



# Estimated Use of Water in the United States, 1960

S W BRANCH  
MAR 9 1962  
ACA - ARLINGTON

GEOLOGICAL SURVEY  
CIRCULAR 456

# Estimated Use of Water in the United States, 1960

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



GEOLOGICAL SURVEY CIRCULAR 456

Washington  
1961



## CONTENTS

	Page		Page
Abstract.....	1	Withdrawal use—Continued	
Introduction.....	1	Self-supplied industrial use—Continued	
Previous investigations .....	1	Fuel-electric power (public utility).....	17
Present investigation .....	3	Air conditioning.....	29
Definition of terms.....	3	Waterpower.....	29
Withdrawal use.....	4	Summary of withdrawal uses .....	31
Public supplies.....	4	Nonwithdrawal uses .....	37
Rural .....	4	Changes since 1955.....	37
Irrigation.....	13	Supply versus demand .....	39
Self-supplied industrial use.....	17	Selected references .....	42

## ILLUSTRATIONS

		Page
Figure 1. Map of the United States showing names and locations of water-use regions.....		2
2. Water used for irrigation (including conveyance losses), by regions in the United States 1960 .....		18
3. Use of self-supplied industrial water, by regions, in the United States 1960.....		19
4. Most industrial water is used for cooling .....		29
5. How water was used in 1960.....		32
6. Where water is consumed.....		32
7. Trends in use of water for waterpower and all other uses .....		37
8. Trends in water used for public supplies, rural supplies, irrigation, and industry.....		38
9. Supply and demand in the Nation .....		41
10. Supply and demand in the West .....		42

## TABLES

		Page
Table 1. Water used for public supplies, by States, 1960 .....		5
2. Water used for public supplies, by regions, 1960 .....		7
3. Water for rural use, by States, 1960.....		9
4. Water for rural use, by regions, 1960 .....		11
5. Water used for irrigation, by States, 1960.....		14
6. Water used for irrigation, by regions, 1960 .....		16
7. Self-supplied industrial water, by States, 1960.....		20
8. Self-supplied industrial water, by regions, 1960 .....		22
9. Water used for public utility generation of fuel-electric power, by States, 1960 .....		26
10. Water used for public utility generation of fuel-electric power, by regions, 1960 .....		28
11. Water withdrawn for air conditioning, by States, 1960 .....		30
12. Water withdrawn for air conditioning, by regions, 1960 .....		31
13. Water used for waterpower, by States, 1960 .....		33
14. Water used for waterpower, by regions, 1960.....		33
15. Summary of water withdrawn except for waterpower, by States, 1960.....		34
16. Summary of water withdrawn except for waterpower, by regions, 1960 .....		36
17. Changes in withdrawals 1950-60.....		39
18. Supply compared with demand .....		40



# Estimated Use of Water in the United States, 1960

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

## ABSTRACT

The estimated average withdrawal use of water in the United States during 1960 was almost 270,000 mgd (million gallons per day), exclusive of water used to develop waterpower. This estimated use amounts to about 1,500 gpd (gallons per day) per capita. An additional 2,000,000 mgd were used to develop waterpower.

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 five types: public supplies, rural, irrigation, self-supplied industrial, and waterpower. Consumptive use of water is the quantity discharged to the atmosphere or incorporated in the products of the process in which it was used. Only 61,000 mgd of the 270,000 mgd withdrawn was consumed.

Of the water withdrawn in 1960, 220,000 mgd (including irrigation conveyance losses) was taken from surface sources and 47,000 from underground sources. Withdrawal of water for uses other than waterpower has increased 12 percent since 1955. The amount of water used for generation of waterpower has increased 33 percent since 1955. The use of saline water was almost twice as great in 1960 as in 1955.

The upper limit of our water supply is the average annual runoff, nearly 1,200,000 mgd. The supply in 1960 was depleted by 61,000 mgd, the amount of water consumed. However, a large part of the water withdrawn but not consumed was deteriorated in quality.

## INTRODUCTION

The use of water generally reduces the water resources and frequently deteriorates the quality of the water, whether the use is withdrawal or nonwithdrawal, consumptive or nonconsumptive. The water quality may be deteriorated by the addition of the following: wastes containing high concentrations of dissolved solids, wastes containing organic matter, bacterial active wastes, and heat. Because the use of water affects the resource, an adequate evaluation of the water resources of the Nation 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 the use of water during 1960 in broad categories and in States and regions. (See fig. 1.)

## PREVIOUS INVESTIGATIONS

Many Federal, State, and local agencies are interested in data on the use of water, and in recent years a number of agencies have compiled water-use data. The U.S. Public Health Service (1959), under the auspices of the Inter-Agency Committee on Water Resources, Subcommittee on Hydrology, has compiled a report on Federal programs for collection of data on water use. Some investigators made inventories or estimates of water used in a single category. The U.S. Public Health Service (1948), in cooperation with the sanitary-engineering divisions of the State health departments, made inventories of public water-supply facilities in 1945 which included data on the quantity of water used. Similar inventories of facilities serving populations of 25,000 or more were made in 1954, 1955, 1956, 1958, and 1960. The U.S. Public Health Service (1960-61) made a complete inventory again in 1958. The American Water Works Association (1948, 1953, 1957) has made several national surveys of municipal water works, including information on water use for about 500 water systems serving populations of 10,000 or more.

The U.S. Bureau of the Census (1955) made a survey of water used by the manufacturing industries in 1953, as part of their annual survey of manufactures. Additional data on use of water were collected with the 1954 Census of Manufactures. Picton (1952, 1956, and 1960) made estimates of water used in the United States from 1900 to 1950 and 1955 and forecast estimates of future use. Guyton (1950) made an estimate of ground water used in the United States during 1945, and Langbein (1950) made an estimate of the quantity of water used in the United States in 1946 for the generation of hydroelectric power. An inventory made by Mangan and Graham (1953)

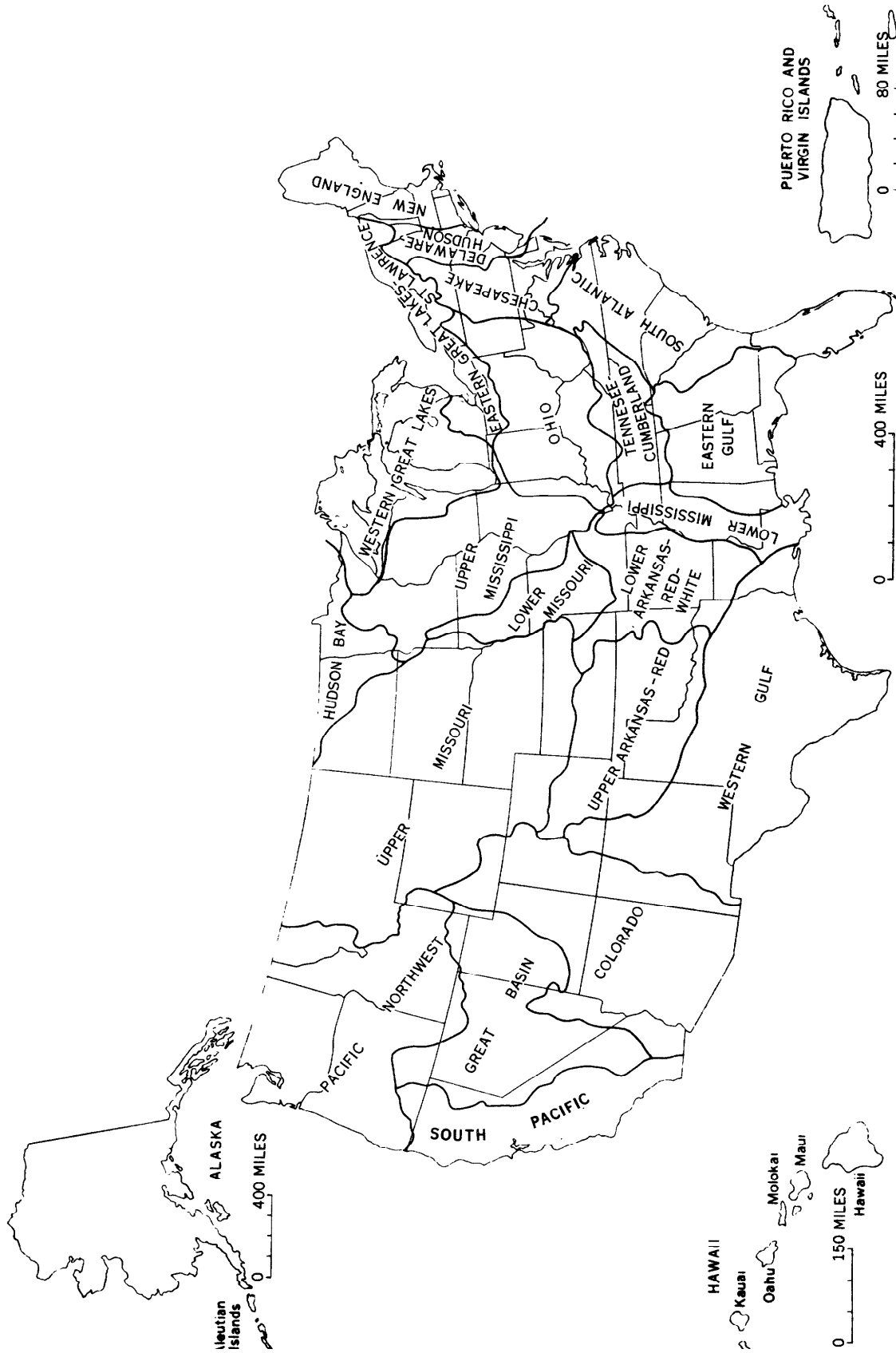


Figure 1. —Map of the United States showing names and locations of water-use regions.

showed the quantity of water used in Pennsylvania in 1951, and Kammerer (written communication, 1961) estimated water use in 1955 for the Delaware River basin. The U.S. Federal Power Commission (1957b) inventoried the water requirements of utility steam electric generating plants in 1954. MacKichan (1951 and 1957) made estimates of the quantity of water used in each of the 48 States during 1950 and 1955 for five major uses: rural, public supplies, industry, irrigation, and waterpower. He also gave the quantity used in 1955 in 19 major regions. MacKichan and Kammerer (1961) estimated water use in 1959-60 for Georgia and parts of adjacent States as a contribution to the water resources investigations being conducted by the U.S. Southeast Area Study Commission.

Woodward (1957) projected water needs for rural supplies, public supplies, self-supplied industry, and irrigation to 1980. The Select Committee on National Water Resources, United States Senate (1959a, 1959b, 1960a, 1960b, 1960c, 1960d, and 1960e) published information on current use of water and gave projections to 1980 and 2000.

Among the many reports which give water-use data for all the principal withdrawal uses within a single State are those for Arkansas (Wood, 1959), California (California Water Resources Board, 1955), Connecticut (Connecticut Water Resources Commission, 1957), Delaware (Smith and others, 1960), Georgia (Thomson and others, 1956), Indiana (Indiana Water Resources Study Committee, 1956), Kansas (Foley, Smrha, and Metzler, 1955), Kentucky (Kentucky Water Resources Commission, 1959), New York (Temporary New York State Commission on Water Resources Planning, 1960), Ohio (Rudnick, 1959), Tennessee (Tennessee Water Resources Division, 1961), Virginia (Virginia Advisory Legislative Council, 1955), and Wisconsin (Wirth, 1959).

#### PRESENT INVESTIGATION

This report presents an estimate of the quantity of water withdrawn and the quantity consumed in 1960. It is similar in objective and scope to MacKichan's earlier estimates (1951 and 1957). 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 Geological Survey supplied estimates of water used for public supplies and for manufacturing and nonmanufacturing industries. The estimates were based on data in the Geological Survey files and those furnished by State and local officials. The quantities of water used for power generation at fuel-electric utilities, for rural domestic and stock use, and for irrigation, were computed using statistics of the U.S. Bureau of the Census (1952, 1956, and 1960c), the U.S. Federal Power Commission (1957b, and 1960-61), and the U.S. Department of Agriculture (1960). Information on the sources of water (ground water, surface water, or sewage) was furnished by the district offices of the Water Resources Division of the Geological Survey.

#### DEFINITION OF TERMS

Uses of water may be classified in several different ways: among them are withdrawal and nonwithdrawal, 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 rate of streamflow. The quantity of water withdrawn at a place 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 directly from the source for his own use. The latter is self supplied.

Consumptive use is the quantity of water discharged to the atmosphere (evaporated) 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 regardless of composition. Sodium chloride may not be the principal salt in the water. (Krieger, Hatchett, and Poole, 1956.)

Quantities of water given in this report are generally in 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. Fuel-electric utilities and air conditioning are important subdivisions of primary withdrawal uses and have been evaluated. Withdrawal use may be further subdivided into consumptive and non-consumptive use. The water consumed has been estimated.

#### PUBLIC SUPPLIES

Public water-supply systems in the United States served about 136 million people an average of 151 gpd per person or nearly 21,000 mgd. (See tables 1 and 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 6,600 mgd from public supplies of which about 560 mgd was used for air conditioning. Of the 20,600 mgd withdrawn for public supplies, almost 3,500 mgd or about 17 percent was consumed. Public water-supply systems may be either publicly or privately owned.

#### RURAL

Rural use of water totaled about 3,600 mgd, of which 1,600 mgd was used by livestock and 2,000 mgd was for domestic use. (See tables 3 and 4.) Rural homes are defined as those not served by public water-supply systems. About 2,800 mgd was obtained from wells and springs and only 850 mgd was obtained from lakes, streams, and ponds. The resource was depleted by almost 2,800 mgd by this use because practically all the water withdrawn was evaporated or transpired after being discharged on or immediately below the surface of the ground.

The 1,600 mgd of livestock water does not include large quantities of water evaporated from stock ponds. In some areas water thus evaporated may equal or exceed the water consumed by the stock. For example, in North Dakota there are 35,000 stock-water ponds having an average surface area of about 1.5 acres (Erskine, written communication). Assuming an evaporation loss of 2.8 feet per year, the average daily evaporation amounts to about 130 mgd. Water consumed by livestock in North Dakota amounted to only 28 mgd.

The rural use of water was computed by multiplying per capita uses by the human and livestock population. Of the 182 million people living in the United States, 48 million supply their own water. Of this 48 million, 36 million have running water in their homes.

Frank (1955) states that people living in the average electrified farm or urban home in the United States use an average of 60 gpd or more per person 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. Quantities of rural

Table 1.—Water used for public supplies, by States, 1960

	Population served				Water withdrawn				Water delivered				Water consumed (mgd)
	Ground water (thousands)	Surface water (thousands)	All water (thousands)	Ground water (mgd)	Surface water (mgd)	All water (mgd)	Per capita (gpd)	Industrial and commercial uses			Domestic use and losses <sup>1</sup> (mgd)		
								Air conditioning (mgd)	Except air conditioning (mgd)	All uses (mgd)			
Alabama-----	808	1,200	2,000	84	150	230	118	9.4	69	78	160	54	
Alaska-----	31	43	74	7.9	15	23	307	0	10	10	13	.3	
Arizona-----	697	283	980	100	42	150	150	6.4	15	21	130	74	
Arkansas-----	457	478	935	48	51	100	107	0	27	27	73	18	
California-----	5,800	7,310	13,100	1,200	1,400	2,600	201	76	300	380	2,300	370	
Colorado-----	209	1,290	1,500	41	250	290	196	9.1	69	78	220	69	
Connecticut-----	115	1,970	2,090	14	240	260	122	6.9	90	97	160	77	
Delaware-----	134	176	310	11	28	40	128	1.6	20	22	18	4.0	
Florida-----	3,320	54	3,370	500	23	530	156	7.5	142	150	370	140	
Georgia-----	711	1,600	2,310	110	260	370	161	8.1	71	79	290	33	
Hawaii-----	511	70	581	74	11	85	146	5.0	25	30	55	25	
Idaho-----	352	97	449	91	28	120	264	1.5	54	56	62	18	
Illinois-----	2,860	5,600	8,470	200	1,400	1,600	186	67	320	390	1,200	160	
Indiana-----	1,230	1,680	2,910	130	230	370	126	29	110	140	220	92	
Iowa-----	943	555	1,500	91	68	160	106	5.1	67	72	88	16	
Kansas-----	734	583	1,320	120	81	200	150	.8	24	25	170	69	
Kentucky-----	251	1,400	1,660	18	210	230	138	1.3	71	72	160	23	
Louisiana-----	1,020	1,140	2,150	91	180	270	126	27	54	81	190	110	
Maine-----	136	608	744	11	75	86	116	1.0	30	31	55	17	
Maryland-----	190	2,200	2,390	21	280	300	127	12	100	110	200	22	
Massachusetts-----	1,300	3,640	4,930	120	470	590	119	8.3	170	170	420	59	
Michigan-----	1,310	4,230	5,540	170	670	840	153	28	410	440	400	94	
Minnesota-----	1,080	1,070	2,140	100	120	220	104	10	60	70	150	29	
Mississippi-----	777	238	1,020	87	28	110	113	4.0	28	32	83	39	
Missouri-----	460	2,300	2,760	49	370	410	150	12	180	190	230	80	
Montana-----	96	356	452	24	89	110	250	1.0	18	19	94	56	
Nebraska-----	648	342	990	120	58	180	178	3.9	72	76	100	8.3	
Nevada-----	139	89	228	43	36	79	346	.7	13	14	65	42	

See footnote at end of table.

## ESTIMATED USE OF WATER IN THE UNITED STATES, 1960

Table 1.—Water used for public supplies, by States, 1960—Continued

	Population served			Water withdrawn				Water delivered				Water consumed (mgd)
	Ground water (thousands)	Surface water (thousands)	All water (thousands)	Ground water (mgd)	Surface water (mgd)	All water (mgd)	Per capita (gpd)	Industrial and commercial uses			Domestic use and losses <sup>1</sup> (mgd)	
								Air conditioning (mgd)	Except air conditioning (mgd)	All uses (mgd)		
New Hampshire	222	292	514	18	36	54	106	0.8	16	17	37	2.8
New Jersey	1,610	3,080	4,700	230	440	670	143	50	150	200	470	20
New Mexico	556	105	661	84	24	110	163	.9	11	12	96	49
New York	3,360	11,900	15,300	330	1,700	2,100	136	18	570	590	1,500	350
North Carolina	355	1,860	2,220	34	260	290	131	2.9	55	58	230	29
North Dakota	182	172	354	14	19	32	91	.3	1.9	2.2	30	12
Ohio	1,900	5,440	7,330	230	790	1,000	138	0	600	610	410	120
Oklahoma	568	1,250	1,820	56	150	210	115	15	51	66	140	72
Oregon	284	1,100	1,380	170	220	390	284	.4	130	130	260	36
Pennsylvania	736	8,460	9,200	110	1,200	1,300	144	32	640	670	650	120
Puerto Rico	350	1,400	1,750	6.8	61	68	39	1.1	21	22	46	11
Rhode Island	140	689	829	10	71	81	97	2.0	38	40	41	5.0
South Carolina	411	967	1,380	35	150	190	137	2.9	55	58	130	19
South Dakota	341	71	412	46	8.6	54	132	.1	4.9	5.0	50	19
Tennessee	1,220	1,190	2,410	150	190	340	142	4.2	96	100	240	81
Texas	4,420	4,160	8,580	530	600	1,100	132	37	320	360	780	480
Utah	363	369	732	100	120	220	301	5.5	6	12	210	45
Vermont	70	160	230	8.1	24	32	140	.6	12	13	19	1.7
Virginia	304	1,900	2,200	43	220	260	129	14	110	120	160	29
Virgin Islands	10	14	24	.3	.6	.9	37	0	.1	.1	.8	.7
Washington	946	1,310	2,260	200	570	770	341	1.7	310	310	460	77
West Virginia	450	802	1,250	37	87	120	99	.3	46	46	78	6.6
Wisconsin	1,390	1,040	2,430	160	210	370	152	20	150	170	200	37
Wyoming	93	124	217	33	26	59	271	2.2	10	12	46	34
District of Columbia.	0	764	764	0	140	140	185	7.1	54	61	81	15

See footnote at end of table.

United States excluding Alaska, Hawaii, Puerto Rico, and Virgin Island.	45,700	87,700	133,000	6,240	14,100	20,400	153	556	6,020	6,580	13,800	3,430
United States ---	46,600	89,200	136,000	6,330	14,200	20,600	151	562	6,080	6,640	13,900	3,470

<sup>1</sup>Includes public use.

Table 2.—Water used for public supplies, by regions, 1960

	Population served			Water withdrawn				Water delivered				Water con- sumed (mgd)
	Ground water (thousands)	Surface water (thousands)	All water (thousands)	Ground water (mgd)	Surface water (mgd)	All water (mgd)	Per capita (gpd)	Industrial and commercial uses			Domestic use and losses <sup>1</sup> (mgd)	
								Air conditioning (mgd)	Except air conditioning (mgd)	All uses (mgd)		
New England ---	1,900	7,020	8,920	170	870	1,000	117	19	320	350	700	150
Delaware—	4,830	16,200	21,100	550	2,400	3,000	142	84	920	1,000	1,970	370
Hudson.	936	5,460	6,390	120	760	880	135	32	340	370	500	82
Chesapeake ---	4,200	4,780	8,980	590	690	1,300	145	24	390	410	900	200
South Atlantic --	1,710	2,160	3,860	220	280	490	128	17	93	110	390	100
Eastern Gulf ---	600	1,570	2,170	73	240	320	146	4.5	80	84	230	60
Tennessee -	3,640	8,720	12,400	400	1,100	1,500	122	27	590	620	880	190
Cumberland.	912	9,090	10,000	93	1,400	1,500	151	24	800	820	690	200
Ohio -----	2,700	7,210	9,900	270	1,600	1,900	192	92	520	610	1,300	200
Eastern Great Lakes—St. Lawrence.	197	167	364	15	18	33	90	.8	4.2	5.0	28	9.0
Western Great Lakes.	4,480	3,700	8,180	410	600	1,000	123	34	350	380	630	130
Hudson Bay ---	1,620	2,100	3,720	280	380	650	176	14	170	180	470	180
Upper Mississippi.	389	873	1,260	36	130	160	130	3.3	60	63	100	32

WITHDRAWAL USE

Table 2.—Water used for public supplies, by regions, 1960—Continued

	Population served			Water withdrawn				Water delivered				Water consumed (mgd)
	Ground water (thousands)	Surface water (thousands)	All water (thousands)	Ground water (mgd)	Surface water (mgd)	All uses (mgd)	Per capita (gpd)	Industrial and commercial uses			Domestic and use losses <sup>1</sup> (mgd)	
								Air conditioning (mgd)	Except air conditioning (mgd)	All uses (mgd)		
Lower Mississippi, Upper Arkansas—Red.	1,900	1,080	2,980	210	170	380	127	23	100	120	260	110
Lower Arkansas—Red—White.	888	1,520	2,400	85	190	280	117	13	75	88	190	86
Western Gulf--	4,820	3,980	8,800	590	590	1,200	136	36	320	360	820	520
Colorado-----	898	508	1,410	160	110	270	193	8.5	25	33	240	120
Great Basin---	493	445	938	130	140	280	296	5.8	27	33	250	67
South Pacific--	5,710	7,250	13,000	1,300	1,400	2,700	208	76	400	480	2,200	370
Pacific Northwest.	1,550	2,620	4,170	350	840	1,200	286	3.2	390	390	810	150
Hawaii-----	511	70	581	74	11	85	146	5.0	35	30	55	25
Alaska-----	31	43	74	7.9	15	23	307	0	10	10	13	.3
Puerto Rico and Virgin Islands.	360	1,410	1,770	7.1	62	69	39	1.1	21	22	47	11
United States excluding Alaska, Hawaii, Puerto Rico, and Virgin Islands.	45,700	87,700	133,000	6,240	14,100	20,400	153	556	6,020	6,580	13,800	3,430
United States--	46,600	89,200	136,000	6,330	14,200	20,600	151	562	6,080	6,640	13,900	3,470

<sup>1</sup>Includes public use.

Table 3.—Water for rural use, by States, 1960

[Million gallons per day]

	Domestic use				Livestock use				Domestic and livestock uses			
	Withdrawn		Con- sumed	All water	Withdrawn		Con- sumed	All water	Withdrawn		Con- sumed	All water
	Surface water	Ground water			Surface water	Ground water			Surface water	Ground water		
Alabama	0	37	37	13	13	26	26	13	50	63	63	63
Alaska	1.2	4.9	6.1	0	.1	.1	.1	1.2	5.0	6.2	6.4	6.4
Arizona	1.5	27	28	4.9	9.1	14	14	6.4	36	43	43	42
Arkansas	0	23	23	18	10	28	28	18	33	51	51	51
California	18	200	130	25	61	86	70	42	260	310	200	200
Colorado	1.2	8.2	9.4	10	21	31	28	11	29	40	30	30
Connecticut	.4	22	22	.6	2.4	3.0	3.0	1.0	24	25	25	25
Delaware	0	6.1	6.1	.2	1.6	1.8	.9	.2	7.7	7.9	1.5	1.5
Florida	0	86	86	6.5	16	23	23	6.5	100	110	110	110
Georgia	0	62	62	23	5.8	28	28	23	68	91	91	91
Hawaii	2.0	6.0	8.0	1.9	.5	2.4	1.9	3.9	6.5	10	8.3	8.3
Idaho	1.2	19	20	11	10	21	19	12	29	42	24	24
Illinois	12	61	73	18	60	78	78	30	120	150	130	130
Indiana	12	84	96	16	28	44	44	28	110	140	110	110
Iowa	.5	55	56	69	69	140	130	70	120	190	140	140
Kansas	3.0	34	37	25	32	57	57	28	66	94	94	94
Kentucky	5.6	18	24	28	2.7	31	31	34	21	54	45	45
Louisiana	2.4	38	41	13	10	23	23	15	49	64	64	64
Maine	.7	6.7	7.4	2.0	1.4	3.4	3.4	2.7	8.1	11	5.6	5.6
Maryland	0	30	30	.4	8.4	8.8	8.8	.4	39	39	39	39
Massachusetts	.1	4.6	4.7	1.8	1.2	3.0	2.7	1.9	5.8	7.7	6.9	6.9
Michigan	0	100	100	5.8	23	29	23	5.8	130	130	44	44
Minnesota	0	52	52	16	55	71	71	16	110	120	78	78
Mississippi	0	36	36	22	14	36	36	22	50	72	68	68
Missouri	22	33	55	36	36	71	71	58	69	130	130	130



United States excluding Alaska, Hawaii, Puerto Rico, and Virgin Islands.	140	1,900	2,000	1,200	700	890	1,600	1,500	840	2,800	3,600	2,700
United States -----	150	1,900	2,000	1,200	700	890	1,600	1,500	850	2,800	3,600	2,800

**Table 4.—Water for rural use, by regions, 1960**  
[Million gallons per day]

Region	Domestic use				Livestock use				Domestic and livestock uses			
	Withdrawn		Consumed		Withdrawn		Consumed		Withdrawn		Consumed	
	Surface water	Ground water	All water	Surface water	Ground water	All water	Surface water	Ground water	All water	Surface water	Ground water	All water
New England-----	1.6	37	39	31	6.1	7.3	13	13	7.7	45	52	44
Delaware-Hudson--	.9	160	160	37	8.1	14	22	19	9.0	180	180	56
Chesapeake-----	.5	100	100	49	18	24	42	39	18	120	140	87
South Atlantic-----	.4	210	210	200	29	40	69	67	29	250	280	270
Eastern Gulf-----	0	110	110	110	38	23	60	60	38	140	170	170
Tennessee-	1.1	57	58	54	28	9.9	38	38	29	66	96	91
Cumberland.												
Ohio-----	31	190	230	140	69	58	130	130	100	250	350	260
Eastern Great Lakes-St. Lawrence.	8.6	130	130	54	15	23	38	36	24	150	170	90
Western Great Lakes.	1.1	160	160	42	13	41	54	49	14	200	210	90
Hudson Bay-----	.1	9.7	9.8	6.7	9.8	11	21	21	9.9	20	30	27
Upper Mississippi-	17	160	180	73	91	200	290	290	110	360	470	360
Upper Missouri---	2.7	65	67	56	96	140	230	220	99	200	300	280
Lower Missouri---	12	33	45	33	41	42	83	81	53	74	130	110
Lower Mississippi	4.6	50	55	52	23	18	41	41	28	68	95	93
Upper Arkansas - Red.	2.5	29	31	28	43	32	74	72	45	61	110	100



Table 4.—Water for rural use, by regions, 1960—Continued

Region	Domestic use				Livestock use				Domestic and livestock uses			
	Withdrawn		Con- sumed	All water	Withdrawn		Con- sumed	All water	Withdrawn		Con- sumed	
	Surface water	Ground water			Surface water	Ground water			Surface water	Ground water		Surface water
Lower Arkansas- Red-White.	3.2	40	42	43	43	24	67	67	46	64	110	110
Western Gulf	.2	40	34	40	40	78	120	120	40	120	160	150
Colorado	3.7	39	35	43	14	18	32	29	18	57	75	64
Great Basin	2.0	14	7.9	16	11	10	22	19	13	25	38	27
South Pacific	17	190	120	210	25	57	82	66	42	250	290	190
Pacific Northwest	30	39	23	69	38	21	59	55	67	61	130	78
Hawaii	2.0	6.0	6.4	8.0	1.9	.5	2.4	1.9	3.9	6.5	10	8.3
Alaska	1.2	4.9	.3	6.1	0	.1	.1	.1	1.2	5.0	6.2	.4
Puerto Rico and Virgin Islands.	8.7	1.6	9.2	10	3.2	.8	3.9	3.6	12	2.4	14	13
United States ex- cluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	140	1,900	1,200	2,000	700	890	1,600	1,500	840	2,800	3,600	2,700
United States	150	1,900	1,200	2,000	700	890	1,600	1,500	850	2,800	3,600	2,800

domestic water were computed for this report using the following per capita rates:

	With running water (gpd)	Without running water (gpd)
Arizona.....	100	10
California.....	80	20
Florida.....	60	5
Hawaii.....	160	70
Idaho.....	100	20
Illinois.....	60	10
Kentucky.....	35	5
Minnesota.....	50	5
New Jersey.....	60	10
New York.....	75	10
Puerto Rico.....	25	10
All other States.....	50	10

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 quantity of water used by livestock in most States was computed using the following rates per head:

Livestock	Use per head (gpd)
Milk cows.....	20
Horses and mules.....	10
Beef cattle.....	10
Hogs.....	3
Sheep.....	2
Goats.....	2
Chickens.....	.04
Turkeys.....	.06

Major exceptions to the above rates per head are as follows:

	Livestock	Use per head (gpd)
Arizona---	Milk cows.....	30
Arkansas -	-----do.....	30
	Beef cattle.....	15
	Horses and mules.....	15

California..	Milk cows.....	25
	Beef cattle.....	15
	Horses and mules.....	15
Colorado..	Milk cows.....	15
Kentucky..	Beef cattle.....	8
Maryland..	Milk cows.....	35
Missouri..	-----do.....	30
Nevada---	Beef cattle.....	6
Virginia --	Milk cows.....	25

IRRIGATION

Water was withdrawn for irrigation in 1960 at the rate of 94 million acre-feet per year (tables 5 and 6) to irrigate 39 million acres. An additional 26 million acre-feet was lost in conveyance between the points of diversion and use. About two-thirds of the water was obtained from lakes, reservoirs, and streams; the remaining third was obtained from wells and springs.

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 tables 5 and 6.

Irrigation varies greatly throughout the Nation. Of the 39 million acres irrigated, almost 36 million acres was in the 17 Western States, whereas only 3.5 million acres was in the other 33 States and Puerto Rico. Therefore, the quantity of water used for irrigation in the Western States is much greater than in the remaining States and Puerto Rico. (See fig. 2). Furthermore, the water used for irrigation in the East is usually conveyed to the fields in pipes so the conveyance losses are very small compared to those losses in the Western States where the water is usually transported to the fields in ditches.

About 60 percent of the irrigation water applied in 1960 was consumed by evaporation and transpiration. This percentage is more than 25 times the percent consumed by self-supplied industry, and about four times the percent consumed by public supplies.

ESTIMATED USE OF WATER IN THE UNITED STATES, 1960

TABLE 4. - WATER USE FOR IRRIGATION BY STATE, 1960

	Acres irrigated (1,000's of acres)	Water delivered to farms (1,000 ac-ft per year)				Conveyance loss (1,000 ac-ft/yr)	Consumptive use (1,000 ac-ft/yr)	Water delivered to farms (million gallons per day)				Conveyance loss (mgd)	Consumptive use (mgd)
		Surface water	Ground water	Other water	All water			Surface water	Ground water	Other water	All water		
Alabama	27	11	2.7	0	14	0	14	9.8	2.4	0	12	0	12
Alaska	.36	.03	.06	0	.09	0	.06	.03	.05	0	.08	0	.05
Arizona	1,300	1,900	3,300	0	5,200	1,200	3,200	1,700	3,000	0	4,700	1,100	2,900
Arkansas	980	160	860	0	1,000	82	710	150	770	0	920	73	640
California	8,000	10,000	9,500	490	20,000	5,100	16,000	9,400	8,500	430	18,000	4,500	14,000
Colorado	3,200	8,000	2,100	43	10,000	1,000	5,400	7,100	1,800	38	9,000	930	4,800
Connecticut	5.5	1.1	.06	0	1.2	0	1.2	1.0	.05	0	1.0	0	1.0
Delaware	8.0	1.4	1.2	0	2.6	0	2.6	1.3	1.1	0	2.4	0	2.4
Florida	680	440	300	0	740	22	740	390	270	0	660	20	660
Georgia	96	23	18	0	41	0	41	20	16	0	37	0	37
Hawaii	130	610	420	0	1,000	120	410	540	380	0	920	110	370
Idaho	3,200	9,600	2,600	0	12,000	5,600	5,100	8,600	2,300	0	11,000	5,000	4,500
Illinois	11	1.4	1.2	.05	2.6	0	2.6	1.2	1.1	.04	2.4	0	2.4
Indiana	20	4.5	3.6	0	8.0	0	8.0	4.0	3.2	0	7.2	0	7.2
Iowa	79	26	42	0	68	0	68	23	38	0	61	0	61
Kansas	1,000	1,000	1,000	0	2,000	350	1,800	900	900	0	1,800	310	1,600
Kentucky	8.2	2.1	.58	.07	2.8	0	2.8	1.9	.52	.06	2.5	0	2.5
Louisiana	510	530	380	0	910	270	640	470	340	0	810	240	570
Maine	3.0	.98	0	.01	.99	0	.99	.88	0	.01	.88	0	.88
Maryland	13	4.2	1.6	.09	6.0	0	6.0	3.8	1.4	.08	5.3	0	5.3
Massachusetts	15	7.9	.21	.29	8.4	0	3.7	7.1	.19	.26	7.5	0	3.3
Michigan	68	16	8.7	0	25	0	25	14	7.8	0	22	0	22
Minnesota	20	3.8	4.2	0	8.0	0	8.0	3.4	3.8	0	7.1	0	7.1
Mississippi	310	210	360	0	570	10	460	190	320	0	510	9.2	410
Missouri	41	8.5	22	0	31	0	31	7.6	20	0	28	0	28
Montana	2,000	5,600	38	0	5,700	1,900	2,700	5,000	34	0	5,100	1,700	2,400
Nebraska	2,600	1,000	1,500	0	2,500	1,300	1,200	900	1,300	0	2,200	1,200	1,100
Nevada	660	1,700	300	1.1	2,000	430	1,100	1,500	270	.97	1,700	380	960
New Hampshire	3.6	1.1	.18	.24	1.5	0	1.4	.97	.16	.21	1.4	0	1.3
New Jersey	66	11	29	0	40	0	40	9.5	26	0	35	0	35

WITHDRAWAL USE

New Mexico	930	1,000	1,000	10	2,100	640	1,500	920	910	9.1	1,800	570	1,300
New York	57	20	11	0	31	0	31	18	9.5	0	28	0	28
North Carolina	60	23	7.5	0	30	0	30	20	6.7	0	27	0	27
North Dakota	62	94	.14	0	94	31	63	84	.13	0	84	28	56
Ohio	21	6.6	2.9	0	9.5	0	8.6	5.9	2.6	0	8.5	0	7.7
Oklahoma	310	94	210	0	300	18	210	84	190	0	270	16	190
Oregon	1,600	5,100	270	0	5,400	1,700	3,100	4,600	240	0	4,800	1,500	2,800
Pennsylvania	17	3.0	.28	0	3.3	0	3.3	2.7	.25	0	3.0	0	3.0
Puerto Rico	100	130	190	0	320	38	280	110	170	0	280	34	250
Rhode Island	.50	.19	.05	.01	.25	0	.25	.17	.04	.01	.22	0	.22
South Carolina	68	30	21	0	51	0	51	27	19	0	46	0	46
South Dakota	140	130	38	0	170	97	130	120	34	0	150	86	110
Tennessee	26	11	2.0	0	13	0	13	9.7	1.8	0	11	0	11
Texas	7,100	1,300	8,600	37	9,900	2,600	7,000	1,200	7,700	33	8,900	2,300	6,200
Utah	1,200	3,400	270	54	3,700	840	2,500	3,000	240	48	3,300	750	2,200
Vermont	2.0	.81	.03	0	.84	0	.80	.72	.03	0	.75	0	.71
Virginia	40	26	13	.80	40	0	39	23	12	.71	36	0	35
Virgin Islands	.10	.36	.04	0	.40	0	.36	.32	.04	0	.36	0	.32
Washington	1,000	3,700	470	0	4,100	1,100	1,500	3,300	420	0	3,700	1,000	1,300
West Virginia	2.1	1.3	.07	.04	1.4	0	1.4	1.1	.06	.04	1.2	0	1.2
Wisconsin	41	3.7	14	.79	18	0	18	3.3	12	.71	16	0	16
Wyoming	1,400	3,400	64	0	3,500	1,400	2,100	3,100	57	0	3,100	1,300	1,900
District of Columbia	0	0	0	0	0	0	0	0	0	0	0	0	0
United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	39,000	59,000	33,000	630	93,000	26,000	57,000	53,000	30,000	570	83,000	23,000	51,000
United States	39,000	60,000	34,000	630	94,000	26,000	58,000	53,000	30,000	570	84,000	23,000	52,000

Table 6.—Water used for irrigation, by regions, 1960

	Acres irrigated (1,000's of acres)	Water delivered to farms (1,000 ac-ft per year)				Convey- ance loss (1,000 ac-ft/yr)	Con- sump- tive use (1,000 ac-ft/yr)	Water delivered to farms (million gallons per day)			Convey- ance loss (mgd)	Con- sump- tive use (mgd)	
		Surface water	Ground water	Other water	All water			Surface water	Ground water	Other water			All water
England --- aware- idson.	28 120	11 17	0.51 40	0.55 0	13 57	0 0	7.8 57	10 15	0.46 36	0.49 0	11 51	0 0	6.9 51
sapeake --- th Atlantic --- thern Gulf ---	44 840 110	21 510 29	14 320 35	.58 .30 0	35 830 64	0 22 .67	34 830 64	18 450 26	12 290 32	.52 .28 0	31 740 57	0 19 .60	31 740 57
nessee- amberland.	30	13	1.7	.01	15	0	15	12	1.5	.01	14	0	14
o --- thern Great akes St.	33 34	10 19	3.7 1.6	.11 0	14 21	0 0	14 21	9.4 17	3.3 1.5	.10 0	13 19	0 0	12 18
awrence. stern Great akes.	79	16	14	.33	30	0	30	14	13	.29	27	0	27
lson Bay --- er ississippi. er Missouri er issouri. er ississippi. er rkansas-Red.	12 92 7,000 61 650 2,300	15 18 12,000 22 290 2,500	.16 30 2,500 30 660 1,900	0 .51 26 0 0 17	15 49 14,000 51 950 4,400	4.8 0 4,900 .39 57 640	10 49 7,700 51 730 3,300	13 16 11,000 19 260 2,200	.14 27 2,200 26 590 1,700	0 .46 24 0 0 15	13 44 13,000 46 850 3,900	4.3 0 4,400 .35 50 570	9.0 44 6,900 46 660 2,900
er rkansas-Red hite. stern Gulf --- lorado --- eat Basin --- ith Pacific ---	760 8,300 3,100 2,100 7,700	150 3,500 8,900 5,000 8,700	630 10,000 3,600 710 9,200	0 47 2.1 53 490	780 14,000 12,000 5,800 18,000	62 3,300 2,700 1,400 4,400	550 9,200 7,700 3,600 14,000	140 3,100 7,900 4,500 7,800	560 9,300 3,200 640 8,200	0 42 1.8 48 430	700 12,000 11,000 5,100 16,000	55 3,000 2,400 1,200 4,000	490 8,200 6,900 3,200 13,000

	5,700	18,000	3,300	0	21,000	8,100	8,900	16,000	2,900	0	19,000	7,300	8,000
acific North-													
west.													
awai-----	130	610	420	0	1,000	120	410	540	380	0	920	110	370
aska-----		.03	.06	0	.09	0	.06	.03	.05	0	.08	0	.05
uerto Rico	100	130	190	0	320	38	280	110	170	0	280	34	250
and Virgin Islands.													
nited States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	39,000	59,000	33,000	630	93,000	26,000	57,000	53,000	30,000	570	83,000	23,000	51,000
nited States --	39,000	60,000	34,000	630	94,000	26,000	58,000	53,000	30,000	570	84,000	23,000	52,000

SELF-SUPPLIED INDUSTRIAL USE

Industry used an average of 140,000 mgd of self-supplied water during 1960, including 100,000 mgd used for fuel-electric power (tables 7 and 8). About 95 percent of the self-supplied industrial water was obtained from surface sources. In contrast to water used for irrigation, most industrial water is used east of the Mississippi River (fig. 3), and only about 2 percent of the industrial water withdrawn is consumed.

Water has many industrial uses, including processing, cooling, washing, conveyance of material, boiler feed, and sanitation. The commercial fish growing (fish farms and minnow farms or bait hatcheries) is an unusual industry. This industry used 47 mgd in 1960 in Arkansas. About 22 mgd or almost half this water was consumed. Fish hatcheries and log ponds in Oregon withdrew slightly more than 600 mgd, of which only 16 mgd was consumed. In Oregon these uses require a water right. Some industries require water containing small amounts of dissolved solids, whereas other industries are relatively unconcerned about the dissolved-solids content of the water. Most industrial water is self supplied, although a small amount is purchased from public supplies (tables 1 and 2).

About 94 percent of the self-supplied industrial water is used for cooling (fig. 4). Most water for cooling is returned to a stream or an aquifer unchanged except for an increase in temperature. Cooling water need not have a low dissolved-solids content; some cooling equipment is designed for use of sea water or other saline water. Almost one-fourth of the water withdrawn by industry was saline.

FUEL-ELECTRIC POWER (PUBLIC UTILITY)

The amount of water used by public utilities for fuel-electric power was more than twice the amount of self-supplied industrial water used by other industries (tables 7 and 8). Almost all the water used by public utilities for generation of fuel-electric power was for condenser cooling (tables 9 and 10). Water for other uses, such as boiler feed, sanitary services, cooling of machinery within the plant, and irrigation of lawns was a little more than 1 percent of the total. All water for these uses was fresh.

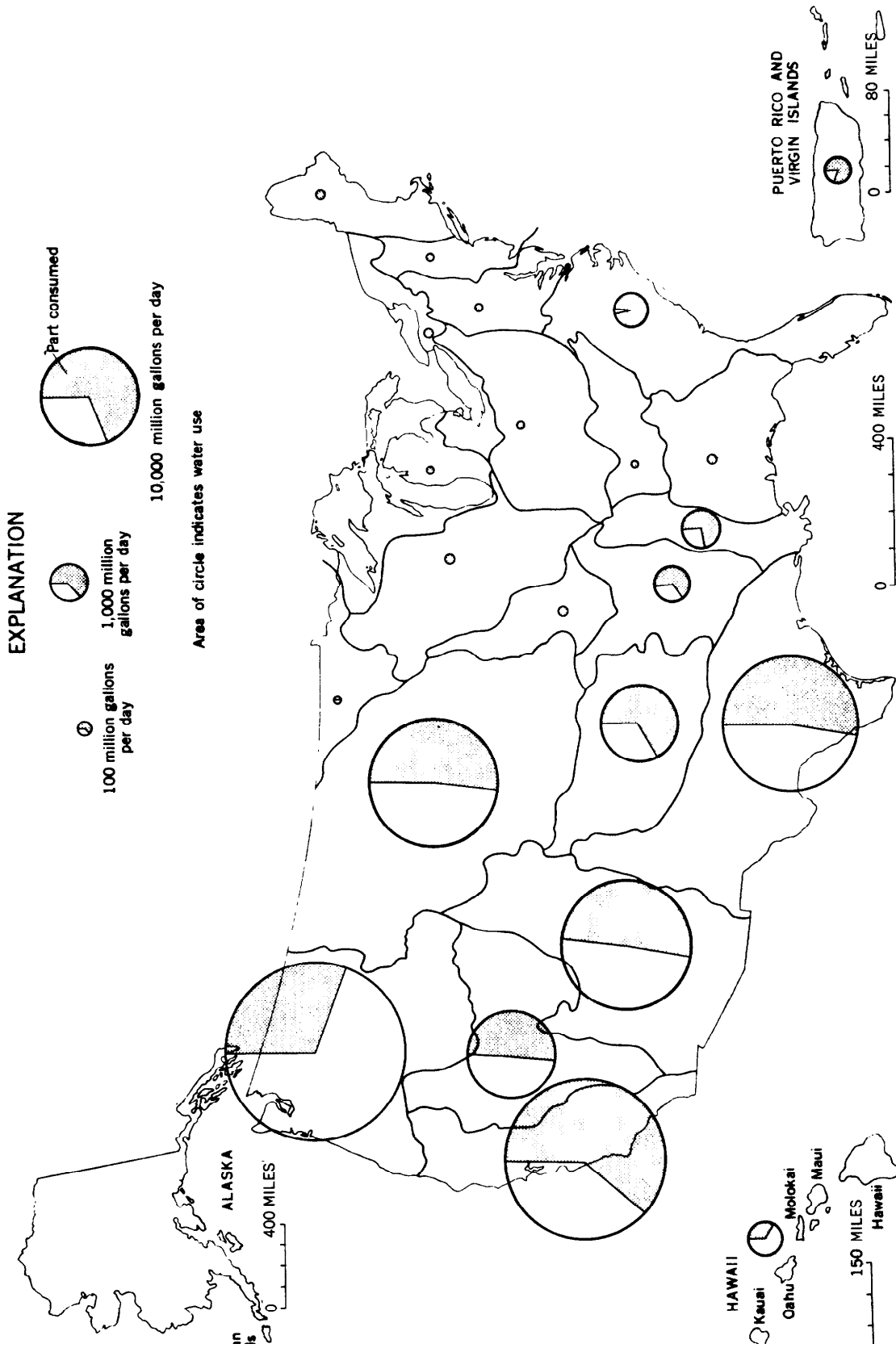


Figure 2. —Water used for irrigation (including conveyance losses), by regions in the United States, 1960.

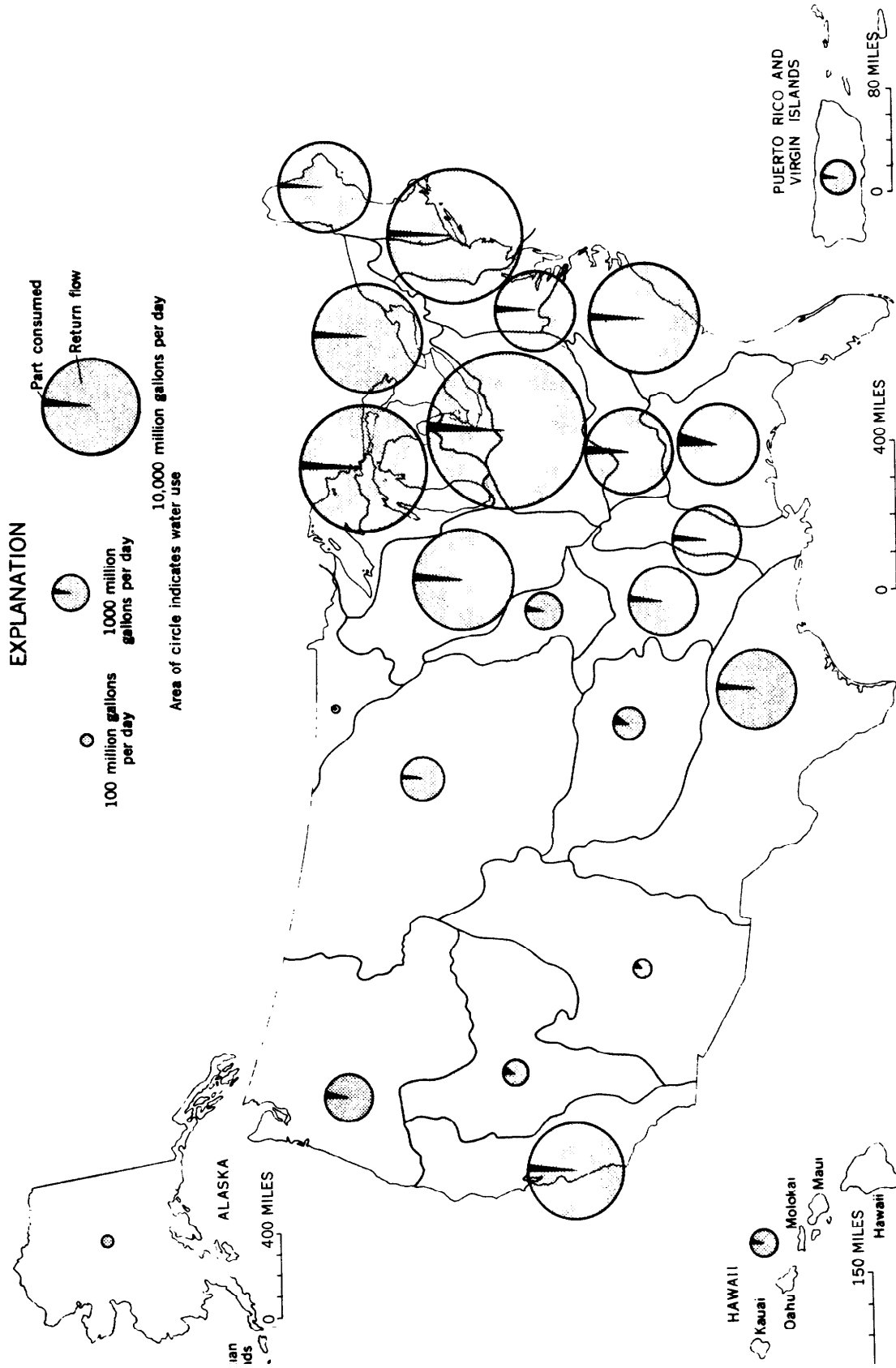


Figure 3.—Use of self-supplied industrial water, by regions in the United States, 1960.



Table 7.—Self-supplied indus-

[Million gal-

	Fuel-electric power (public utility) use						
	Water withdrawn						Water con- sumed
	Ground water		Surface water		Ground and Sur- face water		
	Fresh	Saline	Fresh	Saline	Fresh	Saline	
Alabama .....	1	0	3,000	140	3,000	140	0
Alaska .....	0	0	86	0	86	0	0
Arizona .....	18	0	33	0	51	0	12
Arkansas .....	7	0	270	0	280	0	7
California .....	290	0	140	8,600	430	8,600	17
Colorado .....	2	0	160	0	160	0	7
Connecticut .....	0	0	580	940	580	940	0
Delaware .....	2	0	0	440	2,0	440	0
Florida .....	8	0	1,700	3,100	1,700	3,100	2
Georgia .....	3	0	1,400	320	1,500	320	0
Hawaii .....	14	16	12	260	26	280	0
Idaho .....	0	0	0	0	0	0	0
Illinois .....	8	0	9,700	0	9,700	0	2
Indiana .....	0	0	3,200	0	3,200	0	7
Iowa .....	0	0	1,500	0	1,500	0	2
Kansas .....	24	0	510	0	530	0	12
Kentucky .....	0	0	2,000	0	2,000	0	1
Louisiana .....	28	0	3,000	1,700	3,000	1,700	11
Maine .....	0	0	1	120	1	120	0
Maryland .....	0	0	500	590	500	590	0
Massachusetts .....	0	0	160	1,600	160	1,600	1
Michigan .....	0	0	3,900	0	3,900	0	1
Minnesota .....	0	0	1,200	0	1,200	0	0
Mississippi .....	6	0	110	160	110	160	10
Missouri .....	1	0	1,300	0	1,300	0	1
Montana .....	0	0	58	0	58	0	0
Nebraska .....	0	0	640	0	640	0	2
Nevada .....	0	3	0	0	0	3	1
New Hampshire .....	6	0	0	250	6	250	0
New Jersey .....	0	0	1,300	1,400	1,300	1,400	4
New Mexico .....	5	0	18	0	23	0	8
New York .....	1	0	3,900	4,400	3,900	4,400	8
North Carolina .....	0	0	2,000	32	2,000	32	0
North Dakota .....	3	0	7	0	10	0	2
Ohio .....	18	0	8,100	0	8,200	0	22

trial water, by States, 1960

lons per day]

Other uses							All industrial uses					
Water withdrawn							Water consumed	Water withdrawn				Water consumed
Ground water		Surface water		Sewage	All water			Fresh	Saline	Sewage	All water	
Fresh	Saline	Fresh	Saline		Fresh	Saline						
79	0	810	0	0	890	0	87	3,900	140	0	4,000	87
12	0	70	0	0	82	0	0	170	0	0	170	0
62	0	16	0	0	78	0	24	130	0	0	130	36
140	0	43	0	0	190	0	40	470	0	0	470	47
310	140	42	510	.5	350	650	81	790	9,300	.5	10,000	98
35	10	120	10	0	160	20	36	310	20	0	330	44
40	0	210	66	0	250	66	20	830	1,000	0	1,800	20
27	0	28	380	0	55	380	54	57	820	0	880	54
680	0	79	260	0	760	260	300	2,500	3,300	0	5,800	300
230	0	76	100	0	310	100	6.9	1,800	430	0	2,200	7
110	5.0	33	.1	0	140	5.1	13	170	280	0	450	13
91	0	90	0	0	180	0	36	180	0	0	180	36
280	40	1,800	0	0	2,100	40	44	12,000	40	0	12,000	46
150	11	1,900	0	0	2,000	11	78	5,300	11	0	5,300	85
74	0	37	0	0	110	0	11	1,600	0	0	1,600	13
120	0	60	0	0	180	0	8.9	710	0	0	710	21
68	.6	180	.3	0	250	.9	24	2,300	1	0	2,300	25
310	39	1,700	0	0	2,100	39	540	5,000	1,700	0	6,800	550
12	0	340	3.0	0	350	3.0	25	350	120	0	480	25
49	0	140	690	70	190	690	74	700	1,300	70	2,000	74
66	0	380	140	0	440	140	30	600	1,800	0	2,300	31
99	14	1,700	0	0	1,800	14	51	5,800	14	0	5,800	52
120	0	720	0	0	840	0	59	2,100	0	0	2,100	59
160	0	58	0	0	220	0	29	330	160	0	480	39
55	3.0	110	0	0	160	3.0	9.0	1,500	3	0	1,500	10
35	1.0	170	0	0	200	1.0	23	260	1	0	260	23
12	0	32	0	0	44	0	4.2	680	0	0	680	6
34	0	10	0	.2	44	0	8.8	44	3	.2	48	10
2.0	0	150	0	0	150	0	8.0	160	250	0	410	8
190	7.6	370	760	0	560	760	150	1,800	2,100	0	4,000	150
18	.1	4.1	0	0	22	.1	4.5	45	.1	0	45	12
150	15	1,600	1,300	0	1,700	1,300	120	5,600	5,800	0	11,000	130
33	0	230	0	0	260	0	22	2,300	32	0	2,300	22
1.6	6.0	1.4	0	0	3.0	6.0	.9	13	6	0	19	2.9
270	0	2,300	0	0	2,600	0	87	12,000	0	0	12,000	110

Table 7.—Self-supplied industrial

	Fuel-electric power (public utility) use							Water con- sumed
	Water withdrawn							
	Ground water		Surface water		Ground and Sur- face water			
	Fresh	Saline	Fresh	Saline	Fresh	Saline		
Oklahoma .....	6	0	180	120	190	120	8	
Oregon .....	0	0	7	0	7	0	0	
Pennsylvania .....	0	0	6,600	0	6,600	0	4	
Puerto Rico and Virgin Islands .....	0	0	4	490	4	490	0	
Rhode Island .....	0	0	0	300	0	300	0	
South Carolina .....	0	0	560	95	560	95	2	
South Dakota .....	0	0	1	0	1	0	1	
Tennessee .....	0	0	3,900	0	3,900	0	1	
Texas .....	470	0	2,000	1,300	2,500	1,300	52	
Utah .....	0	0	77	0	77	0	3	
Vermont .....	0	0	29	0	29	0	0	
Virginia .....	0	0	2,500	810	2,500	810	2	
Washington .....	0	0	0	0	0	0	0	
West Virginia .....	0	0	2,200	0	2,200	0	10	
Wisconsin .....	0	0	2,900	0	2,900	0	0	
Wyoming .....	0	0	84	0	84	0	1	
District of Columbia .....	0	0	270	0	270	0	0	
United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	910	3	72,000	26,000	73,000	26,000	220	
United States .....	920	19	72,000	27,000	73,000	27,000	220	

Table 8.—Self-supplied indus-  
[Million gal-

Region	Fuel-electric power (public utility) use							Water con- sumed
	Water withdrawn							
	Ground water		Surface water		Ground and sur- face water			
	Fresh	Saline	Fresh	Saline	Fresh	Saline		
New England .....	6	0	620	3,200	630	3,200	1	
Delaware-Hudson .....	3	0	5,200	6,100	5,200	6,100	13	
Chesapeake .....	0	0	2,900	1,200	2,900	1,200	2	
South Atlantic .....	10	0	5,200	3,600	5,200	3,600	3	
Eastern Gulf .....	7	0	3,200	610	3,200	610	4	

water, by States, 1960—Continued

Other uses								All industrial uses				
Water withdrawn							Water con- sumed	Water withdrawn				Water con- sumed
Ground water		Surface water		Sew- age	All water			Fresh	Saline	Sew- age	All water	
Fresh	Saline	Fresh	Saline		Fresh	Saline						
23	46	26	11	0	50	57	21	240	180	0	420	29
140	0	1,000	0	0	1,200	0	33	1,200	0	0	1,200	33
300	0	4,100	460	0	4,400	460	190	11,000	460	0	11,000	200
29	1.6	130	160	0	160	160	6.9	160	650	0	810	6.9
15	0	32	.3	0	47	.3	2.2	47	300	0	340	2.2
54	0	84	28	0	140	28	13	700	120	0	820	15
6.7	3.9	5.8	0	0	12	3.9	4.4	14	3.9	0	17	5.4
420	0	940	0	0	1,400	0	310	5,200	0	0	5,200	310
330	11	430	3.6	0	760	15	100	3,300	1,400	0	4,600	160
58	3.0	150	5.5	0	210	8.5	4.6	290	8.5	0	300	7.6
9.1	0	25	0	0	34	0	2.0	63	0	0	63	2.0
51	0	1,100	85	0	1,200	85	0	3,700	900	0	4,600	2.0
170	0	520	48	0	690	48	14	690	48	0	740	14
73	.4	2,200	0	0	2,300	.4	120	4,500	.4	0	4,500	130
230	0	470	0	0	700	0	17	3,600	0	0	3,600	17
8.5	0	56	0	0	65	0	7.3	150	0	0	150	8.3
1.0	0	.8	0	0	1.8	0	.7	280	0	0	280	.7
5,900	350	27,000	4,900	71	33,000	5,200	2,900	110,000	32,000	71	140,000	3,200
6,000	360	27,000	5,000	71	33,000	5,400	3,000	110,000	33,000	71	140,000	3,200

trial water, by regions, 1960

lons per day]

Other uses								All industrial uses				
Water withdrawn							Water con- sumed	Water withdrawn				Water con- sumed
Ground water		Surface water		Sew- age	All water			Fresh	Saline	Sew- age	All water	
Fresh	Saline	Fresh	Saline		Fresh	Saline						
130	0	1,100	210	0	1,200	210	84	1,900	3,400	0	5,300	85
410	12	1,900	2,900	0	2,300	2,900	340	7,500	9,000	0	16,000	350
220	0	930	780	70	1,100	780	120	4,100	1,900	70	6,100	120
830	0	1,200	130	0	2,000	130	260	7,200	3,800	0	11,000	260
310	0	770	260	0	1,100	260	170	4,300	880	0	5,200	180

Table 8.—Self-supplied industrial

Region	Fuel-electric power (public utility) use						
	Water withdrawn						Water consumed
	Ground water		Surface water		Ground and Surface water		
	Fresh	Saline	Fresh	Saline	Fresh	Saline	
Tennessee-Cumberland-----	0	0	5,600	0	5,600	0	0
Ohio-----	19	0	15,000	0	15,000	0	33
Eastern Great Lakes-St. Lawrence-----	0	0	7,800	0	7,800	0	9
Western Great Lakes-----	0	0	9,700	0	9,700	0	3
Hudson Bay-----	3	0	0	0	3	0	2
Upper Mississippi-----	7	0	8,200	0	8,200	7	4
Upper Missouri-----	4	0	1,100	0	1,100	0	12
Lower Missouri-----	1	0	1,100	0	1,100	0	0
Lower Mississippi-----	21	0	930	1,600	950	1,600	19
Upper Arkansas-Red-----	28	0	230	120	260	120	17
Lower Arkansas-Red-White-----	9	0	2,900	3	3,000	3	12
Western Gulf-----	480	0	2,000	1,400	2,500	1,400	56
Colorado-----	18	3	120	0	130	3	15
Great Basin-----	0	0	76	0	76	0	2
South Pacific-----	290	0	140	8,600	430	8,600	17
Pacific Northwest-----	0	0	7	0	7	0	0
Hawaii-----	14	16	12	260	26	280	0
Alaska-----	0	0	86	0	86	0	0
Puerto Rico and Virgin Islands-----	0	0	4	490	4	490	0
United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	910	3	72,000	26,000	73,000	26,000	220
United States-----	920	19	72,000	27,000	73,000	27,000	220

water, by regions, 1960—Continued

Other uses							All industrial uses					
Water withdrawn							Water consumed	Water withdrawn				Water consumed
Ground water		Surface water		Sew-age	All water			Fresh	Saline	Sew-age	All water	
Fresh	Saline	Fresh	Saline		Fresh	Saline						
230	0	1,200	0	0	1,500	0	240	7,100	0	0	7,100	240
600	34	6,600	.3	0	7,200	34	310	22,000	34	0	22,000	340
81	13	3,000	0	0	3,100	13	100	11,000	13	0	11,000	110
340	12	4,200	0	0	4,600	12	180	14,000	12	0	14,000	190
4.9	6.0	80	0	0	85	6.0	6.8	88	6.0	0	94	8.8
480	20	1,200	0	0	1,700	20	36	9,900	20	0	9,900	40
140	13	220	5.0	0	360	18	49	1,500	18	0	1,500	61
43	0	60	0	0	100	0	6.1	1,200	0	0	1,200	6.1
450	25	940	0	0	1,400	25	380	2,300	1,600	0	4,000	390
110	20	91	15	0	200	36	35	460	150	0	610	52
200	38	590	1.0	0	790	38	150	3,700	42	0	3,800	160
430	14	830	3.4	0	1,300	17	270	3,700	1,500	0	5,200	330
80	3.3	53	0	.2	130	3.3	37	270	6.3	.2	270	52
110	6.0	200	5.5	0	310	12	9.1	390	12	0	400	11
300	140	64	510	.5	360	640	80	790	9,300	.5	10,000	97
400	0	1,700	48	0	2,100	48	91	2,100	48	0	2,100	91
110	5.0	33	.1	0	140	5.1	13	170	280	0	450	13
12	0	70	0	0	82	0	0	170	0	0	170	0
29	1.6	130	160	0	160	160	6.9	160	650	0	810	6.9
5,900	350	27,000	4,900	71	33,000	5,200	2,900	110,000	32,000	71	140,000	3,200
6,000	360	27,000	5,000	71	33,000	5,400	3,000	110,000	33,000	71	140,000	3,200

Table 9.—Water used for public utility generation of fuel electric power, by States, 1960

[Million gallons per day]

	Condenser cooling						Other uses						Con- sumed
	Self-supplied			Public supplies	Self- supplied and public supplies	Ground water fresh	Self-supplied		Public supplies	Self- supplied and public supplies	Con- sumed		
	Ground water	Surface water					Fresh	Saline					
		Fresh	Saline										
Alabama	0	2,900	140	0	3,100	1	91	0	0	92	0		
Alaska	0	86	0	0	86	0	0	0	0	0	0		
Arizona	18	33	0	0	51	0	0	0	0	0	12		
Arkansas	7	270	0	0	280	0	0	0	0	0	7		
California	290	140	8,600	100	9,200	0	1	0	13	14	17		
Colorado	2	160	0	40	200	0	0	0	0	0	7		
Connecticut	0	580	940	0	1,500	0	0	0	1	1	0		
Delaware	0	0	440	0	440	2	0	0	0	2	0		
Florida	6	1,700	3,100	690	5,500	2	1	0	2	5	2		
Georgia	3	1,400	320	0	1,800	0	0	0	0	0	0		
Hawaii	14	12	260	0	300	0	0	0	2	2	0		
Idaho	0	0	0	0	0	0	0	0	0	0	0		
Illinois	0	9,400	0	1	9,400	8	320	0	2	320	2		
Indiana	0	3,200	0	0	3,200	0	41	0	0	41	7		
Iowa	0	1,500	0	2	1,500	0	2	0	2	4	2		
Kansas	23	510	0	0	530	1	3	0	0	4	12		
Kentucky	0	2,000	0	0	2,000	0	1	0	0	1	1		
Louisiana	22	3,000	1,700	5	4,700	6	0	0	0	6	11		
Maine	0	0	120	0	120	0	1	0	1	2	0		
Maryland	0	500	560	0	1,100	0	0	22	1	23	0		
Massachusetts	0	160	1,500	9	1,800	0	0	3	6	9	1		
Michigan	0	3,900	0	0	3,900	0	24	0	1	25	1		
Minnesota	0	1,200	0	0	1,200	0	22	0	0	22	0		
Mississippi	6	110	160	0	270	0	0	0	0	0	10		
Missouri	1	1,300	0	2	1,300	0	4	0	2	6	1		





Table 10.—Water used for public utility generation of fuel electric power, by regions, 1960  
 [Million gallons per day]

Region	Condenser cooling						Other uses						Con- sumed
	Self-supplied			Public supplies	Self- supplied and public supplies	Ground water fresh	Self-supplied		Public supplies	Self- supplied and public supplies	Con- sumed		
	Ground water		Surface water				Fresh	Saline					
	Fresh	Saline											
New England	0	0	620	3,200	18	3,900	6	1	3	9	19	1	
New York-Hudson	1	0	5,000	6,000	1	11,000	2	150	29	13	190	13	
New England	0	0	2,900	1,100	0	4,000	0	40	22	3	65	2	
North Atlantic	9	0	5,200	3,600	690	9,500	1	23	0	2	26	3	
North Atlantic	5	0	3,200	610	0	3,900	2	1	0	0	3	4	
North Atlantic	0	0	5,400	0	0	5,400	0	210	0	0	210	0	
North Atlantic	18	0	15,000	0	0	15,000	1	120	0	1	120	33	
North Atlantic	0	0	7,800	0	0	7,800	0	75	0	6	81	9	
North Atlantic	0	0	9,500	0	0	9,500	0	170	0	3	170	3	
North Atlantic	3	0	0	0	0	3	0	0	0	0	0	2	
North Atlantic	0	0	8,000	0	3	8,000	7	210	0	4	220	4	
North Atlantic	4	0	1,100	0	70	1,200	0	5	0	1	6	12	
North Atlantic	1	0	1,100	0	2	1,100	0	0	0	1	1	0	
North Atlantic	15	0	930	1,600	0	2,600	6	0	0	1	7	19	
North Atlantic	27	0	230	120	2	380	1	0	0	0	1	17	
North Atlantic	9	0	2,900	3	7	3,000	0	0	0	0	0	12	
North Atlantic	470	0	2,000	1,400	8	3,900	6	3	0	2	11	56	
North Atlantic	18	3	120	0	0	140	0	1	0	0	1	15	
North Atlantic	0	0	75	0	0	75	0	1	0	0	1	2	
North Atlantic	290	0	140	8,600	100	9,200	0	1	0	13	14	17	
North Atlantic	0	0	7	0	0	7	0	0	0	0	0	0	
North Atlantic	14	16	12	260	0	300	0	0	0	2	2	0	
North Atlantic	0	0	86	0	0	86	0	0	0	0	0	0	
North Atlantic	0	0	4	490	0	500	0	0	0	1	1	0	
United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	880	3	71,000	26,000	910	99,000	32	1,000	54	59	1,200	224	
United States	890	19	71,000	27,000	910	100,000	32	1,000	54	62	1,200	224	

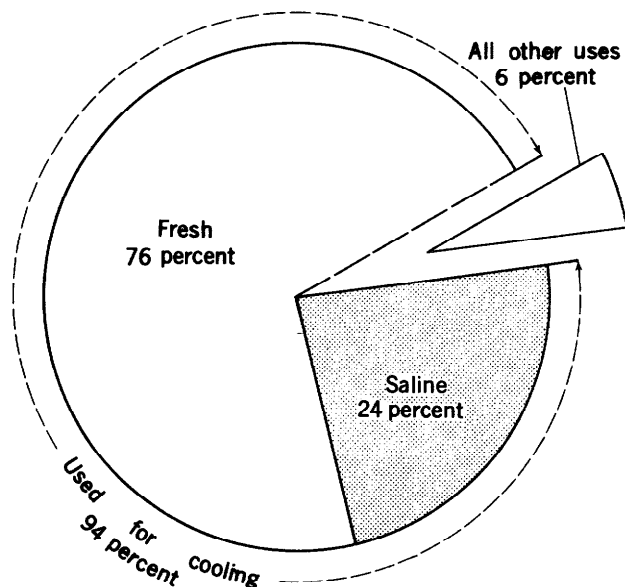


Figure 4. —Most industrial water is used for cooling.

Almost all the water used for cooling condensers was obtained from surface sources, and about one-fourth was saline. Less than 1 percent of the water withdrawn was consumed. The effect of differences in climate and availability of water in the West and in the East is reflected in the kind of water used and how it is used for generation of electric power. Although consumption is very small, the percent of intake consumed is several times greater in the dry West than in the humid East. About 5 percent of the water withdrawn in the West is from wells, whereas only about one-tenth of 1 percent of the water withdrawn in the East is from wells. About two-thirds of the water withdrawn in the West is saline, whereas in the East, where the supply of water is greater, only about one-fifth of the water withdrawn is saline.

#### AIR CONDITIONING

About 560 of the 1,500 mgd of water used for air conditioning was taken from public supplies; the remainder was self-supplied (tables 11 and 12). The 560 mgd from public supplies is part of the 6,600 mgd used by industry (tables 1 and 2). The 920 mgd of self-supplied water for air conditioning is included in the 140,000 mgd self-supplied water which industry uses for all purposes (tables 7 and 8).

The quantities given in tables 11 and 12 are annual rates. Air conditioning is seasonal, most of the water being 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 tables 11 and 12; during the rest of the year, little or no water is used. The effect of seasonal demand on self-supplied water supplies is usually not serious; however, it may have a serious effect on public supplies. For example, the capacity to supply the air-conditioning demand becomes a problem. Seidel and Carpenter (1958) state that the air-conditioning season in Ames, Iowa, comprises possibly 10 percent of the year and facilities provided to serve these unusual demands would be idle and unproductive the remaining 90 percent of the time. Because the facilities are idle such a great part of the time, air-conditioning demands do not carry their full share of the cost unless some kind of demand charge is applied. A study in Grand Rapids, Mich., showed that air-conditioning requirements were 22 percent of the demands on maximum days but required only 4 percent of the annual demands (Am. Water Works Assoc. Committee on Water Use in Air Conditioning and Other Refrigeration, 1958).

#### WATERPOWER

About 2,200 million acre-feet of water was used during 1960 to generate waterpower (tables 13 and 14). The rate of use is variable and depends on the water available and the demand for power. The quantities of water used were computed with the aid of two publications of the U.S. Federal Power Commission (1957a and 1960-61). The average plant efficiency was estimated. Much of the water was used more than once.

Waterpower is considered a nonconsumptive use; however, many reservoirs are built to store water for power. The amount of evaporation from these reservoirs is very large, estimated at 9,000 mgd during 1954. This is almost half the quantity of water withdrawn for all public supplies in the United States in 1960 and 2.5 times the quantity consumed.

Table 11.—Water withdrawn for air conditioning, by States, 1960  
[Million gallons per day]

	Self-supplied industrial	Public supplies	All water		Self-supplied industrial	Public supplies	All water
Alabama .....	10	9.4	20	New Mexico .....	0.2	0.9	1.1
Alaska .....	0	0	0	New York .....	61	18	79
Arizona .....	6.0	6.4	12	North Carolina .....	8.0	2.9	11
Arkansas .....	0	0	0	North Dakota .....	.3	.3	.6
California .....	48	76	120	Ohio .....	0	0	0
Colorado .....	15	9.1	24	Oklahoma .....	2.2	15	17
Connecticut .....	6.4	6.9	13	Oregon .....	48	.4	49
Delaware .....	0	1.6	1.6	Pennsylvania .....	97	32	130
Florida .....	50	7.5	58	Puerto Rico .....	0	1.1	1.1
Georgia .....	1.7	8.1	10	Rhode Island .....	.1	2.0	2.1
Hawaii .....	1.0	5.0	6.0	South Carolina .....	6.6	2.9	9.5
Idaho .....	1.8	1.5	3.3	South Dakota .....	.1	.1	.2
Illinois .....	3.4	67	70	Tennessee .....	67	4.2	71
Indiana .....	17	29	46	Texas .....	97	37	130
Iowa .....	0	5.1	5.1	Utah .....	3.2	5.5	8.7
Kansas .....	0	.8	.8	Vermont .....	2.0	.6	2.6
Kentucky .....	18	1.3	20	Virginia .....	0	14	14
Louisiana .....	100	27	130	Virgin Islands .....	0	0	0
Maine .....	0	1.0	1.0	Washington .....	.4	1.7	2.1
Maryland .....	19	12	31	West Virginia .....	.8	.3	1.1
Massachusetts .....	28	8.3	36	Wisconsin .....	30	20	50
Michigan .....	6.6	28	34	Wyoming .....	.3	2.2	2.5
Minnesota .....	7.0	10	17	District of Columbia .....	.2	7.1	7.3
Mississippi .....	9.1	4.0	13	United States ex- cluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	910	560	1,500
Missouri .....	3.0	12	15	United States .....	920	560	1,500
Montana .....	0	1.0	1.0				
Nebraska .....	0	3.9	3.9				
Nevada .....	1.0	.7	1.7				
New Hampshire .....	6.0	.8	6.8				
New Jersey .....	130	50	180				

Table 12.—Water withdrawn for air conditioning, by regions, 1960

[Million gallons per day]

Region	Self-supplied industrial	Public supplies	All water	Region	Self-supplied industrial	Public supplies	All water
New England.....	41	19	60	Lower Arkansas-Red-White.	31	13	44
Delaware-Hudson .....	200	84	280	Western Gulf.....	110	36	150
Chesapeake.....	34	32	66	Colorado.....	7.9	8.5	16
South Atlantic.....	41	24	65	Great Basin.....	3.5	5.8	9.3
Eastern Gulf.....	36	17	52	South Pacific.....	47	76	120
Tennessee-Cumberland.	58	4.5	63	Pacific Northwest...	51	3.2	54
Ohio.....	88	27	120	Hawaii.....	1.0	5.0	6.0
Eastern Great Lakes-St. Lawrence.	18	24	42	Alaska.....	0	0	0
Western Great Lakes	45	92	140	Puerto Rico and Virgin Islands.	0	1.1	1.1
Hudson Bay.....	1.2	.8	2.0	United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	910	560	1,500
Upper Mississippi...	7.0	34	42	United States.....	920	560	1,500
Upper Missouri.....	13	14	27				
Lower Missouri.....	2.0	3.3	5.3				
Lower Mississippi ..	68	23	91				
Upper Arkansas-Red	13	14	26				

## SUMMARY OF WITHDRAWAL USES

The estimated withdrawal of water in the United States amounted to 270,000 mgd during 1960, exclusive of water used for waterpower (tables 15 and 16). This amounts to 1,500 gpd per person. Surface-water sources supplied 220,000 mgd, and ground water supplied 47,000 mgd. Industry used the largest part of the water withdrawn—140,000 of the 270,000 mgd (fig. 5). Irrigation used the next greatest amount—110,000 mgd including conveyance losses. Rural, domestic, and stock use was the smallest—3,600 mgd.

The withdrawal of water was the greatest in the eastern industrial areas and in western areas where irrigation is practiced

extensively. Withdrawals in the midcontinent region were the smallest. Only about one-fourth of the water withdrawn was consumed; 61,000 of the 270,000 mgd withdrawn.

Most of the water consumed was used for irrigation, a fact of added importance when we consider that most irrigation is practiced at times and places where the water supply is likely to be inadequate. Generally a greater percentage of the water withdrawn for any use is consumed in areas having a dry climate than in humid areas (fig. 6), and a greater percentage is consumed in the hot, dry part of the year. Irrigation consumed the largest quantity of water, 52,000 mgd; public supplies the next largest amount, 3,500 mgd; and rural uses consumed the least, 2,800 mgd.

ESTIMATED USE OF WATER IN THE UNITED STATES, 1960

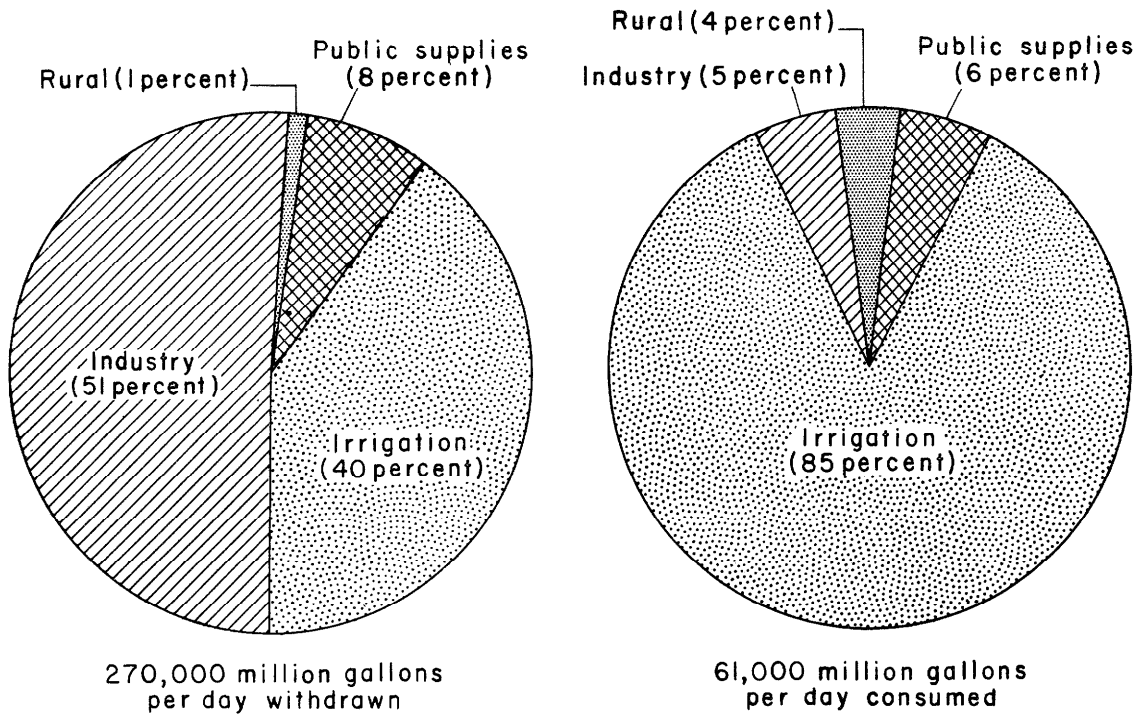


Figure 5.—How water was used in 1960.

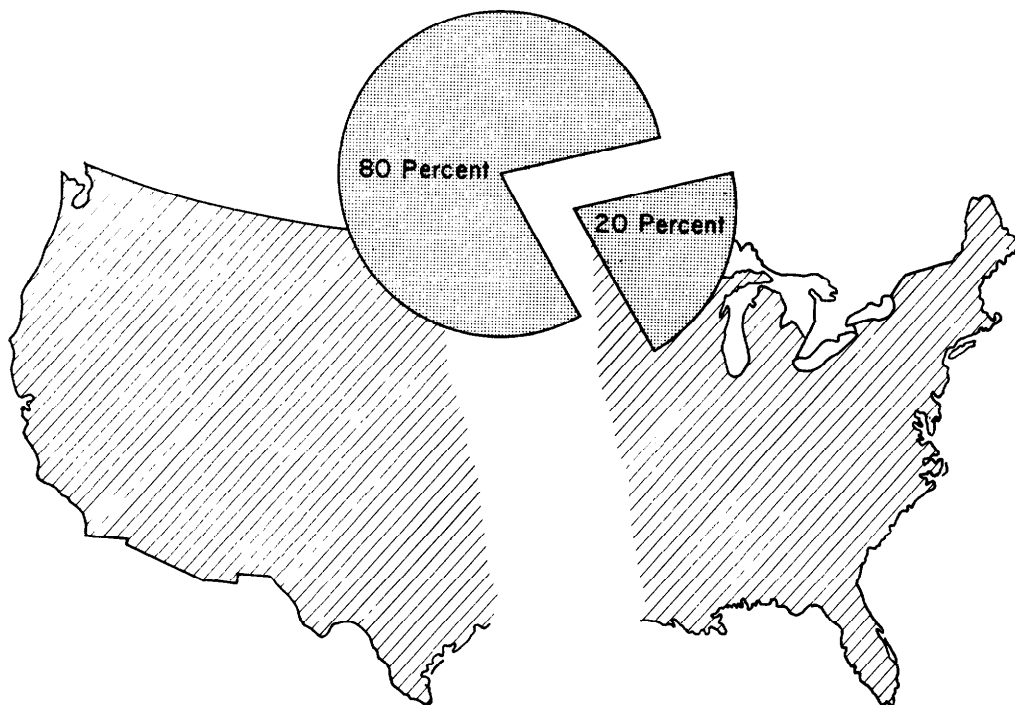


Figure 6.—Water consumption by region.

Table 13.—Water used for waterpower, by States, 1960

	Mgd	1,000's of acre-ft per year		Mgd	1,000's of acre-ft per year
Alabama .....	120,000	130,000	New Jersey.....	1,200	1,300
Alaska .....	370	410	New Mexico.....	520	580
Arizona .....	14,000	16,000	New York.....	270,000	310,000
Arkansas.....	8,200	9,200	North Carolina .....	50,000	56,000
California.....	67,000	75,000	North Dakota.....	7,700	8,600
Colorado.....	3,200	3,500	Ohio.....	780	870
Connecticut.....	8,800	9,800	Oklahoma.....	9,300	10,000
Delaware.....	0	0	Oregon.....	180,000	200,000
Florida.....	13,000	15,000	Pennsylvania.....	47,000	52,000
Georgia.....	41,000	46,000	Puerto Rico.....	780	870
Hawaii.....			Rhode Island.....	430	480
Idaho.....	120,000	130,000	South Carolina.....	62,000	70,000
Illinois.....	14,000	15,000	South Dakota.....	11,000	12,000
Indiana.....	5,300	5,900	Tennessee.....	150,000	170,000
Iowa.....	34,000	38,000	Texas.....	17,000	19,000
Kansas.....	1,500	1,600	Utah.....	1,800	2,000
Kentucky.....	55,000	61,000	Vermont.....	18,000	20,000
Louisiana.....	0	0	Virgin Islands.....		
Maine.....	87,000	97,000	Virginia.....	31,000	35,000
Maryland.....	19,000	21,000	Washington.....	170,000	190,000
Massachusetts.....	25,000	28,000	West Virginia.....	21,000	23,000
Michigan.....	79,000	88,000	Wisconsin.....	99,000	110,000
Minnesota.....	25,000	28,000	Wyoming.....	4,500	5,100
Mississippi.....	0	0	District of Columbia.....	27	30
Missouri.....	13,000	14,000	United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	2,000,000	2,200,000
Montana.....	46,000	51,000			
Nebraska.....	19,000	21,000	United States.....	2,000,000	2,200,000
Nevada.....	5,500	6,200			
New Hampshire.....	30,000	34,000			

Table 14.—Water used for waterpower, by regions, 1960

Region	Mgd	1,000's of acre-ft per year	Region	Mgd	1,000's of acre-ft per year
New England.....	160,000	180,000	Lower Arkansas-Red- White.	22,000	24,000
Delaware-Hudson.....	85,000	95,000	Western Gulf.....	15,000	16,000
Chesapeake.....	71,000	80,000	Colorado.....	43,000	48,000
South Atlantic.....	140,000	160,000	Great Basin.....	6,800	7,700
Eastern Gulf.....	62,000	70,000	South Pacific.....	43,000	48,000
Tennessee-Cumberland.....	290,000	320,000	Pacific Northwest.....	470,000	530,000
Ohio.....	45,000	51,000	Hawaii.....		
Eastern Great Lakes- St. Lawrence.	200,000	220,000	Alaska.....	370	410
Western Great Lakes.....	110,000	120,000	Puerto Rico and Virgin Islands.	780	870
Hudson Bay.....	2,500	2,800			
Upper Mississippi.....	140,000	160,000	United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	2,000,000	2,200,000
Upper Missouri.....	76,000	85,000			
Lower Missouri.....	8,900	10,000	United States.....	2,000,000	2,200,000
Lower Mississippi.....	0	0			
Lower Arkansas-Red.....	2,000	2,200			

**Table 15.—Summary of water withdrawn except for waterpower, by States, 1960**  
 [Million gallons per day]

	Popu- lation 1,000's	Per capita use (gpd)	Water withdrawn												Water con- sumed					
			Excluding irrigation conveyance losses													Including convey- ance losses				
			Ground water						Surface water								Sew- age	All sources		
			Fresh	Saline	Fresh and saline	Fresh	Saline	Fresh and saline	Fresh	Saline	Fresh and saline	Fresh	Saline	Fresh and saline						
Alabama	3,267	1,300	220	0	220	4,000	140	4,100	0	4,200	140	4,400	4,400	220						
Alaska	226	870	25	0	25	170	0	170	0	200	0	200	200	.7						
Arizona	1,302	4,700	3,200	0	3,200	1,800	0	1,800	0	5,000	0	5,000	6,100	3,000						
Kansas	1,786	900	1,000	0	1,000	530	0	530	0	1,500	0	1,500	1,600	750						
California	15,717	2,200	11,000	140	11,000	11,000	9,100	20,000	.5	22,000	9,300	31,000	35,000	15,000						
Colorado	1,754	6,000	1,900	10	1,900	7,600	10	7,700	0	9,600	20	9,600	11,000	5,000						
Connecticut	2,535	840	78	0	78	1,000	1,000	2,000	0	1,100	1,000	2,100	2,100	120						
Delaware	446	2,100	50	0	50	58	820	880	0	110	820	930	930	62						
Florida	4,952	1,400	1,600	0	1,600	2,200	3,300	5,600	0	3,800	3,300	7,100	7,100	1,200						
Georgia	3,943	680	430	0	430	1,800	430	2,300	0	2,300	430	2,700	2,700	170						
Hawaii	634	2,500	580	21	600	600	260	860	0	1,200	280	1,500	1,600	410						
Idaho	667	24,000	2,500	0	2,500	8,700	0	8,700	0	11,000	0	11,000	16,000	4,600						
Illinois	10,081	1,300	600	40	640	13,000	0	13,000	0	14,000	40	14,000	14,000	340						
Indiana	4,662	1,200	400	11	410	5,400	0	5,400	0	5,800	11	5,800	5,800	290						
Iowa	2,758	740	330	0	330	1,700	0	1,700	0	2,100	0	2,100	2,100	230						
Kansas	2,179	1,400	1,200	0	1,200	1,600	0	1,600	0	2,800	0	2,800	3,100	1,800						
Kentucky	3,038	840	110	.6	110	2,400	.3	2,400	0	2,500	.9	2,500	2,500	96						
Kentucky	3,257	2,500	820	39	860	5,400	1,700	7,100	0	6,200	1,700	7,900	8,200	1,300						
Louisiana	969	590	32	0	32	420	120	540	0	450	120	570	570	49						
Maine	3,101	770	110	0	110	930	1,300	2,200	70	1,100	1,300	2,400	2,400	140						
Massachusetts	5,149	570	190	0	190	1,000	1,800	2,800	0	1,200	1,800	3,000	3,000	100						
Michigan	7,823	870	400	14	420	6,400	0	6,400	0	6,800	14	6,800	6,800	210						
Minnesota	3,414	710	330	0	330	2,100	0	2,100	0	2,400	0	2,400	2,400	170						
Mississippi	2,178	550	620	0	620	400	160	560	0	1,000	160	1,200	1,200	560						
Missouri	4,320	470	190	3.0	200	1,800	0	1,800	0	2,000	3.0	2,000	2,000	240						

WITHDRAWAL USE

Montana	675	11,000	110	1.0	110	5,400	0	5,400	0	5,500	1.0	5,500	7,100	2,500
Nebraska	1,411	3,100	1,500	0	1,500	1,600	0	1,600	0	3,200	0	3,200	4,400	1,200
Nevada	285	8,000	360	3.0	360	1,500	0	1,500	.2	1,900	3.0	1,900	2,300	1,000
New Hampshire	607	770	32	0	32	190	250	440	0	220	250	470	470	18
New Jersey	6,067	780	530	7.6	540	2,100	2,100	4,200	0	2,600	2,100	4,800	4,800	240
New Mexico	951	2,700	1,000	.1	1,000	970	0	970	0	2,000	.1	2,000	2,600	1,400
New York	16,782	810	620	15	640	7,200	5,700	13,000	0	7,900	5,800	14,000	14,000	550
North Carolina	4,556	600	170	0	170	2,500	32	2,500	0	2,700	32	2,700	2,700	190
North Dakota	632	320	36	6.0	42	130	0	130	0	170	6.0	170	200	110
Ohio	9,706	1,200	630	0	630	11,000	0	11,000	0	12,000	0	12,000	12,000	380
Oklahoma	2,328	420	290	46	340	480	130	620	0	780	180	960	970	350
Oregon	1,769	4,500	570	0	570	5,800	0	5,800	0	6,400	0	6,400	8,000	2,900
Pennsylvania	11,319	1,100	520	0	520	12,000	460	12,000	0	12,000	460	13,000	13,000	360
Puerto Rico	2,353	510	210	1.6	210	320	650	970	0	520	650	1,200	1,200	280
Rhode Island	859	500	27	0	27	100	300	400	0	130	300	430	430	7.7
South Carolina	2,383	460	140	0	140	830	120	960	0	980	120	1,100	1,100	120
South Dakota	681	540	120	3.9	120	160	0	160	0	280	3.9	280	370	180
Tennessee	3,567	1,600	610	0	610	5,000	0	5,000	0	5,700	0	5,700	5,700	460
Texas	9,580	1,800	9,100	11	9,100	4,300	1,400	5,600	0	13,000	1,400	15,000	17,000	7,000
Utah	891	5,100	410	3.0	420	3,400	5.5	3,400	0	3,800	8.5	3,800	4,500	2,300
Vermont	390	280	28	0	28	82	0	82	0	110	0	110	110	17
Virginia	3,967	1,300	180	0	180	4,000	900	4,800	0	4,100	900	5,000	5,000	120
Virgin Islands	32	59	.8	0	.8	1.1	0	1.1	0	1.9	0	1.9	1.9	1.6
Washington	2,853	2,200	790	0	790	4,400	48	4,500	0	5,200	48	5,300	6,300	1,400
West Virginia	1,860	2,500	130	.4	130	4,600	0	4,600	0	4,700	.4	4,700	4,700	150
Wisconsin	3,952	1,000	530	0	530	3,600	0	3,600	0	4,100	0	4,100	4,100	150
Wyoming	330	14,000	110	0	110	3,300	0	3,300	0	3,400	0	3,400	4,600	2,000
District of Columbia	764	550	1.0	0	1.0	420	0	420	0	420	0	420	420	16
United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	178,463	1,500	46,000	360	46,000	170,000	31,000	200,000	71	210,000	32,000	240,000	270,000	60,000
Total United States	181,708	1,500	46,000	380	47,000	170,000	32,000	200,000	71	210,000	33,000	250,000	270,000	61,000



Table 16.—Summary of water withdrawn except for waterpower, by regions, 1960  
[Million gallons per day]

Region	Popu- lation 1,000's	Per capita use (gpd)	Water withdrawn												Water con- sumed
			Excluding irrigation conveyance losses												
			Ground water			Surface water			Sew- age	All sources			Includ- ing convey- ance losses		
			Fresh	Saline	Fresh and saline	Fresh	Saline	Fresh and saline		Fresh	Saline	Fresh and saline			
New England	9,921	640	350	0	350	2,600	3,400	6,000	0	3,000	3,400	6,400	6,400	290	
New York-Hudson	23,796	830	1,200	12	1,212	9,500	9,000	18,000	0	11,000	9,000	20,000	20,000	830	
Appalachian	8,663	820	480	0	480	4,700	1,900	6,600	70	5,200	1,900	7,100	7,100	320	
North Atlantic	14,539	910	2,000	0	2,000	7,500	3,800	11,000	0	9,500	3,800	13,000	13,000	1,500	
South Atlantic	6,933	860	700	0	700	4,400	880	5,200	0	5,100	880	5,900	5,900	510	
West North Central	4,184	1,800	370	0	370	7,200	0	7,200	0	7,500	0	7,500	7,500	400	
Northwest	17,950	1,300	1,300	34	1,334	22,000	3	22,003	0	24,000	34	24,000	24,000	800	
Great Lakes-St. Lawrence	12,424	1,000	320	13	333	12,000	0	12,000	0	13,000	13	13,000	13,000	420	
West South Central	13,183	1,200	820	12	832	16,000	0	16,000	0	16,000	12	16,000	16,000	510	
Mountain	666	260	44	6.0	50	120	0	120	0	160	6.0	170	170	54	
South	12,359	920	1,300	20	1,320	10,000	0	10,000	0	11,000	20	11,000	11,000	570	
West	5,382	3,700	2,800	13	2,813	12,000	5.0	12,005	0	15,000	18	15,000	20,000	7,400	
Northwest	2,451	640	180	0	180	1,400	0	1,400	0	1,600	0	1,600	1,600	200	
South	4,735	1,100	1,300	25	1,325	23,000	1,600	3,900	0	3,700	1,600	5,300	5,300	1,300	
West	3,309	1,700	2,100	20	2,120	2,800	130	2,900	0	4,800	150	5,000	5,500	3,200	
South	3,884	1,300	920	38	958	3,900	4.0	3,904	0	4,800	42	4,900	4,900	850	
West	10,029	2,200	11,000	14	11,014	6,600	1,400	8,000	0	17,000	1,500	19,000	22,000	9,200	
South	2,027	7,000	3,500	6.3	3,506.3	8,200	0	8,200	.2	12,000	6.3	12,000	14,000	7,100	
Northwest	1,204	580	910	6.0	916	4,900	5.5	4,905.5	0	5,800	12	5,800	7,000	3,300	
South	15,412	2,100	10,000	140	10,140	9,400	9,100	19,000	.5	20,000	9,300	29,000	33,000	13,000	
West	5,412	5,400	3,700	0	3,700	18,000	48	18,000	0	22,000	48	22,000	29,000	8,300	
South	634	2,500	580	21	601	600	260	860	0	1,200	280	1,500	1,600	410	
Northwest	226	870	25	0	25	170	0	170	0	200	0	200	200	.7	
South	2,385	510	210	1.6	211.6	320	650	970	0	530	650	1,200	1,200	280	
United States excluding Alaska, Hawaii, Puerto Rico and Virgin Islands.	178,463	1,500	46,000	360	46,360	170,000	31,000	200,000	71	210,000	32,000	240,000	270,000	60,000	
United States	181,708	1,500	46,000	380	46,380	170,000	32,000	200,000	71	210,000	33,000	250,000	270,000	61,000	

## NONWITHDRAWAL USES

Nonwithdrawal uses do not lend themselves to evaluation of the quantity of water used. These uses, however, do have a very large economic value and may have an appreciable effect on the quantity and quality of water available for other uses. The most important nonwithdrawal uses are navigation, waste disposal, recreation, and conservation of fish and wildlife.

The consumption of water by nonwithdrawal uses in the United States has not been estimated; however, fresh water evaporation in the 17 Western States has been estimated. According to Meyers (1962), annual evaporation in the 17 Western States amounts to 24,000 acre-feet per year or an average rate of 21,000 mgd. This is an amount equal to the water used by all public supplies in the United States in 1960 and equal to 18 percent of the fresh water withdrawn and 41 percent of the water consumed in these States. Evaporation from all water surfaces should be an approximate measure of consumption by nonwithdrawal use.

## CHANGES SINCE 1955

The present survey is comparable to the 1950 and 1955 surveys (MacKichan, 1951 and 1957) and the 1945 survey of ground water (Guyton, 1950). The 1950 survey did not include irrigation conveyance losses nor did it include water-use data tabulated by regions. The withdrawal of water for all uses except waterpower increased 12 percent since 1955 (see table 17). The use of water for waterpower increased 33 percent. The use of self-supplied industrial water increased 27 percent and the use of water for public supplies increased 23 percent. Rural use was about the same in 1960 as in 1955.

During the last 5 years the use of surface water, exclusive of that for waterpower, increased from 190,000 to 220,000 mgd, and the use of ground water increased from 46,000 to 47,000 mgd. The percentage increase for surface water was 16 percent as compared with 2 percent for ground water. Earlier surveys did not include estimates of water consumed, but trends in consumptive use would probably be similar to trends in

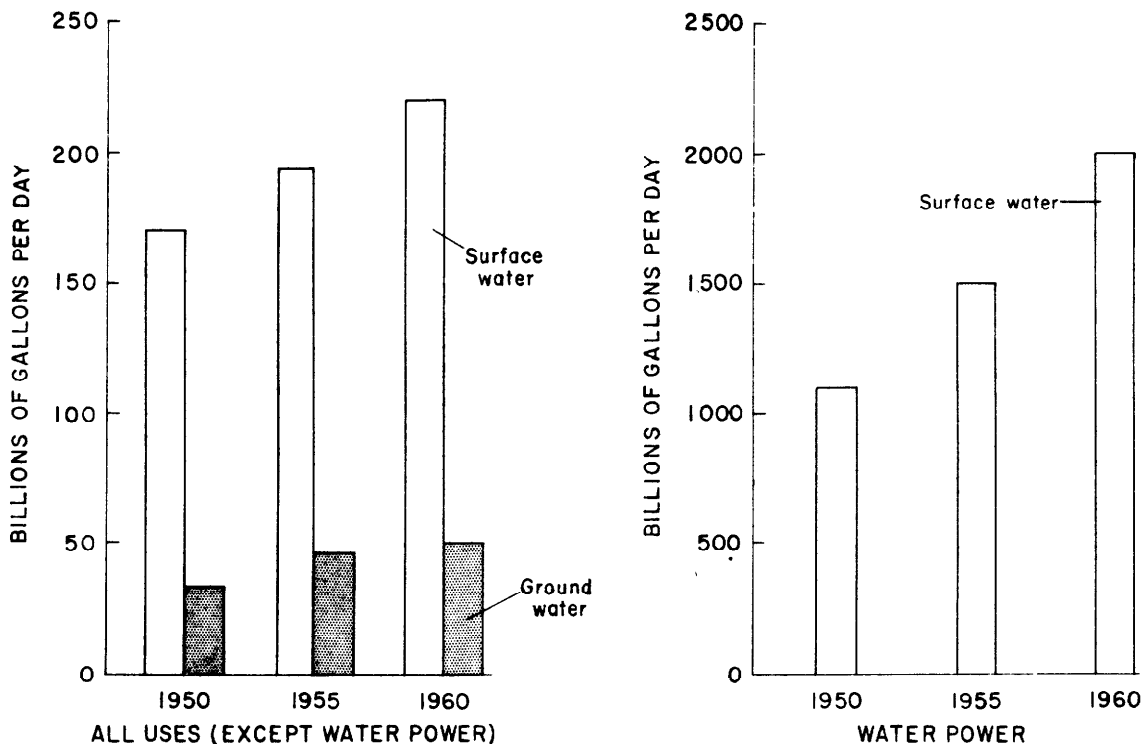


Figure 7.—Trends in use of water for waterpower and all other uses.

ESTIMATED USE OF WATER IN THE UNITED STATES, 1960

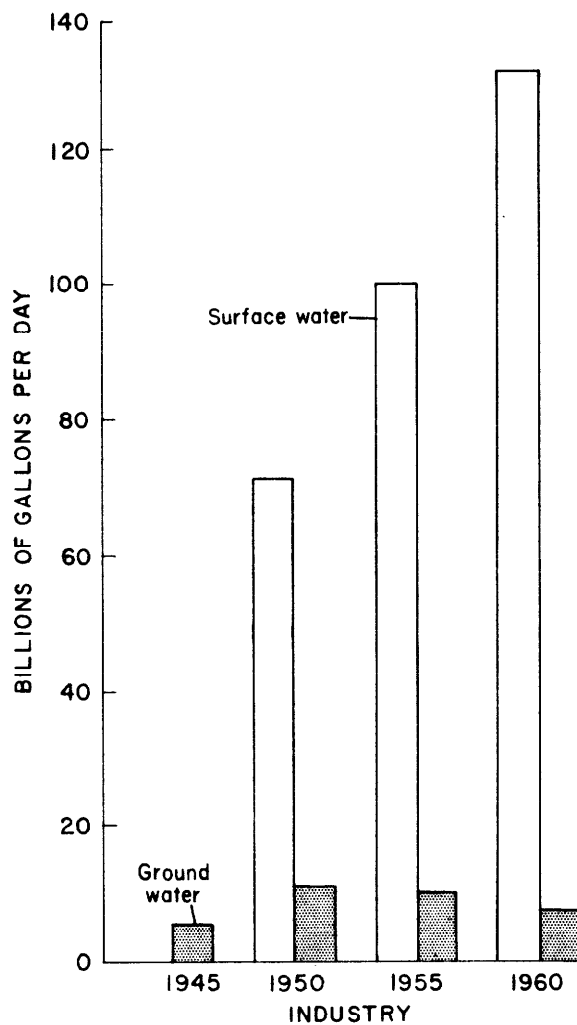
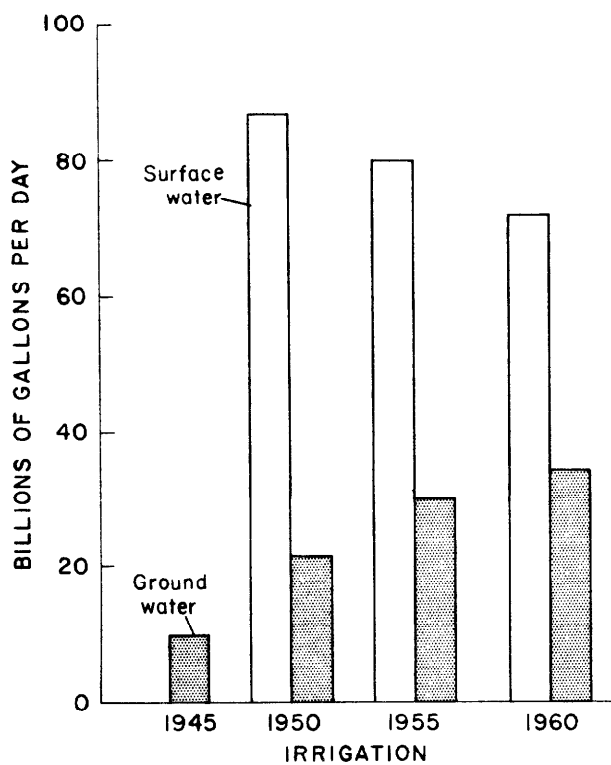
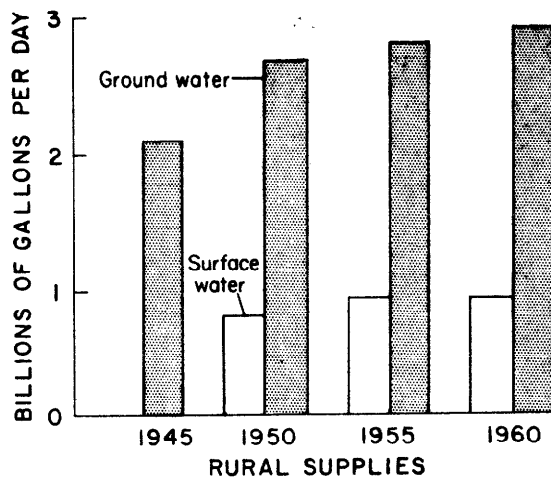
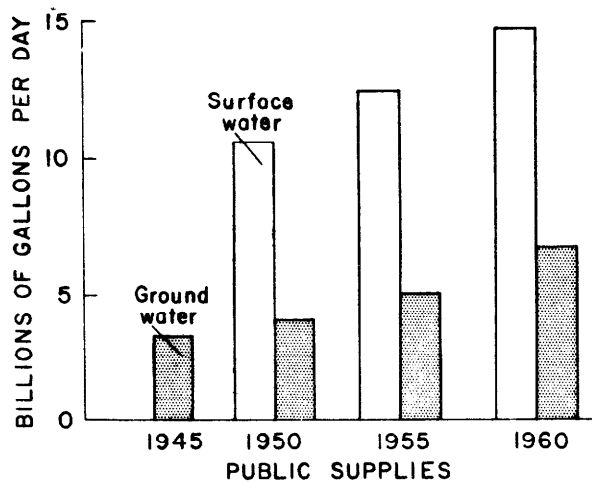


Table 17.—Change in withdrawals, 1950—1960

	1950 (mgd)	1955 (mgd)	1960 (mgd)	Percent increase 1955 to 1960
Rural .....	3,600	<sup>1</sup> 3,600	3,600	0
Public supplies.....	14,000	17,000	21,000	23
Self-supplied industrial .....	77,000	110,000	140,000	27
Irrigation (except conveyance losses).....	79,000	81,000	84,000	4
Irrigation (including conveyance losses).....		110,000	110,000	0
All uses (excluding conveyance losses).....	170,000	210,000	250,000	-----
All uses (including conveyance losses).....		240,000	270,000	12
Waterpower.....	1,100,000	1,500,000	2,000,000	33

<sup>1</sup>Revised.

withdrawals. The trend in total water withdrawn has been upward. (See fig. 7.) However, there is some evidence that the rate of increase is declining in some areas and in some categories. (See fig. 8.) Although the accuracy of some parts of the 1950, 1955, and present estimates may be rather poor, the downward trends in surface water used for irrigation and in ground water used by industry are too well defined to be ignored. Ground water used for irrigation shows an equally well-defined upward trend. The great increase in surface water used by industry is mostly in cooling water for fuel-electric powerplants.

Part of the downward trend is caused by economies in the use of water. For example, many petroleum refineries in the Delaware River basin have installed cooling towers during the last few years, which reduce their water intake but increase the water consumed slightly. Rates of water use in some localities have declined because of reduced production, such as by the steel industry, or because industries using large quantities of water have moved to other areas.

### SUPPLY VERSUS DEMAND

Much of the withdrawn water is not consumed but is returned to a downstream or underground source after use; therefore, the total supply is not depleted by the entire amount withdrawn. For this reason the quantity of water withdrawn is not directly comparable with the supply and, in fact, may exceed the total supply, owing to repeated use.

On the other hand, water that is consumed in its use is no longer available; consequently, consumptive use can be compared with supply.

The dependable supply is not a fixed amount but can be increased by surface storage, artificial recharge of ground water, and by reducing evapotranspiration losses or other forms of waste. These measures increase the cost of water; therefore, the increase in dependable supply depends on the ability and willingness of the user to pay the higher cost.

The long-term average runoff of a river basin, with few exceptions, is the upper limit of possible production of the combined surface- and ground-water resources of the basin. The exceptions are in the narrow fringes along the coasts where some water that percolates underground directly into the ocean could be used without affecting runoff, provided such use does not cause contamination by sea water. Runoff is the total flow of a stream including outflow from groundwater storage through springs and seeps as well as the overland flow that follows hard rains.

The runoff of all streams in the United States, exclusive of Alaska and Hawaii, averages 1,200,000 mgd, but it is not uniformly distributed throughout the Nation (table 18). The average annual runoff ranges from less than one-fourth inch in several places in the Southwest to more than 80 inches at some places along the Pacific Coast. In addition to this great areal variation, runoff varies widely from day to day and year to year in

## ESTIMATED USE OF WATER IN THE UNITED STATES, 1960

Table 18.—Supply compared with demand, 1960

Region	Area (1,000's sq mi)	Average runoff <sup>1</sup>		Estimated dependable <sup>2</sup> supply, 1980 (mgd)	Withdrawals 1960 (mgd)	Water consumed <sup>3</sup> 1960 (mgd)	Streamflow avail- able <sup>3</sup> 90 percent of the time (mgd)	Fresh surface water with- drawn, 1960 (mgd)
		Inches per year	Mgd					
New England-----	59	24	67,000	22,000	6,400	290	9,500	2,600
Delaware-Hudson-----	31	21	32,000	24,000	20,000	830	4,300	9,500
Chesapeake-----	57	19	51,000	12,000	47,100	320	8,000	44,700
South Atlantic-----	170	14	110,000	75,000	513,000	1,500	22,000	57,500
Eastern Gulf-----	109	19	99,000		5,900	510	10,000	4,400
Tennessee-Cumberland-----	59	21	59,000	22,000	7,500	400	3,300	7,200
Ohio-----	145	16	110,000	40,000	24,000	800	4,000	22,000
Eastern Great Lakes-St. Lawrence-----	47	18	40,000	33,000	13,000	420	3,500	12,000
Western Great Lakes-----	81	11	42,000	36,000	16,000	510	11,000	16,000
Hudson Bay-----	60	1.6	4,600		170	54	360	120
Upper Mississippi-----	182	7.2	62,000	31,000	11,000	570	12,000	10,000
Upper Missouri-----	458	1.0	24,000	33,000	620,000	7,400	2,500	612,000
Lower Missouri-----	62	7.8	23,000		1,600	200	3,200	1,400
Lower Mississippi-----	64	16	49,000	25,000	5,300	1,300	2,800	23,000
Upper Arkansas-Red-----	153	1.6	11,000	20,000	75,500	3,200	540	72,800
Lower Arkansas-Red-White-----	117	14	79,000		4,900	850	3,200	3,900
Western Gulf-----	341	3.2	52,000	20,000	822,000	9,200	3,300	86,600
Colorado-----	258	1.1	13,000	15,000	14,000	7,100	1,500	8,200
Great Basin-----	200	1.1	10,000	9,000	97,000	3,300	1,400	94,900
South Pacific-----	112	12	64,000	28,000	1033,000	13,000	1,500	109,400
Pacific Northwest-----	257	13	159,000	70,000	29,000	8,300	24,000	18,000
Hawaii-----	6.4				1,600	410		600
Alaska-----	586				200	.7		170
Puerto Rico-----	3.4				1,200	280		320
United States excluding Alaska, Hawaii, and Puerto Rico.	3,022		1,200,000	515,000	270,000	61,000	130,000	170,000
Grand total-----	3,618				270,000	61,000		170,000

<sup>1</sup>Adapted from Langbein (1949) by James K. Searcy.<sup>2</sup>Woodward (1957), p. 49.<sup>3</sup>Computed using variability indexes furnished by Glennon Mesnier.<sup>4</sup>Includes 21 mgd diverted from the Delaware-Hudson region.<sup>5</sup>Includes 1.5 mgd diverted from the Chesapeake region.<sup>6</sup>Includes 320 mgd diverted from the Colorado region.<sup>7</sup>Includes 52 mgd diverted from the Colorado region.<sup>8</sup>Includes 2 mgd diverted from the Colorado region.<sup>9</sup>Includes 98 mgd diverted from the Colorado region.<sup>10</sup>Includes 250 mgd diverted from Colorado region and 270 mgd diverted from Great Basin region.

any one locality. Some of the runoff which occurs during times of flood cannot be made available for water supply for economic and sometimes technical reasons.

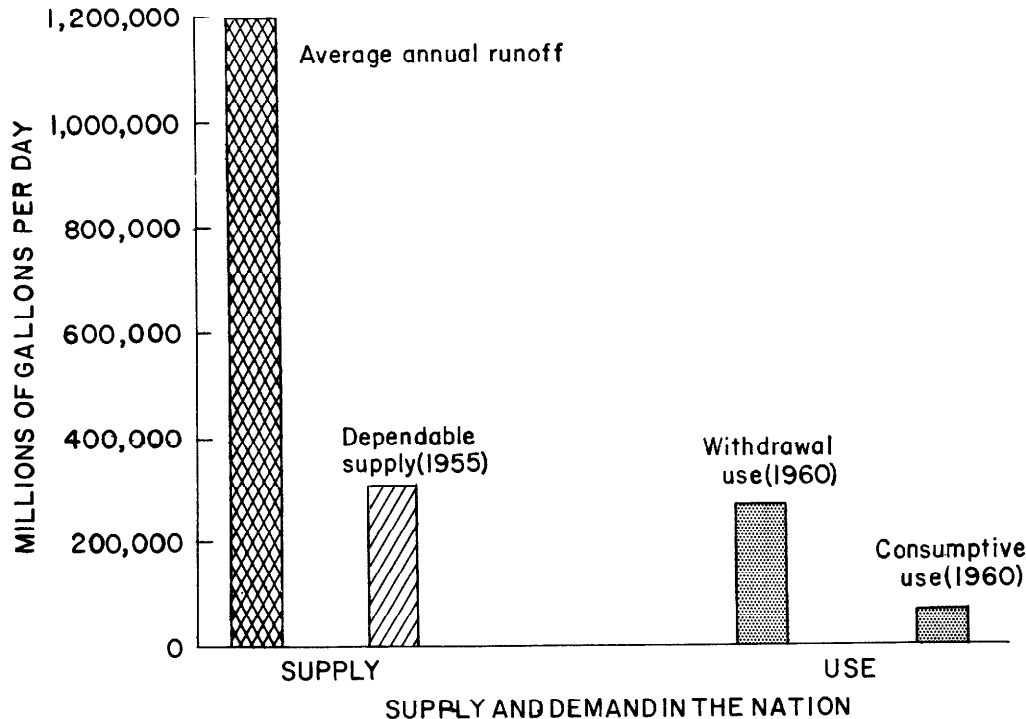
There is no simple method of computing the combined dependable supply of surface water and ground water. The flow, available 90 percent of the time without storage (table 18), is used by some as an index to the practicable dependable streamflow; but even this quantity of water is not available 100 days out of every thousand. This quantity of water can be made available all the time by supplementing the natural streamflow with releases from reservoirs. Even greater flows may be made dependable by increased storage; however, the benefits derived from storing water follows a law of diminishing returns (Langbein, 1959). Each increment of controlled flow requires a larger amount of reservoir storage space than the preceding increment, and consequently each increment costs more than the preceding one. Furthermore, with each increment of controlled flow, the surface area of the reservoir is increased, which permits additional evaporation. Storage capacity in a basin may become so great that the most recent increment of

stored water will be dissipated by evaporation.

Woodward (1957) estimated that the economically dependable supply was 314,000 mgd in 1955. He also estimated that the probable dependable supply would be 515,000 mgd by 1980. The increase in dependable supply from 314,000 to 515,000 mgd would be accomplished by providing additional surface storage, by using artificial recharge, and by salvaging waste water by reducing evapotranspiration.

Figure 9 shows that the Nation is far from running out of water. Consumptive use is only 20 percent of Woodward's estimated dependable supply in 1955. However, withdrawal uses in 1960 were approaching Woodward's estimate of supply.

Although the outlook in the West is less promising (fig. 10) there is still room for further development. Present withdrawals are about equal to Woodward's estimate of the 1955 dependable supply but considerably less than the ultimate supply (average runoff). Woodward estimates that the dependable supply by 1980 will be almost 200,000 mgd or



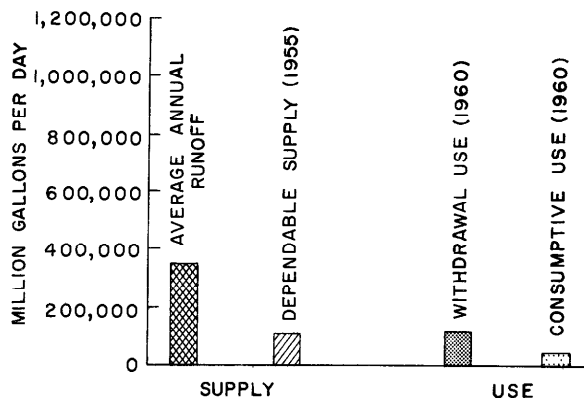


Figure 10.—Supply and demand in the West.

about 70,000 mgd greater than in 1955. Present withdrawals are 120,000 mgd, of which 52,000 mgd is consumed.

The fresh surface water used in the Nation as a whole may be properly compared with the streamflow which is available 90 percent of the time. During 1960, 170,000 mgd of fresh surface water was used, whereas the streamflow available amounted to only 130,000 mgd. Some of the 170,000 mgd was withdrawn from storage and some of the water was used two or more times. The above comparison does not include water for developing waterpower. Table 18 shows that the streamflow available 90 percent of the time was less than the quantity of surface water used in several regions.

#### SELECTED REFERENCES

- American Water Works Association, 1948, A survey of operating data for water works in 1945: *Am. Water Works Assoc. Jour.*, v. 40, no. 2, p. 167–260.
- 1953, A survey of operating data for water works in 1950: *Am. Water Works Assoc. Jour.*, v. 45, no. 6, p. 583–678.
- 1957, A survey of operating data for water works in 1955: *Am. Water Works Assoc. Jour.*, v. 49, no. 5, p. 555–696.
- American Water Works Association Committee on Water Use in Air Conditioning and Other Refrigeration, 1958, Trends in air-conditioning use regulation: *Am. Water Works Assoc. Jour.*, v. 50, no. 1, p. 75–96.
- American Water Works Association Task Group, 1953, Water conservation in industry: *Am. Water Works Assoc. Jour.*, v. 45, no. 12, p. 1249–1260.
- Arkansas-White-Red Basins Inter-Agency Committee, 1957, Development of water and land resources of the Arkansas-White-Red River basins: 85th Cong., 1st sess., S. Doc. 13.
- California Water Resources Board, 1955, Water utilization and requirements of California: California Water Resources Board Bull. 2, v. I, 227 p.; v. II, 358 p.
- Connecticut Water Resources Commission, 1957, Water resources of Connecticut, a report to the General Assembly: 200 p.
- Foley, F. C., Smrha, R. V., and Metzler, Dwight, 1955, Water in Kansas: Report to the 1955 State Legislature, 216 p.
- Frank, Bernard, 1955, The story of water as the story of man: U.S. Dept. Agriculture Yearbook—Water, 1955, p. 1–8.
- Guyton, W. F., 1950, Estimated use of ground water in the United States, 1945: U.S. Geol. Survey open-file report.
- Indiana Water Resources Study Committee, 1956, Indiana water resources: 44 p., 13 figs., 2 tables.
- Kentucky Water Resources Commission, 1959, Kentucky water resources study: Dept. Conserv., Div. Flood Control and Water Usage, 109 p.
- Krieger, R. A., Hatchett, J. L., and Poole, J. L., 1957, Preliminary survey of the saline-water resources of the United States: U.S. Geol. Survey Water-Supply Paper 1374, 172 p.
- Langbein, W. B., 1950, An American survey: *Water Power*, v. 2, no. 6, London, p. 238–245.
- 1959, Water yield and reservoir storage in the United States: U.S. Geol. Survey Circ. 409, 5 p.
- Langbein, W. B., and others, 1949, Annual runoff in the United States: U.S. Geol. Survey Circ. 52, 14 p.
- Mangan, J. W., and Graham, J. B., 1953, The use of water in Pennsylvania, 1951: U.S. Geol. Survey Circ. 257, 11 p.
- MacKichan, K. A., 1951, Estimated use of water in the United States, 1950: U.S. Geol. Survey Circ. 115, 13 p.
- 1957, Estimated use of water in the United States, 1955: U.S. Geol. Survey Circ. 398, 18 p.
- MacKichan, K. A., and Kammerer, J. C., 1961, Preliminary estimates of water used, Southeast river basins, 1960: U.S. Geol. Survey Circ. 449.
- Marion, A. W., 1952, The water situation and Ohio agriculture, in the Proceedings of the First Ohio Water Clinic, Ohio State Univ.: *Eng. Expt. Sta. Bull.* 147, p. 21–26.

- Meyers, J. S., 1962, Evaporation from the 17 Western States, *with a section on Evaporation rates*, by Nordenson, T. J.: U.S. Geol. Survey Prof. Paper 272-D, 76 p., (in press).
- Piction, W. L., 1952, The national picture: Ill. State Water Survey Bull. 41, p. 127-130.
- 1956, Water use in the United States, 1900-1975: U.S. Dept. Commerce, Business and Defense Services Adm., Business Service Bull. 136, 6 p.
- 1960, Water use in the United States, 1900-1980: U.S. Dept. Commerce, Business and Defense Services Adm., 6 p.
- Rudnick, A. R., 1959, Water use in Ohio: Ohio Dept. of Natural Resources, Div. Water, Ohio Water Plan Inventory Rept. 6, 50 p., 6 pls., 10 tables.
- Seidel, H. F., and Carpenter, J. M., 1958, Relationships of temperature and air-conditioning water use: Am. Water Works Assoc. Jour., v. 50, no. 2, p. 226-232.
- Smith, J. G., Haber, R. A., Kaplovsky, A. J., and Simpson, C. O., 1960, Intrastate water resources survey, 1959: Delaware members of the Delaware Basin Survey Coordinating Comm., 432 p.
- Sykes, J. F., 1955, Animals and fowl and water: U.S. Dept. Agriculture Yearbook—Water, 1955, p. 14-18.
- Temporary (New York) State Commission on Water Resources Planning, 1960, Dynamic planning—First step in water resources development for New York State: Legislative Doc. 24, 260 p.
- Tennessee Water Resources Division, 1961, Tennessee's water resources: 128 p.
- Thomson, M. T., Herrick, S. M., Brown, Eugene, and others, 1956, Availability and use of water in Georgia: Georgia Dept. of Mines, Mining, and Geology Bull. 65, 316 p.
- U.S. Dept. of Agriculture, 1960, Livestock and poultry inventory, January 1: Agr. Marketing Service, Crop Reporting Board, Ann. Rept. 30 p.
- U.S. Bureau of the Census, 1952, U.S. Census of agriculture: 1950; v. III, Irrigation of Agricultural Lands.
- 1955, Water use in Manufacturing: 1953: U.S. Bur. Census Rept. MAS-53-3.
- 1956, U.S. census of agriculture: 1954; v. I, Counties and State economic areas:
- 1957, U.S. census of manufactures: 1954; v. 3.
- 1960a, U.S. census of manufactures: 1954; Industrial water use supplement: U.S. Bur. Census Bull. MC-209 (supp.), 51 p.
- 1960b, U.S. census of manufactures: 1958.
- U.S. Bureau of the Census, 1960c, 1959, census of agriculture.
- U.S. Federal Power Commission, 1957a, Hydroelectric power resources of the United States, developed and undeveloped, 1957: FPC P-32, 196 p.
- 1957b, Water requirements of utility steam electric generating plants—1954: Rept. FPC-DC-57.
- 1960-61, Production of electric energy and capacity of plants, section 1, in Electric power statistics: FPC-DC, Rept. nos. 60-1A to 60-12A.
- U.S. Public Health Service, 1948, Inventory of water and sewage facilities in the United States, 1945.
- 1954, Inventory of municipal and industrial waste facilities in the United States, 1953.
- 1955a, Inventory of municipal water facilities for larger communities, 1954 revised.
- 1955b, Municipal water facilities, communities of 25,000 population and over, continental United States, as of December 31, 1954, revised: 153 p.
- 1956, Municipal water facilities, communities of 25,000 population and over, continental United States, as of December 31, 1955: 153 p.
- 1957, Municipal water facilities, communities of 25,000 population and over, continental United States and territorial possessions, as of December 31, 1956: 163 p.
- 1959a, Federal programs for collection of data on water use: Subcomm. on Hydrology, Inter-Agency Comm. on Water Resources, Notes on Hydrol. Activities Bull. 10, 43 p.
- 1959b, Municipal water facilities, communities of 25,000 population and over, continental United States and territorial possessions, as of January 1, 1958: Public Health Service Pub. 661, 83 p.
- 1960, Municipal water facilities, communities of 25,000 population and over, United States and possessions, as of January 1, 1960: Public Health Service Pub. 661 (1960 ed.), 91 p.
- 1960-61, Municipal water facilities inventory as of January 1, 1958: U.S. Public Health Service Pub. 775, v. 1-9.
- U.S. Senate, Select Committee on National Water Resources, 1959a, Water resources activities in the United States: U.S. 86th Cong., 1st sess., Comm. print 1, 59 p.



- U.S. Senate, Select Committee on National Water Resources, 1959b, National water resources and problems: U.S. 86th Cong., 2d sess., Comm. print 3, 42 p., 43 figs., 13 tables.
- 1960a, Future water requirements for municipal use: U.S. 86th Cong., 2d sess., Comm. print 7, 24 p.
- 1960b, Future water requirements of principal water-using industries: U.S. 86th Cong., 2d sess., Comm. print 8, 101 p.
- 1960c, Electric power in relation to the Nation's water resources: U.S. 86th Cong., 2d sess., Comm. print 10, 86 p.
- 1960d, Estimated water requirements for agricultural purposes and their effects on water supplies: U.S. 86th Cong., 2d sess., Comm. print 13, 34 p.
- U.S. Senate, Select Committee on National Water Resources, 1960e, Water supply and demand: U.S. 86th Cong., 2d sess., Comm. print 32, 131 p.
- Virginia Advisory Legislative Council, 1955, Water resources of Virginia: Richmond, Va., Rept. to Governor and General Assembly, 139 p.
- Wirth, H. E., 1959, Water use in Wisconsin: Wisconsin State Board Health, 36 p., [bibliography].
- Wood, Noel H., 1959, Arkansas water resources: Arkansas Univ. Coll. Business Adm., Indus. Research Ext. Center, 180 p.
- Woodward, D. R., 1957, Availability of water in the United States with special reference to industrial needs by 1980: Industrial College of Armed Forces, Washington, D.C., 74 p.