8-1-1980

A Five Year Water Research Plan for the State of Arkansas

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A FIVE YEAR WATER RESEARCH PLAN

FOR THE

STATE OF ARKANSAS

By: Robert E. Babcock

Publication No. 72

ARKANSAS WATER RESOURCES RESEARCH CENTER

A Five Year Water Research Plan

for the

State of Arkansas

submitted to

The Office of Water Research and Technology

as partial fulfillment of

P.L. 95-467

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August, 1980

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SUMMARY

The present economy and quality of life in Arkansas have largely been determined by our natural resources and the way they have been used. Likewise, insuring a sound economic future and a healthful environment in the state will depend on the efficiency and the wisdom with which nature's gifts are managed in the future. As the state's population grows and places new demands on finite resources, the need for effective resource management becomes increasingly critical. Often, a history of plenty can lead to the belated recognition of emerging resource problems. In Arkansas, such is the case with the state's water resources.

The early settlers of this land found it abundant with sparkling wild rivers, pure water and limitless fish. They found major streams, such as the White and Arkansas Rivers, useful for commerce. Over the state's history, development of its water resources has included the building of dams to create reservoirs of water supply, electric power generation, recreation and flood control. The use of surface and groundwaters for irrigation has expanded the state's agricultural potential. The state's waters attract fishermen, boaters and swimmers and serve as an important element in the natural beauty that Arkansas uses as its main tourist attraction. The McClellan-Kerr Arkansas River Navigation Project has made available a means of cheap, efficient transportation to national and international markets and provides the potential for the growth of the industrial development of a number of Arkansas cities.

Arkansas's underground geological structure provides abundant groundwater that in some instances requires little purification before being suitable for domestic, agricultural and industrial uses.

Historically, the state's main problem with water has been flooding, although droughts have occurred, such as those in the early 1930's and 1950's and the present summer of 1980. There are a number of emerging resource problems, however, that indicate the time has come for Arkansans to pay more attention to the management of their waters. The problems of water affect farmers, industrialists, local officials, environmentalists and outdoorsmen alike. Since all of these activities heavily depend on an integrated use of water, it is necessary to take collective action to solve the problems.

All water problems are interrelated. Quality cannot be separated from quantity, nor can groundwater issues be separated from surface water issues. Water must be examined as an economic commodity as well as an environmental issue. It must be rationed and used wisely, or the demand for adequate clean water will become a major issue. Grave consequences could result that would seriously affect the present quality of life enjoyed by Arkansans, if the state fails to recognize and address the water management problems that are beginning to occur around the state.

Among those problems is the declining quality of the state's surface waters, as contributed to by the discharge of municipal and industrial wastewater and by polluted rainwater run-off. New threats to the quality of groundwater supplies are appearing because of increased reliance on septic tanks and solid waste landfills. In the Grand Prairie region, south and east of Little Rock the groundwater has long been

depleting faster than it is being replenished by natural processes. Since agricultural practices are one of the major water users, they face severe shortages if these problems become more acute. Over the years, several State government agencies have been assigned responsibilities for dealing with various aspects of the state's water resources. Sometimes, those responsibilities overlap, creating confusion not only among the agencies but also among the public seeking to deal with them. Water does not recognize political boundaries. In Arkansas, the majority of the larger streams are not confined to the State's boundaries. The quality of water in the Arkansas River is affected by natural salt basins in Oklahoma, as well as by man-made pollutants discharged into the river upstream from the state boundary. Recreational pressures are severely stressing Arkansas lakes and streams. In addition, significant stress results from the development of resort communities and urban sprawl. The production of lignite and other water-related energy issues are also becoming important.

Arkansas is unique in that it still has a choice as to how it wishes to develop its resources. Water and water related resources are perhaps the single most important factor in this development. This report presents a summary of the State's water resources, the future demand for water, present water planning activities, water development projects, perceived water problems and water resources research priorities for the State over the next five years.

ARKANSAS WATER RESOURCES

Physiographic and Hydrologic Regions

The State of Arkansas can be broken into six geophysical regions:

1) The Interior Highlands (Ozark Plateau)
2) Arkansas River Valley
3) Ouachita Mountains Province
4) West Gulf Coastal Plains
5) Mississippi River Plains
6) Crowley's Ridge

The Ozark Plateaus cover northern Arkansas. They consist of sedimentary rock which has undergone massive uplift and which remains relatively horizontal with only minor deformations. Stream erosion has removed much of the original surface rock and has dissected the area into hills and low mountains although some plains occur.

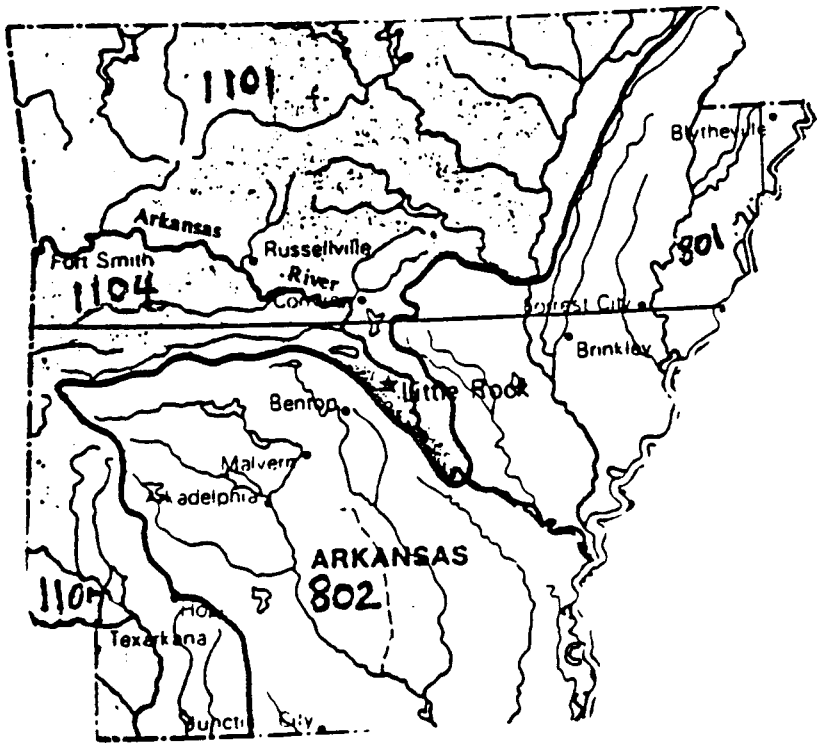
The Arkansas Valley is from thirty to forty miles wide as the Arkansas River traverses the state from north-west to south-east. The ridges are widely spaced, with valleys dominating. The Arkansas alluvial plain is a distinct feature. Elevations of valleys generally are 500 feet, declining eastward.

The Ouachita Mountains are also of sedimentary rock but here it has been folded to create generally parallel ridges and valleys which have an east-west orientation. Most of the mountain ridges are narrow, with steep slopes; crests tend to be sharp; valleys are generally rather broad. Within the Ouachitas, the sections are distinguished largely by the spacing of the folds.

The West Gulf Coastal Plain stands between 100 and 500 feet above sea level. It has a gently rolling surface, only moderately dissected by streams. Much of the surface material is unconsolidated sands deposited in the sea which once covered the area.

The Mississippi Alluvial Plain is a trough filled by stream sediments of great depth. The surface is generally flat, with local relief of less than 100 feet. Elevations range from 500 to 100 feet, decreasing southward. Crowleys Ridge is a striking irregularity upon the Plain. It is 3 to 12 miles wide, rising 200 feet above the Plain in the north and 100 feet in the south. It has a deep cover of loess, a fine wind-deposited material, and is dissected into a rolling hill region.

In terms of the U.S. Water Resources Council Regions, the State is divided almost equally between the Arkansas-White-Red Region and the lower Mississippi Region with portions of five assessment sub-areas (1101, 1104, 1107, 801 and 802) being present in Arkansas.



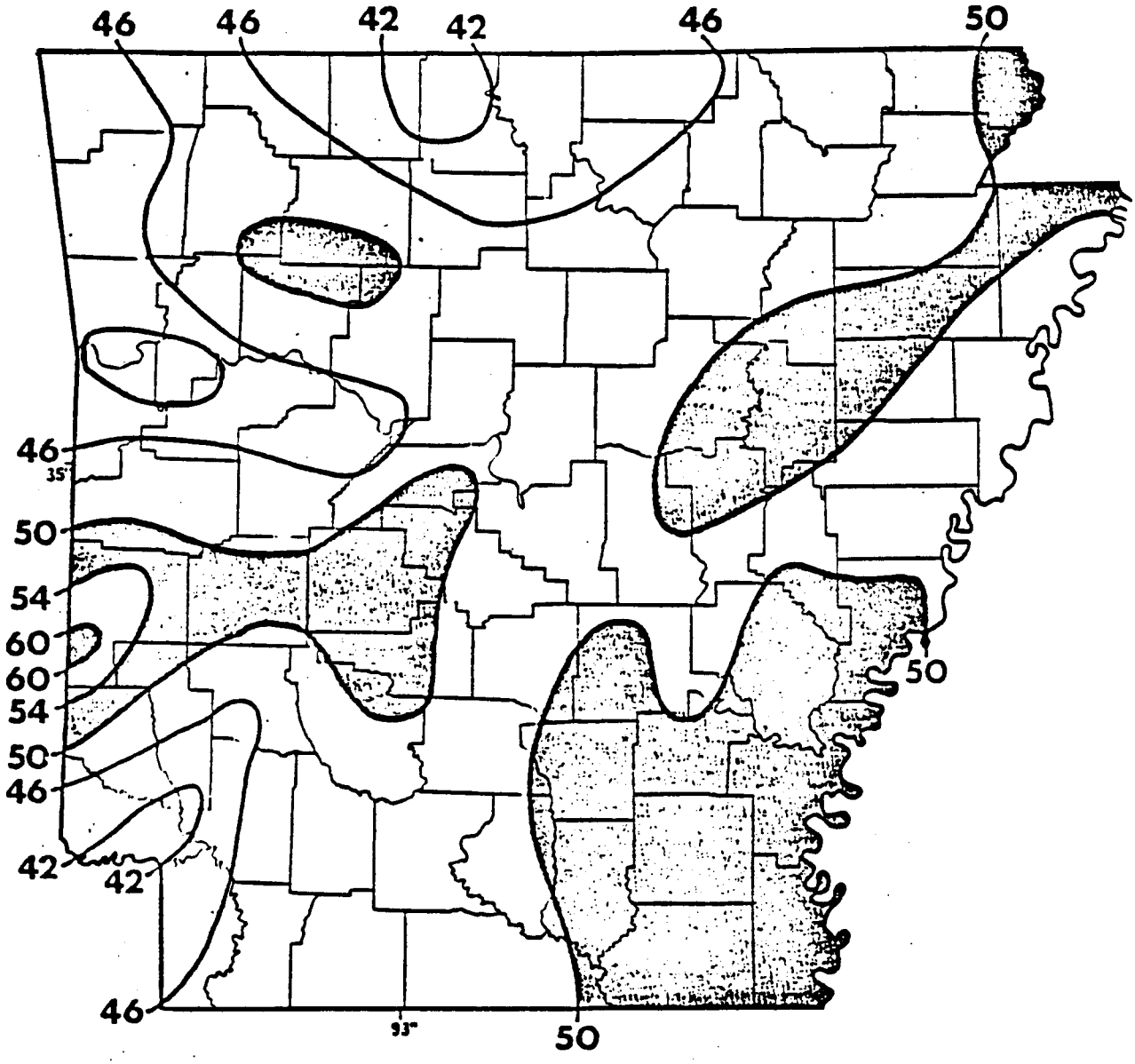
The water-related problems existing in each of these assessment sub-areas as identified by the 1st and 2nd National Water Assessment is discussed in a later section.

Mean Annual Precipitation

The mean annual precipitation ranges from about 40 inches in the western Arkansas River Valley to about 60 inches in the western Ouachitas. Most precipitation in Arkansas is frontal in origin, occurring along the "front" where two unlike air masses meet. Locally in highland areas precipitation amounts are increased by orographic action which occurs when moist air is forced to rise over a landform barrier. This happens especially in the Ouachitas that has the highest mean annual precipitation in the state. Most precipitation is in the form of rain. Snowfall occurs throughout the state, but nowhere is it great enough to add significantly to the precipitation total.

Since most of the state's precipitation is of the frontal type, the locations of the major storm tracks in the area are important factors in Arkansas' precipitation. Three major storm tracks affect the state. The most important is the South Pacific track which crosses the state diagonally from the southwest to the northeast. As a low moving along this track reaches the central part of the nation, it draws warm, moist air toward it from the Gulf of Mexico; thus creating precipitation in Arkansas.

The Texas storm track passes to the south and east of the State. Lows following this track are able to draw considerable moisture up from



MEAN ANNUAL PRECIPITATION IN INCHES

SOURCE: 1941 YEARBOOK OF AGRICULTURE

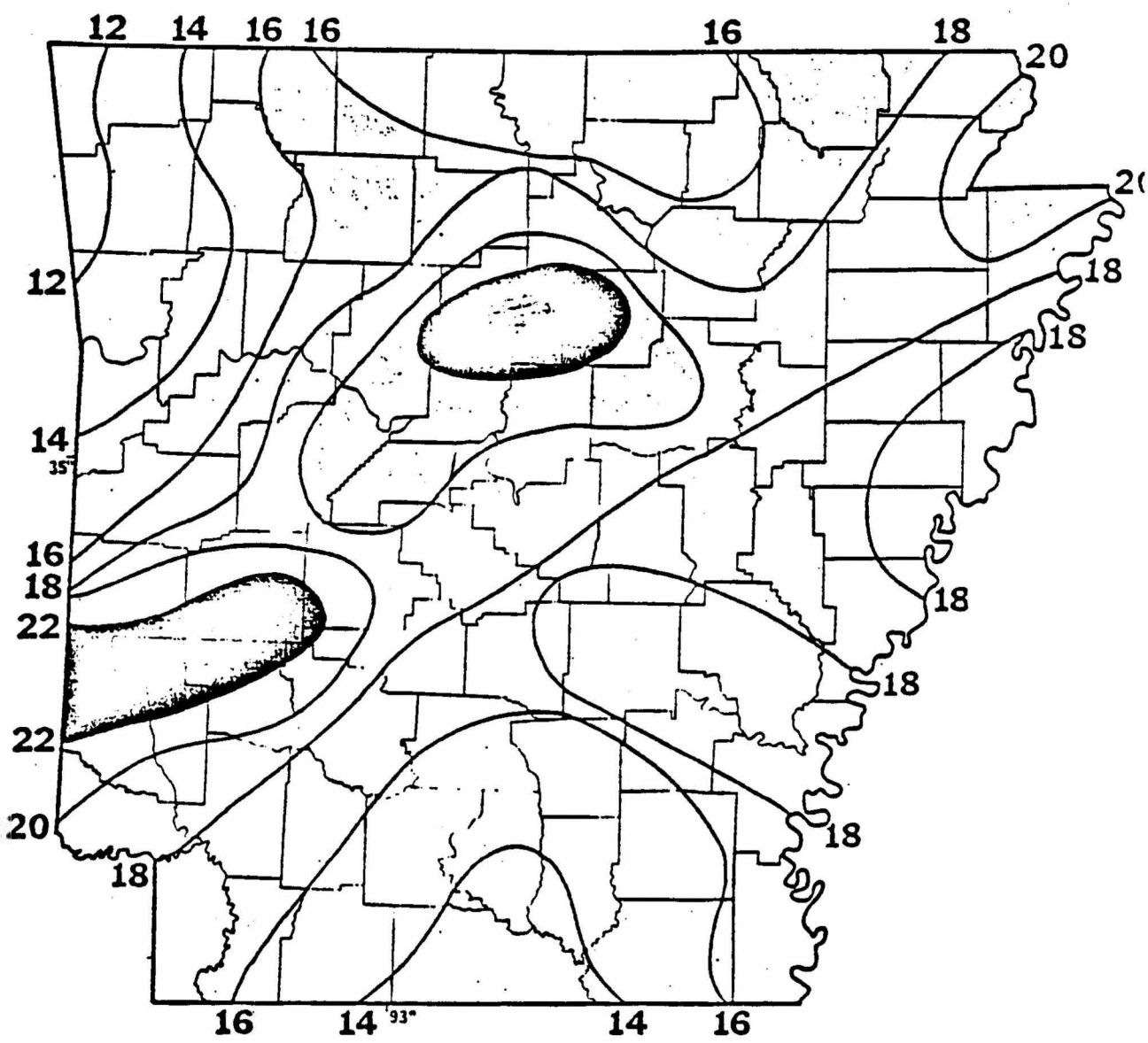
the Gulf. The track comes closest to the southeast corner of Arkansas, evidenced by the area with above 50 inches of precipitation in that region of the state.

The third track, and the one of least importance to the state, is the Colorado storm track which passes to the north of Arkansas through southern and central Missouri. This track is farther from the moisture source of the Gulf so it has less effect on the precipitation in the State. However, the Colorado track is responsible for some of the precipitation received in Northwest Arkansas.

Mean Annual Runoff

Runoff is defined as the water that drains from the land by means of surface streams. These streams are supplied by surface flow and by drainage from groundwater sources. Basically, runoff is the water remaining from precipitation after losses to evaporation, transpiration, soil moisture and groundwater.

Many variables regulate the amount of runoff. Precipitation is the most basic regulator. Amount, duration, intensity and frequency of precipitation all affect it. If precipitation amounts are small, or infrequent, or come as light showers, runoff will be small. It will be greater if precipitation comes in large quantities in a short period of time. Vegetative cover is another factor that determines the amount of runoff. A thick ground cover will retain most of the precipitation and slow surface runoff. Soil conditions are yet another factor to be considered.



MEAN ANNUAL RUNOFF IN INCHES

1940-1960

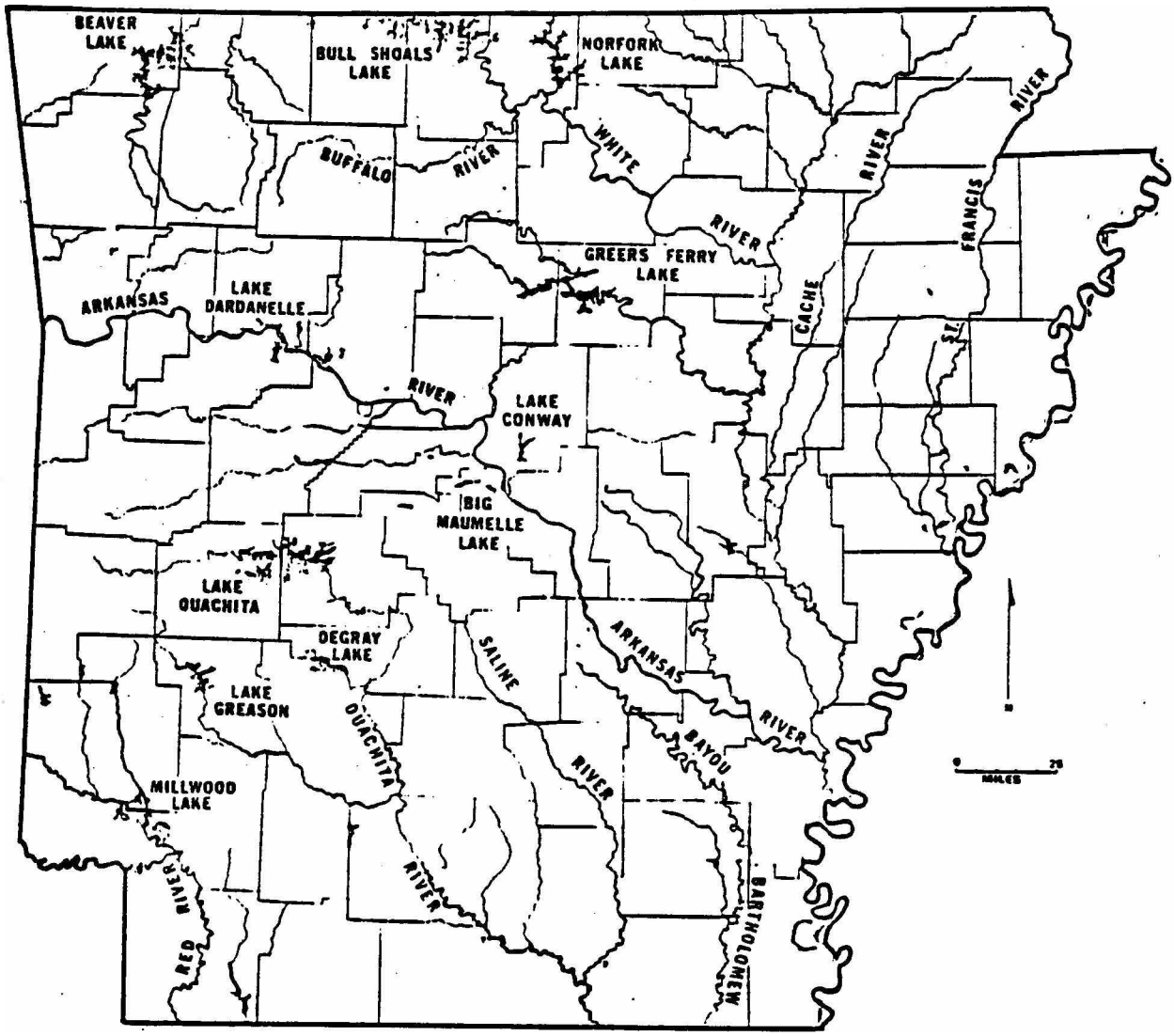
SOURCE: U. S. GEOLOGICAL SURVEY, 1955

If the soil is loose and porous, more water can percolate into the ground to become part of the soil moisture or the groundwater, thus slowing the rate and decreasing the amount of runoff. A hard-packed soil increases the amount, and the porosity of the subsoil and bedrock can also influence it. Slope, of course, also has a significant effect. All these factors must be considered together in order to understand properly the pattern of runoff in Arkansas.

A few examples of these effects of runoff will aid in interpreting the mean annual data. Heavy precipitation, considerable slope, and shallow soil with rather impervious bedrock are probable reasons for the large annual runoff in southwestern Arkansas. Similar effects are possibly responsible for the area with the greatest amount of runoff in the north central part of the state. Dense forest vegetation, little slope, plus a combination of various other factors create the low amount of runoff in extreme southern Arkansas.

Surface Drainage

Most of the major streams in Arkansas' surface drainage system flow generally toward the southeast. In the northeastern quarter of the State this general rule is broken where the White, Cache, and St. Francis rivers flow southward. Also, in the northwest corner the White River flows north before turning toward the east and then south. The largest streams, in descending order according to volume-flow, are the Mississippi, Arkansas, Red, White, Ouachita, and St. Francis rivers. All surface drainage in Arkansas eventually flows into the Mississippi River.



SURFACE DRAINAGE AND IMPOUNDMENTS

SOURCE: ARKANSAS DEPARTMENT OF PLANNING

The majority of the larger impoundments are located in the highlands along the upper reaches of the streams. Most of the lakes were constructed by the Corps of Engineers primarily for flood control, with the generation of hydro-electricity a secondary benefit. Many of the lakes and streams also serve as municipal water supplies, as well as recreational areas. Development of the Arkansas River for navigation necessitated the building of 17 dams with locks between the mouth of the river and the head of navigation on the Verdigris River in Oklahoma, 12 of which are in Arkansas. The environmental effects of this development have been surprisingly positive.

The drainage and impoundments system in the state, in addition to furnishing water, electricity, flood control, and transportation, is a valuable recreational asset of the state. Residents of Arkansas have access to fishing, boating, camping, sight-seeing, and a host of other water-related sports and activities on and around these water bodies These same facilities draw thousands of tourists to the state each year. Millions of dollars are added to the state's economy by those coming to take advantage of the recreational opportunities provided by the state's streams and lakes. This is an important factor in generating a five year water research priority plan.

Groundwater Resources

The Ouachita and Ozark highlands have relatively old bedrock composed of shale, sandstone, and limestone. These rock formations have been cemented and compacted to such a degree that the amount of pore

space has been considerably reduced. Also, the greater slope in these areas increases runoff and decreases the amount of water that can percolate down into the groundwater supply. These factors combine to give the highlands the least amount of groundwater of any region of the state. However, groundwater is present and often is found very near the surface, but wells in the highlands will usually yield less than 50 gallons per minute.

A narrow, elongated area yielding 50 to 500 gallons of water per minute through the center of the western half of the state occurs in alluvium of the Arkansas Valley. Here, unconsolidated alluvial material furnishes large amounts of pore space in which groundwater can collect. Most deposits of alluvium are less than 65 feet deep, but rather large quantities of water are present.

The remainder of the state is underlain by deep sedimentary deposits which have not been greatly cemented or compacted. These deep, porous deposits furnish large quantities of groundwater. The water table, or the top of the groundwater supply is usually less than 100 feet below the surface, but the largest supplies are sometimes found at much greater depths.

Arkansas' groundwater is used for irrigation, municipal and private water supplies, and for industry. Most areas in the eastern half of the state still have good reserves, but in a few areas, such as the rice growing regions, the water table has been lowered as much as 60 feet through heavy usage, where withdrawal exceeds the recharge rate. The recharge rate is determined by precipitation, slope, and porosity of

earth material. This problem presents a very significant research area that has been addressed in the past but much additional work remains to be accomplished.

WATER DEMAND PROJECTIONS

The data contained in this section has been developed from published reports by the U. S. Geological Survey, the Arkansas Soil and Water Resources Commission, and the 1975 National Water Assessment, as well as unpublished reports within the Department of Agricultural Economics and The Water Resources Research Center, University of Arkansas. Estimates have been made of the presently available water and water use categories for the portions of the five WRC Assessment Subareas (ASA) in Arkansas which are also in general coincident with the five Water Resources Planning Areas (AWRPA) of Arkansas. Future water demand has been projected through the year 2000 considering both quantity and quality while holding price constant. This procedure is equivalent to projecting demand requirements by applying water use coefficients to projected growth in population and per capita personal income. The technique does not account for the impact of future price changes on consumptive use and therefore can be expected to identify maximum water demand qunatities. The state total of the aggregate figures of each AWRPA presented herein varies considerably for some categories from the state totals presented by U.S.G.S. and the 2nd National Water Assessment. However, the aggregate figures represent the "best" figures available considering all available data sources and applying local knowledge and information concerning the State of Arkansas. Where possible an explanation is given for gross discrepancies between data sources.

Manufacturing Water Use

The figures presented in the following table indicate that most of the state's industrial water use is concentrated in the Lower Arkan-

MANUFACTURING WATER REQUIREMENTS
FOR ARKANSAS BY AWRPA

(Millions of Gallons per Day)

AWRPA & ASA Region	1975		1985		2000	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
Mississippi-St. Francis and Crittenden (ASA 801)	20.7	3.7	20.6	9.6	20.8	14.9
Ouachita and Mississippi-Tensas (ASA 802)	134.7	14.9	172.0	52.1	175.6	138.5
White (ASA 1101)	5.1	.9	4.5	2.1	4.4	3.0
Lower Arkansas and Benton (ASA 1104)	110.3	18.9	105.5	48.2	105.2	79.9
Lower Red (ASA 1107)	16.4	1.4	22.3	6.5	22.6	17.5
STATE TOTALS	287.2	39.8	324.9	118.5	328.6	253.9
WRC 2ND NATIONAL ASSESSMENT TOATLS	(351)	(46)	(245)	(84)	(243)	(186)

sas and Ouachita regions. Total withdrawal in these areas accounts for up to 85 percent of the state total. The largest water users in these regions are the chemical industry in the Lower Arkansas area and the paper industry in the Ouachita area. The projected estimates indicate the continued dominance of these two regions and industries as water users.

The 2nd National Water Assessment figures are shown in parentheses and indicate a large discrepancy. The manner in which the discrepancy exists indicates that the primary reason for the discrepancy is due to a difference of opinion as to the impact of the practice of recycling of water. The figures presented herein take a much more moderate position on the impact of recylcing than do the figures generated in the 2nd National Water Assessment.

Domestic Water Use

The domestic water use projections are developed directly from population projections using a constant per capita use parameter. This assumes that environmental pressures for conservation will offset any expansional usage.

The 1975 estimates indicate that the state's domestic water use is currently concentrated in the Mississippi-St. Francis (ASA 101) and Lower Arkansas Regions (ASA 1104). The projections to the year 2000 do not show any significant trends between regions. However, the total domestic use will increase by 25% by the year 2000 to a total daily withdrawal of over 2.0 million gallons per day. These figures agree well with those included in the 2nd National Water Assessment.

DOMESTIC WATER REQUIREMENTS
FOR ARKANSAS BY AWRPA

(Millions of Gallons per Day)

Region	1975 Withdrawal	1975 Consumption	1985 Withdrawal	1985 Consumption	2000 Withdrawal	2000 Consumption
Mississippi-St. Francis and Crittenden (ASA 101)	38.6	10.9	41.3	10.9	44.0	11.3
Ouachita and Mississippi-Tensas (ASA 802)	33.8	9.6	36.9	10.3	40.6	10.9
White (ASA 1101)	12.5	4.6	14.4	4.9	16.3	5.1
Lower Arkansas and Benton (ASA 1104)	63.6	16.6	73.5	18.9	88.9	22.1
Lower Red (ASA 1107)	9.4	2.7	10.4	2.9	11.5	3.0
STATE TOTALS	160.9	44.4	176.5	47.9	201.3	52.4
WRC 2ND NATIONAL ASSESSMENT TOTALS	(165)	(48)	(181)	(52)	(120)	(57)

Agricultural Water Use

Livestock:

The livestock water requirements are developed from information provided by the United States Department of Agriculture in conjunction with the 1975 National Water Assessment, the United States Geological Survey, the Lower Mississippi Region Comprehensive Study Coordinating Committee and the Statistical Reporting Services of the U. S. D. A.

Growth factors for projected livestock water requirements are a function of (1) drinking water and other water use rates, and (2) livestock production. Drinking water use rates were based on published reports and depend in part on pasture, range conditions and temperature zones. Non-drinking water use rates were estimated based upon published reports, uses reported in special area studies and on river basin studies. Evaporation losses allotted to livestock were assumed to be a proportion of the range animal drinking water scaled in accordance with net evaporation to precipitation ratios. Watering losses were assumed at 10% and 15% of animal and poultry drinking water, respectively. The livestock water use for consumption is assumed to be equivalent to that withdrawn, thus for this particular category the terms are synonomous. The figures are somewhat higher than those reported by the 2nd National Water Assessment but the observed trends are consistent.

Irrigation Water Use:

Estimates of annual water requirements for crop irrigation were developed for each Aggregated Sub-Area (ASA) as part of the 1975 National Water Assessment. However, these estimates did not anticipate the removal of rice acreage allotment restrictions or the large increases in rice acreage that accompanied the removal of acreage restric-

LIVESTOCK WATER USE
FOR ARKANSAS BY AWRPA

(Millions of Gallons per Day)

Region	1975 Withdrawal = Consumption	1985 Withdrawal = Consumption	2000 Withdrawal = Consumption
Mississippi-St. Francis and Crittenden	5.9	6.8	8.8
Ouachita and Mississippi-Tensas	7.9	9.5	12.4
White	11.8	12.6	13.9
Lower Arkansas and Benton	16.8	18.5	21.3
Lower Red	5.4	5.9	7.0
STATE TOTAL	47.8	53.3	63.4
WRC 2ND NATIONAL ASSESSMENT TOTALS:	(31)	(32)	(39)

IRRIGATED CROP WATER USE
FOR ARKANSAS BY AWRPA

(Millions of Gallons per Day)

Region	1975 Withdrawal	1975 Consumption	1985 Withdrawal	1985 Consumption	2000 Withdrawal	2000 Consumption
Mississippi-St. Francis and Crittenden (ASA 801)	1,768.8	1,310.4	1,866.0	1,380.4	2,070.9	1,531.8
Ouachita and Mississippi-Tensas (ASA 802)	515.1	383.6	751.1	560.5	836.3	623.9
White (ASA 1101)	98.7	74.0	97.4	73.0	108.0	80.9
Lower Arkansas and Benton (ASA 1104)	32.5	23.7	31.3	22.8	34.9	25.4
Lower Red (ASA 1107)	15.5	11.6	17.6	13.1	19.3	14.4
STATE TOTAL	2,403.7	1,803.4	2,763.3	2,049.8	3,069.4	2,276.5
WRC 2ND NATIONAL ASSESSMENT TOTALS	(2262)	(1535)	(2497)	(1773)	(2601)	(1912)

tions in 1973. Rice irrigation plays such a large role in irrigation water use in Arkansas that new estimates were necessary.

Intensive study of the potential for rice acreage expansion has been underway in the Agricultural Economics Department at the University of Arkansas in cooperation with the Economic Research Service of the U.S.D.A. Estimates of irrigated rice acreage as part of the total irrigated acreage presented in this report are based on the finding of these intensive studies.

Water use estimates assume continued use of flood irrigation in rice production and seven percent conveyance losses for irrigation of soybeans and cotton. It is highly probable that center-pivot sprinkler irrigation of rice may replace flooding at some time during the projection period. If this takes place, reductions in irrigation water of 50 to 60 percent for rice could be achieved.

All increases in irrigation will be assumed to be withdrawn from surface water. Declining ground water tables within the Mississippi-St. Francis and Crittenden area and the Ouachita and Mississippi-Texas area will also cause increasing use of surface waters in these regions. A 25 percent shift from ground water to surface water is projected for land which is irrigated during the period 1975 - 2000.

Power Generation Water Use

The water requirements for power generation were developed directly from information provided by the Federal Power Commission which participated in the 1975 National Water Assessment. The F. P. C. developed estimates of present water use for both steam-electric and hydroelectirc plants and also projected future requirements based in part on the OBERS Series E projections.

The withdrawal for once-through cooling plants is defined as the entire daily condenser flow. However, for wet tower and cooling plants it is defined as the sum of the evaporative losses (consumption) plus the water quality uses.

This definition of withdrawals for once-through plants is consistent with the definition used in other parts of this report. The flow of a river will be continually decreased between the point of withdrawal and the point of discharge for a once-through cooling plant. In the case of the wet towers and cooling pond plants, the flow of a river will be only temporarily decreased as the wet tower or cooling pond is filled. Once this filling process is completed, only evaporation losses and blowdown losses will be incurred on a continual basis. The amount of water used by steam-electric plants is thus determined by a combination of factors involving the size and design characteristics of each plant.

In 1975 most of the water withdrawals were concentrated in the Mississippi-St. Francis region which accounted for 80 percent of the state total. The projections show that this region will account for an estimated 47 percent of the state's withdrawals in 2000. This dramatic decrease in relative water use is a direct result of the equally dramatic increase in water use in the Lower Arkansas region as well as increased recirculation rates for new plants. All of the estimated withdrawals reflect water use by steam-electric plants. Hydroelectric plants require large amounts of water for turbine blow but do not divert any appreciable amounts.

POWER GENERATION WATER USE
FOR ARKANSAS BY AWRPA

Region	1975 Withdrawal	1975 Consumption	1985 Withdrawal	1985 Consumption	2000 Withdrawal	2000 Consumption
Mississippi-St. Francis and Crittenden (ASA 801)	340.0	0.0	576.0	4.0	238.0	1.0
Ouachita and Mississippi-Tensas (ASA 802)	55.0	2.0	69.0	4.0	39.0	9.0
White (ASA 1101)	0.0	0.0	0.0	0.0	21.0	14.0
Lower Arkansas (AS 1104)	30.0	7.0	129.0	37.0	148.0	31.0
Lower Red (ASA 1107)	2.0	0.0	0.0	0.0	0.0	0.0
STATE TOTAL	427.0	9.0	774.0	45.0	446.0	55.0
WRC 2ND NATIONAL ASSESSMENT TOTALS	(427)	(14)	(774)	(45)	(446)	(55)

Commercial Fish Farm and Fish Hatchery Water Use

The aquaculture industry of Arkansas has experienced considerable fluctuation over time as producers enter and leave the industry. However, most knowledgeable people feel production has leveled off. Expert opinion from the National Marine Fisheries Service, U. S. Dept. of Commerce and the Arkansas Game and Fish Commission indicate expected future growth should be in the range of zero to 2.4 percent per year. While some producers are expanding their acreages, others are leaving the business resulting in zero net gain or loss. There are an estimated 41,000 acres of surface water devoted to fish farming at the present time; 21,200 acres devoted to bait fish, minnows and goldfish; 18,000 acres of food fish, primarily catfish, and approximately 1,000 acres of fingerling and miscellaneous fish. Of the total 41,000 acres, approximately 30,000 acres are farmed intensively with annual stocking and harvesting, while 11,000 acres are non-intensive.

A federal fish hatchery is planned for the White River below the dam on Beaver Reservoir. This hatchery will utilize a raceway system and will have roughly the same water requirements as the Greers Ferry National Fish Hatchery, which is eleven million gallons per day.

Expansion of state owned nursery ponds and fishing lakes are planned, according to the Arkansas Game and Fish Commission. Three new nursery ponds will be constructed in the state. These will be constructed above the power pool level at Beaver Reservoir, Lake Dardanelle, and at Lake Maumelle and will require a total withdrawal of approximately one and one-half million gallons per day. These withdrawals are required to fill the nursery ponds which are drained and refilled at least once each year.

COMMERCIAL FISH FARMS AND FISH HATCHERIES WATER REQUIREMENTS FOR ARKANSAS BY AWRPA

(Millions of Gallons per Day)

Region	1975		1985		2000	
	Withdrawal	Consumption	Withdrawal	Concumption	Withdrawal	Consumption
Mississippi-St. Francis and Crittenden	211.7	127.0	213.9	128.3	213.9	128.3
Ouachita and Mississippi-Tensas	64.1	38.4	66.4	39.8	66.4	39.8
White	41.7	25.0	42.1	25.2	42.1	25.2
Lower Arkansas and Benton	21.5	12.9	22.7	13.6	22.7	13.6
Lower Red	3.7	2.2	4.5	2.7	4.5	2.7
STATE TOTALS	342.6	205.6	359.5	209.7	359.5	209.7

***2nd National Assesment data not available for this category.

Six public fishing lakes are also being planned at this time. These lakes will normally be given a fifty percent draw down and refill every four years. Average withdrawals will amount to over five million gallons per day.

County water withdrawal and consumption data reported by the U.S.G.S. was aggregated to form the 1975 estimate for each of the five AWRPAs. Planned expansions of fish and hatcheries, fishing lakes and wildlife impoundments reported by the various agencies are projected to be completed by 1985.

Legal Obligations to Bordering States

The Arkansas River Basin Compact of 1970 apportioned up to 60 percent of the annual yield of the Arkansas River Sub-basin to the state of Oklahoma. Annual yield is defined as the computed annual gross runoff that would have passed any certain point on a stream and would have originated within the specified sub-basin under natural conditions, without any man-made depletion or accretion during the water year.

In 1974, the Arkansas River Sub-basin had an annual yield equivalent to 56,834.69 MGD. If Oklahoma retained 60 percent of this as allowed in the compact, Arkansas would have received 22,733.875 MGD. Actual run-off figures as measured at Dam 13 near Van Buren, Arkansas show that Arkansas actually received 41,642.857 MGD or 83 percent more than the compact apportionment.

Annual yield for 1975 was estimated to equal 56,882.14 MGD of which Arkansas had a right to 22,752.857 MGD. Actual runoff measured at Dam 13 showed 41,848.214 MGD which is 84 percent more than the compact

apportionment. Oklahoma used only 17 percent of the water allotted to them by the compact in 1974 and 16 percent of their allotment in 1975.

If Oklahoma were to withdraw all of its Arkansas River allotment, the flow of the Arkansas at Dam No. 13 would be decreased by 45.5 percent. The discharge of the Arkansas at Murray Dam at Little Rock would be decreased by 37.0 percent.

Legally required flows at Van Buren represent 40 percent of the annual yield of the Arkansas River Sub-basin in Oklahoma. The legally required flow at Little Rock represents that flow which would exist if Oklahoma were to increase its use from present levels to maximum allowable levels and normal accretion and depletion of Arkansas River waters existed between Van Buren and Little Rock.

ACTUAL FLOW AND LEGALLY REQUIRED FLOW OF THE ARKANSAS RIVER, 1971 THROUGH 1975

Water Year	Arkansas River at Dam No. 13 Near Van Buren	
	Actual Flow	Legally Required Flow
	- - - - - - - - -in million gallons per day- - - -	
1971	12,910.714	7,036.339
1972	12,794.643	6,973.080
1973	45,669.943	24,889.955
1974	41,642.857	22,733.875
1975	41,848.214	22,752.857
Average 1971-75	30,973.219	16,877.221
	Arkansas River at Murray Dam at Little Rock	
1971	17,321.429	11,447.054
1972	15,794.643	9,973.080
1973	57,482.143	36,702.455
1974	49,732.143	30,823.161
1975	50,008.929	30,913.571
Average 1971-75	38,067.857	23,971.864

In evaluating surplus water only "firm" discharges should be considered. "Firm" discharges are those discharges remaining after legal obligations to border states are considered. At the present time, Arkansas' only agreement with a border state is the Arkansas River Basin Compact of 1970. However, other such compacts are in the planning process and similar agreements may be expected.

Arkansas' "firm discharge" is deveolped assuming compacts will be developed with Missouri, Oklahoma, Texas, and Louisiana on all waters which flow directly between the states. These compacts would apportion 60 percent of the annual yield of streams to the state where the water originated. The remaining 40 percent must be allowed to flow to the downstream state.

Under these conditions Arkansas would receive 40 percent of the annual yield of streams entering the state and in turn would be required to allow 40 percent of the annual yield of Arkansas streams to flow to the downstream states of Louisiana and Missouri.

Firm discharge assumes that no compacts will be developed for waters flowing into the Mississippi River. While this is the most likely situation, it would be unreasonable to ignore the possibility of legal obligations on these waters and caution should be taken in applying these figures.

Since annual yield figures have been computed for only the Arkansas River Sub-basin it is assumed that the relationship between the annual yield and discharge on all other streams will be proportional to the relationship between annual yield and discharge for the Arkansas River Sub-basin as reported for the Arkansas River Basin Compact. There dis-

charge represented 73 percent of annual yield or conversely annual yield equalled 137 percent of discharge. Based on this relationship the "firm" discharge of Arkansas' major river basins was computed.

PRESENT DISCHARGES AND PROJECTED "FIRM" DISCHARGES FOR ARKANSAS[1] MAJOR RIVER BASINS

(Million gallons per day)

Region	Discharge Mean[2]	Firm[3]
Mississippi-St. Francis and Crittenden		
St. Francis River at Parkin, AR	1,829,464	827.018
L'Anguille River at Palestine, AR	763.929	345.338
Basin total	2,593.393	1,172.356
Ouachita and Mississippi-Tensas		
Ouachita River at Camden, AR	4,825.000	2,181.164
Bayou Bartholomew near McGehee, AR	445.089	201.205
Saline River near Rye, AR	1,696.429	766.88
Moro Creek near Fordyce	148.125	66.96
Basin total	7,114.643	3,216.209
White		
White River at Clarendon, AR	19,321.429	8,734.345
Lower Arkansas and Benton		
Arkansas River at Little Rock, AR	38,067.857[2]	10,835.282
Lower Red		
Red River at Fulton, AR	11,589.286	5,238.992
STATE TOTAL	78,686.608	29,197.184

[1] Mean discharge for period of record as most recently reported by U.S.G.S. in Water Resources Data for Arkansas.

[2] Mean Discharge for period 1971 to 1975

[3] "Firm" discharges are those discharges remaining after projected legal obligations to border states are considered.

Future Water Use and Surface Water Availability

Total water withdrawals for Arkansas are expected to increase by one thousand million gallons per day by the year 2000 according to knowledgeable state officials. This conflicts with the Second National Water Assessment projection of only a four hundred million gallons per day increase.

Increased withdrawals are not the only source of decreasing water availability in Arkansas. Measurements of the mean discharge for each basin as reported by the U.S.G.S. have been recorded as close as possible to the basin's discharge point within the state. Thus, the major water withdrawals within the state have already been made and in most cases user discharges have re-entered the rivers as return flows. If major water users within a basin were to increase their consumption of water while decreasing, maintaining, or increasing to a lesser degree their withdrawal, the impact would be to decrease mean discharges through the decrease in return flows.

Thus, evaluation of the use of Arkansas waters must include not only changes in withdrawals but also changes in consumption. In some cases, increases in consumption may exceed increases in withdrawals. This situation will likely be the case in manufacturing and power where increased recirculation and land disposal are going to be required to meet environmental regulations.

STATE WATER RESOURCES RELATED PLANNING ACTIVITIES

In developing a comprehensive state water policy, the State of Arkansas has continually been faced with a number of state and federal agencies involved in water policy. Each of these agencies has its specific objectives as developed through its legislative mandate, certain regulatory authority and varying criteria for approving and funding water related projects. The result of having so many agencies involved in water decisions is often duplicative, fragmented inefficient decisions, timely delays, and lack of statewide coordination. For the farmer, local mayor, small businessman or industrialist, the complicated bureaucracy means complicated procedures for approval and permitting of a water supply or treatment facility, costly delays in funding and endless hours of cutting the "red tape". Also, the existing institutional situation may result in unnecessary expenses in a time when state government is attempting to minimize its spending. Arkansas wants both to protect its environmental resources and to encourage sound economic growth. The structure of environmental and funding review for water projects in Arkansas makes it difficut for those making decisions to understand the complexities involved and to determine the trade-offs between environmental quality and economic growth.

Presently, there are five state agencies actively involved in approving and funding water supply and wastewater treatment systems: the Soil and Water Conservation Commission, the Department of Local Services, the Department of Health, the National and Scenic River Commission, and the Department of Pollution Control and Ecology. With respect to planning and developing water supplies, the Arkansas Soil

and Water Conservation Commission, as the primary water planning responsibility for the State, receives and disperses funds received from the State Legislature to the State Water Development fund. These funds are used to assist in the utilization of reservoir sites and the planning and development of water supplies. In addition, the Department of Local Services receives state appropriations for the planning and development of water, sewer and solid waste projects in the State. These projects must meet certain criteria established by the Department to provide services to areas of high unemployment, elderly and low income, and can only be used to match federal funds. The Health Department has the responsibility for the safety of municipal water supplies requiring their approval before a public water supply, lake or dam can be developed. The Natural and Scenic Rivers Commission has the legislative charge of protecting the State's free flowing streams and therefore takes a major role in water policy issues.

The Department of Pollution Control and Ecology is the primary regulatory agency in the State concerning pollution abatement. This agency is the lead agency in the State in terms of interacting with EPA and is responsible for conducting the State's 208 Water Quality Management Planning program.

While the State agencies work closely together, the planning approval and funding of a project on the state level has become a lengthy, cumbersome and expensive process. On all Arkansas water supply projects, federal funds are required to supplement state funding. There are five federal agencies involved with funding water supply projects: the Farmers Home Administration, Economic Development Adminsitration, the Ozark Regional Commission, the Corps of

Engineers and the Department of Housing and Urban Development. Each federal agency has specific requirements for funding of projects and budget cycles that vary from state's cycles.

Most communities in Arkansas continue to have deficient, inadequate or non-existing methods for treating their sewage problems. The agency concerned with the permitting of wastewater treatment facilities is the Department of Pollution Control and Ecology. Their major funding source for this type project is the U. S. Environmental Protection Agency (EPA). The state plans to assume the total authority for permitting treatment facilities, but the major funding will remain with the EPA. The Department of Local Services has state appropriations to match federal funds for sewer projects if they qualify under their criteria. The Health Department must review all of the Department of Pollution Control and Ecology's permits to assure compliance with minimum health standards. This process has also resulted in duplicative and time-consuming efforts in review and monitoring. At least three other federal agencies on occasion can become involved in these public works projects, including Farmers Home Administration, Economic Development Administration and the Ozark Regional Commission.

In addition to the number of agencies involved, there are conflicting regulations among these agencies and often unnecessary restrictions which do not increase environmental protection. The maze of agencies involved discourages rather than promotes cost-effective innovative or alternative approaches to wastewater treatment. Rather than attempt to try a new approach, a municipality may desire assurance that the project will not be delayed or rejected and consequently request a traditional system that may be more expensive to build, operate and maintain.

With increasing problems of groundwater supplies there is a need for greater coordination among state agencies and an active leadership role in controlling groundwater quality and quantity. There are several agencies scattered throughout State government directly involved with groundwater. The Soil and Water Conservation Commission has been active in working with farmers to utilize groundwater supplies for irrigation. At the same time, the Geological Commission samples groundwater and evaluates its depletion and recharge capabilities. The Health Department approves the use of wells around the State, while the Department of Pollution Control and Ecology samples for hazardous wastes and operates an Underground Injection Program. With the depletion of groundwater supplies, and the contamination by hazardous and toxic substances, the legal question of Groundwater Conservation Districts has been raised but remains unresolved at this time.

There are no easy answers to these problems but the Governor and the General Assembly should be encouraged to make every effort possible to alleviate these institutional problems. The state cannot change the declining economic situation nor raise the income level of Arkansas citizens overnight. There are certain institutional conditions which should be changed for the benefit of the public. There are five specific suggestions that have been recommeded by a special Governor's Task Force on Water Policy. They are:

(1) Develop an exchange program which would require top agency officials to work in other agencies for several months. This would increase awareness of duplicative activities and generate ways to work more closely together but probably not cure the problems;

(2) Develop memorandums of understanding between state and federal agencies and between state agencies. These agreements would establish in writing the responsibilities of each agency and determine how overlapping or duplicative efforts can be eliminated. These agreements would require a commitment by agencies to change some existing policies and coordinate more closely with other agencies;

(3) Establish Executive Orders by the Governor on certain areas such as groundwater pollution. These orders could be most effective on broad issues such as floodplains or wetlands but would not solve the majority of institutional considerations;

(4) Expand role of the Technical Advisory Committee to oversee all water related issues and review decision making processes among agencies. The Committee could work more closely with the Governor's Subcabinet in Natural Resources to highlight emerging water problems, coordinate agency problems, provide criteria for evaluating water projects and serve as a review council to resolve review process disputes. This function would generate greater coordination on water policy but not substantively alter the existing situation;

(5) Establish a Department of Natural Resources. The Governor and the General Assembly would combine many of the agencies involved with water policy which are not dispersed throughout State Government, under a central administration. A Department of Natural Resources would eliminate many of the duplicative

responsibilities and coordinate the state's efforts in managing its natural resources to better serve the public interest. A single agency would be more economical than the numerous existing state agencies. Both the private and public sectors would benefit from the review process being expedient and overall policies being classified. The State would be in a position to provide local government assistance on how to use their water resources wisely and to anticipate the environmental and social impacts of the new business or industry that they need in order to grow.

STATE WATER RESOURCES DEVELOPMENT PROJECTS

Most citizens of Arkansas feel there is no reason to conserve water supplies because of the numerous U. S. Corps of Engineers major impoundments in Arkansas. However, shortages of potable water have periodically occurred in some areas even prior to the drought of the summer of 1980. The causes of shortages have ranged from inadequate treatment facilities to insufficient raw water supplies. As demands increase Arkansas can expect additional shortages to begin to surface.

One supply problem that is already of major concern to water resources planners in the state is Ft. Smith. Authorization and detailed planning is substantially complete for a water development project on Lee Creek known as the Pine Mountain Project. The plans call for a suface area impoundment of 3020 acres with a storage capacity of 168,000 acre-ft. This reservoir is a multi-purpose project calling for water supply, flood control, recreation, and hydropower.. The project is currently awaiting the necessary local assurances before final planning action can be initiated. Environmental issues are playing a major role in this delay wherein creative alternatives are being considered.

The Conway water supply project is currently under construction and will be complete by 1985. It is a small single purpose water supply project creating a surface area impoundment of 1165 acreas and a storage capacity of 23,500 acre-ft. The drainage area is 36 sq. miles.

Numerous municipal projects serving small rural areas or individual cities are underway. In most cases the primary funding agency for these projects is the Farmers Home Administration. However, the Department of Housing and Urban Development and the Environmental Protection Agency

also fund some projects. Approximately 40 such projects are ongoing with assistance from the Arkansas Department of Local Services and the Arkansas Soil and Water Conservation Commission. These current domestic and industrial water supply projects are of particular interest because many of them reflect the regional concept of efficient water resource managment. Two specific examples of these are summarized below.

The Carroll-Boone Regional Water Distribution District will eventually transport treated water from Beaver Lake in Northwest Arkansas to much of Carroll and Boone Counties, including the cities of Berryville and Harrison rural areas. Carroll-Boone is being constructed in phases, Phase One being completed and funding recently arranged for Phase Two.

The Mid-Arkansas Regional Water District will serve rural areas in Pulaski, Faulkner and White counties as well as the cities of Jacksonville and Cabot. This system will be supplied by a reservior to be constructed on Bull Creek near Beebe. Land acquisition, environmental assessments and final design is underway.

STATE WATER RESOURCE PROBLEMS

The state of Arkansas is one of the few states that still adheres essentially to the Reparian Water Use doctrine which simply stated entitles land owners to make "reasonable" use of the waters running through or adjoining their land without any prior authorization by a state agency. Thus an element of the basic quality of life attitudes in Arkansas is the demand for unlimited pure clear water. In recent years higher standard for water quality combined with inflation has produced drastic increases in water supply and distribution costs. In addition, population growth and the location of new industries consuming large volumes of water have taxed the water supply of some cities. Some of these cities are looking to the state's remaining free-flowing streams to meet their critical water needs, resulting in conflicting water use pressures with agriculture, tourists, and recreational activities. The Arkansas River has been opened to navigation and industrial development creating the need for additional water supplies.

The institutional framework within the state government is not capable at the present time of appropriating and monitoring these conflicting water use pressures. For example, because of the manner in which municipal water supply projects are selected and funded in Arkansas, the state does not have major authority in deciding which water development projects will provide the most benefit to Arkansas as a whole and therefore should be constructed. The institutional framework relating to water resources decisions must be re-evaluated and brought into conformity with modern Federal and State water related programs.

Water quality management in Arkansas's many impoundments is a major problem in the state. Beaver Reservoir in Northwest Arkansas is a prime example. The reservoir supplies various beneficial uses to Benton and Washington Counties, including water for industrial and domestic uses. Upon completion of the Boone-Carroll Water District, Beaver water will be extended to domestic and industrial customers east of the reservoir in Boone and Carroll Counties. Beaver Water District, serving Washington and Benton Counties, and Boone-Carroll Water District, together, will serve approximately 100,000 people as well as numerous industries. By the year 2000 the population served is projected to be near 300,000. Industrial and economic growth will be highly dependent on a sufficient supply of good quality water.

Northwest Arkansas is experiencing the fastest growth rate in the state. Consequently, land uses within the watershed are rapidly changing. The major activities that affect the water quality are urban growth, residential development adjacent to the shore, intensive agricultural activities, and wastewater treatment facilities.

The urban areas of Northwest Arkansas are experiencing phenomenal growth. The three largest cities situated on the Beaver Watershed continually divide and extend their boundaries further into the watershed. Unsewered urban areas and urban runoff threaten the integrity of the water in the reservoir.

Residential resort development adjacent to Beaver Reservoir shores threatens the water quality. Approximately 300 subdivisions have been platted adjacent to or within a mile of the shore. When the subdivisions are completed, there will be approximately 23,400 dwelling units. No sewers are available; therefore, each unit must use a septic tank as a

means of sewage disposal. The soil and geologic structure around the reservoir is not entirely suitable for proper treatment of septic tank effluent. Consequently, residential developments constitute a major threat to the water quality.

Agricultural activity is increasing in the watershed. Land is being cleared and an increasing number of confined livestock operations are being built, including swine farms and large cattle feedlots. If uncontrolled and improperly maintained, these activities constitute a threat to the water quality in the reservoir.

There are three wastewater treatment facilities that discharge effluent either into the reservoir or its tributaries. The largest of these belongs to Fayetteville, the largest city in the area. Fayetteville's treatment plant has experienced effluent quality difficulties in the past and is quickly reaching its designed capacity for proper wastewater treatment. This city is currently in the process of selecting the proper alternative concerning its waste disposal.

Having acknowledged these problems, those charged with the responsibility of providing a continuing source of quality water for Northwest Arkansas are looking for management techniques and data for the management of the reservoir. The nutrients input, its effect on algae, and the eutrophic stage of the reservoir are not currently available as a data base. There are more than 16 major impoundments in Arkansas with a total surface area of the top of the flood control pool of over 437,000 acres. Therefore, water quality management of impoundments must be considered a serious problem in Arkansas.

Groundwater contamination is a major water resources problem in Arkansas. Contamination continues to increase from seepage from house

septic tank fields, municipal, agricultural, and industrial wastewaters, and solid waste landfill disposal systems. In some areas, deepwell injections of toxic and hazardous materials has contributed significantly to this problem. Groundwater pollution reduces available water supplies for industrial, agricultural, and municipal uses. Over 75% of domestic water supply sources in Arkansas rely in part on groundwater. Once polluted, it takes decades, even centuries, to restore groundwater to an acceptable quality.

The management of the Arkansas River Navigation System is also a major problem in Arkansas. The river transverses the central part of the state and thereby has many competing demands for its water resources. One major decision to be made in the next few years is whether the Arkansas River water is suitable for municipal water supplies. A sufficient data base on the current and projected water quality of the river is not currently available. This is particularly true near Fort Smith which is one very crucial area.

The effect of lignite running on groundwater aquifers and surface streams by either strip mining methods or institu gasification will be a major water resource problem in the state in the near future. Contracts have been signed for the mining of some lignite deposits in Hope County in southeast Arkansas and additional commercial deposits are known to exist in central Arkansas. Little lignite mining has been previously conducted in Arkansas and its effect on the environment and specifically on water quality is not known.

ARKANSAS WATER RESOURCES RESEARCH CENTER
RESEARCH PRIORITIES AND GOALS (1980-1985)

The State of Arkansas has an abundance of good high quality water in the form of impoundments, rivers and streams, and groundwater. The overriding research priority for the center therefore is the proper management of this resource among competing needs. These competing needs can be classified in three major categories: (1) agricultural activities, (2) recreational and resort development, and (3) municipal and light industry. Heavy industry in the form of lignite mining and other energy related processes loom in the near future. The management of these competing needs are dependent on a consistent and readily available data base in concert with a functional institutional framework. The above discussion serves as background information for the basic research priorities of the Arkansas Water Resources Research Center which are stated below in terms of the water categories established by the Commission on Natural Resources, National Research Council.

Category I - Atmospheric, Hydrologic, and Hydraulic Processes.

Priority No. 1 - Hydrologic Characteristics of the Vadose Zone - This type research finds direct application to Arkansas because of the large number of septic tank installations, the type of soil present, and because of the important role groundwater plays in the development of the state.

Priority No. 2 - Hydrological Inputs to Water Quality Monitoring - The Arkansas Center considers this type research extremely important because of the role storm

events place in impacting water quality in lakes and impoundments.

Category II - Ecological-Environmental Relationships

Priority No. 1 - Effects of Contamination on Ecosystems - Because of the many lakes and impoundments in Arkansas, this research is vital to the state's needs. The effect of inorganic and organic non-point source pollutants on the aquatic ecosystem of impoundments has direct application to water quality management in Arkansas for both municipal and industrial use.

Category III - Water Quality Protection

Priority No. 1 - Virus Research - Evaluation of the presence and survival of water-borne virus in water reuse systems.

Priority No. 2 - Control of Contaminants Resulting from Energy Development - This type study will become more prevalent as the lignite deposits of Arkansas are commercially mined.

Category IV - Water Resource Management

Priority No. 1 - Data Base - Water Resource Management in Arkansas is hampered by lack of a comprehensive data base and an effective information dissemination system.

Priority No. 2 - Institutional Framework Studies - Studies are needed to explore alternative ways of moderating conflicting water use needs.

The goals of the Arkansas Water Research Center for the period 1980-1985 are:

1. To conduct a comprehensive study of the nutrient and sediment loading on Beaver Reservoir in N.W. Arkansas and to relate the loading to its impact on the biological communities and its impact on municipal drinking water quality. The presence and survival of viruses will be studied also.
2. To conduct studies on household waste disposal systems including both modified septic systems and alternative systems. These studies will be related to the protection and management of the Vadose zone as well as wastewater impacts on groundwater aquifers and impoundment eutrophication.
3. To develop a comprehensive data base for water related parameters and establish the institutional framework to effectively disseminate the data.
4. To study and model the impact of non-point source pollutants on the ecosystems of rivers and streams.
5. To investigate the water quality impacts of both surface mining and insitu-gasification of lignite deposits.
6. To instigate studies comparing viable state institutional frameworks for control and moderations of conflicting water use needs.

ACKNOWLEDGEMENTS

Extensive use has been made of the following references and data sources without specific reference:

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Table 9. PROJECTED EXPENDITURE OF RESEARCH FUNDS
(Thousands of Dollars)

Research Category	Funding Source	Fiscal Year 82	83	84	85	86
I. Atmospheric, Hydrologic, and Hydraulic Processes	a	10	10	10	10	10
	b	60	40	40	40	40
	c	164	110	110	10	10
	d	100	90	240	240	240
II. Ecological/Environmental Relationships	a	50	50	50	50	50
	b	80	100	100	100	100
	c	90	90	100	100	110
	d	300	300	350	350	350
III. Water Quality Protection	a	35	35	35	35	35
	b	75	90	90	100	100
	c	85	85	95	95	105
	d	150	150	175	175	200
IV. Water Resource Management	a	20	20	20	20	20
	b	35	20	20	10	10
	c	30	30	35	35	35
	d	50	50	75	75	75

	Funding Source Totals 82	83	84	85	86	Totals
a) OWRT ACP @ $115,000 per year	115	115	115	115	115	575
b) OWRT ACP @ $250,000 per year	250	250	250	250	250	1250
c) State of Arkansas Appropriation*	369	315	340	240	260	1524
d) Other (OWRT-Matching, Corp. of Eng., NSF, etc.)	600	590	840	840	865	3735

*Includes Director's Office Overhead and Principal Investigator release time.