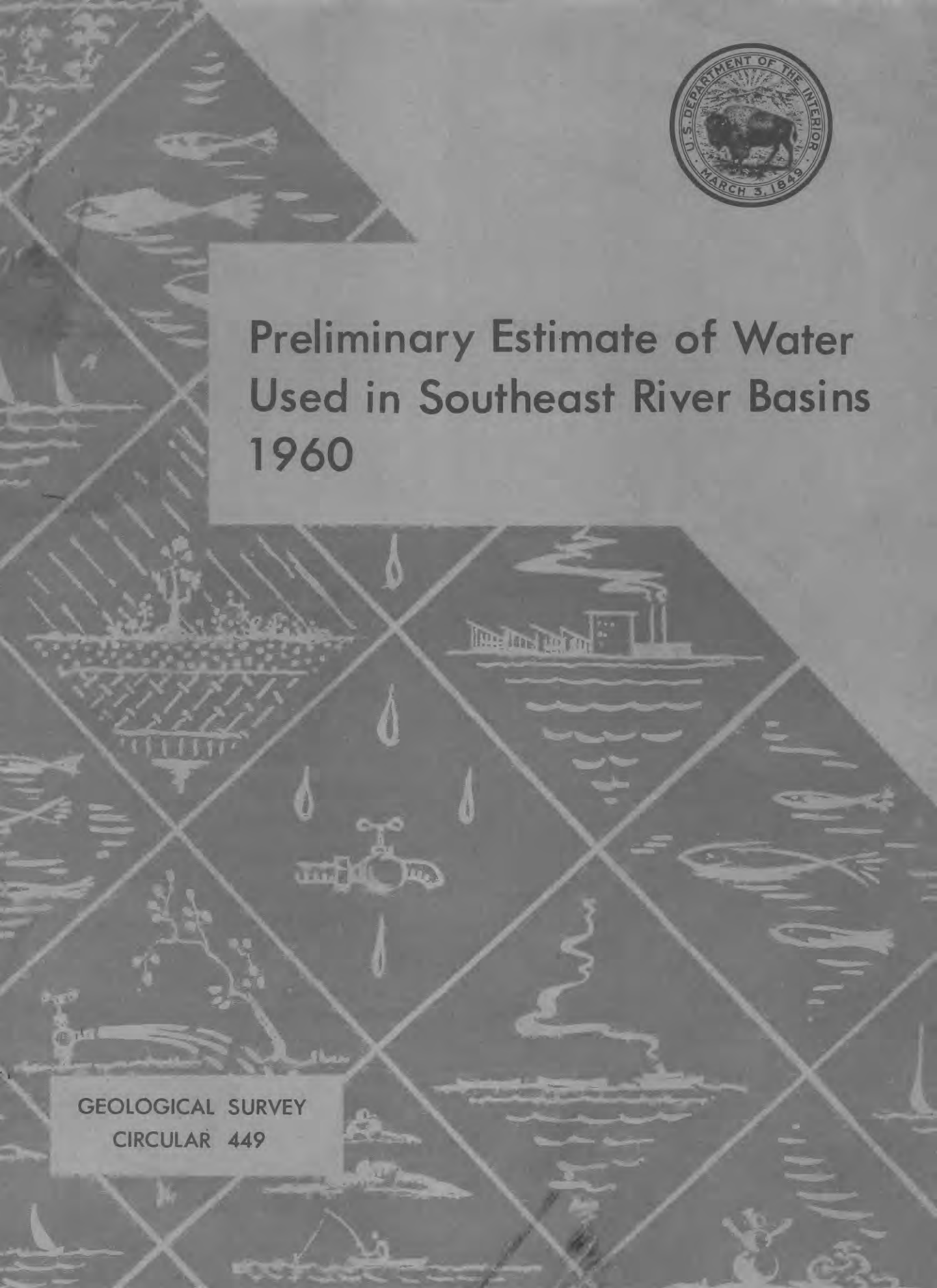

Preliminary Estimate of Water Used in Southeast River Basins 1960

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By K. A. MacKichan and J. C. Kammerer

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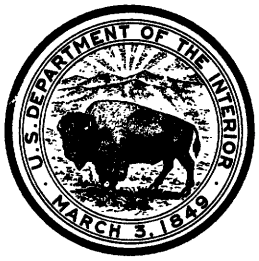

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By K. A. MacKichan and J. C. Kammerer

ABSTRACT

The estimated withdrawal use of water in the Southeast River Basins during 1960 was about 3,900 mgd exclusive of water used to develop waterpower and exclusive of water used by the Savannah River Plant of the U.S. Atomic Energy Commission. This estimated use amounts to 770 gallons per capita per day.

Withdrawal use of water requires that the water be removed from the ground or diverted from a stream or lake. In this report the use is divided into four types: public supplies, rural, irrigation, and self-supplied industrial. An estimate of water used for waterpower is not included in this report. Consumptive use is the quantity of water discharged to the atmosphere or incorporated in the products of the process in which it was used. Only about 290 million of the 3,900 mgd withdrawn was consumed.

Of the water withdrawn in 1960, 3,200 mgd was taken from surface sources and 710 mgd from underground sources. Withdrawal of water has increased 31 percent in South Carolina, Alabama, and Georgia since 1955. The use of saline water was almost three times as great in 1960 as in 1955.

INTRODUCTION

The use of water generally reduces the water resources and frequently deteriorates the quality of water, whether the use is withdrawal or nonwithdrawal, consumptive or nonconsumptive. The quality may be adversely affected by addition or concentration of mineral constituents, addition of bacteria or organic matter, or the addition of heat. Because the use of water affects the quantity and quality of the supply, an adequate evaluation of the water resources of a region requires a knowledge of the quantity of water used, where it is used, and the type of use. The purpose of this report is to evaluate in broad categories the use of water in the Southeast River Basins.

PRESENT INVESTIGATION

The present investigation is part of a nationwide survey of water use in 1960. It covers the same area of 86,543 square miles being investigated by the U.S. Study Commission, Southeast River Basins, and includes the following principal river basins: Savannah, Ogeechee, Altamaha, St. Marys, Suwannee, Ochlockonee, Apalachicola, and Escambia. (See fig. 1.) These basins were selected for an initial or pilot study in recognition of the need of the Study Commission for early information on the magnitude and character of water used within its area of study.

This report presents an estimate of the quantity of water withdrawn and the quantity consumed in 1960. Some water was withdrawn from a source, used, and discharged into a stream or the ground, only to be withdrawn again. Each time the water was withdrawn it was added to the accumulated total; therefore, the same water was withdrawn several times and was counted each time that it was withdrawn. However, if the water was withdrawn and recirculated, so that it was used several times in the same plant before it was discharged into a stream or the ground, it was counted only once. Although the best information available was used, the estimates in this report are, in general, only approximations of the quantity of water used. The estimate for municipal use is probably the most accurate and that for industrial use, the least accurate.

District offices of the Water Resources Division of the U.S. Geological Survey supplied estimates of water used for public

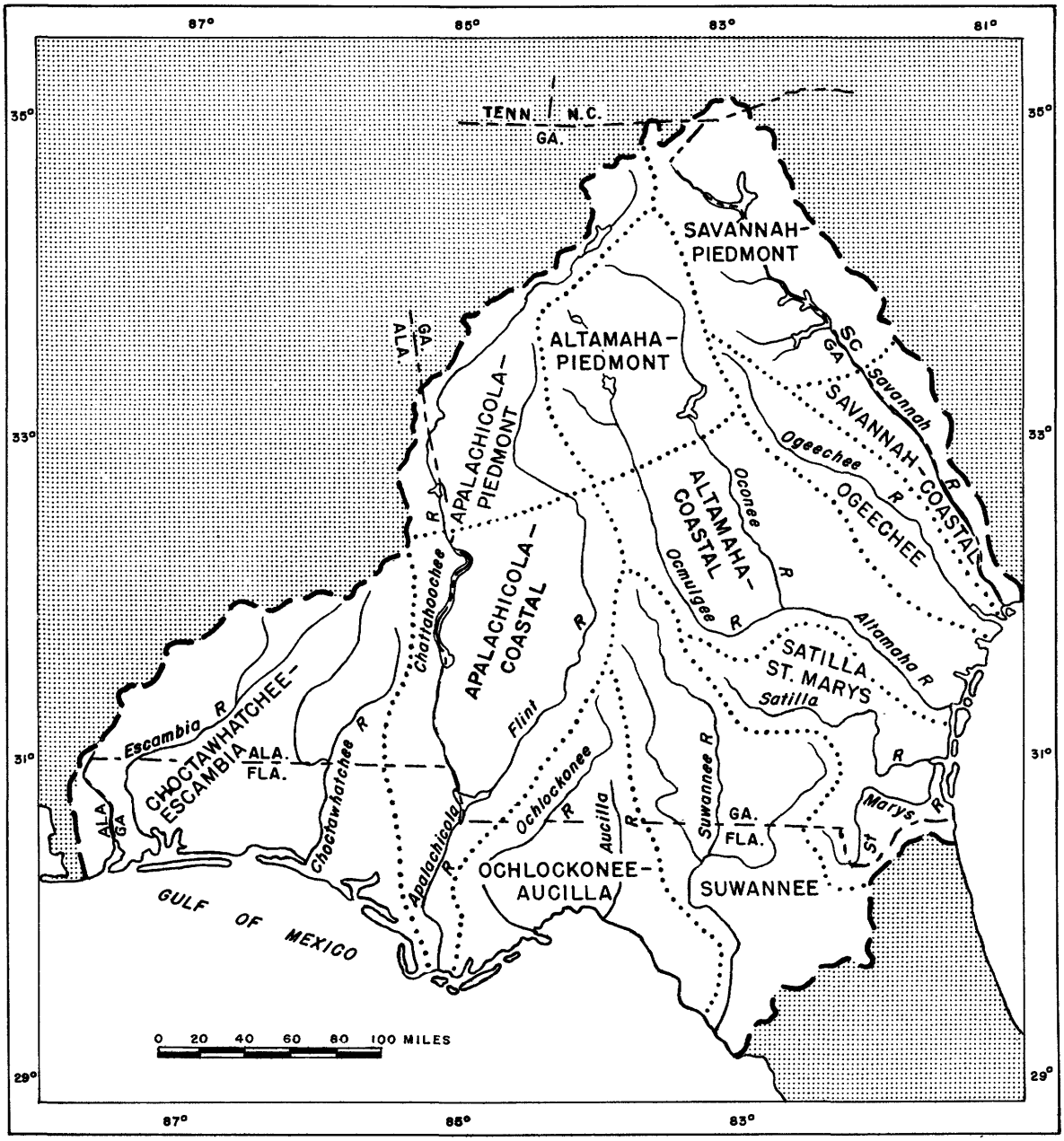

Figure 1.—Regions of the Southeast River Basins.

supplies and for manufacturing and nonmanufacturing industries. The estimates were based on data in the Geological Survey files and on data furnished by State officials. The quantities of water used by electric utilities, for rural domestic and stock use, and for irrigation were computed from statistics of the U.S. Bureau of the Census (1952, 1953, and 1956), the U.S. Federal Power Commission (1957, 1960), and the U.S. Agricultural Marketing Service (1960). Information on the sources of water (ground water and surface water) was furnished also by the district offices, Water Resources Division of the Geological Survey.

ACKNOWLEDGMENTS

Data for Alabama were compiled by L. B. Peirce, under the supervision of L. E. Carroon, district engineer; H. E. Blanchard compiled data for Georgia under the supervision of J. T. Callahan, district geologist; A. E.

Johnson, district engineer, G. E. Siple, district geologist, J. C. Chemerys, under the supervision of G. A. Billingsley district chemist, compiled data for South Carolina; and data for Florida were compiled by J. H. Criner, under the supervision of M. I. Rorabaugh, district engineer.

DEFINITION OF TERMS

Uses of water may be classified in several different ways. Among them are withdrawal and nonwithdrawal uses and consumptive and nonconsumptive uses. Withdrawal uses require that the water be removed from the ground or diverted from a stream or lake. Irrigation, domestic, stock, public, and industrial uses are of this type. Generation of waterpower is also considered a withdrawal use; even in run-of-river plants the water is diverted through the turbines, and frequently the generation of waterpower has a very definite effect on the streamflow. The quantity withdrawn is the entire quantity of water taken for use. This quantity is sometimes termed "pumpage," "water intake," "duty of water," or "water requirement" (Am. Water Works Assoc. Task Group, 1953). Nonwithdrawal uses do not require diversion. Navigation, recreation, waste disposal, and conservation of fish and wildlife are examples of nonwithdrawal uses. The water user either purchases the water from a public supply system or withdraws it from the source himself for his own use.

Consumptive use is the quantity of water discharged to the atmosphere or incorporated in the products of the process in connection with vegetative growth, food processing, or incidental to an industrial process (Am. Water Works Assoc. Task Group, 1953).

Saline water has been defined as water containing more than 1,000 ppm (parts per million) of dissolved solids (Krieger, Hatchett, and Poole, 1956) regardless of the composition of the solids and is not necessarily a salty (NaCl) water.

Quantities of water given in this report are generally in terms of million gallons per day (mgd); however, some quantities are also given in acre-feet per year. An acre-foot of water will cover an acre to a depth of 1 foot; 1,000 acre-feet per year equals 0.89 mgd.

WITHDRAWAL USE

Withdrawal uses can be evaluated quantitatively because they require removal of the water from the ground, stream, lake, or reservoir. The total quantity of water withdrawn can be obtained by adding together the known amounts of withdrawals. The primary withdrawal uses are public supplies, rural domestic and stock, irrigation, self-supplied industrial, and waterpower. Withdrawals for waterpower are not evaluated in this report; however, fuel-electric utilities and air conditioning are important subdivisions of primary withdrawal-uses and have been evaluated.

PUBLIC SUPPLIES

Public water-supply systems in the Southeast River Basins served almost 3 million people an average of 137 gallons per person per day or about 400 mgd. (See table 1.) The 11 major public systems in the area supplied about half the water served by all public systems. (See table 2.)

Water used for public supplies includes all water pumped into the system. This water may be used for fire protection, street flushing, irrigation of lawns and gardens, and by industry and commerce, as well as for domestic supply. Because the water is measured at the source, leakage is also included. Industry and commerce used slightly more than 100 mgd from public supplies, of which almost 10 mgd was used for air conditioning. Public water-supply systems may be either publicly or privately owned.

RURAL

Nearly 110 mgd was used in rural homes and for stock watering (table 3). About three-fourths of this water was obtained from wells and springs and only one-fourth from lakes, streams, and ponds. The resource was depleted by more than 100 mgd by this use, because practically all the water was evaporated or transpired. Rural homes are defined as those not served by public water-supply systems.

The rural use of water was computed by multiplying per capita uses by the human and livestock population. Of the 4.9 million people

Table 1.—*Water used for public supplies*

Region	Population served (thousands)	Water withdrawn				Water delivered			Water consumed (mgd)
		Surface water (mgd)	Ground water (mgd)	Total (mgd)	Per capita (gpd)	Industry and commerce		Other uses including losses (mgd)	
						Air conditioning (mgd)	Other (mgd)		
Savannah-Piedmont	158	18	4.3	23	140	0.2	5.4	17	2.6
Savannah-Coastal	318	43	24	66	210	.5	35	31	1.8
Ogeechee	42	0	2.6	2.6	61	0	.7	1.9	.3
Altamaha-Piedmont	351	37	.9	38	110	.4	7.6	30	4.9
Altamaha-Coastal	189	25	16	41	220	.5	11	30	.4
Satilla-St. Marys	99	0	15	15	150	.1	2.2	13	1.5
Suwannee	136	.4	18	18	130	.1	2.2	16	1.8
Ochlockonee-Aucilla	94	0	11	11	120	.2	2.2	8.8	1.5
Apalachicola-Piedmont	812	110	2.2	110	130	5.7	2.3	100	13
Apalachicola-Coastal	356	17	18	36	100	.6	10	25	4.1
Choctawhatchee-Escambia	351	0	42	42	120	1.3	17	24	8.6
Southeast River Basins	2,906	250	150	400	137	9.6	96	300	41

Table 2.—*Major public water systems, 1959*

Region where water is withdrawn	Name of system	Source of water	Water delivered (mgd)
Savannah-Coastal	Augusta	Surface	13
Do	Savannah	Ground and surface	22
Altamaha-Piedmont	Macon[1]	Surface	25
Ochlockonee-Aucilla	Tallahassee	Ground	6
Apalachicola-Piedmont	Atlanta[2]	Surface	70
Do	Cobb County-Marietta Water Authority.	--do	9
Do	DeKalb County[3]	--do	19
Do	East Point	--do	6
Apalachicola-Coastal	Albany	Ground	6
Do	Columbus	Surface	15
Choctawhatchee-Escambia	Pensacola	Ground	9
Total			200

[1]Part of area served is in the Altamaha-Coastal region.
[2]Part of area served is in the Altamaha-Piedmont region.
[3]Area served is in the Altamaha-Piedmont region.

Table 3.—*Water, self-supplied for rural use, in million gallons per day*

Region	Rural domestic use				Livestock use				Domestic and livestock uses			
	Water withdrawn			Water consumed	Water withdrawn			Water consumed	Water withdrawn			Water consumed
	Surface water	Ground water	Total		Surface water	Ground water	Total		Surface water	Ground water	Total	
Savannah-Piedmont.	0	5.2	5.2	5.2	3.0	0.13	3.1	3.1	3.0	5.3	8.3	8.3
Savannah-Coastal.	0	8.7	8.7	8.7	.82	.18	1.0	1.0	.82	8.9	9.7	9.7
Ogeechee-----	0	2.0	2.0	2.0	.11	2.1	2.2	2.2	.11	4.2	4.3	4.3
Altamaha-Piedmont.	0	10	10	10	2.7	0	2.7	2.7	2.7	10	13	13
Altamaha-Coastal.	0	.77	.77	.77	2.9	.95	3.8	3.8	2.9	1.7	4.6	4.6
Satilla-St. Marys.	0	3.6	3.6	3.6	1.6	.52	2.1	2.1	1.6	4.1	5.7	5.7
Suwannee-----	0	7.2	7.2	7.2	4.7	.25	5.0	5.0	4.7	7.5	12	12
Ochlockonnee-Aucilla.	0	6.3	6.3	6.3	1.6	.08	1.6	1.6	1.6	6.4	8.0	8.0
Apalachicola-Piedmont.	0	9.4	9.4	9.4	4.0	.15	4.2	4.2	4.0	9.6	14	14
Apalachicola-Coastal.	0	12	12	12	4.4	3.2	7.6	7.6	4.4	15	20	20
Choctawatchee-Escambia.	0	3.7	3.7	3.7	2.5	2.5	5.0	5.0	2.5	6.2	8.7	8.7
Southeast River Basins.	0	70	70	70	28	10	38	38	28	80	110	110

living in the Southeast River Basins, 2 million supply their own water. Of the 2 million self-supplied population, 1.4 million have running water in their homes.

Frank (1955) states that each person living in the average electrified-farm or urban home in the United States uses an average of 60 gpd (gallons per day) for household purposes and watering of lawns. The corresponding average for homes without running water is only 10 gpd per person. Other investigators report that only 50 gpd per person is used in homes with running water. Assuming these averages, about 70 mgd was used for rural domestic purposes in the Southeast River Basins, which was all obtained from wells or springs.

About 38 mgd out of the 110 mgd was used for stock watering; about one-fourth of the stock water was obtained from wells and springs and three-fourths from stream, ponds, and lakes. The quantity of water used by livestock ranges widely, depending on kind and age of the animal and the temperature of the air (Sykes, 1955). Several authorities (Sykes, 1955; Marion, 1952; U.S. Inter-Agency Committee on the Arkansas-White Red Basins, 1957) have given the water requirements of livestock. The per capita rates used in this report were taken from these and several other sources and are given below:

Livestock	*Per capita use (gpd)*
Horses and mules	10
Beef cattle	10
Milk cows	20
Hogs	3
Sheep	2
Goats	2
Chickens	.04
Turkeys	.06

IRRIGATION

Water was being withdrawn for irrigation in 1960 at the rate of 48,000 acre-feet per year (table 4) to irrigate 124,000 acres. A small amount of additional water was lost in conveyance before it reached the field. About 38 percent of the water came from wells and springs, the remaining 62 percent came from lakes, ponds, and streams.

Irrigation water is usually measured in acre-feet per year. However, in this report it is given also in average million gallons per day so that the quantities can be compared with and added to quantities of water used for other purposes. Irrigation water is applied during only a part of each year, and at variable rates; therefore, the actual rate of application is much greater than the average daily rate given in table 4.

SELF-SUPPLIED INDUSTRIAL USE

Water has many industrial uses, including processing, cooling, conveyance of material, boiler feed, and sanitation. Some industries require water of very high quality, whereas other industries are relatively unconcerned about the quality of the water. Most industrial water is self-supplied, although a small amount is purchased from public supplies (table 1). Industry used an average of 3,300 mgd of self-supplied water during 1960 (table 5). Most self-supplied industrial water 86 percent) was obtained from surface sources.

A large part of the industrial water is used for cooling and is returned to a stream or an aquifer unchanged, except for an increase in temperature. Water for cooling does not need to be of high quality; some cooling equipment is designed for use of sea water or other saline water. About 25 percent of the water used was saline. Only 110 of the 3,300 mgd was lost through evaporation.

FUEL-ELECTRIC POWER (PUBLIC UTILITY)

The amount of water used by public utilities for fuel-electric power was about three times the amount of self-supplied industrial water used by other industries (table 5). Almost all the water used by public utilities for generation of fuel-electric power was for condenser cooling (table 6). Water for other uses, such as boiler feed, sanitary services, cooling of machinery within the plant, and irrigation of lawns was less than 0.1 percent. All water used for cooling condensers was obtained from surface sources, and about 19 percent of it was saline. The only use made of saline water was in condensers. Less than 0.1 percent of the water withdrawn was consumed.

Table 4.—*Water used for irrigation*

Region	Water delivered to farms				Conveyance losses		Water consumed	
	Surface water		Ground water					
	1,000 acre-ft per year	Average annual (mgd)	1,000 acre-ft per year	Average annual (mgd)	1,000 acre-ft per year	Average annual (mgd)	1,000 acre-ft per year	Average annual (mgd)
Savannah-Piedmont	7.1	6.3	0.5	0.4	0	0	7.6	6.8
Savannah-Coastal	1.4	1.3	.4	.4	0	0	1.8	1.6
Ogeechee	3.2	2.8	1.2	1.1	0	0	4.4	3.9
Altamaha-Piedmont	1.5	1.3	0	0	0	0	1.5	1.3
Altamaha-Coastal	3.9	3.4	2.2	1.9	0	0	6.0	5.4
Satilla-St. Marys	1.9	1.7	1.2	1.1	0	0	3.1	2.8
Suwannee	5.0	4.4	6.0	5.4	0	0	11	9.8
Ochlockonee-Aucilla	.8	.7	1.4	1.2	0	0	2.2	1.9
Apalachicola-Piedmont	1.9	1.7	0	0	0	0	1.9	1.7
Apalachicola-Coastal	2.1	1.8	4.3	3.8	0	0	6.4	5.7
Choctawhatchee-Escambia	1.1	1.0	.4	.3	0	0	1.5	1.3
Southeast River Basins	30	27	18	16	.1	.1	47	42

Table 5.—*Self-supplied industrial water, in million gallons per day*

[Water used by U.S. Atomic Energy Commission Savannah River plant is not included]

Region	Fuel-electric power (public utility) use							Other uses							Total amount of water			
	Water withdrawn						Water consumed	Water withdrawn						Water consumed	Withdrawn			Consumed
	Surface water		Ground water		Total			Surface water		Ground water		Total						
	Fresh	Saline	Fresh	Saline	Fresh	Saline		Fresh	Saline	Fresh	Saline	Fresh	Saline		Fresh	Saline	Total	
Savannah-Piedmont.	0	0	0	0	0	0	0	7.3	0	2.4	0	9.7	0	1.0	9.7	0	9.7	1.0
Savannah-Coastal.	330	3.0	0	0	330	3.0	.64	37	83	54	0	91	83	3.5	420	86	510	4.1
Ogeechee	0	0	0	0	0	0	0	0	0	.9	0	.9	0	0	.9	0	.9	0
Altamaha-Piedmont.	0	0	0	0	0	0	0	.1	0	.1	0	.2	0	.1	.2	0	.2	.1
Altamaha-Coastal.	230	150	0	0	230	150	.01	20	0	44	0	64	0	1.6	290	150	440	1.6
Satilla-St. Marys.	0	0	0	0	0	0	0	0	20	190	0	190	20	23	190	20	210	23
Suwannee	83	0	0	0	83	0	.01	0	0	40	0	40	0	2.0	120	0	120	2.0
Ochlockonee-Aucilla.	0	61	0	0	0	61	.65	0	0	39	0	39	0	11	39	61	99	12
Apalachicola-Piedmont.	980	0	.1	0	980	0	.07	14	0	.1	0	15	0	1.7	990	0	990	1.8
Apalachicola-Coastal.	300	0	0	0	300	0	.03	6.8	0	1.7	0	8.5	0	.8	310	0	310	.83
Choctawhatchee-Escambia.	1.0	220	0	0	1.0	220	.01	54	260	86	0	140	260	62	140	480	620	62
Southeast River Basins.	1,900	430	.1	0	1,900	430	1.4	140	370	460	0	600	370	110	2,500	800	3,300	110

Table 6.—*Water used for public utility generation of fuel–electric power, in million gallons per day*

Region	Condenser cooling						Other uses					Water consumed
	Self-supplied				Public supplies	Total	Self-supplied			Public supplies	Total	
	Surface water		Ground water				Surface water		Ground water			
	Fresh	Saline	Fresh	Saline			Fresh	Saline	Fresh			
Savannah-Piedmont	0	0	0	0	0	0	0	0	0	0	0	0
Savannah-Coastal	330	3	0	0	0	330	.59	0	.05	0	.64	.64
Ogeechee	0	0	0	0	0	0	0	0	0	0	0	0
Altamaha-Piedmont	0	0	0	0	0	0	0	0	0	0	0	0
Altamaha-Coastal	230	150	0	0	0	370	.04	0	.01	0	.05	.01
Satilla-St. Marys	0	0	0	0	0	0	0	0	0	0	0	0
Suwannee	83	0	0	0	0	83	.01	0	0	0	.01	.01
Ochlockonee-Aucilla	0	60	0	0	0	60	0	.65	0	0	.65	.65
Apalachicola-Piedmont	980	0	0	0	0	980	.05	0	.06	0	.11	.07
Apalachicola-Coastal	300	0	0	0	0	300	.05	0	.01	0	.06	.03
Choctawatchee-Escambia	1	220	0	0	0	220	.03	0	0	0	.03	.01
Southeast River Basins	1,900	430	0	0	0	2,300	.77	.65	.13	0	1.60	1.40

AIR CONDITIONING

About one-fourth of the 38 mgd of water used for air conditioning was taken from public supplies (table 7). The quantities of water used for air conditioning are annual rates. Air conditioning is very seasonal with most of the water used in a 4-, to 6-month period. Therefore, during the air-conditioning season water is used at a much higher rate than that shown in table 7; during the rest of the year this use is negligible.

Table 7.—*Water withdrawn for air conditioning, in million gallons per day*

Region	Self-supplied industrial water	Public supplies	Total
Savannah-Piedmont	0.5	0.2	0.7
Savannah-Coastal	1.8	.5	2.3
Ogeechee	.1	0	.1
Altamaha-Piedmont	0	.4	.4
Altamaha-Coastal	.1	.5	.6
Satilla-St. Marys	4.0	.1	4.1
Suwannee	.7	.1	.8
Ochlockonee-Aucilla.	1.9	.2	2.1
Apalachicola-Piedmont.	.4	5.7	6.1
Apalachicola-Coastal.	0	.6	.6
Choctawhatchee-Escambia.	18	1.3	19
Southeast River Basins.	28	9.6	38

SUMMARY OF WITHDRAWAL USES

The estimated withdrawal of water in the Southeast River Basins amounted to 3,900 mgd during 1960, exclusive of water used for waterpower (table 8). This amounts to 770 gallons per capita per day. Surface-water sources supplied 3,200 mgd and ground-water sources supplied 710 mgd. Industry used the largest part of the water withdrawn, 3,300 mgd of the 3,900 mgd. Irrigation used the smallest amount of water, only 43 mgd. Most of the surface water (61 percent) and practically all the ground water (94 percent) was withdrawn in the Coastal Plain of the region.

CONSUMPTIVE USE

The gross supply in the Southeast River Basins was reduced about 290 mgd during 1960—this was the quantity of water that was consumed in use. Industry consumed 110 mgd of

Table 8.—*Summary of water used, in million gallons per day*

[Water used by U.S. Atomic Energy Commission Savannah River plant is not included]

Region	Drainage area (sq mi)	Water withdrawn		Total	Water consumed
		Surface water	Ground water		
Savannah-Piedmont	6,768	35	12	48	19
Savannah-Coastal	3,531	500	87	590	17
Ogeechee	5,436	2.9	8.8	12	8.5
Altamaha-Piedmont	5,699	41	11	52	19
Altamaha-Coastal	8,796	420	64	490	12
Satilla-St. Marys	5,425	23	210	230	32
Suwannee	10,929	92	71	160	26
Ochlockonee-Aucilla	6,203	63	58	120	22
Apalachicola-Piedmont	6,671	1,100	12	1,100	27
Apalachicola-Coastal	12,845	330	39	370	30
Choctawhatchee-Escambia	14,240	540	130	670	81
Southeast River Basins	86,543	3,200	710	3,900	290

the 290 mgd; self-supplied rural users consumed nearly the same amount; public supplies consumed the least, 41 mgd.

CHANGES IN WITHDRAWALS SINCE 1955

The present survey is comparable to the surveys made for 1950 and 1955. However, the area was not divided into the same subregions in 1955. A comparison of trends in three States, South Carolina, Georgia, and Alabama, should be a good indication of trends in the Southeast River Basins. The withdrawal of water increased 31 percent during the 5-year period. The greatest actual increase was in the withdrawal of water for industrial use, 1,700 mgd (see table 9); but the greatest percentage increase was in the use of self-supplied rural water, 58 percent. The withdrawal of saline water by self-supplied industry increased 180 percent, from 250 to 730 mgd.

Table 9.—*Trends in water use in Alabama, Georgia, and South Carolina, in million gallons per day*

Use	Water used in—		Percent increase
	1955	1960	
Public supplies	630	690	10
Rural	120	190	58
Irrigation	76	90	18
Industry	5,300	7,000	32
All uses	6,100	8,000	31

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