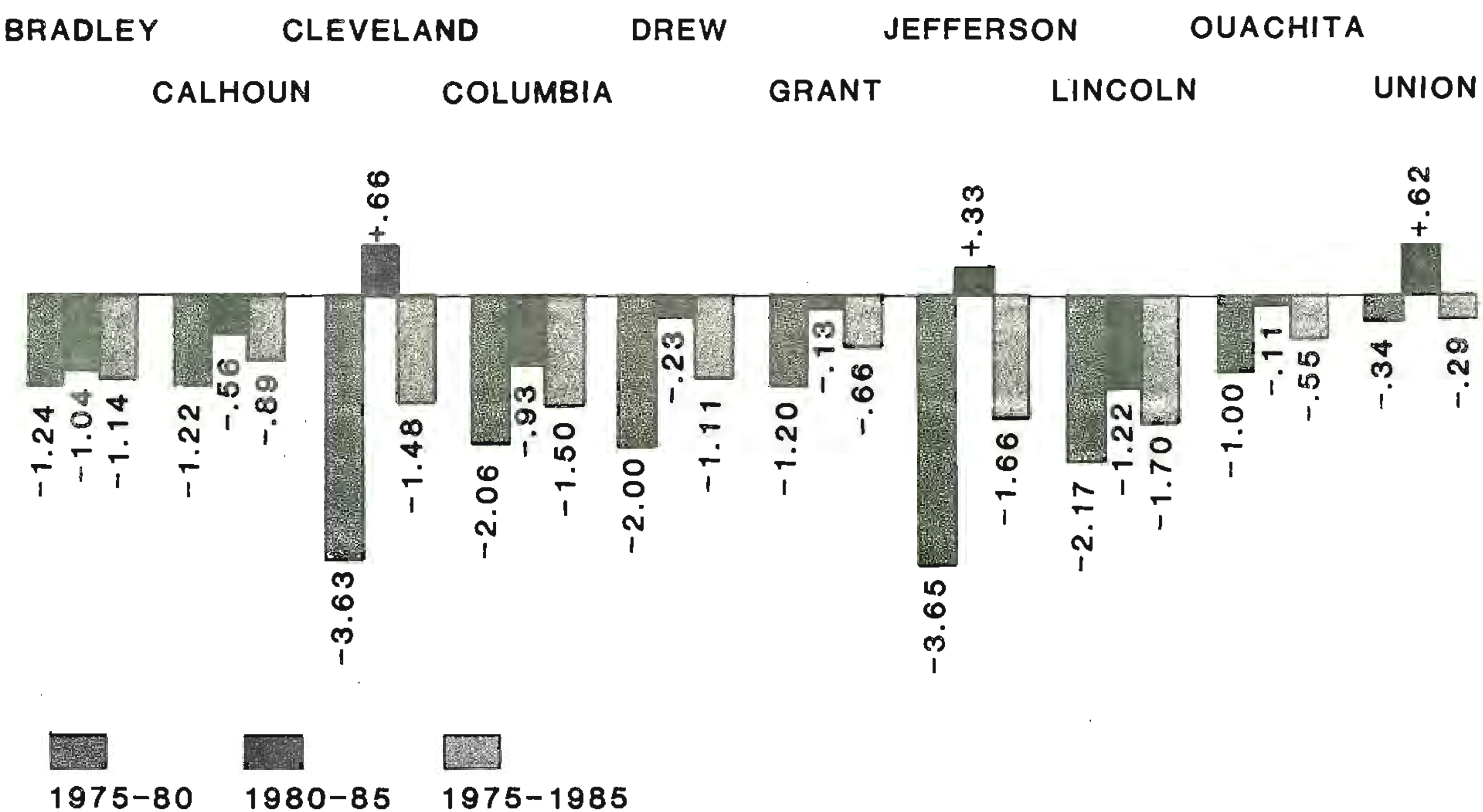


SOURCE: U.S. GEOLOGICAL SURVEY, File Data

figure 4-44

SPARTA SAND
AVERAGE ANNUAL GROUNDWATER LEVEL CHANGE
(WITHIN THE LOWER OUACHITA BASIN)

1975 - 1985



UNITS ARE IN FEET

SOURCE: Ref #29, 36, 103

TABLE 4-17
WATER LEVEL CHANGES IN THE SPARTA SAND
(FEET - WITHIN THE BASIN)

	# OF WELLS	1975-1980 NET	1975-1980 ANNUAL	1980-1985 NET	1980-1985 ANNUAL	1975-1985 NET	1975-1985 ANNUAL
BRADLEY	(3)	-6.2	-1.24	-5.2	-1.04	-11.4	-1.14
CALHOUN	(2)	-6.1	-1.22	-2.82	-.56	-8.91	-.89
CLEVELAND	(1)	-18.13	-3.63	+3.29	+.66	-14.84	-1.48
COLUMBIA	(3)	-10.31	-2.06	-4.64	-.93	-14.95	-1.50
DREW	(3)	-9.98	-2.0	-1.14	-.23	-11.12	-1.11
GRANT	(8)	-6.01	-1.20	-.65	-.13	-6.66	-.66
JEFFERSON	(5)	-18.26	-3.65	+1.63	+.33	-16.63	-1.66
LINCOLN	(3)	-10.87	-2.17	-6.09	-1.22	-16.96	-1.70
OUACHITA	(4)	-4.99	-1.0	-.55	-.11	-5.54	-.55
UNION	(8)	-1.68	-.34	+3.08	+.62	-2.88	-.29
MEAN CHANGE			-1.85		-.52		-1.10

SOURCE: USGS - GROUNDWATER LEVELS IN AR 1975-1985.
REF. # 29, 36, 103

Bradley (1.04) and Columbia (.93). Levels declined in Calhoun, Drew, Grant, and Ouachita but at lesser rates. Levels rebounded in Cleveland County at the rate of .66 feet per year followed by Union (.62) and Jefferson Counties (.33). <29, 36, 103>

Illustrated on Figure 4-45 are areas of equal average annual groundwater level change in the Sparta Sand for a five year period (March, 1980 to March, 1985). Three small areas near heavy pumping centers experienced a rebound of water levels, which include El Dorado, Magnolia and Pine Bluff. This is probably in response to reduced withdrawals. Another small area near the Union-Columbia County line had rebounding levels exceeding two feet per year. <35>

Over most of the basin, however, groundwater levels declined for the five year period. Except for Dallas and central Ouachita Counties and isolated areas of rebound, levels declined at variable rates. The greatest declines which exceeded two feet per year occurred in western Union, east central Calhoun, southern Ouachita and various locations in Jefferson County. Areas exceeding one foot average annual decline per year include most of Calhoun and Lincoln Counties, western Union, eastern Columbia, central Grant and Jefferson County. <35>

The importance of the relationship between the potentiometric surface and the structural top of artesian aquifers has been stated in earlier sections of this basin report. Subsidence and aquifer compaction may occur when the potentiometric surface declines below the top of the formation being mined. Figure 4-46 illustrates this relationship in the Sparta Sand in the Lower Ouachita Basin. The method used to compile data for the map consisted of overlaying a 1985 potentiometric surface map with a structural map showing the elevation of the top of the Sparta Sand Formation. Control points were plotted where isolines on the two maps intersected. At these locations, a value could be calculated for depth down to the top of the Sparta or depth below the top. A new isoline map was then drawn from the resulting data points.

The new map allows for a much better evaluation of the severity of the cones of depression at Magnolia, El Dorado and Pine Bluff. For example, the cone at Pine Bluff is approximately 500 feet above the top of the formation. The cone at Magnolia is approximately 200 feet below the top of the Sparta Formation and the El Dorado cone is 160 feet below the top. An area from the outcrop zone in Columbia County to Central Union county has a potentiometric surface below the top of the Sparta Sand Formation.

In the El Dorado area, the lower 2/3's of the Sparta Sand formation (El Dorado Aquifer) appears to be hydrologically distinct from the upper third (Greensand Aquifer), due to an intervening clay lense. The lateral extent of the clay is unknown. In some areas, two different potentiometric surfaces exist but the affected area has not been delineated, except in Union county. The potentiometric surface is approximately 140 feet above the lower

Sparta Aquifer in El Dorado at this time. In summary, the potentiometric surface of the Sparta Sand is below the top of the formation but has not declined below the top of the aquifer being used as an drinking water source.

Quality Degradation.

The most significant water-quality problems in the Sparta Sand Aquifer are excessive iron concentrations and salt water intrusion. Iron concentrations were high, averaging 0.46 mg/L in water from non-municipal wells in the basin. Groundwater in Grant County contained the highest concentrations of iron with a mean concentration of 2.2 mg/L. No iron was detected in samples from wells in Calhoun county. The mean iron concentration for public supply wells was .80 mg/L, which exceeded the 0.30 mg/L limit for drinking water. <3>

The sodium ion is a major constituent of natural waters. Results of a national survey of 2100 water supplies revealed that 42% of the systems exceeded the 20 mg/L recommended standard but only 5% exceeded 250 mg/L. The mean concentration of sodium in water from public supply wells in the basin was 67 mg/L, and ranged from 8.8 mg/L in Grant County to 111.3 mg/L in Bradley County. The mean sodium concentrations for Union County (24 samples-Public Supply Wells) was 110.3 mg/L. All of the 24 samples exceeded 50 mg/L, sixteen (66%) exceeded 100 mg/L, 10 (41%) exceeded 120 mg/L and 2 (8%) exceeded 150 mg/L.

Health studies have documented the detrimental effects of high sodium in the diets of persons that have been diagnosed with heart disease, however, insufficient evidence is available to conclude whether or not sodium in drinking water causes an elevation of blood pressure in the general population. EPA has been reluctant to propose a maximum contaminant level for sodium due to insufficient data but supports the American Health Association's recommendation of a guidance level of 20 mg/L in drinking water, since water below this level would not present a sodium related hazard to those segments of the population thought to be at high risk (eg. genetic predisposition to hypertension, pregnant women, hypertensive patients). <101>

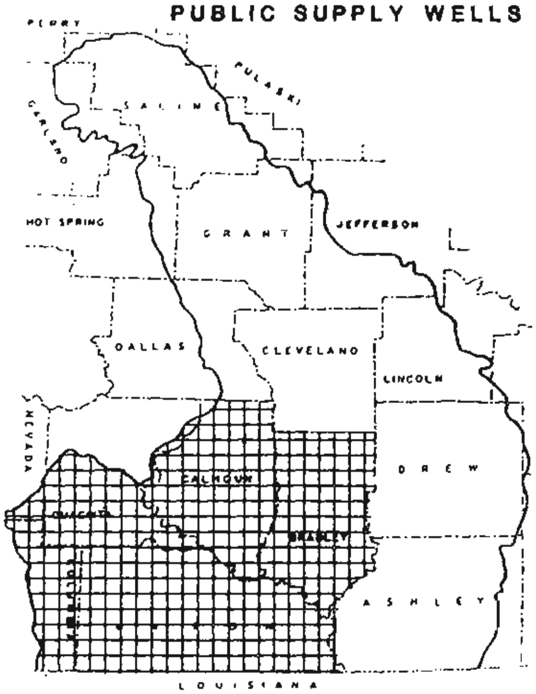
The Arkansas Department of Health issues a salt warning to public supply systems when sodium levels reach 100 mg/L. In 1982, the State Health Department issued sodium alerts to thirteen public supply systems in Union, Bradley and Calhoun Counties.
(See Figure 4-47). <3>

Mean chloride concentrations in the basin were less than the 250 mg/L drinking water standard. County averages, however, do not reflect local problems at individual wells. A reconnaissance study of saltwater contamination in Union County by the USGS revealed an unusual gradient of chloride concentrations in the El Dorado area. The following paragraph was modified from that report. <19>

figure 4- 47

SPARTA SAND
SODIUM ALERT

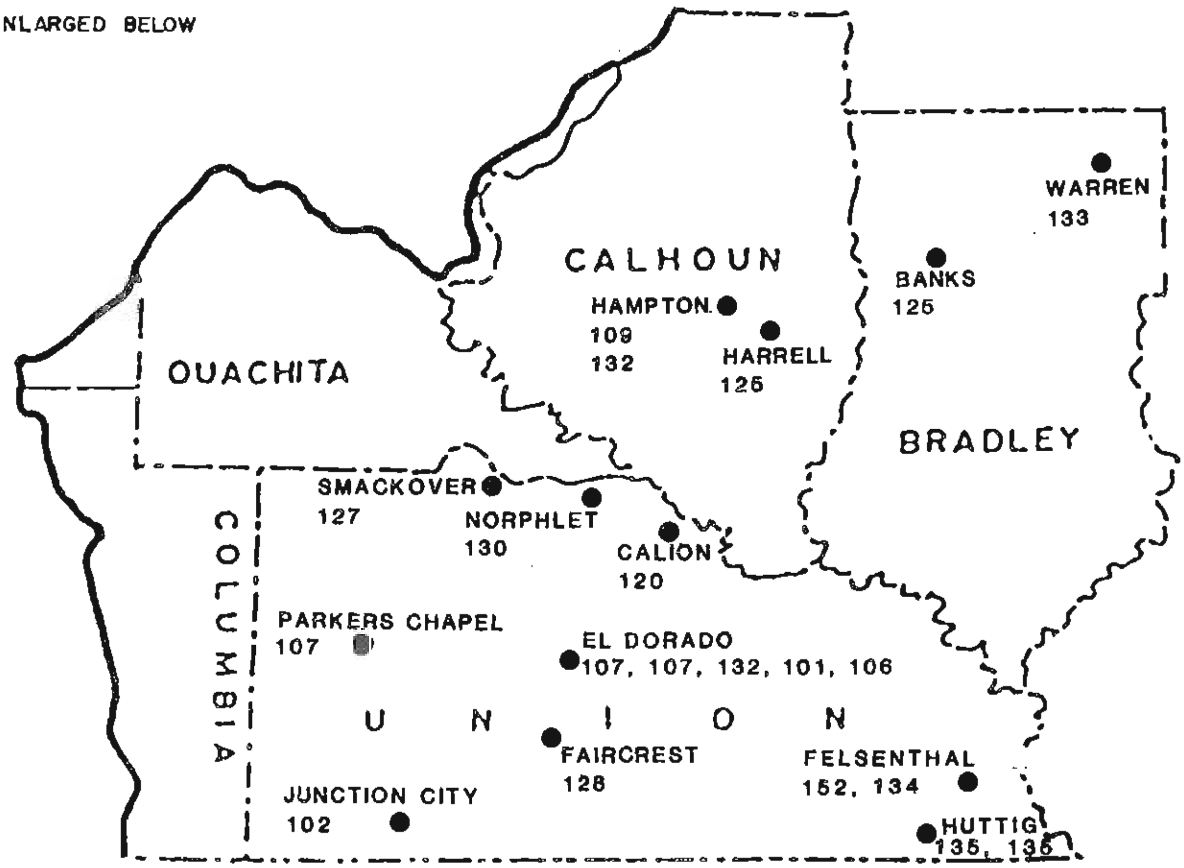
PUBLIC SUPPLY WELLS EXCEEDING 100 mg/L - 1982



● PUBLIC SUPPLY SYSTEMS

XXX - Sodium (mg/L) one well. Multiple values indicate multiple wells.

ENLARGED BELOW



SOURCE: Arkansas Department of Health, 1982 Ref #3

Landfills

Many open landfills and dumps exist in the basin. Figure 4-50 shows the location of 57 sites. The contents of many of these fills are basically unknown. Some have remained as open dumps while others are called sanitary landfills. Hazardous materials may be stored in these areas that could eventually percolate into the surface aquifer. <20>

Hazardous Waste

Hazardous materials generated or stored in the basin exceeded 7000 tons in 1982. Most of these materials were stored near El Dorado. Eighty-three percent of the waste generated in the state is in the form of brine, a by product of oil and bromine production. <20> Although not listed as a hazardous waste, brine is potentially a major source of groundwater pollution.

A recent study by the Central Interstate Low-Level Radioactive Waste Compact Commission listed 17 counties in southern Arkansas as possible locations for a multistate waste disposal site. The counties listed are: Lincoln, Drew, Grant, Bradley, Cleveland, Dallas, Calhoun, Clark, Columbia, Hempstead, Howard, Little River, Nevada, Ouachita, Pike, Sevier and Union. Under federal law, states are responsible for disposal of their own wastes. Arkansas has joined Louisiana, Oklahoma, Nebraska and Kansas under a compact to rotate the location of the site from state to state every thirty years.

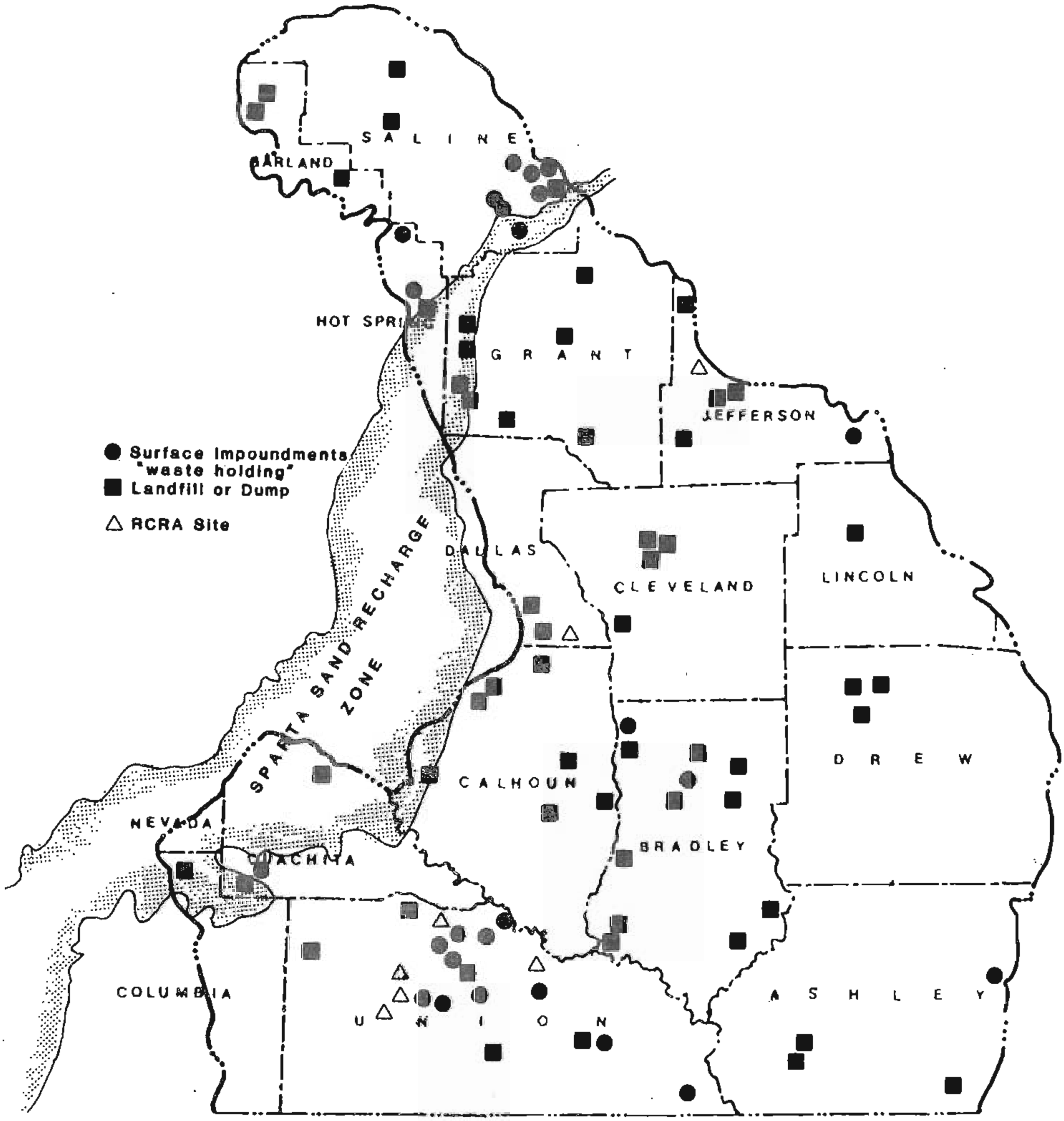
Surface Impoundments (waste holding)

"Millions of barrels of brine have been pumped from the Nacatoch Sand during more than 60 years of oil development in the area of contamination. Most of this brine was discharged to the south-southeastward draining streams. Appreciable amounts of brine were injected through wells back into the Nacatoch Sand for disposal and formation repressurization. Generally the brine has been held in surface ponds before going to streams or to injection wells. Brine in surface ponds leaking to the water table would contaminate the Cockfield Formation." <19>

"The hydrologic regimen of the Cockfield has not been measurably stressed by water development. Today as in the past, any brine contaminant in the Cockfield from surface ponds would move in the direction of land slope. Land slope generally is south-southeast from the area of contamination in the El Dorado aquifer. Because of a large lateral component of water movement, enhanced by the high water table and locally by clay lenses in the formation, much of the contaminant would be discharged to streams rather than penetrating deeply into the Cockfield. However, the contaminant could be captured in water wells of the Cockfield in the path of the contaminant." <19>

figure 4-60

POTENTIAL GROUND WATER PROBLEMS



SOURCE: USGS - Modified from Bryant and Others, 1985 Ref #20

While brine can be observed leaking from these pits and percolating into the soil, the few water quality data for the Cockfield Formation in the El Dorado area show little evidence of brine contamination. A well near El Dorado was noted by refinery personnel in 1982 as being contaminated with brine from oil and gas activities and several industrial monitoring wells in the Cockfield Formation located around disposal sites in the vicinity of Smackover indicated contamination of part of the aquifer. Contaminants exceeding recommended drinking water levels included chloride, iron, manganese and sulfate. Mount Holly and Highway 82 Water Association have also been polluted by shallow contamination. In addition, this poses a significant threat to household wells that tap the Cockfield for domestic supplies. Fortunately, most rural areas are now served by water associations that have their water tested by the Arkansas Department of Health. There have been no documented cases of brine contamination of the deeper Sparta Sand from these activities to date. The Cook Mountain Formation appears to effectively act as a confining bed to stop vertical movement.

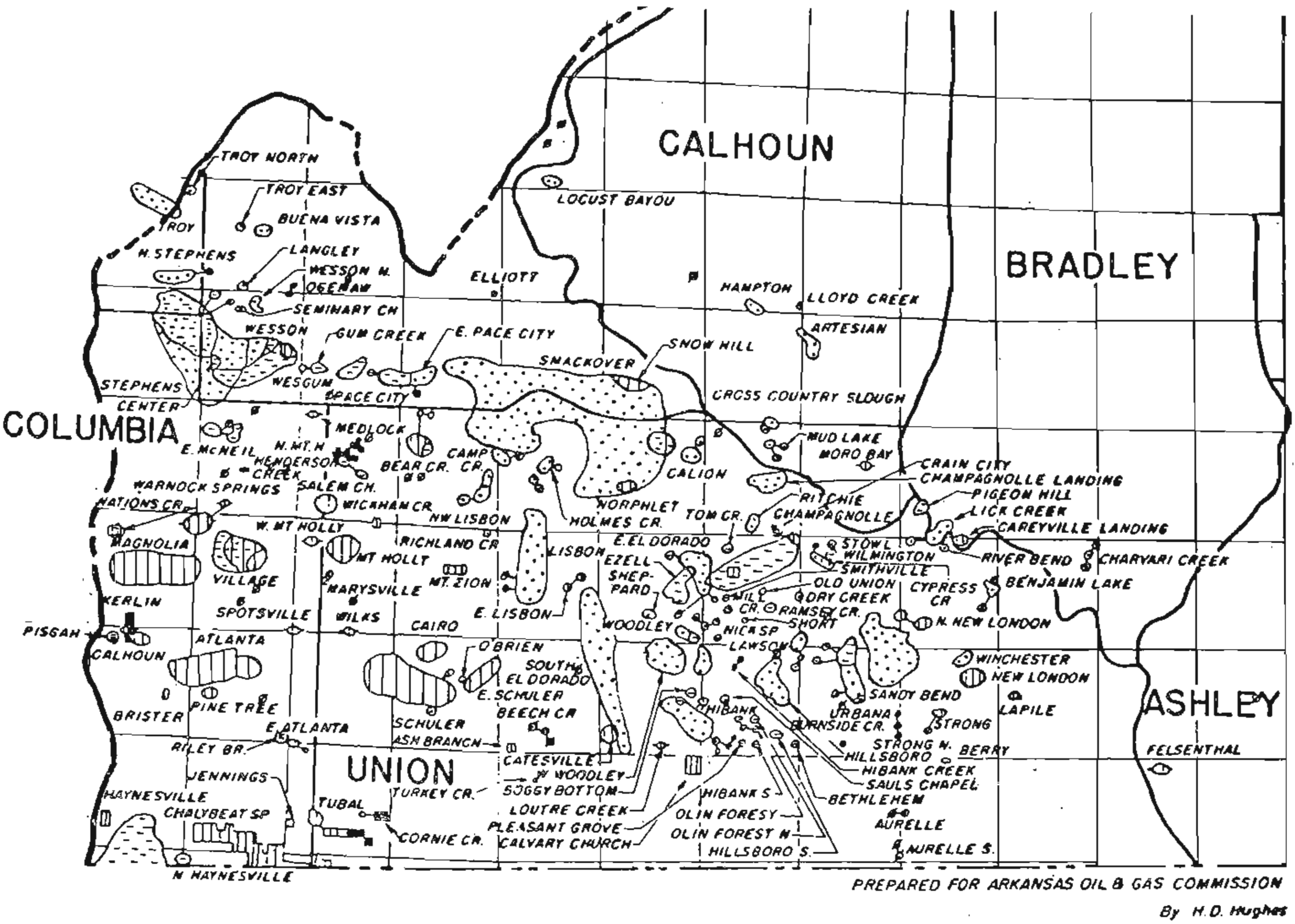
Regulatory control over impoundments receiving waste materials in Arkansas is primarily vested in the Arkansas Department of Pollution Control and Ecology. More than 2800 impoundments exist in the basin, most of which are oil and gas in which petroleum waste and brines are stored, many without liners. Many pits have been abandoned and the owners are hard to identify and locate. The number of impoundments and quantity of brine produced is unmanageable under current authority and staffing by ADPC&E and the Oil and Gas Commission. (See Figure 4-51).

The Arkansas Department of Pollution Control and Ecology operates under authority of the Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended), which confers broad powers of regulation and enforcement to the agency. The Arkansas Hazardous Waste Management Act (Act 406 of 1979) has direct applicability to surface impoundments holding toxic wastes but brine is not classified as hazardous. This Act, which is to be enforced through the ADPC&E, requires permits for the construction, alteration and operation of hazardous waste treatment or disposal facilities or the storage of hazardous wastes.

The most stringent State requirements concerning impoundments have resulted from ADPC&E Regulation No. 1 (1958) concerning disposal of wastes resulting from oil and gas field operations. Regulation No. 1 requires disposal of brines and wastes in new fields or pools by underground injection wherever possible and denies disposal in earthen pits unless the pits are underlain by tight soil or lined with asphalt or other water tight material. However, there is not a procedure for requiring testing of permeability for new impoundments and enforcement is difficult. The definition of impervious layer is subject to interpretation.

figure 4-51

OIL AND GAS CONDENSATE FIELDS



UPPER CRETACEOUS

UPPER CRETACEOUS (Abandoned)

NEW FIELDS DISCOVERED - 1977

LOWER CRETACEOUS

LOWER CRETACEOUS (Abandoned)

EXTENSIONS TO FIELDS - 1977

JURASSIC

JURASSIC (Abandoned)

UNPRODUCTIVE WILDCAT WELLS - 1977

SOURCE: Arkansas Oil and Gas Commission, 1977. Ref #5

The regulation states that these pits should be used only in emergency situations but, the term "emergency" is not operationally defined.

The best available source on pits, ponds, and lagoons is the Surface Impoundment Assessment (SIA) funded by ADPC&E and conducted in Arkansas in 1978 and 1979 by the Arkansas Soil and Water Conservation Commission and the Federal Soil Conservation Service. The study found 7,640 impoundments at 872 sites in the state. Five hundred and six impoundments were then selected for assessment of pollution potential. <21>

About ten percent of the industrial sites have monitoring wells, less than two percent of the municipal sites assessed have monitoring wells. The fact that 95% of the sites (on which information was available) had no monitoring wells, attests to the need for a strategy for developing a statewide monitoring system. <21>

These surface impoundments are distributed throughout localities where little or no protection of groundwater is afforded by an impermeable surface layer. Some unlined ponds have been constructed at these sites which apparently are potentially hazardous because of the lack of natural protection. A more detailed investigation at each site would be required to quantify the validity of this concern. Seventy-eight percent of the impoundments surveyed reported no liner, 95% have no monitoring wells, and 32% are within one mile of a well used for drinking water. <21>

Based on the data collected during the SIA, and previous cases of known groundwater pollution, the activities and geographic regions of the State with the highest potential for groundwater contamination was, "Highest Hazard - Oil and Gas Activity in Southern Arkansas". The reason for the high hazard rating was the number of impoundments and poor construction practices. <21>

The lack of attention to groundwater protection is reflected in the few state and federal programs which regulate construction and modification of waste holding impoundments in the state. Several state agencies are empowered to issue and enforce orders to abate pollution, and in the past, such orders have been issued in cases of reported groundwater pollution, but effective preventive programs have not been developed. A unified program is needed to prevent pollution by groundwater quality management planning, proper siting and construction requirements and site surveillance of groundwater.

LEGAL AND INSTITUTIONAL PROBLEMS
Public Supply Systems

Many Arkansas communities have water supply systems which are improperly maintained and operated. The 1980 drought caused a vast majority of the state's public water systems to reach record demands. The heavy consumption placed unexpected strain on existing sources, pumps, treatment facilities and distribution systems. Many customers experienced service interruptions due to an inadequate source, pump failure, single well systems, inadequately trained personnel and undersized piping systems. During this period, five water systems in the state were forced to haul water to meet demands, and the Arkansas Department of Health issued boiling orders to water systems due to suspected contamination when these systems experienced pressure loss. In addition, many water system managers had to impose voluntary or mandatory water conservation practices. The extreme climatic conditions of the summer of 1980 focused attention on the importance of proper planning, operation and maintenance of water systems. Due to a lack of sufficient funds, many small water systems have only a part-time operator and excessive personnel turnover is a common problem. Needed operation and maintenance is minimally performed, resulting in costly water projects having a shortened operational life.

Many of the public water supply systems do not have backup wells for use during periods when repairs are being made on their equipment. In addition, there is insufficient storage to supply the sustaining needs of their customers. There are 64 public water supply systems in the basin, of which, 22 are one well systems. Storage facilities for 5 of the systems have capacities of less than one day's supply. <3>

Improper Well Construction and abandonment

Oil and Gas Wells

The potential for contaminating the Sparta Sand with brine from the Nacatoch Sand (below the Midway Group) increases with continuing water level declines in the Sparta Sand.

During the early days of oil field development, the tools and methods used today for oil reservoir management and conservation were not available. Peak production was reached a few years following discovery, after which oil production dropped off and brine production increased. <19>

"The oil wells in Union county were drilled by the rotary method, except for some cable tool drilling, in the producing interval. Most of the wells were constructed with 12 1/2 inch diameter iron surface casing, set, uncemented, to a depth of about 200 feet below land surface. Metal inner liners of five to six inches were then set to the top of the Nacatoch. Many wells were completed as open holes, but most were completed with perforated pipe or screen. Within a one-half mile radius of the El Dorado area about 85 oil wells have been completed in the Nacatoch. Most of them are abandoned and some are unplugged. Oil operators have been required to plug abandoned wells drilled since 1939 according to rules of the Arkansas Oil and Gas Commission. <19>"

"All units deeper than the El Dorado aquifer in Union County yield saltwater or brine. Under natural controls, fluid movement between Cretaceous and Tertiary units is prevented by the confining Midway Group; likewise, fluid movement between the Wilcox Group and the El Dorado aquifer is prevented by the Cane River Formation. The hydrostatic head differences between the Nacatoch Sand, the Wilcox Group, and the Lower Sparta are evidence that the confining beds are highly effective in preventing fluid mixing. Apparently, with the exception of fractures related to faulting, the only plausible means of mixing between the Lower Sparta and the underlying saltwater-bearing units is through "leaky" wells. Leaky wells can result from inappropriate methods and materials used during construction of the wells and from deterioration of casings and liners. However, deterioration of casings and liners will not necessarily lead to the mixing of fluids between discrete aquifers. Residual drilling-mud cake and natural clay bridges in the annular space between the hole wall and casings (or liners) can be effective in preventing fluid mixing between the units penetrated by the well." <18>

In the absence of open bore holes and leaky wells, which would allow fluid communication between the Cockfield and deeper units, the Cook Mountain Formation would act as a hydrologic barrier to movement of the contaminant to units below the Cockfield Formation. <19>

According to the hydrostatic heads indicated for the different units, the direction of flow would be from the Cockfield to any of the deeper units if avenues of flow were provided by wells. Thus, open bore holes and leaky wells could be plausible avenues of brine contamination from the surface ponds and contaminated areas of the Cockfield to the Sparta Sand. <19>

Nearly all of the oil wells in the area of contamination produce from the Nacatoch Sand. According to data on hydrostatic heads in the Nacatoch and all overlying units, a nonpumping or abandoned Nacatoch well at the present time would not leak brine to the Lower Sparta nor to any of the other freshwater units. However, the Lower Sparta and any of the other freshwater-bearing units plus the saltwater-bearing Wilcox Group might leak water to the Nacatoch. An abandoned or non-pumping well in the Nacatoch, plugged only between the Nacatoch and the Wilcox, could leak saltwater from the Wilcox to the Sparta Sand. Wells in the Lower Sparta Sand with inadequate or deteriorated casing might receive leakage from the Upper Sparta Sand, the Cockfield Formation and from the surface. <19>

Previous investigators, have expressed concern that substantial declines in the hydraulic head or potentiometric surface of the El Dorado aquifer (Lower Sparta) might result in some leakage of brine from old abandoned oil wells. Those concerns had merit then as they do now, particularly in view of the methods of oil-well construction, the age of many of the wells and projected water needs in the basin. <19>

Water Wells

The authority to regulate the construction of water wells is vested in the Water Well Construction Committee. The Committee licenses water well contractors, provides drilling rig permits, and tests and registers water well drillers. The Committee also establishes rules and regulations regarding proper construction methods and holds hearings regarding violations of the Rules.

The problems center around enforcement of existing legislation concerning proper construction techniques and changing the law to address and alleviate current and potential problems. All well contractors are required to submit a construction report within 30 days after the completion of a well. It has been estimated that approximately 1/2 of all wells drilled in certain areas of the state do not have construction reports on file. The Committee has a staff of two people to maintain files, investigate complaints, inspect or enforce regulations and perform necessary administrative functions required of a state committee. Lack of time and funds hinders enforcement of well construction regulations and is creating resentment among contractors who are finding it difficult to compete with those who are cutting corners.

The escalating incidence of heat pump installation by drillers is a potential problem of unknown proportions. The variety of different heat pump systems exacerbates the problem. Some systems use a single water well for withdrawing water to be circulated through a heat exchanger and then discharge the water out on the ground; others use two wells, one for withdrawal and one for injection. Other variations include closed loop systems where groundwater circulates through field lines or a heat exchanger down in the well itself. Since the potential for contamination of groundwater exists from these systems, regulations to insure that the well construction phase of installation is conducted properly are presently being drafted by the Committee in conjunction with the Arkansas Soil and Water Conservation Commission and the Arkansas Department of Pollution Control and Ecology.

Groundwater Use Data

Various state and federal agencies have limited authority over groundwater. This has resulted in several different groundwater data bases, slightly different in nature, reflecting the authority and interest of the individual agency. The best source for data on the quantity of groundwater withdrawn has been from the U.S.Geological Survey and Arkansas Geological Commission. The problems have resulted from the various sources, conflicting data, estimation methodology and incompatiable computers among state agencies. Heavy reliance on many agencies, organizations, industry and individuals to report their piece of data have caused delays in compilation, adjustments and interpretation. Consequently, the U.S.G.S. publications on water use run approximately two years behind. The 1985 legislative session solved some of these problems with the passage of Act 1051 which required groundwater users to report the quantity of groundwater withdrawn on an annual basis. With approximately 20,000 well reports expected annually, new problems arise. Computer capability, storage, retrieval, etc. is of considerable concern. One of the biggest problems with data bases is that computers at ADPC&E (Storet) and the Arkansas Health Department, Arkansas Geological Commission and the Arkansas Soil and Water Conservation Commission are incompatible. Data can be retrieved but no statistical software can be used. Data bases must be set up to facilitate data exchange and retrieval capability among state agencies.

Groundwater Quality Data

For groundwater quality, one of the best sources is the Chemical Data, 1982, released by the Arkansas Health Department about every ten years. It includes chemical analysis of samples submitted by public water supplies every three years. Similar chemical analyses are done by the University of Arkansas Cooperative Extension Service for farmers who turn in irrigation well samples to their county agents. A computer printout of these analyses is available from the UA Extension Office. Further chemical data from the sampling stations of the USGS are presented annually in Water Resources Data, Arkansas. These analyses are also placed in the federal computer systems, WATTSTORE and STORET.

Another data source on the quantity and quality of groundwater in the state is in the ADPC&E publication, Nonpoint Source Pollution Assessment Summaries, 1979, for each of the five major river basins in the state. This can be supplemented with the groundwater section of ADPC&E's, Arkansas Water Quality Inventory Report, 1984, which also summarizes recent reports issued by the Soil and Water Commission, the United States Geological Survey and the ADPC&E. The State Water Plan of 1975, produced by the Arkansas Soil and Water Commission contains much information on municipal supplies. In addition, there is valuable groundwater use and quality data scattered throughout the numerous reports published by the USGS and the Arkansas Geological Commission. The Arkansas Water Resources Research Center also publishes studies dealing with all aspects of groundwater.

The problems stem mainly from data accessibility. Data entry commonly runs far behind data gathering. Many data bases are not compatible from agency to agency. The time and effort to secure the information needed from files seems inhibitive and not cost effective. Inhouse terminal link ups are needed to ADPC&E, USGS, ADH, and ASWCC, or a central data base system to share information. These sources possess valid, reliable and accurate data but is not directly accessible by enough state and federal agencies, at this time.

GROUNDWATER, SOLUTIONS AND RECOMMENDATIONS

Selected Geologic Units

Quaternary Aquifer

The critical use area encompassing Crossett and Hamburg was based on the saturated thickness being less than 50%. The area around the Crossett well field has less than 20% remaining which is equal to approximately 35 or 40 feet. The water is used for public supply and is high in total dissolved solids.

Considerably more data is necessary to evaluate the problems in this area. Research topics should include; (A) structural elevation map of the top and bottom of the aquifer, (B) clay cap thickness map, (C) extension of water level measurements, westward to the Ouachita River and (D) water quality trend analysis. Once this data is available, the significance of the limited saturated thickness and quality degradation can be evaluated. If these data indicate that the Quaternary Aquifer is not a dependable source for the long term based on quantity or quality criteria, then alternate sources such as the deeper Cockfield aquifer or surface water sources could be evaluated for feasibility.

The declining water levels in the alluvial aquifer caused by agriculture and industry can be reduced by demand reduction, increasing recharge to the system or securing alternate surface water sources. Groundwater demand reduction, in lieu of withdrawal regulations is possible by increasing the availability of surface water and by conservation. Surface water must be available in sufficient quantities in June, July and August for continuation of current land uses without endangering groundwater supplies.

Several structural alternatives have been proposed for multi-purpose application. Many of the alternatives discussed in this section apply to the problems in the Sparta and Cockfield Aquifers as well as the Quaternary. These are listed and discussed below in brief and in detail in the surface water solutions section of this report.

(A) Soil Conservation Service (PL 83-566) These structures could provide an alternate source of surface water, increase discharge during normally low flow periods, provide recreation, and increase fish and wildlife habitat. The increased surface water flows would help to alleviate the problems of overdraft and quality degradation in the alluvial aquifer.

(B) Bayou Bartholomew Study, (Corps of Engineers Vicksburg District). The escarpment lakes, in conjunction with Soil Conservation Service structures, could provide surface water for irrigation that would partially relieve the pressure on groundwater withdrawals in the basin. Storage in the ten escarpment lakes is equal to 285,000 acre feet of water that would be available for water supply in the Bayou Bartholomew Basin if 75% of the total storage volume was used for water supply purposes. This represents more water than was withdrawn from the Alluvial Aquifer in the entire basin in 1980.

(C) Interbasin Transfer-Bayou Bartholomew Diversion Project. The proposed diverson has not been studied in enough detail to reach any conclusions on feasibility. Additional research is needed to determine the actual feasibility of the project for supplementing surface water for agricultural uses and reducing the demand on groundwater. Study on the three structural options should continue with new evaluations of feasibility as groundwater overdraft data becomes available. Refer to the Surface Water Section of this report for more details on the structural alternatives (A,B,C) mentioned above.

Nonstructural solutions to Quaternary overdraft include conservation, conversion incentives, legal and institutional changes, public education, continued research and groundwater quality monitoring.

(A) Conservation: Decades of overuse of groundwater supplies left some agricultural wells "high and dry" in the summer of 1980. The drought of that summer evoked significant interest in information on groundwater levels, recharge rates and safe aquifer yields. The need for more monitoring of groundwater levels in wells and data on stream-aquifer connections was apparent. Inquisitions and expressions of need by farmers led to a vision in the minds of Jeff Ellis (District Conservationist-Jackson County Conservation District), Jim Denton, and Board Members of the Jackson County Conservation District to pursue funding for additional water level monitoring in wells, evaluating different crop water requirements and pumping plant efficiency evaluations. The Arkansas Soil and Water Conservation Commission provided $3000.00 the first year and the results were significant. It was apparent that the entire delta region could benefit from this type of study. Consequently, Jeff Ellis, Jim Denton and others assisted in securing federal funding in 1984 in the amount of $450,000. The second year efforts concentrated on initiating a water level monitoring program. Approximately 400 alluvial wells were added to the monitoring network of 410 the U.S.G.S. monitors annually in the alluvial aquifer. In fiscal 1985, the project was funded with $475,000 and expanded to concentrate on irrigation application, pumping plant efficiency evaluations and infiltration studies. Accomplishments for 1984 and 1985 in the state are illustrated in Table 4-18.

In addition to the studies in the Lower Ouachita Basin, several studies in the adjacent basin (Boeuf-Tensas) and the entire 26 County study area will have a bearing on the agricultural conservation efforts within the Lower Ouachita Basin. Most of the studies are similiar to those in the Lower Ouachita Basin with the addition of salinity studies. Many studies in other parts of the United States have documented up to 40% savings in efficiency and reduction of losses and waste by using the application techniques, mobile labs, pumping plant efficiency and soil moisture monitoring equipment that will be utilized as a part of the Eastern Arkansas

TABLE 4-18
EASTERN ARKANSAS WATER CONSERVATION PROJECT

TYPE OF STUDY	QUANTITY SEASON LONG	TOTAL
CONTINUOUS FLOOD IRRIGATION	8	8
INTERMITTENT FLOOD IRRIGATION	7	7
FURROW IRRIGATION	5	17
SPRINKLER IRRIGATION	-	16
CANAL DELIVERY SYSTEM	-	5
PUMPING PLANT EVALUATION	-	43
SOIL - IRRIGATION CHARACTERISTICS	-	85
SOIL MOISTURE	-	3
AQUIFER MONITORING	-	400

Water Conservation Project. This program has the potential for significant effects on groundwater overdraft and should be continued.

(B) Best Management Practices: B.M.P.'s as outlined in the surface water chapter will also conserve the quantity and quality of groundwater available in the basin and should be continued. Surface water and groundwater systems are interconnected and what happens on the land surface will affect, if not determine, groundwater availability and quality.

(C) Incentives: The problems of groundwater overdraft were addressed in the 1985 General Legislative Session with passage of Act 417, entitled "Water Resource Conservation and Development Incentives Act of 1985". This Act stated that existing water use patterns were depleting underground water supplies at an unacceptable rate because alternative surface water supplies were not available in sufficient quantities and quality at the time of demand. The Act provides groundwater conservation incentives in the form of tax credits to encourage construction and restoration of surface water impoundments and conversion from groundwater to surface water withdrawal and delivery systems.

Impoundment tax credits are limited to 50% of the actual construction costs or $3,000 annually for a period of eleven years. The impoundment or water control structure must store a minimum of 20 acre feet and be used for the production of food and fiber as a business or for industrial purposes. This would include rice, wheat, soybeans, cotton, corn, milo, fruit and vegetable crops and domestic uses. The Arkansas Soil and Water Conservation Commission will administer the program with assistance from the Conservation Districts. All plans, designs and specifications must be submitted to the Commission for approval. If acceptable, a "certificate of tax credit approval" will be issued as proof of eligibility.

The average construction cost for an impoundment is approximately $1200 estimated at $1.00 per cubic yard of earth moved. The number of ponds constructed between 1975 and 1978 averaged 2,364 annually statewide. Current levels average 1,800 annually. Projected increases in impoundment construction could amount to 3000 per year. The limited uses for eligibility mean that most new impoundments would be constructed in the delta or agriculture area of the state where the most significant groundwater deficits are occurring. An additional 12,000 ac/ft/yr or approximately 11 MGD could be available for irrigation, (based on 20 acre feet minimum), if only 20% of the projected 3,000 new impoundments were located in the Lower Ouachita Basin. This represents approximately 5% of the total Quaternary withdrawals in the basin in 1980.

Conversion Credits are limited to 10% of the actual cost of abandoning or reducing the extraction of groundwater and utilizing surface water as an alternative. Applicants must furnish proof to the Commission that groundwater was being used previously and eligible equipment and construction costs will directly reduce the quantity of groundwater withdrawn. The specific rules and regulations for eligibility in both programs can be obtained from the Arkansas Soil and Water Conservation Commission.

(D) Research: In 1985, Act 816 was passed which provided $200,000 for water related research. The money will be made available for a 2 year period ending June 30, 1987. An amount of $60,000 annually will be used to contract for modeling and continuing research on conjunctive use of groundwater and surface water. The results and techniques developed from this research will be made available to water users.

Groundwater Modeling - In 1979, the United States Geological Survey formulated a groundwater model of the alluvial aquifer in the Bayou Bartholomew-Boeuf-Tensas Basins. The model provided many answers to flow patterns and rates of flow within the aquifer system. The model should be extended and modified to be used as a management tool.

A recent proposal by the U.S.G.S. is to expand the original program into a calibrated digital model for use by state and federal agencies for assessing the impact of projected irrigation demands and for evaluating alternate pumping schemes involving the conjunctive use of surface and groundwater. The principle benefit of the modeling effort will be its predictive capability for evaluating spatial and quantitative changes resulting from pumping stresses and delineation of areas of influence. The model will utilize soil moisture data and evaluate temporal variations in the water table elevation resulting from raised or lowered heads near dams, irrigation canals or stream channels. A one mile grid system will be utilized. The model will encompass the entire Mississippi Alluvial Aquifer. Results of the study will be in eight reports. Bayou Bartholomew is in area one of the study area and is due for completion in December of 1988. Area two (East of Crowleys Ridge) will be completed in fiscal year 1989. The modeling work and reports of findings will be cost shared with the Arkansas Soil and Water Conservation Commission resulting in a cost of $30,000 annually over the next four years. Much of the information required to satisfy the requirements of Act 1051 of 1985 should be available with completion of this study.

(E) Groundwater Use Data: The problems of time lag with groundwater use data could be lessened with the passage of Act 1051 of 1985. The mandatory reporting of all groundwater use by quantity, location, type of use and name of user on an annual basis is now state law. The exceptions are wells of 5" or less I.D. or those used for domestic purposes.

Reporting of use will be on the same form and timeframe as Surface Water Diversion Registration is today. Inaccurate reporting of groundwater use can be avoided by the use of flowmeters made available through the Eastern Arkansas Water Conservation Project. Users can have their pumping plants rated at

1/4, 1/2, 3/4 and full throttle (diesel units) and keep records of the time that a particular rate of flow occurred. The use of flowmeters to rate pumps powered by internal combustion engines will also reduce the error in reporting surface water use, such as tailwater recovery pumps. Electric bills can be used to determine operating times for electric powered pumps.

Second year funding for the Eastern Arkansas Water Conservation Project is $475,000. Additional flowmeter purchases should be emphasized during equipment acquisition meetings based on the potential results and benefits to improve water use data bases. Accurate water use data are a vital component of water resources planning and the opportunity to secure accurate data in a timely fashion has never been available. The potential for improvements in water use data accuracy should be addressed in the goals and objectives of the Eastern Arkansas Water Conservation Project. Planners for the project should evaluate the importance of acquiring additional flowmeters for the study in view of the potential results and prioritize the project objectives accordingly.

(F) Water Bank Program: The purpose of the Water Bank Program is to conserve wetlands vulnerable to drainage. It involves 10-year contracts with qualifying applicants who are paid to conserve their wetlands. The present payment in Arkansas is $7.00 per acre per year. The Water Bank Act (PL 91-559) established the Water Bank Program on December 19, 1970. It was originally developed for the northcentral United States to help conserve prairie potholes and adjacent areas valuable as nesting and brood habitats for ducks. The program was introduced in Arkansas, Louisiana, and Mississippi in the early 1970's to help conserve wetlands valuable as resting areas for migratory waterfowl, nesting and brood areas for wood ducks, and habitats for many other animals. Groundwater level declines in the alluvial aquifer were not as severe then as now. The potential for groundwater recharge was not highly valued in the expected benefits of the program. Today with more awareness of the limitations of our groundwater resources, the additional recharge by inundated lands is more significant as a secondary benefit of the program. Reasons for overlooking the positive effects on groundwater in the program may hinge on the regulation denying pumpage for agricultural uses.

The Agricultural Stabilization and Conservation Service administers the Water Bank Program, including selection of participants and distribution of funds each year. The Soil Conservation Service provides technical assistance for the program, including determining which applications qualify and preparing a conservation plan for each qualified area.

The applicant must have at least two acres of permanent wetlands, to be eligible. Adjacent lands (adjacent to designated permanent wetlands) must be essential for protecting the wetlands for migratory waterfowl nesting, breeding and feeding. The minimum total acreage must be at least ten acres, including at least two acres of permanent wetlands. Adjacent lands need not be contiguous to designated wetlands, but may not be farther than one-quarter of a mile away and may not exceed four times the total acreage of designated wetlands.

Currently, only 2 counties in the Lower Ouachita Basin are in the Water Bank Program and are listed below:

Counties and Partial Counties in the Water Bank Program Within the Basin

	County	SCS District Conservationist and Address
1.	Ashley	Louis Jacks - 312 N. Cherry, Hamburg 71646 Telephone 853-5264
2.	Drew	Tom Gentry - 804 N. Main St., Monticello 71655 Telephone 367-3446

Participation in this program should be encouraged and the potential benefits publicized. Procedures necessary to expand the program into other counties should be initiated.

Cockfield Aquifer

Solutions to overdraft problems within the Cockfield formation are similiar in nature to the Sparta Sand and Alluvial Aquifer. Water levels in the formation have been declining and the quality is degraded in some areas. The aquifer is used primarily in Ashley County and Eastern Union County for municipal supplies. Surface water reservoirs will be one option in the future. Research is needed to find potential reservoir sites for municipal and industrial supplies to reduce the current groundwater overdraft.

The Reservoir Tax Credit and conversion to surface water tax credits would both aid in preserving Cockfield water for those municipalities found to not have surface water as an alternative.

Recommendations to alleviate the potential problems of hazardous waste, landfills, surface impoundments (waste holding) and improperly constructed and abandoned wells lie with changing regulation #1, additional monitoring and permit systems.

The potential for pollution of the Cockfield Aquifer from oil and gas activities is significant. Legislation is already in place for controlling or denying construction of liquid waste holding impoundments and for requiring an extensive monitoring system to ensure that any leakage from the impoundments is detected at an early stage and prompt action taken to prevent further contamination. Both the Water and Air Pollution Control Act and the Hazardous Waste Management Act provide procedures for enforcement by holding hearings on cases of alleged violations and taking action through civil and criminal courts. Both acts provide for immediate action by the Arkansas Department of Pollution Control and Ecology in case of emergency and specifies penalties up to $10,000 for each day of violation or a maximum prison sentence of one year. In the past, court-imposed penalties for violation have been in amounts of only a few hundred dollars for each case.

The primary agent of enforcement is the permit system wherein construction or modification plans are reviewed for wastewater treatment and holding facilities. At present, all new wastewater holding impoundments are subject to permit regardless of whether any wastes are discharged to surface waters. Thus all surface impoundments receiving liquid wastes in the state can potentially be controlled by new policies concerning groundwater protection under state programs administered by ADPC&E.

Under ADPC&E Regulation #1 (1958) construction of new pits for oil field disposal has been reduced significantly. Soil characteristics in the oil fields of the Lower Ouachita Basin are generally considered unsafe and any new impoundments pose a potential threat to groundwater. Regulation #1 should be modified to include pre-existing pits that are currently not covered under the regulation. Percolation tests and borings should be required for materials underlying new pits. In 1982, a report was published by the Wright-Pierce Engineering Firm of Topsham, Maine. The report established criteria for siting impoundments and landfills of hazardous and non-hazardous waste and indicated areas that were highly vulnerable due to permeability and posed a significant threat to groundwater quality. The report outlines in detail, the siting criteria that should be required by ADPC&E. The nature of unconsolidated lensed formations in the Lower Ouachita Basin requires that each site be physically inspected to be adequately evaluated. Adequate staffing to inspect these sites and analyze the soils underneath would prevent ADPC&E from relying on reports supplied by firms applying for the permits. Volume II of the Wright-Pierce Report has recently been adopted as the official criteria for siting hazardous and non-hazardous landfills but Volumns I and III for land application of waste and surface lagoons have not.

The siphoning of brine from pits into local streams was and still may be a common practice. Reducing or eliminating brine holding pits by requiring that all waste be injected may be the only method of dealing with this hazard to surface water and groundwater. This, however, may not be practical, economically speaking and legislative authority for such action does not exist. ADPC&E expects to have regulation #1 rewritten soon. Under consideration are; (A) grandfather old pits, (B) five year phase out of existing pits, (C) no pit policy, (D) double shut offs for producing and injection wells, (E) emergency pit defined and (F) impervious liners defined.

Under the RCRA (Resource Conservation and Recovery Act), Program, all open dumps should be upgraded to sanitary landfills. This upgrading would provide a data base for further control. Impoundments holding hazardous waste could be controlled by the permit process of site evaluation. If the program was properly administered, the danger of groundwater contamination from hazardous wastes should no longer be a significant threat in the

State. Although it will be several years before the program is fully implemented, the "interim status" requirements for permit applicants will provide some control on the impoundments as the program progresses.

For impoundments containing non-hazardous materials, the states still must exercise some initiative in developing programs of control but can request funds in support of such projects through the Solid Waste Management Program of RCRA or the Water Quality Management Program under the Clean Water Act. All such impoundments should be permitted. This program could be used to contribute to the overall protection of groundwater by limiting the quantities of brine held in surface impoundments in the Lower Ouachita Basin. ADPC&E is currently updating information on the location and nature of surface holding impoundments in the Lower Ouachita Basin.

Many of the problems associated with the execution of programs that indirectly apply to groundwater and could result in increased groundwater protection are hindered by inadequate funding and staffing of state offices. The addition of any new commitments to groundwater protection will require increased staffing and considerable financial, legislative and public support.

The major emphasis in the past has been on surface water contamination and the result has been Federal legislation to control the nature and extent of same. Commonly, groundwater protection has occurred as a spinoff of surface water pollution regulations. This approach, as evidenced by groundwater pollution problems in this basin is inadequate to protect this resource. The requirements for groundwater protection that do exist are too easily ignored and underfunded when they are secondary components of larger programs. Accountability for groundwater protection is too easily hidden among plans for protection of surface waters.

Considerable research needs to be conducted on the Cockfield Aquifer. In order to fully evaluate the significance of declines in the formation, the structural elevations of the top and bottom will have to be mapped. Currently there is insufficient information to determine the saturated thickness remaining in the aquifer or the Potentiometric-top relationship.

Sparta Sand Aquifer

The Sparta Sand Aquifer problems of declining water levels and subsequent degradation of water quality could be lessened with measures similiar to those outlined in the Cockfield and Alluvial Aquifer sections of this report in lieu of the authority to establish water management districts in critical use areas. Union and Columbia Counties have the more severe problems, are in a critical use area and will require significant efforts to solve. Providing feasible surface water reservoir plans for municipal supplies in Union County is not probable due to the gently undulating surface that is not conducive to deep, (high quality) public supply reservoirs, and the poor quality of surface runoff due to pollution from oil and gas activities. However, research should evaluate potential reservoir sites, transfer of Ouachita River water to El Dorado (above the confluence of Smackover Creek), and encourage conversion to surface water sources, whenever possible. Some industries and municipalities in the basin have shifted to surface water from streams, such as International Paper in Pine Bluff or built their own reservoirs as Georgia Pacific has done. The City of Magnolia has recently completed construction of a public supply reservoir. Act 417 of 1985 will provide incentives to develop reservoirs and convert to surface water sources. The groundwater level rebound from reduced demand could result in dilution of certain contaminants. The increased head on saline water could cause a migration downdip, away from producing areas. The areas of withdrawal from the Sparta for municipalities should be prioritized and protected for those highest uses. The Sparta Sand is essentially a "Sole Source Aquifer" in much of Union County. With sodium and chlorides apparently migrating westward and updip into more producing areas, withdrawals will not be able to continue at the present rate without more and more wells going into salt water production.

Results from a reconnaissance report of salt water contamination in the Lower Sparta Sand (El Dorado Aquifer, Union County), indicate that the principle source of contamination in the immediate El Dorado area is from that part of the aquifer that lies within a graben (fault).

"The alignment of the graben allows an unobstructed avenue for flow between the graben and the area of contamination. Before development of the El Dorado aquifer as the major water source, the direction of flow in the aquifer was southeastward toward the inlet of the graben. Natural dynamics of the flow tended to trap the saltwater in the graben. The large water level declines associated with withdrawals from the aquifer near El Dorado, caused the direction of flow to change locally from southeast to northwest, so that saltwater now flows from the graben toward the center of pumping." <18>

"The lack of data precludes an accurate determination of the magnitude of the saltwater flow from the graben. However, the rate of flow is large enough to cause ever-increasing contamination if plans for future use and development of the El Dorado aquifer do not reckon with this problem. Basically, the solution is to reduce the hydraulic gradient between the contaminant source area and the center of present withdrawals near El Dorado. Theoretically, there are a number of ways to do this but probably the most feasible way would be to gradually redistribute wells to areas away from the present center of heavy withdrawals. With carefully selected well sites, appropriate spacing of new wells and well field schedules with respect to the source and avenues of the saltwater contamination, the El Dorado aquifer could meet future needs in

Union County with water uncontaminated by salt." <19> Recent information indicates that the City of El Dorado is planning to relocate city wells northwest of current well sites, and outside the influence of the graben.

Many characteristics of the Sparta Sand Aquifer are still unknown. A recent cost-sharing agreement between the Arkansas Soil and Water Conservation Commission and the USGS (Arkansas District), for three (3) years at a cost of $40,000 per year will result in the USGS developing a groundwater model of the Sparta Sand in Arkansas and Louisiana. The Sparta Sand model and investigation will develop a method for evaluating the impact of present and proposed aquifer development on water-level declines and ultimately, groundwater availability. The objectives of the study are as follows: (1) Evaluate the hydrogeologic characteristics of major units that control flow in the Sparta Sand Formation within the project area, including recharge, vertical leakage, nature of the flow system and hydraulic characteristiccs. (2) Evaluate areas of major withdrawal in Arkansas and adjacent states with regard to their potential impact on water level declines in this aquifer. (3) Construct and calibrate a groundwater flow model, in coordination with the Louisiana District (USGS), to be used in assessing the feasibility of proposed withdrawals from the Sparta Sand Aquifer in Louisiana and Arkansas. The Regional Aquifer Systems Analysis (RASA), described later, will be utilized during model development and calibration for estimating initial boundary conditions. The study area will include most of the Lower Ouachita Basin except the Ouachita Mountain section in the extreme northwest corner of the basin. A report will be prepared that will describe the hydrogeology of the study area, flow system within the aquifer, the digital model, and provide examples of how the model will run. The report will be part of the cooperators technical report series in Arkansas and Louisiana. The report will be submitted for directors approval prior to the end of FY 1987.

Another regional study will have an impact on current and future modeling investigations. The major objective of the West Gulf Coast Regional Aquifer Systems Analysis (RASA) is to define the magnitude of flow and direction of flow within regional aquifer systems. A digital computer model will be developed to define the framework flow pattern within the Quaternary and Tertiary Systems in Texas, Arkansas, Louisiana, Missouri, Kentucky, Tennessee and Mississippi. The major advantage of this modeling approach will be the elimination of artificial boundaries present in most aquifer models. Two levels of modeling will be utilized. The regional offices will work on a 10 mile grid system while state level involvement will be on a 5 mile grid pattern.

The expected results will include: (1) definition of overall flow pattern within the aquifers (2) increments of movement within each node (3) revision of data bases and (4) a base for more detailed modeling studies. The project should be completed late in 1986.

Paleozoic Rocks

The two most common problems with water from Paleozoic Rocks are low yields and excessive iron concentrations. Low yields are characteristic of the nature of movement and storage within fractures and separated bedding planes of shales and sandstones. Movement to wells is limited by the fracture density size and interconnection of individual cracks. The largest yield from these formations within the basin was 350 GPM in Garland County. Commonly, wells yielding in excess of 10 GPM are considered to be "large producers". The east-west orientation of geologic structures can be utilized to obtain higher yields. Locating new wells east or west of large yielding wells will generally tap the same geologic structure and have a similiar yield. Because of the large drawdowns that occur with larger yields, well spacing should not be less than 1000 feet. Commonly, two areas related to structure have the highest yields: (A) flanks of anticlines and (B) along the axis of a plunging anticline. Bedding plane separations during deformation exposes fractures to recharge along the flanks of anticlines. The axis of a plunging anticline will commonly be highly fractured from distortion and provide high yields. <2>

Research is needed to study the feasibility of utilizing landsat imagery to locate favorable structural zones of higher yields. It is possible that additional small municipalities and industries could obtain sufficient yields from Paleozoic rocks if proper planning and research were conducted; however, low yields will remain an impediment to economic growth and development in the Ouachita Highlands.

Water in Paleozoic Rocks commonly contains excessive iron. Deeper wells commonly have more mineralized water than shallower wells. Treatment for iron removal is necessary over most of the highlands and no changes or alternatives can be expected in the near future.

LEGAL AND INSTITUTIONAL

Public Supply Systems

Act 406 of 1985 was passed to make an appropriation to the Arkansas Soil and Water Conservation Commission to contract with the Arkansas Rural Water Association to provide technical assistance and training to the water systems operators in the state. For the biennial period ending June 30, 1987, $50,000 will be available to provide an additional circuit rider to investigate complaints, problems, or to inspect water systems. The circuit rider will be an experienced, licensed operator that can assist with accounting procedures, inventory, maintenance and management problems. This program will complement the Arkansas Department of Health training and licensing program for operators. The department's training and short courses have approximately 2000 to

3000 graduates a year. Training for operators is essential but the value of a circuit rider to help operators with specific problems on the site of the plant is invaluable. These programs by the Arkansas Soil and Water Conservation Commission and the Arkansas Department of Health will hopefully aid in reducing costly errors in operations, maintenance and management of rural and municipal water supply systems.

Improperly Constructed and Abandoned Wells

In the 1985 legislative session, new laws were passed that will help to alleviate some of the problems concerning improperly constructed and abandoned wells.

Oil and Gas Wells

Oil and gas well construction guidelines have been state law since the passage of Act 105 in 1939. The strict regulations on drilling and exploration after 1939 had no effect on wells drilled prior to that date. The Arkansas Geological Commission have estimated that as many as 15,000 wells may exist in Union County (75,000 in southern Arkansas). As each new case of pollution is documented, old abandoned wells are commonly on the list of prospective causes. Research is needed to evaluate the number of unplugged wells, their locations and their actual contribution to quality degradation in aquifers used as drinking water supplies.

Several methodologies are available to locate abandoned and unplugged wells. These include historical methods such as record searching and the use of metal detectors. Geophysical methods such as electrical resistivity, electromagnetic conductivity and ground penetrating radar have been used in some areas. Remote sensing data have also been used to some degree, e.g. black and white aerial photographs, color photographs, color infrared imagery and thermal imagery. The initial research should evaluate the different methodologies available and recommend the most cost efficient method for southern Arkansas.

Water Wells

The objective of Act 783 of 1985 was to amend section 14 of Act 641 of 1969 to increase certain fees levied and to provide funds for the administration of the Waterwell Construction Act by the Waterwell Construction Committee. New fees are as follows: (A) Certificate of registration - $70, (B) Contractors license - $200 and (C) rig permits - $80. Additional funding provided by this Act will offset cost due to inflation, expanded duties by the committee and pay increases to personnel.

Act 822 of 1985 addressed heat pump well construction practices. The objective of the law was to provide the Waterwell Construction Committee with regulatory control for wells drilled for the purpose of ground water source heat pump installations.

The definition of "water well" in Act 641 of 1969 was amended to include excavations made for the purpose of exchanging geothermal energy found in the earth, termed as heat pump wells.

Heat pump wells were defined as any excavation that is drilled, redrilled, cored, bored, washed, driven, dug, jetted or otherwise artifically constructed for the purpose of obtaining or exchanging geothermal energy for use with ground water source air conditioning or heat pump systems. The excavation may have pipes installed inside the excavation to circulate or discharge various fluids and the well may or may not be backfilled after excavation.

This Act will regulate the heat pump well drillers to the same degree as water well drillers. The same construction and abandonment procedures will apply to wells for heat pump sources as those wells for water supply. This should reduce the potential for contamination from heat pump systems that has been previously unregulated.

DEFINITIONS

ALLUVIUM: Debris from erosion, consisting of some mixture of clay particles, sand, pebbles, or larger rocks. Usually a good, porous storage medium for ground water.

AQUIFER: A water-bearing layer of rock that will yield water in a usable quantity to a well or spring.

BEDROCK: A general term for the consolidated (solid) rock that underlies soils or other unconsolidated surficial material.

BEST MANAGEMENT PRACTICE (BMP): A practice or practices that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

CONE OF DEPRESSION (Or drawdown cone): A conical concavity (or dimple) in the potentiometric surface around a pumping well caused by the withdrawal of water.

CONFINED (or artesian) AQUIFER: An aquifer that is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

CONFINING BED: A body of "impermeable" material stratigraphically adjacent to one or more aquifers, the hydraulic conductivity of which may range from nearly zero to some value distinctly lower than that of the aquifer. Synonyms: aquitard; aquiclude; and aquifuge.

CONSUMPTIVE USE: Use of water in a manner that makes it unavailable for use by others because of absorption, evaporation, transpiration or incorporation in a manufactured product. In some instances, when water is returned to a stream at a distance downstream from the point of diversion, the use may be consumptive as to users immediately below the point of diversion but nonconsumptive as to users below the point where the water is returned.

CRITICAL GROUND WATER AREAS:

Water Table Condition: Water levels have been reduced such that 50% of the thickness of the formation, or less, is saturated; and/or average annual declines of one foot or more have occurred for the preceeding five years; and/or groundwater quality has been degraded or trends indicate probable future degradation that would render the water unusable as a drinking water source or for the primary use of the aquifer.

Artesian Condition: Potentiometric surface has declined below the top of the formation; and/or average annual declines of one foot or more have occurred for the preceeding five years; and/or groundwater quality has been degraded or trends indicate probable future degradation that would render the water unusable as a drinking water source or for the primary use of the aquifer.

CRITICAL SURFACE WATER AREA: Any area where current water use, projected water use, and (or) quality degradation have caused, or will cause, a shortage of useful water for a period of time so as to cause prolonged social, economic, or environmental problems.

DATUM PLANE: An arbitrary surface (or plane) used in the measurement of ground-water heads. The datum most commonly used is the National Geodetic Vertical Datum of 1929, which closely approximates sea level.

DEPENDABLE WATER SUPPLY: The amount of water of desired quality that can be expected to be available at a given point a stated percentage of the time.

DISCHARGE: Outflow of water from a drainage basin, reservoir or other facility through a channel, pipe or other outlet, including the release of polluted water into a stream or waterbody. Also, the rate of discharge measured in units of volume per unit of time, either for an entire outlet or for a specified cross-sectional area of the outlet.

DRAWDOWN IN A WELL: The vertical drop of the water level in a well caused by pumping.

EROSION: The wearing away of the land surface by the detachment and transport of soil materials through the action of moving water, wind or other geological agent.

EVAPOTRANSPIRATION: Evaporation from water surfaces, plus transpiration from plants.

EXCESS STREAMFLOW: Twenty-five percent of that amount of water available on an average annual basis above the amount required to satisfy the existing and projected water needs of the basin.

FAULT: A fracture in the Earth's crust accompanied by displacement of one side of the fracture with respect to the other.

FRACTURE: A break in rock that may be caused by compressional or tensional forces.

GROUND WATER: Water in the saturated zone that is under a pressure equal to or greater than atmospheric pressure.

GROUNDWATER, CONFINED: Groundwater which is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

GROUNDWATER, PERCHED: Unconfined groundwater separated from an underlying body of groundwater by an unsaturated zone. Its water table is a perched water table.

GROUNDWATER, UNCONFINED: Water in an aquifer under atmospheric pressure that has a water table and is free to rise and fall.

HEAD (or static head): The height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point.

HYDRAULIC CONDUCTIVITY: The capacity of a rock to transmit water. It is expressed as the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

HYDRAULIC GRADIENT: The change in static head per unit of distance in a given direction. If not specified, the direction generally is understood to be that of the maximum rate of decrease in head.

HYDROLOGIC CYCLE: The constant movement of water in the atmosphere and on and beneath the earth's surface.

INFILTRATION: The movement of water from the earth's surface into the soil zone.

INSTREAM FLOW REQUIREMENTS: The flow regime which will best meet the individual and collective instream uses and off-stream withdrawals of water. Instream uses of water include uses of water in the stream channel for navigation, recreation, fisheries, riparian vegetation, aesthetics, and hydropower. Off-stream water withdrawals include uses such as irrigation, municipal and industrial water supply, and cooling water.

INTERBASIN TRANSFER: The physical conveyance of water from one watershed to another.

IRRIGATION SCHEDULING: The process that enables an irrigator to apply irrigation water in the proper amounts and at the proper time to efficiently alleviate moisture shortages.

MINIMUM STREAMFLOW: The lowest daily mean discharge that will satisfy minimum instream flow requirements. The minimum streamflow represents the discharge at which all withdrawals from the stream will cease.

NONCONSUMPTIVE USE: Use of water with return to the stream or waterbody of substantially the same amount of water as withdrawn. A use in which only insignificant amounts of water are lost by evapotranspiration or incorporation in a manufactured product.

NONPOINT SOURCE: The entry of a pollutant into a body of water in a diffuse manner with no definite point of entry and where the source is not readily discernable.

PERCOLATION: Movement under hydrostatic pressure of water through the openings of rock or soil, except movement through large openings such as caves.

PERMEABILITY: A measure of the relative ease with which a porous medium can transmit a liquid under a potential gradient.

pH: A measure of the relative acidity of water. Below 7 is increasingly acid, 7.0 is neutral, and above 7 is increasingly alkaline (basic).

POINT SOURCE: The release of a pollutant from a pipe or discrete conveyance into a body of water or a watercourse leading to a body of water.

POROSITY: The voids or openings in a rock. Porosity may be expressed quantitatively as the ratio of the volume of openings in a rock to the total volume of the rock.

POTENTIOMETRIC SURFACE: A surface that represents the total head in an aquifer; that is, it represents the height above a datum plane at which the water level stands in tightly cased wells that pentrate the aquifer.

PRIME FARMLAND: Land well suited to the production of food and fiber. Prime farmland has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when managed according to acceptable farming methods.

RCRA SITES: Resource Conservation and Recovery Act sites where hazardous wastes are treated under authorization of regulatory agencies.

RECHARGE: The entry into the saturated zone of water made available at the water table surface, together with the associated flow away from the water table within the saturated zone.

RECHARGE AREA OR ZONE: That portion of a drainage basin in which the net saturated flow of groundwater is directed away from the water table.

RECHARGE, ARTIFICIAL: The addition of water to the groundwater by activities of man at a recharge rate greater than normal.

RIPARIAN DOCTRINE: The system of law in which owners of lands along the banks of a stream or waterbody have the right to reasonable use of the waters and a correlative right protecting against unreasonable use by others that substantially diminishes the quantity or quality of water. The right is appurtenant to the land and does not depend upon prior use.

RIPARIAN RIGHTS: The rights accompanying ownership of land along the bank of a stream or lake under the riparian doctrine.

RUNOFF: (1) That portion of precipitation which does not return to the atmosphere through evapotranspiration nor infiltrate the soil to recharge groundwater, but leaves the hydrologic system as streamflow; also (2), that portion of precipitation delivered to streams as overland flow to tributary channels.

ROCK: Any naturally formed, consolidated or unconsolidated material (but not soil) consisting of two or more minerals.

SALTWATER INTRUSION (Seawater intrusion): The migration of saltwater into freshwater aquifers under the influence of groundwater development (pumping).

SATURATED ZONE: The subsurface zone occurring below the water table where the soil pores are filled with water, and the moisture content equals the porosity.

SAFE YIELD:

SURFACE WATER: The safe yield of a stream or river is the amount of water that is available on a dependable basis which could be used as a surface-water supply. The safe yield is the discharge which can be expected 95 percent of the time minus the discharge necessary to maintain the minimum flow in the stream during the low-flow season (July-October).

GROUNDWATER: The safe yield of an aquifer is roughly equal to the recharge rate to the system. Due to the temporal and spatial variability of recharge, the safe yield can most easily be expressed as the quantity of groundwater that can be withdrawn while maintaining static water levels over the long term.

SHEET AND RILL EROSION: A combined process caused by runoff water, that removes a fairly uniform layer of soil from the land surface and forms many small channels in the land surface.

SOIL: The layer of material at the land surface that supports plant growth.

SPECIFIC CAPACITY: The discharge from a pumping well (the pumping rate) divided by the drawdown in the well; it is a measure of the productivity of a well.

SPECIFIC RETENTION: The ratio of (1) the volume of water which the rock or soil, after being saturated, will retain against the pull of gravity to (2) the volume of rock or salt.

SPECIFIC YIELD: The ratio of (1) volume of water which the rock or soil, after being saturated, will yield by gravity to (2) the volume of the rock or soil.

STORAGE COEFFICIENT: The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. In an unconfined aquifer, the storage coefficient is equal to the specific yield.

STRATIFICATION: The layered structure of sedimentary rocks.

TRANSMISSIVITY: The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It equals the hydraulic conductivity multiplied by the aquifer thickness.

UNCONFINED AQUIFER: An aquifer in which the upper surface of the saturated zone is free to rise and fall.

UNSATURATED ZONE: The subsurface zone, usually starting at the land surface, that contains both water and air.

WATER TABLE: The level in the saturated zone at which the pressure is equal to the atmospheric pressure.

WATERSHED: The area of contribution to a surface water body or a central discharge point. It is defined by topographic high points.

WATERSHED PROTECTION: Establishing land treatment measures within a particular watershed to reduce erosion, sediment, and/or runoff.

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<101> ....1985, National primary drinking water regulations (section 141.11 of part 141 and section 143.3 of part 143, National primary drinking water regulations): U.S. Code of Federal Regulations, Title 40, Parts 141, 142, and 143, revised as of November 14, 1985, 166 p.

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<103> U.S. Geological Survey, 1975, Groundwater levels in observation wells in Arkansas, Spring 1975: U.S. Geological Survey unnumbered report.

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APPENDIX A

COMMENTS ON THE DRAFT REPORT

Additional comments were received from the U.S. Geological Survey and the Arkansas Geological Commission, but they were transferred to the Arkansas Soil and Water Conservation Commission as notations in the margin of the draft report and cannot be included here.

Arkansas Association of Conservation Districts

May 28, 1986

Arkansas Soil and Water Conservation Commission
#1 Capitol Mall, Suite 2-D
Little Rock, Arkansas 72201

ATTN: J. Randy Young, P. E.,
Director

Dear Mr. Young:

In my review of a Draft of the Arkansas Water Plan which dealt specifically with the Lower Ouachita River Basin, there were some questions that should be considered.

My questions mainly deal with the issue of instream flows and fish and wildlife requirements. The questions arise primarily because it appears that your recommendations would in a number of instances diminish certain riparian use rights that now exist.

I totally agree that we should have instream requirements. What differing set of circumstances makes it possible to use the low flow occurring for one week in a ten year time span as the instream need in Mississippi while we in Arkansas must set that level at least 10% higher.

There must be a workable balance between those existing Agriculture needs and instream needs.

Are there any proposals for mitigation when present use rights are reduced by a state established instream requirements? This may be a consitutional issue. The state has already recognized the need for the development of off stream storage of surplus surface water. I hope that is taken into consideration when establishing instream needs during fall and winter high flow periods.

Your consideration is appreciated.

Sincerely,

King O'Neal

King O'Neal, President
AACD

KON:ccm

DEPARTMENT OF THE ARMY
LITTLE ROCK DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 867
LITTLE ROCK, ARKANSAS 72203-0867

REPLY TO
ATTENTION OF

May 20, 1986

Planning Division

Mr. J. Randy Young
Director, Arkansas Soil and Water
Conservation Commission
Suite 2D
1 Capitol Mall
Little Rock, Arkansas 72201

Dear Mr. Young:

The Little Rock District Corps of Engineers has coordinated the review and comment on the Draft Lower Ouachita Basin Report of the State Water Plan with the Vicksburg and Memphis Corps Districts. We have consolidated all of the comments received. The comments from the Vicksburg District are in Enclosure 1. The Memphis District had no comments. Comments from the Little Rock District are in Enclosure 2.

Thank you for the opportunity to review and comment on the Draft Lower Ouachita Basin Report. If we could be of further assistance, please contact us.

Sincerely,

David L. Burrough
Chief, Planning Division

Enclosures

LMKPD-O (SWLED-PC/18 Apr 86) 1st End Cochran/ejb/5962
SUBJECT: Arkansas State Water Plan, Lower Ouachita Basin Draft

DA, Vicksburg District, CE, Vicksburg, MS 39180-0060 25 April 1986

TO: Commander, Little Rock District, ATTN: SWLED-PC, Post Office Box 867, Little Rock, AR 72203-0867

1. Reference telephone conversation between Mr. Joe T. Clements, Jr., SWLPD, and Mr. David R. Cochran, LMKPD-O, on 23 April 1986, subject as above.

2. We have reviewed subject draft report and have the following comments:

a. On page 3-38, the 24.3 MGD for public supply should be 17.49 MGD in 1980 based on the Corps definition of public supply.

b. On page 3-38, the 77 MGD for public supply should be 43.95 MGD in 2030 based on the Corps methodology for future use.

c. On page 3-38, the 69.2 MGD for self-supplied industry should be 68.2 MGD in 1980.

d. On page 3-38, the 268 MGD for self-supplied industry should be 199.59 MGD in 2030 based on the Corps methodology for future use.

e. On page 3-38, the 7.8 MGD for rural use should be 11.54 MGD in 1980 based on the Corps definition of rural.

f. On page 3-38, the 17 MGD for rural use should be 19.19 MGD in 2030 based on the Corps methodology for future use.

3. A copy of a recent Vicksburg District draft net needs analysis of the entire Ouachita River Basin is enclosed for your review and comment (encl 2). Please provide your comments not later than 30 May 86.

4. If there are any questions, please contact Mr. David Cochran at FTS 542-5962.

FOR THE COMMANDER:

V.C. Ahlrich

2 Encls
wd Encl 1
Added 1 Encl

V. C. AHLRICH
Chief, Planning Division

Enclosure 1

ARKANSAS STATE WATER PLAN
Comments on the Draft Lower Ouachita Basin Report

Abstract. Page 2. The low flow conditions are serious in Bayou Bartholomew as 404 Permit application reviews have revealed. Withdrawal of water for irrigation purposes when the stream was flowing very low is primarily responsible.

Abstract. Page 2. Agree that non-point source pollution is a major problem in this delta region-low lying land (often wetlands are farmed); the clearing of land adjacent to streams and lakes results in non-point source pollution. Hopefully the 1985 Farm Bill will allow more of the marginal low lying land to revert to non-crop status; with these areas becoming vegetated. One might see green buffer zones for wider distances than at present along the basin waterways.

Land Resources Inventory, Wetlands. Page 2-4. There are other wetlands in Arkansas such as wet meadows, freshwater marshes and bottomland hardwood wetlands. Wetlands are waters of the United States and are subject to regulation by the U.S. Army Corps of Engineers as promalgated by Section 404 of the Clean Water Act of 1977, as Amended. Any discharge of dredge or fill material in a wetland that is adjacent to a Phase I, II or III stream (as described in Section 404 of the CWA, 1977) will require a permit from the Corps of Engineers (in this case the Lower Ouachita River Basin wetlands are regulated by the Vicksburg District Corps of Engineers).

Wetlands have numerous functional values which, at least, a few are worth mentioning for the State Water Plan. Major functions of bottomland hardwood wetlands are food and cover for fish and wildlife, water quality improvement, ground water recharge, soil enrichment, erosion control and downstream fishery benefits (Barnes, 1985 Colorado State Report).

Cavities in trees (alive and dead) provide habitat for wood ducks, squirrels, raccoons and other wildlife. Over 90 percent of the birds in eastern North America use bottomlands at some time in their life history; wintering ducks use these areas in the Lower Ouachita River Basin. Deer harvest by hunters is several times higher with larger animals bagged in the bottomland areas as compared to upland forests. A significant decline of these bottomland areas in the Southeast has occured in the last century.

In 1900, about 70 million acres of stream and river valleys existed in the Southeastern states, with about 24 million acres classified as bottomland forest. This has been reduced to 5 million acres in 1984. In Arkansas and Louisiana alone the acreage has decreased by 7 million acres since 1937. It is estimated that there will be an additional one million acres cleared by 1995 which is 20 percent reduction from the present remnant.

Enclosure 2

Some recommended land use practices for the basin are to make 10 to 20 acre small clearcuts and to leave fallen logs in wetlands to provide habitat and soil retention. The retention of wetlands in urban settings are desired to provide educational nature areas, water purification of toxic and urban runoff. Of course, there are limits to the loading that a wetlands can purify and still maintain other functional values.

Surface Water, Introduction. Page 3-3. How large is Georgia Pacific Lake near Crossett? Also, Felsenthal National Wildlife Refuge has a significant water surface area which is a major impoundment on the Lower Ouachita River constructed in the early 1980's by the Corps of Engineers.

Surface Water, Instream Flow Requirements. Minimum flows should be established by season (fall, spring and summer) rather than only one flow for the most severe period (summer through early fall) otherwise future projects such as interbasin or interstate water transfers could significantly impact the stream being diverted. In doing so, other ecological processes would be protected such as high flows in the spring to insure adequate spawning in backwater and wetland areas. The emphasis should also be on maintaining the existing fishery not enhancement via postulations of upstream reservoirs with storage for increased minimum releases. It would be advisable, where possible, to use another method like the IFIM Incremental Flow Methodology to serve as a check on what is suggested by the Tennant Method. In summary, the instream flows to be protected must be a common sense approach that utilizes both scientific data, hydrologic reality, and a prioritization of streams which serves a region.

Surface Water, Potential for Development. Pages 3-32 to 3-35. The firm yield of a potential site should be based on drainage area and drought of record not solely on reservoir storage characteristics.

Surface Water, Potential Water Use. Page 3-36. In projections, no consideration is given to mining(lignite) or oil and gas projection in projections. Also, no consideration is given to water use in areas without a history of water use.

Surface Water, Water Use Trends. Page 3-36. Wildlife impoundment water use history values should be marked "no data" instead of zero.

Surface Water, Legal and Institutional. This section should be a separate volume of the State Water Plan. It should be combined with the Legal and Institutional sections from other chapters especially Ground Water.

Surface Water, Surface-Water Quality Problems. No erosion rates should be shown for landuses of Urban-Builtup and Water, Mines and Other in Tables 3-24, 3-27, 3-30 and 3-33. Average erosion rates should be listed as not computed.

Arkansas GEOLOGICAL COMMISSION
VARDELLE PARHAM GEOLOGY CENTER ● 3815 WEST ROOSEVELT ROAD ● LITTLE ROCK, ARKANSAS 72204

NORMAN F. WILLIAMS
STATE GEOLOGIST
501-371-1488

FROM: Bill Colton *MwL* *To Denny*

TO: Bill Bush

SUBJECT: Quick review of Lower Ouachita Basin draft (1986)

This is a quickly prepared list of comments.

Fig. 1-1. Lousy maps! Can't read county names.

Pg. 4-2. 1st sentence. Seems like a back-handed statement. How about... Freshwater aquifers in the lower Ouachita River basin are Paleozoic, Tertiary, and Quaternary in age.

Fig. 4-1. This is stratigraphy--not lithology. It could be read like this--"Tertiary System lithology excludes Quaternary deposits..." [of course the Tertiary does not include the Quaternary.]

Fig. 4-4. Strange title.

Fig. 4-5. do.

Fig. 4-6 Some "formation use areas" agree fairly closely with those on fig. 4-2, but others do not agree at all. Why not?

Pg. 4-6. 1st paragraph. Fig. 4-7 does not show thickness. Thickness is, however, shown on fig. 4-8, which for some strange reason follows fig. 4-9. Why?

Pg. 4-9. 4th line. Why 60 ft? Fig. 4-8 shows some areas along Ouachita River of 101-150 ft. Did you mean 160 ft--as along Bartholomew River and in western Ashley Co.?

Pg. 4-10. 1st complete sentence. This reads as though withdrawals are increasing at rates of 2.3-4.2 MGD. This can't be!

[General--many of the figures use too fine a stipple pattern. It does not reproduce. Esp. see fig. 4-11.]

Fig. 4-11. Title--what does "average annual and water level change" mean?

Pg. 4-14. It would be nice if these 3 towns were shown on figs. 4-12 and 4-13.

Fig. 4-14. Another over-abbreviated title.

Pg. 4-16. Is Monticello Ridge shown on any map in this report?

Pg. 4-18. Cockfield commonly 300'± thick? Fig. 4-15 shows no 300-ft contour! Most of area looks like about 200'.

Pg. 4-20. 61-80%? I think you mean 81-100%.

Fig. 4-23. Should this read--Shows thickness of unit. Contour interval 100 feet.(?)

Fig. 4-27. I have discussed the problems on this fig (wrong patterns) with D. Goodwin. (5/21/86)

Pg. 4-45. 3rd paragraph. but FIFRA was not listed above.

Pg. 4-53-4. Last line p. 4-53; 1st line pg. 4-54. What is wrong with this statement? Missing word or words?

Pg. 4-55. 2nd paragraph. Are these just potential problems or are some of them existing problems?

Pg. 4-57. 1st paragraph. how about...from wells monitored by the U.S. Geological Survey in each county.(?)

[Throughout the paper: 5- and 10-yr intervals are listed frequently--say, as on pg. 4-60, fig. 4-40, Tab. 4-12, 1975-1980 and 1975-1985. Many, myself included, consider these as 11-yr. intervals. Do you mean, in the 1st case 1975 through 1979 or 1976 through 1980. If I needed to check your data, I would need to know. Furthermore it can lead to an anomalous situation--as in fig. 4-40 where you list the intervals 1975-80 and 1980-85. Except for common sense, one might infer that data for 1980 were used twice.]

Fig. 4-44. (also 4-40 and probably others)--
Neither the type of change (depth to water level) nor the units of measurement (feet) are shown. However on Tab. 4-13 (over page) you went to the trouble to identify both. Why not do so on all such figures?

Fig. 4-45. Wouldn't this be simpler? Isolines showing distance [or interval] between the top of the Sparta Sand and its potentiometric surface

Fig. 4-48. This probably should be redrafted. Clear out pattern over names--among other things.

Pg. 4-70. "Potential Groundwater Problems". This reads strangely because you have been discussing nothing but groundwater problems for the last 20-30 pgs. Why not something like--"Additional [or Other] Groundwater Problems"?

Pg. 4-94. Sentence in brackets--This sentence must be grammatically incorrect. I can't figure it out. What, for example, is antecedent of "itself"?

Arkansas Game & Fish Commission
2 Natural Resources Drive Little Rock, Arkansas 72205

Steve N. Wilson
Director

June 30, 1986

Mr. Randy J. Young, Director
Arkansas Soil & Water Conservation
Commission
One Capitol Mall - Suite 2D
Little Rock, AR 72201

Dear Mr. Young:

My staff is in receipt of your memorandum of June 16, 1986, concerning proposed changes to the ASWCC's Lower Ouachita Basin Report (Draft). I believe your summary of the comments covers the main points of discussion made at the meetings. Several of the statements need to be clarified or explained as follows:

(1) Concerning the effects of river flows at and below the recommended instream flow levels mentioned in the minimum stream flow section, the following levels and results are discussed. Using the instream flow recommendations as computed by the Tennant or Montana method, 60% of the average annual flow is the base flow recommended to provide excellent habitat for most aquatic and related species during their primary periods of growth and for the majority of recreational uses. Most of the normal channel substrate will be covered with water, including riffles, shoals and side channels. Few gravel bars will be exposed so aquatic invertebrate diversity and production should be high, which is the basis for most aquatic food chains. Riparian vegetation will have plenty of water allowing for wildlife nesting, denning, nursery and refuge habitat. Fish production, spawning and nursery areas will be accessible and usable, and spawning migrations will not be hindered by shallow riffle areas. Recreational boating, canoeing, swimming, and rafting will all have an excellent quantity of water available. Some flooding of associated wetlands for waterfowl habitat will be possible.

At 30% of the average annual flow, most aquatic organisms experience good survival since the majority of the substrate is covered with water, except for wide, shallow shoal areas. Most side channels carry some water, and riparian vegetation is not diminished. Most islands and stream banks will provide adequate nesting, denning, nursery and refuge habitat for associated wildlife species. Most pools and many runs will have deep enough water for fish, and many riffle or shoal areas are able to be transversed. Water temperatures are not expected to be a limiting factor in most stream segments. Aquatic invertebrate levels decrease but usually not to the point where fish production is substantially reduced. General recreational activities such as swimming, canoeing, and rafting are possible. Boating usually is limited to shallow, draft boats. Flooding of associated wetlands for waterfowl habitat will not occur.

Ten (10) percent of the average annual flow is a minimum recommendation only to sustain short-term survival habitat for most aquatic life. The aquatic habitat is degraded since channel widths, depths, and velocities are greatly reduced. The stream substrate will be nearly half exposed except in shallow shoal areas where exposure will be higher. Side channels may be severely or totally dewatered and islands and stream bank areas will usually no longer function as wildlife nesting, denning, nursery and refuge habitat. Fish will be crowded into the deepest pools or areas of a river since many wetted areas will be too shallow. Upstream migration by spawning stocks of fish will be hindered, if not stopped. Water temperature will be a limiting factor, especially from July through September. Aquatic invertebrates (benthos) will be severely reduced. Recreational activities are limited to swimming (if esthethics are acceptable) and some shallow water canoeing and/or rafting. Overharvest of fish can occur due to their concentration and accessibility by fishermen.

The instream flows quantified by the Arkansas method and based on principles of the Tennant method follow the natural hydrograph of Arkansas streams and provide adequate but practical protection of associated fish and wildlife. Following the recommended levels will maintain existing fish and wildlife populations inhabiting or depending on the streams in question. Failure to achieve the recommended levels (by whatever means) will cause degradation of the fish and wildlife resource, a decline in survival of the various species associated with our rivers including various fish, waterfowl, furbearers, and terrestrial wildlife, and a shift from desirable forms to more pollution tolerant types will occur. A reduction in flows below those recommended by the Arkansas method will cause a decline in fish spawning due to migration problems and reduced flushing of spawning areas making them unacceptable. Those desirable species able to spawn will experience a decrease in egg and fry survival and more tolerant types will succeed (i.e. carp, gar etc.). Lower flows contribute to increased water temperatures and lower dissolved oxygen levels. Fish kills may occur due to this as well as the increasing concentration of pollutants and sediments in the water. Aquatic invertebrates production decreased, causing proportional decreases in fish production. Septic wastes are not flushed from the system. The natural ability of the stream to accept and dilute human waste products is decreased and groundwater recharge (into the aquifers) is decreased.

At the level set by the ASWCC as a minimum flow (10% of the mean flow for the period of July through October), extreme degradation to the fish and wildlife resource in a stream has already occurred. Water temperatures have significantly increased, mirrored by a substantial decrease in dissolved oxygen content in the water. Shoal or riffle areas are dewatered or essentially out of production. Spawning and survival of desirable fish types is greatly reduced. A shift to more tolerant and less diverse fish and invertebrate populations is occurring. Riparian vegetation and associated wildlife is greatly reduced. Flushing of sediment and septic wastes in the system is essentially nil, magnifying dissolved oxygen depletion, fish kills, pollution, and groundwater contamination. Waterfowl habitat is decimated and terrestrial wildlife dependent on the river become more susceptible to dependent limiting factors such as predation, disease, lack of reproductive success and starvation. Recreational activities are greatly reduced due to extreme reductions in water quality and quantity affecting swimming and other water contact sports (canoeing, boating, etc.). In general, flows lower than those recommended by the Arkansas method and on down to the ASWCC's "minimum" level cause degradation of fish and wildlife to varying degrees, depending on the distance below the acceptable levels (Arkansas method).

(2) It was our understanding at the meetings that after our input and comments into the Lower Ouachita Basin Report (Draft), additional review by appropriate agencies would be possible before the final report is filed.

If there are any questions concerning the above material and understandings, please feel free to contact staff members that have worked with your agency on this project from the beginning. Thank you for the opportunity to comment on the Lower Ouachita Basin Report (Draft) and you can be assured of our continued cooperation on this matter in the future.

Cordially,

Steve N. Wilson
Director

SNW:SF:jmc

STATE OF ARKANSAS
DEPARTMENT OF POLLUTION CONTROL AND ECOLOGY
8001 NATIONAL DRIVE, P.O. BOX 9583
LITTLE ROCK, ARKANSAS 72209

PHONE: (501) 562-7444

June 25, 1986

RECEIVED
JUN 27 1986
SOIL AND WATER
CONSERVATION COMMISSION

Mr. Randy Young, Director
Soil & Water Conservation Commission
No. 1 Capitol Mall, Suite 2D
Little Rock, AR 72201

Dear Mr. Young:

The following comments comprise the input of the staff of the Department of Pollution Control and Ecology concerning the draft copy of the Arkansas State Water Plan - Lower Ouachita River Basin and subsequent meetings with your staff. It is understood that the magnitude of a project of this type and the mandate imposed by the past Legislature has created overwhelming circumstances in trying to supply the resources and manpower to complete the job. Yet the seriousness with which we view the long term directions set out by the State Water Plan along with potential effects on the water resources of our state cannot be overstated. The innately wide range of overlapping concerns and interest dealing with water resource issues provides some insight into the complexities of the solutions. It is with these concerns that we make these constructive comments.

The groundwater section of the report attempts to discuss and develop a plan based on surface water drainage basins. It is well documented that groundwater aquifers and recharge areas are not congruent with surface drainages. In its recent publication on groundwater problems, USGS abandoned the surface drainage basins as a vehicle for dividing its report and this resulted in a much more logical, concise and comprehendable document than its first draft which, like the State Water Plan, was based on a surface approach.

It should be made clear to all readers of this document that there is a significant paucity of data on the quantity and quality of groundwater in Arkansas and that much of the available data is self-supplied by the users and may be heavily biased by their preconception of the uses of the data. An additional source of data which is available concerning groundwater quality is the RCRA industrial monitoring data available through STORET.

Although there have been recent meetings between our agencies' staffs with candid discussions of the philosophic differences, we remain very concerned about the methodology used in the draft document to establish minimum streamflows for surface waters and the negative impact these will have on the biotic uses of the streams. These minimum streamflows are proposed to be only 10% of the historical flows of the driest months of the year, (i.e., July, August, September and October). This minimum streamflow, hereafter referred to as SWC plan, is proposed to supply all instream flow needs, including fish and wildlife, during all seasons of the year. This approach is totally unacceptable and will drastically alter the beneficial uses of the streams. By statutory definition, minimum streamflows are the point at which "all diversions should cease"; however, there remains no effective mechanism to control diversions above this level. Without such controls, diversions will cause the minimum streamflows to become the average streamflow and "worst case" conditions for instream aquatic life will become the standard.

The Clean Water Act was a mandate from Congress to reverse the trends of degradation of the nation's waters and to restore and maintain the chemical, physical and biological integrity of these waters. Such a mandate is not limited to water quality control and is so recognized in the Act. In the goal of the Clean Water Act....."that provides for the protection and propagation of fish, shellfish and wildlife and recreation in and on the water," it further recognizes and mandates the protection of all life stages of the aquatic biota, specifically including the propagation stage. It is intimately clear that maintaining the "biological integrity of the nation's waters" must include maintenance of a flow regime that will be fully protective of the biotic beneficial uses of these waters.

From recent staff discussions, it was recognized that the proposed "Arkansas Plan" represents acceptable streamflow conditions which may become average or standard conditions without significant damage to the aquatic resources. It is realized that there will be both natural and artificial flow conditions above and below these "target" flows. In recognition of this, your letter of June 16, 1986 states that the Arkansas Method of establishing minimum streamflows is recognized as "the point at which fisheries begin to be impacted" and that "this impact on fisheries should be given consideration if allocation of water is implemented." Such an allocation plan needs to be developed, agreed upon and made a part of this plan. If a rigid and effective allocation plan is developed, a minimum streamflow can be set at relatively low levels; without an active allocation plan, minimum streamflows must be set high enough to ensure protection of the aquatic resources in the streams.

Your intent to "recommend a stream classification system be established so that minimum flows could reflect the weight of their historic pattern and recognition be made of the variation in uses of the state's surface waters," has merit and could be a valuable asset to the State Water Plan and to numerous other water resource management activities. Therefore, to establish minimum streamflows before this option is thoroughly investigated would be inappropriate.

It is imperative that minimum streamflows be established on a seasonal scale since the instream flow needs for fish and wildlife are drastically different in the spring of the year than during the late summer. The needs are more critical during the reproductive season of the fish than at any other time. To assume that there will always be sufficient water for fish reproduction in the springtime and that removal of water from the streams during this period could not be of significant magnitude to affect the fishery is erroneous. Our studies have shown that higher water quality standards requiring more sophisticated treatment procedures and/or higher background flows are necessary during the springtime when the most sensitive life stages of various aquatic organisms are present. Therefore, allocation level flows and/or minimum streamflows should mimic the general hydrological pattern of the stream.

We fail to find the rationale or justification for the SWC plan for establishing minimum streamflows; (i.e., 10% of historical flows of July through October), particularly since data from Bayou Bartholomew, an established "critical water area" was used to develop these flows. We are also convinced that these levels will have severe negative impacts on the stream biota.

Since there appears to be several factors which may influence the establishment of minimum streamflows, e.g., allocation procedures and stream classification, we suggest the establishment of minimum streamflows be delayed until all of the basin plans can be thoroughly reviewed and the factors mentioned above resolved.

Sincerely,

Phyllis Garnett

Phyllis Garnett, Ph.D.
Director

PG/sy

United States Department of Agriculture

Soil Conservation Service

Room 2405 Federal Office Building
700 West Capitol Avenue
Little Rock, Arkansas 72201

MAY 27 1986

Mr. J. R. Young, Director
Arkansas Soil and Water Conservation Commission
One Capitol Mall, Suite 2D
Little Rock, Arkansas 72201

Dear Randy,

Thank you for the opportunity and additional time given to us to review the draft report on the Lower Ouachita Basin portion of the State Water Plan.

My staff has completed their review of the document and feel that you have done a good job in putting such an important and complex report together.

We have furnished Mike Sullivan with a marked copy of the basin report indicating our comments, questions, and suggestions. The comments are written in the narrative portions and margins of the draft.

Sincerely,

Jack

JACK C. DAVIS
State Conservationist

3753F

223 Ozark Hall
(501) 575-4404
Fayetteville, Arkansas 72701

UNIVERSITY OF ARKANSAS · Arkansas Water Resources Research Center

May 23, 1986

Mr. Randy Young, Director
Arkansas Soil and Water Conservation Commission
One Capitol Mall, Suite 2D
Little Rock, AR 72201

Dear Randy:

Thank you for sending me a copy of the Draft Lower Ouachita Basin Report to review.

You folks did a great job. Most readers don't appreciate the blood, sweat and tears that go into a job like this from the writers to the typists including all the other people in between.

As Earl knows, I was concerned beforehand that the "Plan" might just be a historical review with little to no planning, but you include recommendations and it is a planning document.

Congratulations for a job well done.

Sincerely,

Les

Leslie E. Mack
Director

dcw

James H. Phillips
Exec. Director
Phone: 501-371-1173

Arkansas Waterways Commission

1515 West Seventh Street, Suite 505
Little Rock, Arkansas 72202

April 25, 1986

Mr. J. Randy Young, Director
Arkansas Soil & Water Conservation Commission
#1 Capitol Mall- Suite 2D
Little Rock, Arkansas 72201

Dear Randy:

Re: Arkansas State Water Plan

Responding to your letter of April 21st re the above subject, this Commission has reviewed the Draft for the Lower Ouachita Basin Report and there are no comments.

Sincerely,

Jim

James H. Phillips
Executive Director

JHP/cjf

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

Henry Gray, Director
Telephone (501) 569-2000

AHTD — Arkansas State Highway and Transportation Department

P.O. Box 2261
Little Rock, Arkansas 72203

May 14, 1986

Mr. J. Randy Young, P.E.
Director
Arkansas Soil & Water Conservation
Commission
One Capitol Mall, Suite 2D
Little Rock, AR 72201

RE: Arkansas State Water Plan

Dear Mr. Young:

This is to acknowledge receipt of your Draft Lower Ouachita Basin Report for the Arkansas State Highway and Transportation Department to review. We have no comments that would be helpful in the writing of the final report.

We appreciate being informed of the proposed report and look forward to receiving the final copy. Thank you for the opportunity to provide comments at this time.

Sincerely,

Charles E. Venable
Charles E. Venable
Assistant Chief Engineer
Program Management

CEV/DLP/kjf

ARKANSAS
FORESTRY
COMMISSION

P. O. Box 4523, Asher Station ■ Little Rock, Arkansas 72214

Edwin E. Waddell
State Forester

Ph. 501 664-2531

May 16, 1986

Mr. J. Randy Young, Director
Arkansas Soil & Water Conservation Commission
One Capitol Mall, Suite 2D
Little Rock, AR 72201

Dear Randy:

Thank you for the opportunity to review the draft Arkansas State Water Plan for the Lower Ouachita Basin.

Forest land data recorded in Table 2-1 of your report apparently reflects all forest land. We have more recent data from the U.S. Forest Service 1985 timber survey regarding commercial forest land. Let us know if this information would be helpful.

The Arkansas Forestry Commission is the Designated Management Agency for the silvicultural portion of Arkansas' Water Quality Management Plan. In that capacity, the Arkansas Forestry Commission has produced a booklet entitled Best Management Practices Guidelines for Silviculture. You may want to make reference to this booklet on Page 3-101 or in the Appendix of the Water Plan.

Sincerely,

Edwin E. Waddell
State Forester

Garner Barnum

By: Garner Barnum
Assistant State Forester
Resource Management

JGB:dr

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MAY 19 1986
SOIL AND WATER
CONSERVATION COMMISSION

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DEPARTMENT OF PARKS AND TOURISM
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Wesley Creel
Museum Services

May 16, 1986

J. Randy Young, Director
Arkansas Soil and Water Conservation Commission
One Capitol Mall Suite 2D
Little Rock, Arkansas 72201

Dear Mr. Young:

Thank you for the opportunity to review the draft of the Lower Ouachita Basin Report. The document contains a wealth of information which will be useful to us in recreation planning.

The ten-county study area chosen for the Report contains a variety of unique environmental and recreational resources, such as the Felsenthal National Wildlife Refuge and the Saline River, which is one of only four rivers in the state listed in the Arkansas Natural and Scenic Rivers Commission System. While the Best Management Practices (BMP'S) listed in the section on "Solutions and Recommendations" will certainly serve to enhance the environment, and, in some cases, serve to increase recreational opportunities, I am concerned that recreation was not discussed as a form of water use in the basin.

Water-based recreation in our state is very important and also very difficult to quantify. Arkansas would not be the "Natural State" without its free-flowing streams and clear, blue lakes. These water resources serve as major attractions for our tourist industry as well as giving pleasure to our residents and beauty to our surroundings. Yet many times when studies such as yours attempt to discuss and define uses of our natural resources, recreation is often forgotten or ignored.

In preparing the 1985 Statewide Comprehensive Outdoor Recreation Plan (SCORP), our department discovered some rather startling statistics which illustrate the tremendous, far-reaching impact of water-based recreation in Arkansas:

- A survey conducted for SCORP found that "fishing" ranks second only to "walking for pleasure" as a favorite outdoor activity in our state, with six out of every ten persons surveyed participating at some time of the year.

- Arkansas has three times as many registered boats per 1,000 residents as the national average.

- Last year in Arkansas, retail sales of boats, trailers, outboard motors, and other marine accessories totaled $46,390,000.

- Canoeing participation rates in Arkansas have doubled from 11% in 1980 to 22.5% in 1984. And over half (56.9%) of these floaters reported their river recreation expenses to be at least $250 a year.

- 53% of the respondents in the SCORP survey indicated that they would favor a governmental incentive such as a tax credit to land owners for not destroying wetlands.

This information leads us to believe that the recreational use of our state's water resources should be included in all our planning efforts. We would like to see recreation considered in the state water plan. We would be glad to provide any research materials that we have and to work with your staff to develop information suitable to be included in the plan.

I hope these comments will prove helpful. If you have any questions, please do not hesitate to contact our office.

Sincerely,

Jo Luck

Jo Luck Wilson

Arkansas **DEPARTMENT OF HEALTH**

4815 WEST MARKHAM STREET • LITTLE ROCK, ARKANSAS 72205-3867
TELEPHONE AC 501 661-2000

BILL CLINTON
GOVERNOR

BEN N. SALTZMAN, M.D.
DIRECTOR

May 27, 1986

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MAY 28 1986
SOIL AND WATER
CONSERVATION COMMISSION

Mr. J. Randy Young, P.E.
Arkansas Soil and Water
Conservation Committee
#1 Capitol Mall, Suite 2-D
Little Rock, AR 72201

RE: Arkansas State Water Plan
Lower Ouachita Basin Report
(Draft)
86 E 1121-6

Dear Mr. Young:

The staff of the Division of Engineering has reviewed the referenced document, and the following comments are proposed:

1. While realizing that the Groundwater Technical Steering Committee is working on a Groundwater Protection Strategy for the State of Arkansas, we feel that each Basin report should include specific protection plans for known recharge areas of drinking water aquifers.

2. The Department of Health supports the designation of a Critical Use Area because of the salt water intrusion into the Sparta Sands aquifer, which is currently the primary source of drinking water in the region. We must note, however, that a link between sodium in the diet and high blood pressure (hypertension) is far from proven. Various epidemiological studies quoted in the attached Federal Register copy failed to establish such a link.

   Even though the data currently available are inconclusive, the Department must support any plan which will prevent further degradation of the water quality in this aquifer, due to salt water intrusion.

3. This Basin Report, and possibly others, should address the fact that a low-level nuclear waste disposal facility could be constructed in the basin. A study currently being conducted for the Central Interstate Low Level Radioactive Waste Compact Commission has identified potential sites in 17 counties in South Arkansas. The counties are: Bradley, Calhoun, Clark, Cleveland, Columbia, Dallas, Drew, Grant, Hempstead, Howard, Lincoln, Little River, Navada, Ouachita, Pike, Sevier, and Union.

We will continue our review of this document, and inform you if we have any further comments.

Sincerely,

Bruno Kirsch Jr.

Bruno Kirsch, Jr., P.E.
Director
Division of Engineering

BK:HRS:cjd

Enclosure

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Arkansas