

Figure 41. Fairfax County Water Authority principal supply and transmission facilities, 1967.

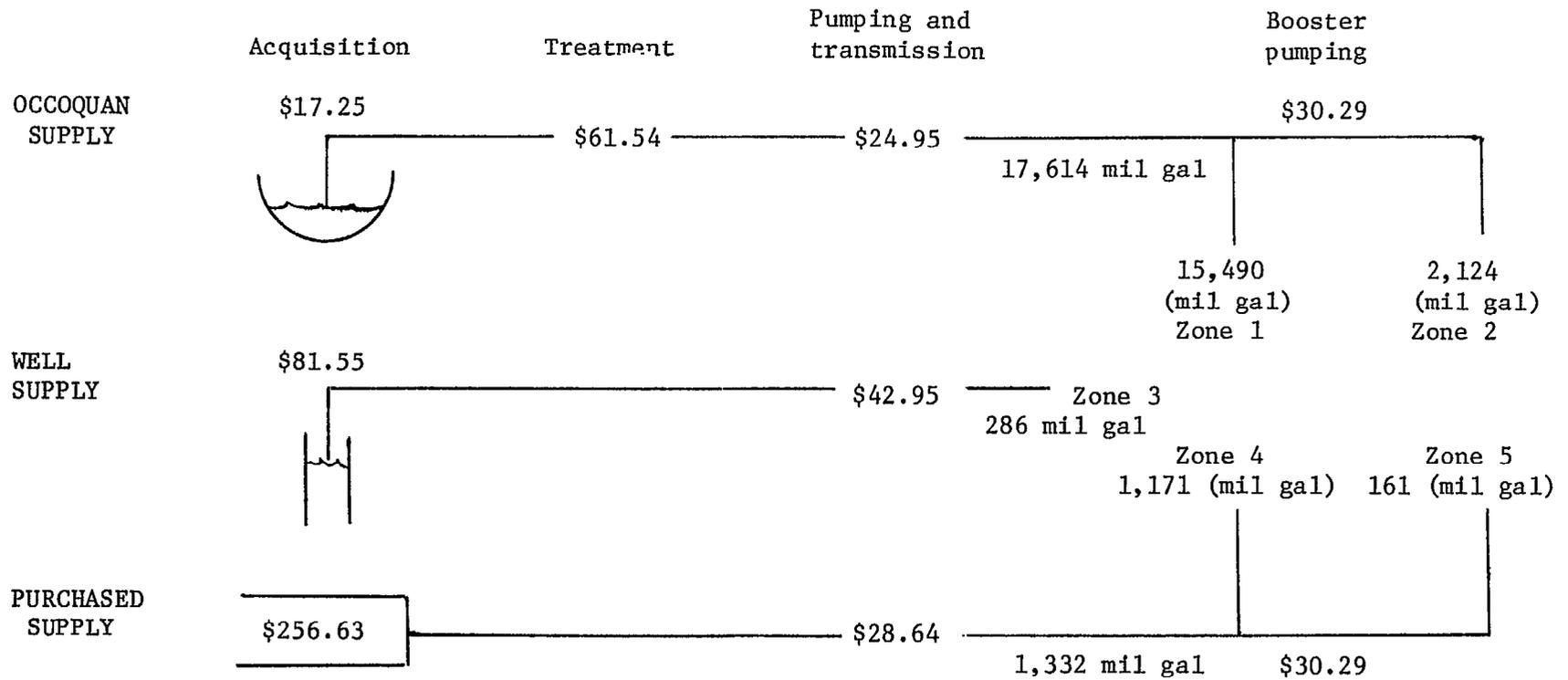


Figure 42. Fairfax County Water Authority allocation of capital and operating expenses to water system components.

TABLE 83. FAIRFAX COUNTY WATER AUTHORITY COST ELEMENTS BY ZONES

Zone	Incremental cost (\$/mil gal)	Distribution cost (\$/mil gal)	Interest (\$/mil gal)	Overhead (\$/mil gal)	Total cost (\$/mil gal)	RPW (mil gal)	Revenue
1	103.74	104.44	208.57	88.27	505.02	15,490	\$7,822,760
2	134.03	104.44	208.57	88.27	535.31	2,124	1,136,998
3	124.50	104.44	208.57	88.27	525.78	286	150,373
4	285.27	104.44	208.57	88.27	686.55	1,171	803,950
5	315.56	104.44	208.57	88.27	716.84	161	115,411
Total	---	---	---	---	---	19,232	10,029,492

TABLE 84. FAIRFAX COUNTY WATER AUTHORITY METER RATES\* (\$/mil gal)

Meter size (in.)	Charge
5/8	\$3.00
3/4	3.50
1	4.00
<b>1½</b>	5.25
2	6.50
3	15.00
4	25.00
6	45.00
8	70.00
10	100.00

\* Commodity charge is \$0.68/1,000 gallons.

TABLE 85. FAIRFAX COUNTY WATER AUTHORITY CHARGE ANALYSIS

Units used (cu ft x 100)	Gallons used	Commodity + Meter Charge
13.5	10,000	<b>\$14.71</b>
<b>5,000</b>	3,740,260	5,500.38
100,000	74,805,200	110,007.65
150,000	112,207,800	165,011.47

TABLE 86. FAIRFAX COUNTY WATER AUTHORITY WATER COSTS FOR 10 MAJOR USERS

Major user	High or low quarter	Quarter	Consumption (mil gal)	Amount billed*	Unit charge (\$/mil gal)	Cost zone+
Fairfax County Hospital	High	3	14.7	\$10,048.32	\$684.77	
	Low	1	1.2	894.84	737.71	
New Alex Dairy	High	4	9.8	6,655.54	680.66	
	Low	1	9.2	6,287.66	680.70	
Hazelton Labs	High	4	8.7	5,897.45	680.61	
	Low	3	6.0	4,066.21	680.88	
Woodley Mobile Homes	High	4	6.2	4,234.06	681.05	
	Low	3	1.0	715.74	686.23	
Oakland Manor Apartments	High	2	7.2	4,894.34	680.90	
	Low	3	5.7	3,872.98	681.14	
Fairfax County Hospital	High	3	6.6	4,565.48	690.59	
	Low	1	3.6	2,506.44	699.54	
Allen and Rocks, Inc.	High	3	6.9	4,684.22	680.94	
	Low	1	3.1	2,113.82	682.10	
Washington Real Estate	High	3	4.9	3,347.34	681.32	
	Low	2	4.1	2,800.62	681.58	
Allen and Rocks, Inc.	High	3	5.4	3,683.94	681.20	
	Low	1	3.6	2,426.62	681.83	
Charterhouse Motor Hotel	High	4	4.5	3,047.46	681.45	
	Low	1	2.3	1,565.06	682.84	

\* Meter charge plus commodity charge at current rate.

† Could not be determined.

## SECTION 11

### PHOENIX WATER DEPARTMENT

The City of Phoenix (Maricopa County) lies in the south central part of Arizona in what is considered to be a water-short area. The county, which is also the SMSA boundry, had a population of 1.3 million in 1974. The retail service area of the Phoenix Water Department serves 794,542 persons. Estimates are that in this rapidly growing area, the population served will more than double by the year 2,000. Table 87 gives some facts pertaining to the system.

#### WATER SUPPLY SERVICE AREA

The retail service area for the Phoenix Water Department encompasses approximately 185 sq miles, and water is provided on a wholesale basis to other areas, increasing the total service area to approximately 280 sq miles (Figure 43). The present retail service area includes retail service to most of the incorporated area of the City of Phoenix (some small portions of the city are still served by private companies), some unincorporated areas around the city, and a portion of the City of Scottsdale, Arizona.

The elevations within the service area vary from a low of 940 ft to a high of 1,600 ft, and in some cases water must be moved over fairly long distances to provide service to the citizens. The population within the Phoenix Water Department's service area is increasing at a rapid rate, a trend that is expected to continue. In the future, it is anticipated that the Phoenix Water Department will expand by construction and by acquiring some of the smaller private companies in the area. By the year 2,000 its service area will increase to approximately 455 sq miles. The water department has placed major emphasis on developing a plan to meet future water needs through acquiring the water and providing the physical facilities for treatment and distribution.

#### ORGANIZATION

Organizationally, the Phoenix Water Department combines both water supply and wastewater treatment functions; the accounting systems for the two operations are also combined. Where an overlap in function occurred, it was necessary to estimate the cost assigned to each operation. The Phoenix Water Department organizational structure (Figure 44) is composed of two major sections: administration and operations. The administrative area accomplishes all tasks not associated with the direct production of water or wastewater and includes three divisions: Accounting, Engineering, and Technical

TABLE 87. PHOENIX WATER DEPARTMENT, BASIC FACTS (1974)

Item	Amount
Population:	
SMSA	1,306,000
County	1,306,000
Retail service area	794,542
Area of retail service area (sq miles)	185
Recognized customer classes (active accounts):	
Residential	172,503
Commercial	20,347
Industrial	142
Government	1,028
Flat rate (no. accounts)	400
Percent metered	100
Purchased water (raw, mil gal)	29,485
Source water	60% Surface - 40% Ground
Pipe in system (miles)	3,445
Elevation of treatment plants (ft above sea level datum):	
Verde	1,370
Deer Valley	1,228
Squaw Peak	1,390
Elevation of service area (min-max, ft)	940/1600
Revenue-producing water (mil gal)	63,661
Treated water (treated and well water, mil gal)	67,042
Maximum day/maximum hour (MGD)	323.8/449.0

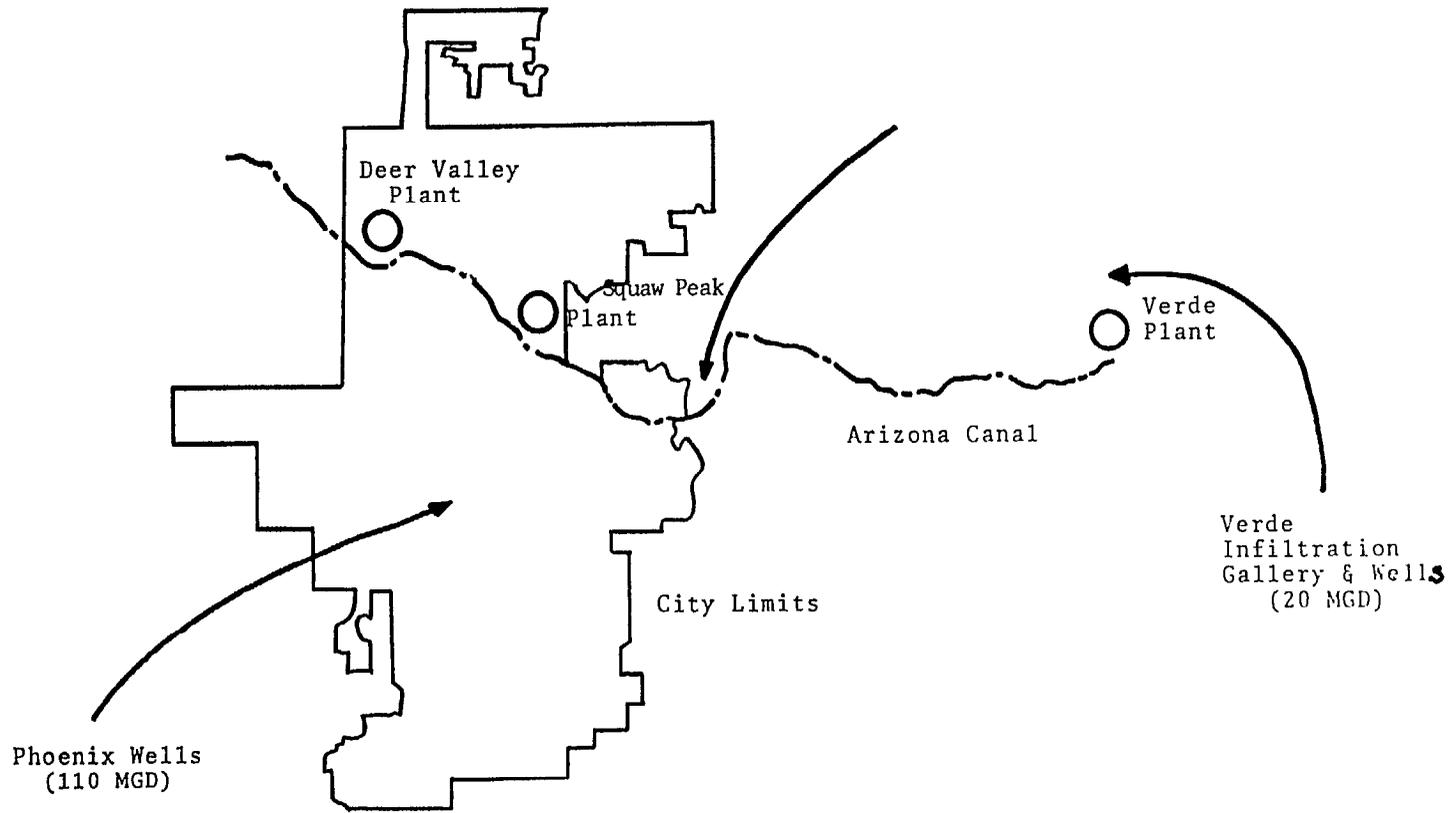


Figure 43. Phoenix Water Department retail service area.

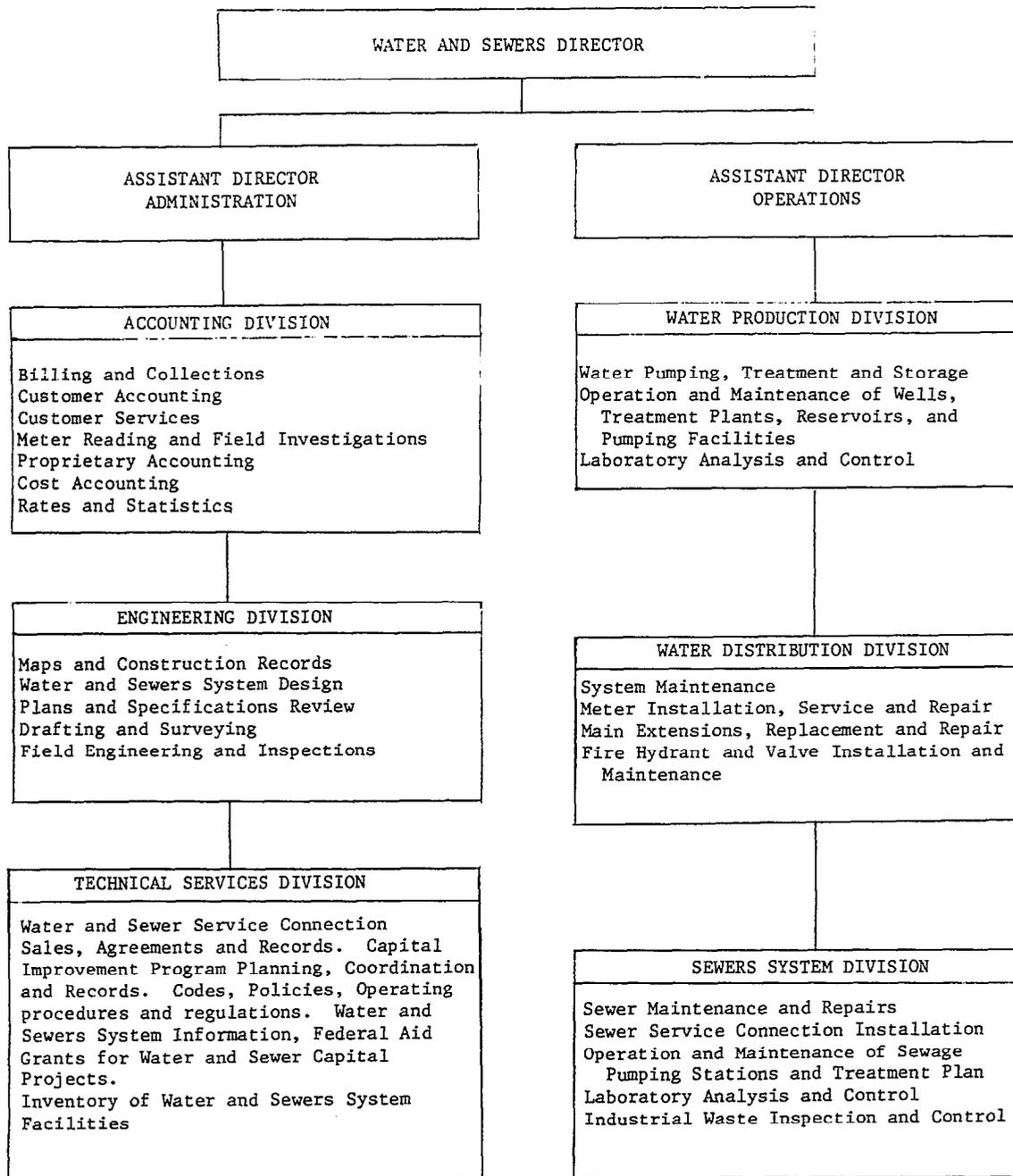


Figure 44. Phoenix Water Department organizational chart.

Services. The Operations Section, which performs the physical operations and maintenance for water supply and wastewater, also has three major divisions: Water Production, Water Distribution, and Sewer Systems. The function of each division is shown on Figure 44.

For the most part, the operations areas of the water supply and sewer services are reasonably well divided; in the administrative area, however, considerable overlapping of function occurs and it is necessary to estimate the portion of each service allocated to the water production. For example, all billing and collection for both water and sewer are accomplished through a common accounting system.

#### ACQUISITION

Raw water for the Phoenix Water Department comes from both surface and ground sources. Approximately 60% of the water used is surface water and 40% is groundwater.

The surface water for the Phoenix Water Department is obtained from two basic sources: the Salt and Verde Rivers.\* The surface water is controlled by the Salt River Project, and there is a tight accountability for the water extracted from the source and ultimately returned to the water source system.

There are 110 wells with a total capacity of 155 MGD producing for the Phoenix Water Department. These wells are somewhat clustered in fields and are geographically distributed over portions of the area. Some wells are held in reserve for emergency use only.

Well water is used in two ways by the department: (1) water is pumped from the well, chlorinated, and moved directly into the transmission and distribution system; and (2) well water is pumped directly into canals controlled by the Salt River Project. This water is traded for surface water, which can be utilized at a different point in the water system or at a different time when the need may be greater. When well water is pumped into a canal above the city water department, a greater amount of water can be stored in the Salt River Project's reservoirs for release at a later time.

#### TREATMENT

Raw surface water is treated at three treatment plants with a total design capacity of 230 MGD. The Verde treatment plant (40 MGD) is located approximately 15 miles east of the city; Squaw Peak treatment plant, 110 MGD, is located on the Arizona Canal\* at 24th Street near the center of the city; and Deer Valley treatment plant, 80 MGD, is located northwest of the city.

Figure 45 is a flow diagram of the Squaw Peak treatment plant. The other two treatment plants are similar to this system.

\* Arizona Canal water comes from the Salt and Verde Rivers.

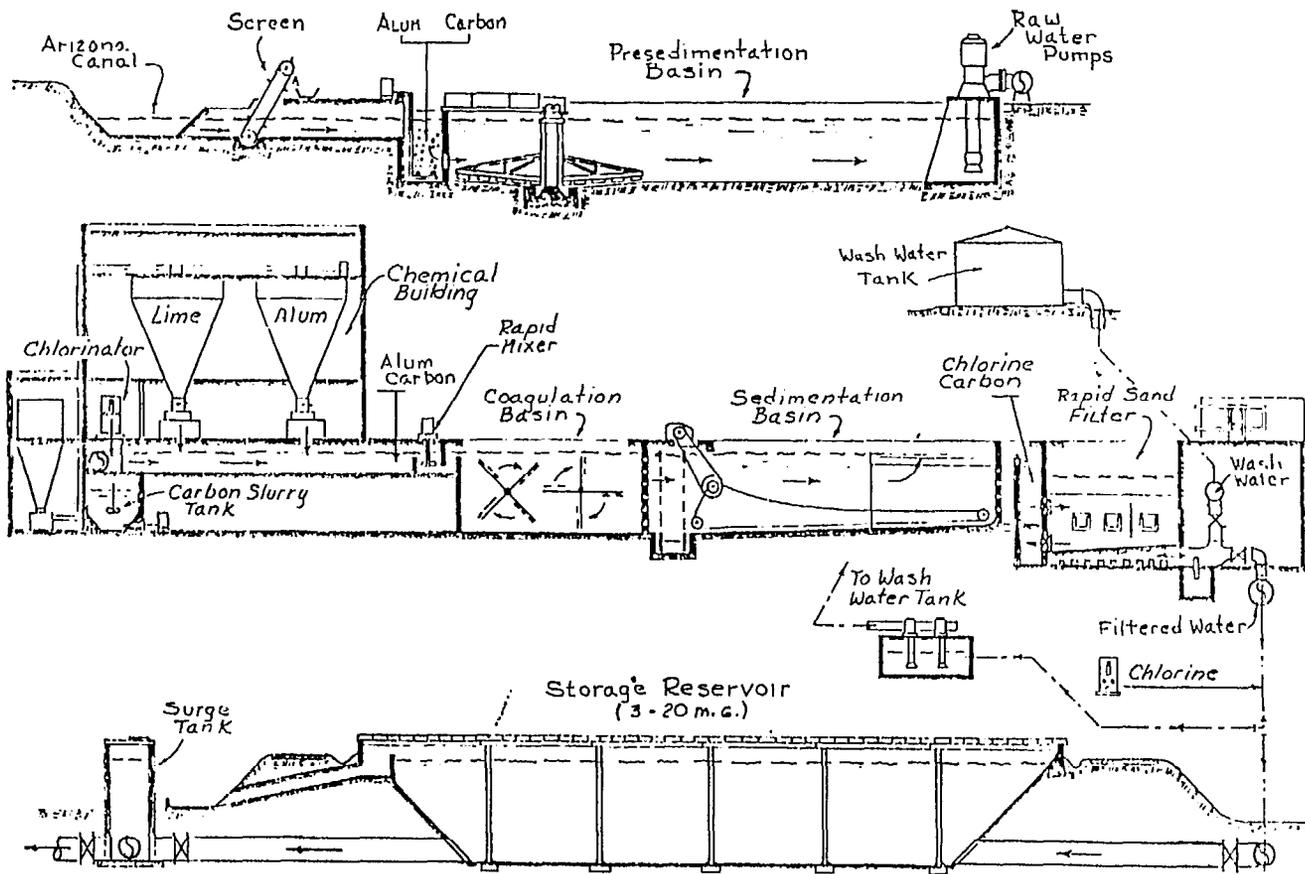


Figure 45. Squaw Peak Treatment Plant flow diagram.

## TRANSMISSION AND DISTRIBUTION

The transmission and distribution system of the Phoenix Water Department consists of approximately 3,445 miles of underground pipe ranging from 2-in. pipe used for distribution to some of the residential areas up to 60-in. pipe used in some of the transmission lines.

The distribution system is divided into 21 separate service areas located within six pressure zones. Each 100 ft rise in elevation requires the establishment of a new pressure zone to provide the desirable range of water pressure to each customer. In every case, a higher service zone is serviced in whole or in part by pumps from the zone or zones below. Water delivered to some of the higher zones passes through several lower zones and has to be repumped as many as four times. The result is that each of the 21 service areas is interdependent and is affected by the water production capacity and rate of water consumption in other areas. The interrelationship of the 21 areas is complex, and the actual flow of water is controlled by hundreds of valves located throughout the system. At any given time, the interrelationship of the service areas and pressure zones is dependent on the valve setting configurations, making it extremely difficult to determine water flow. In the transmission and distribution system, there are 44 booster pumping stations and 25 storage reservoirs, which have a capacity of over 191 mil gal. In addition to these storage facilities, 31 booster stations with wells have a storage capacity of almost 13 mil gal. Table 88 lists the storage facilities and their capacities.

## COST ANALYSIS

Growth in consumer demand for water from 1965 through 1974 is illustrated in Figure 46.

Using the standard cost categories, data were collected and reported as shown in Tables 89, 90, and 91. As indicated by the relative increase in the support services category, a major portion of the operating budget is expended for labor. Table 92 examines labor costs for operations and maintenance of the utility. The cost/man-hour increased by 122%, whereas the total payroll hours required to produce 1 mil gal of RPW decreased by 31%; thus the operating cost for producing water did not increase as rapidly as the labor cost/man-hour. However, at some future date it will no longer be possible to gain increasing efficiencies with respect to manpower, and the total payroll cost will increase at least at the same rate as the labor cost. Table 93 summarizes the operating, depreciation, and interest expenses for the 10-year period of the analysis. Capital and operating expense ratios are computed in Table 94. The operating expenses shown in Table 89 are costs incurred in the normal day-to-day operation of the system. The capital expenses are the total expenditures for providing major equipment items and facilities plus the interest charged on money borrowed for those purposes.

A comparison (Table 94) of the operating and capital expenses as a percent of the total cost shows that in the Phoenix Water Department, more expenses are associated with operations than with capital. Over the 10-year period, this trend continued to shift more heavily toward the operating

TABLE 88. PHOENIX SYSTEM STORAGE FACILITIES

Reservoir name	Capacity* (mil gal)	Elevation	
		Overflow (ft)	Ground (ft)
Sweetwater and 18th St.	0.1	1,543	1,532
Cactus Rd. and 20th St,	1.0	1,629	1,601
Greenway Rd. and 16th St.	2.0	1,629	1,598
Lincoln Dr. and 36th St.	1.0	1,503	1,476
Cinnabar and 5th St. (2)	2.3	1,483	1,453
Hatcher Rd. and 18th St.	1.0	1,483	1,454
Mineral Rd. and 9th St.	1.0	1,468	1,437
Moon Mtn. and 18th Ave. (2)	4.15	1,452	1,430
Shaw Butte (2)	10.0	1,405	1,357
Squaw Pk. Wash Water	2.0	1,346	1,323
Papago Park (2)	3.0	1,462	1,430
Mineral Rd. and 9th St.	2.0	1,360	1,328
Olney and 15th Ave.	2.0	1,360	1,329
Thomas Rd. and 64th St. (3)	60.0	1,286	1,266
Squaw Peak Clearwell (3)	60.0	1,283	1,258
South Mountain	20.0	1,283	1,251
Deer Val Clearwell	20.0	1,228	1,203

\* Total capacity of tanks at each location.

An additional 12.88 mil gal storage is distributed among 31 booster stations with the wells.

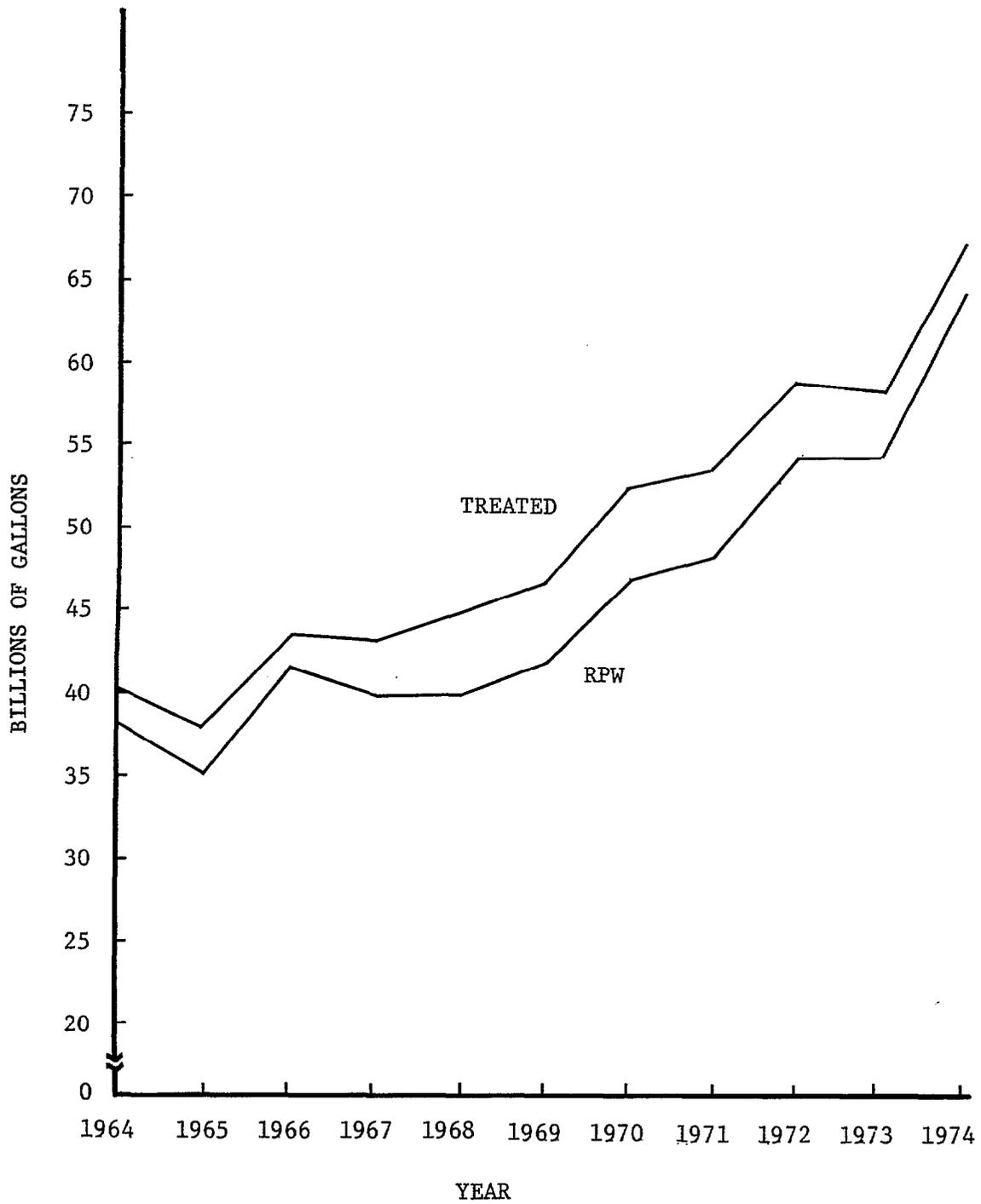


Figure 46. Phoenix Water Department water flow: treated water versus RPW.

TABLE 89. PHOENIX WATER DEPARTMENT ANNUAL OPERATING COSTS

Category	1965*	1966*	1967	1968	1969	1970	1971	1972	1973	1974
Support services:										
Administration	---	---	\$ 589,212	\$ 649,286	\$ 692,791	\$ 798,830	\$ 903,020	\$1,016,810	\$1,134,421	\$1,273,269
Accounting and collection	---	---	1,119,069	1,155,357	1,183,205	1,313,009	1,456,148	1,748,834	1,913,198	2,207,037
Other	---	---	1,112,676	1,212,944	1,420,457	1,514,275	1,601,935	1,693,404	1,760,845	1,831,773
Total support services	---	---	2,820,957	3,017,587	3,296,453	3,626,114	3,961,103	4,459,048	4,808,464	5,312,079
Acquisition	---	---	182,138	252,054	334,943	425,059	491,747	602,885	632,158	653,091
Treatment	---	---	875,362	930,437	1,007,997	1,151,044	1,331,632	1,421,131	1,634,991	1,630,577
Power and pumping	---	---	1,262,866	1,226,583	1,080,230	1,174,795	1,359,108	1,671,913	1,956,441	2,237,248
Transmission and distribution	---	---	1,024,055	1,225,687	1,283,099	1,539,713	1,773,444	1,960,999	2,211,966	2,628,261
Total operating cost	\$5,299,336 <sup>+</sup>	\$5,731,336 <sup>+</sup>	6,165,378	6,652,348	7,002,722	7,916,725	8,917,034	10,115,976	11,244,020	12,461,256

\* Cost breakout for these years is not available.

+ Estimated.

TABLE 90. PHOENIX WATER DEPARTMENT UNIT OPERATING COSTS (\$/mil gal RPW)

Category	1965*	1966*	1967	1968	1969	1970	1971	1972	1973	1974
Support services:										
Administration	---	---	\$14.93	\$16.60	\$16.84	\$17.35	\$19.11	\$18.98	\$21.35	\$20.00
Accounting and collection	---	---	28.36	29.55	28.75	28.51	30.81	32.65	36.01	34.67
Other	---	---	28.20	31.02	34.52	32.88	33.90	31.61	33.14	28.77
Total support services	---	---	71.49	77.17	80.11	78.74	83.82	83.24	90.51	83.44
Acquisition	---	---	4.62	6.45	8.14	9.23	10.41	11.25	11.90	10.26
Treatment	---	---	22.18	23.79	24.50	24.99	28.18	26.53	30.78	25.61
Power and pumping	---	---	32.00	31.37	26.25	25.51	28.76	31.21	36.83	35.14
Transmission and distribution	---	---	25.95	31.34	31.18	33.43	37.53	36.61	41.64	41.29
Total unit operating cost	\$152.31 <sup>+</sup>	\$139.10 <sup>+</sup>	156.24	170.12	170.18	171.90	188.70	188.85	211.65	195.74

\* Cost breakout for these years is not available.

+ Estimated.

TABLE 91. PHOENIX WATER DEPARTMENT OPERATING COST CATEGORIES AS PERCENT OF TOTAL COST

Category	1965*	1966*	1967	1968	1969	1970	1971	1972	1973	1974
Support services:										
Administration	---	---	9.56	9.76	9.89	10.09	10.13	10.05	10.09	10.22
Accounting and collection	---	---	18.15	17.37	16.90	16.59	16.33	17.29	17.01	17.71
Other	---	---	18.05	18.23	20.28	19.13	17.96	16.74	15.66	14.70
Total support services	---	---	45.76	45.36	47.07	45.81	44.42	44.08	42.76	42.63
Acquisition	---	---	2.95	3.80	4.78	5.37	5.51	5.96	5.62	5.24
Treatment	---	---	14.20	13.99	14.39	14.54	14.93	14.05	14.54	13.09
Power and pumping	---	---	20.48	18.44	15.43	14.84	15.24	16.53	17.40	17.95
Transmission and distribution	---	---	16.61	18.41	18.33	19.44	19.90	19.38	19.68	21.09
Total operating expense	---	---	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

\* Cost breakout for these years is not available.

TABLE 92. PHOENIX WATER DEPARTMENT LABOR COST ANALYSIS

Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total payroll (\$)	2,039,599	2,426,455	2,454,856	2,769,303	2,852,055	3,089,632	3,586,964	4,774,176	5,237,496	5,743,024
Total hours on payroll	881,000	878,000	894,000	902,000	938,000	930,000	946,000	1,002,000	1,050,000	1,113,000
Revenue-producing water (mil gal)	34,794	41,203	39,459	39,104	41,148	46,054	47,255	53,566	53,126	63,661
Total payroll/mil gal (\$)	58.62	58.89	62.21	70.82	69.31	67.09	75.91	89.13	98.59	90.21
Total hours RPW/mil gal	25.32	21.30	22.65	23.06	22.79	20.19	20.01	18.70	19.76	17.48
Average cost/man-hour (\$)	2.32	2.76	2.75	3.07	3.04	3.32	3.79	4.76	4.99	5.16

TABLE 93. PHOENIX WATER DEPARTMENT CAPITAL AND OPERATING COST

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Operating expense	\$5,299,336*	\$5,731,336*	\$6,165,378	\$6,652,348	\$7,002,722	\$7,916,725	\$8,917,034	\$10,115,976	\$11,244,020	\$12,461,256
Depreciation	2,536,867	2,650,000*	2,868,063	2,984,716	3,152,513	3,319,446	3,474,388	4,013,693	4,182,875	4,524,535
Interest	2,135,831	2,215,029	2,364,290	2,326,628	2,317,427	2,343,740	2,145,752	2,077,064	2,542,319	3,419,045
Total	9,972,034	10,596,365	11,397,731	11,963,692	12,472,662	13,579,911	14,537,174	16,206,733	17,769,214	20,404,836
Total cost/mil gal RPW	286.60	257.17	288.85	305.94	303.12	294.87	307.63	302.55	338.24	320.52

\* Estimates.

TABLE 94. PHOENIX WATER DEPARTMENT CAPITAL VERSUS OPERATING EXPENSE RATIOS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Operating expense (\$)	5,299,336*	5,731,336*	6,165,378	6,652,348	7,002,722	7,916,725	8,917,034	10,115,976	11,244,020	12,461,256
Capital expense (\$)	4,672,898	4,865,029*	5,232,353	5,311,344	5,469,940	5,663,186	5,620,140	6,090,757	6,725,194	7,943,580
Total (\$)	9,972,234	10,596,365	11,397,731	11,963,692	12,472,662	13,579,911	14,537,174	16,206,733	17,969,214	20,404,836
Operating expense as % of total	53.14	54.08	54.09	55.60	56.14	58.29	61.33	62.41	62.57	61.07
Capital expense as % of total	46.86	45.92	45.91	44.40	43.86	41.71	38.67	37.59	37.43	38.93

\* Estimates.

expense area. In 1965, the ratio was about 53% operating to 47% capital. This gradually changed to the point that in 1974, the ratio was 61% operating to 39% capital. During this time, there were no major capital expenditures, but labor costs increased drastically.

The Phoenix system is relatively old; therefore, the capital depreciated was expended when costs were significantly lower than at present. On the other hand, the operating expense is in current dollars. This ratio will change whenever major capital investments are made by the utility. For example, if a major modification to the treatment facility is required, capital expenses will increase without a corresponding increase in operating costs.

#### SYSTEM COSTS

Examination of the cost on a functional basis is only part of the total picture. Since the purpose of a water supply utility is to deliver water to a consumer, it is important to be able to present costs in such a way that they relate delivery of water to a demand point within the distribution system. The functional categories, both operating and capital, will therefore be reaggregated and assigned to physical components in the water delivery system. This section contains such an analysis of water supply system costs.

Figure 47 is a schematic presentation of the Phoenix Water Department supply system. As shown, the system is extremely complex, and because of the interdependence of the various service areas and pressure zones and the continual change in the water flowing within the system, it becomes impossible to accurately allocate costs and identify specific flow patterns of water through the physical components of the system. Therefore, a schematic diagram was not developed to identify operating and capital costs to the various physical components of the system.

Total unit costs for Phoenix were \$320.52/mil gal RPW in 1974 (Table 93). This value includes all operating, depreciation, and interest costs associated with the utility's operation. It does not identify the costs of the specific components, but it does allow an overall evaluation of the cost to the department to produce water.

Though Phoenix is located in a water-short area, the charge for water usage (Tables 95 and 96) is relatively low--in fact, less than that charged in some areas that are not short of water.

The 10 top users of water from the Phoenix Water Department are listed in Table 97. Note that these major users are relatively low consumers of water as compared to the top 10 users of many other utilities across the United States. One reason is that Phoenix is considered a water-short area, and the city does not encourage industry requiring large volumes of water to locate in the vicinity.

Figure 48 shows the Phoenix service area and the locations of the top 10 users of the water. For the most part, they are clustered relatively close to the center of the total service area, and thus close to the Squaw Peak

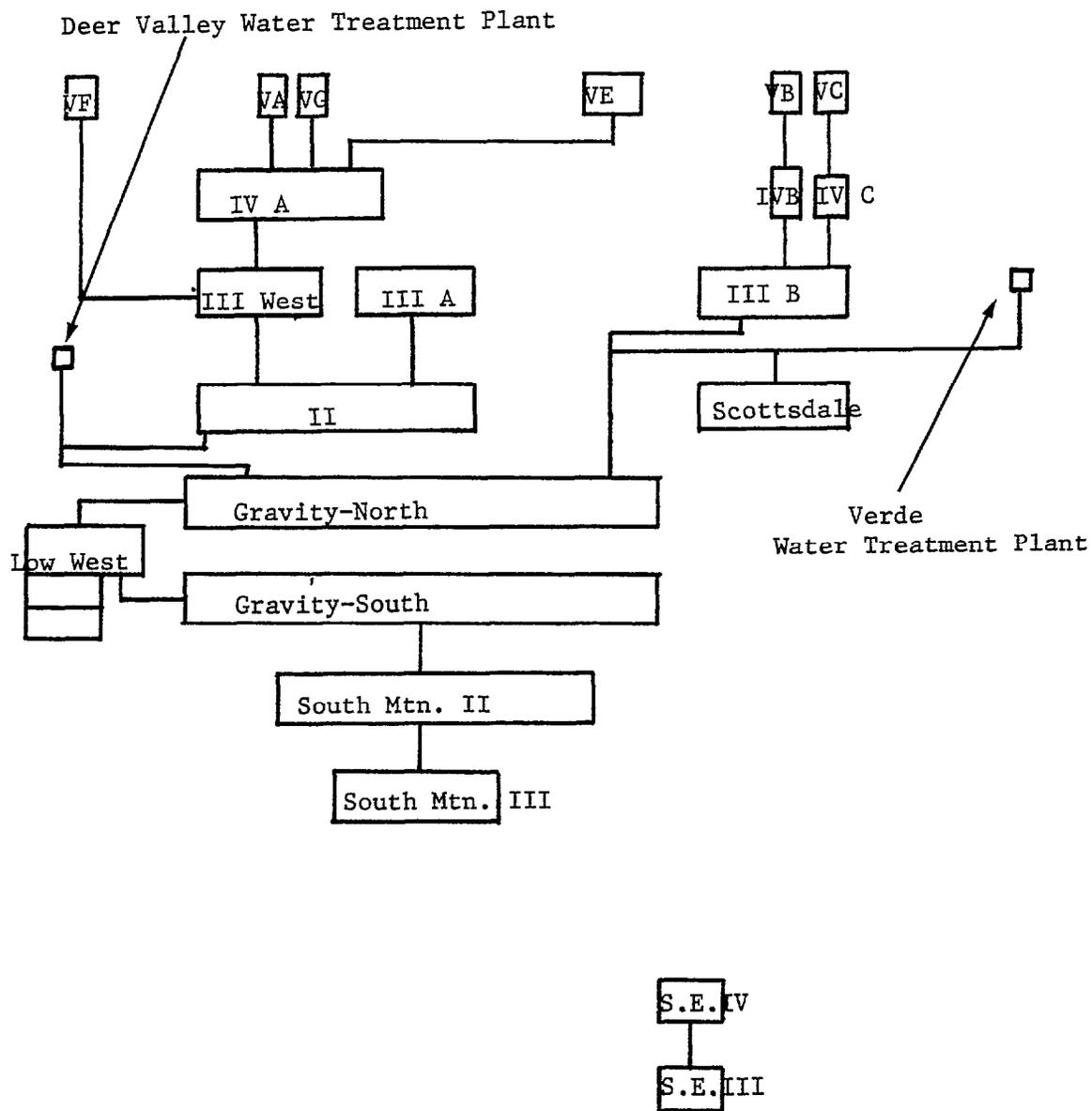


Figure 47. Simplified Phoenix Waterworks schematic, 1975.

TABLE 95. PHOENIX WATER DEPARTMENT METER RATES EFFECTIVE JANUARY 1, 1974 (cu ft)

Inside city rates			Outside city rates			Scottsdale/ Paradise Valley rates		
Size of meter (in.)	Minimum allowance	Monthly rate	Size of meter (in.)	Minimum allowance	Monthly rate	Size of meter (in.)	Minimum allowance	Monthly rate
5/8 x 3/4	600	\$3.30	5/8 x 3/4	600	\$5.00	5/8 x 3/4	600	\$4.00
1	800	4.35	1	800	6.50	1	800	5.20
1½	1,200	6.10	1½	1,200	9.15	1½	1,200	7.30
2	1,500	7.50	2	1,500	11.25	2	1,500	9.00
3	1,900	9.40	3	1,900	14.10	3	1,900	11.30
4	2,400	11.70	4	2,400	17.55	4	2,400	14.00
6	3,200	15.50	6	3,200	23.25	6	3,200	18.60

TABLE 96. PHOENIX WATER DEPARTMENT UNIT RATES (EFFECTIVE JANUARY 1, 1974)\*

Quantity in excess of minimum allowance (cu ft)	Cost/100 cu ft	
	May thru Oct.	Nov. thru April
Inside city:		
Next 3,000	\$0.21	\$0.23
Next 57,000	0.20	0.22
Next 100,000	0.19	0.20
Next 140,000	0.18	0.18
Next 1,000,000	0.17	0.17
Next 2,000,000	0.15	0.15
Over 3,300,000	0.14	0.14
Outside city:		
Next 3,000	\$0.30	\$0.34
Next 57,000	0.29	0.33
Next 100,000	0.28	0.30
Next 140,000	0.27	0.27
Next 1,000,000	0.24	0.24
Next 2,000,000	0.22	0.22
Over 3,300,000	0.20	0.20
Scottsdale/Paradise Valley:		
Next 3,000	\$0.25	\$0.28
Next 57,000	0.24	0.26
Next 100,000	0.23	0.24
Next 140,000	0.22	0.22
Next 1,000,000	0.20	0.20
Next 2,000,000	0.18	0.18
Over 3,300,000	0.17	0.17

\* Rates applicable for duplex, triplex, combination residential and/or commercial usage; trailer courts and churches, furnished upon request.

TABLE 97. PHOENIX WATER DEPARTMENT WATER COSTS FOR 10 MAJOR USERS

Major user	High or low month	Month	Units used (mil gal)	Amount billed	Unit charge (\$/mil gal)	Cost zone
Pepsi Cola	High	Nov.	4.0	\$985	\$248.54	1
	Low	Jan.	3.2	803	253.87	
Arizona State Hospital	High	July	5.4	1,290	238.75	1
	Low	Feb.	2.2	674	310.59	
Honeywell	High	July	4.9	1,167	239.43	1
	Low	Jan.	2.3	598	263.32	
Air Research	High	Sept.	10.1	2,347	232.49	1
	Low	Dec.	4.0	1,001	247.95	
Coca Cola	High	June	5.1	1,216	237.68	1
	Low	Jan.	3.6	897	250.13	
Cudahy	High	Nov.	10.8	2,515	232.16	1
	Low	July	8.1	1,893	234.63	
Carnation	High	July	13.1	2,941	225.01	1
	Low	Feb.	9.3	2,195	236.04	
Reynolds Metals	High	May	23.5	5,034	214.26	1
	Low	Feb.	1.7	473	271.99	
Western Electric	High	June	14.6	3,256	222.63	1
	Low	Jan.	0.4	130	315.53	
Motorola	High	July	26.1	5,546	212.14	1
	Low	Aug.	13.6	3,053	224.27	

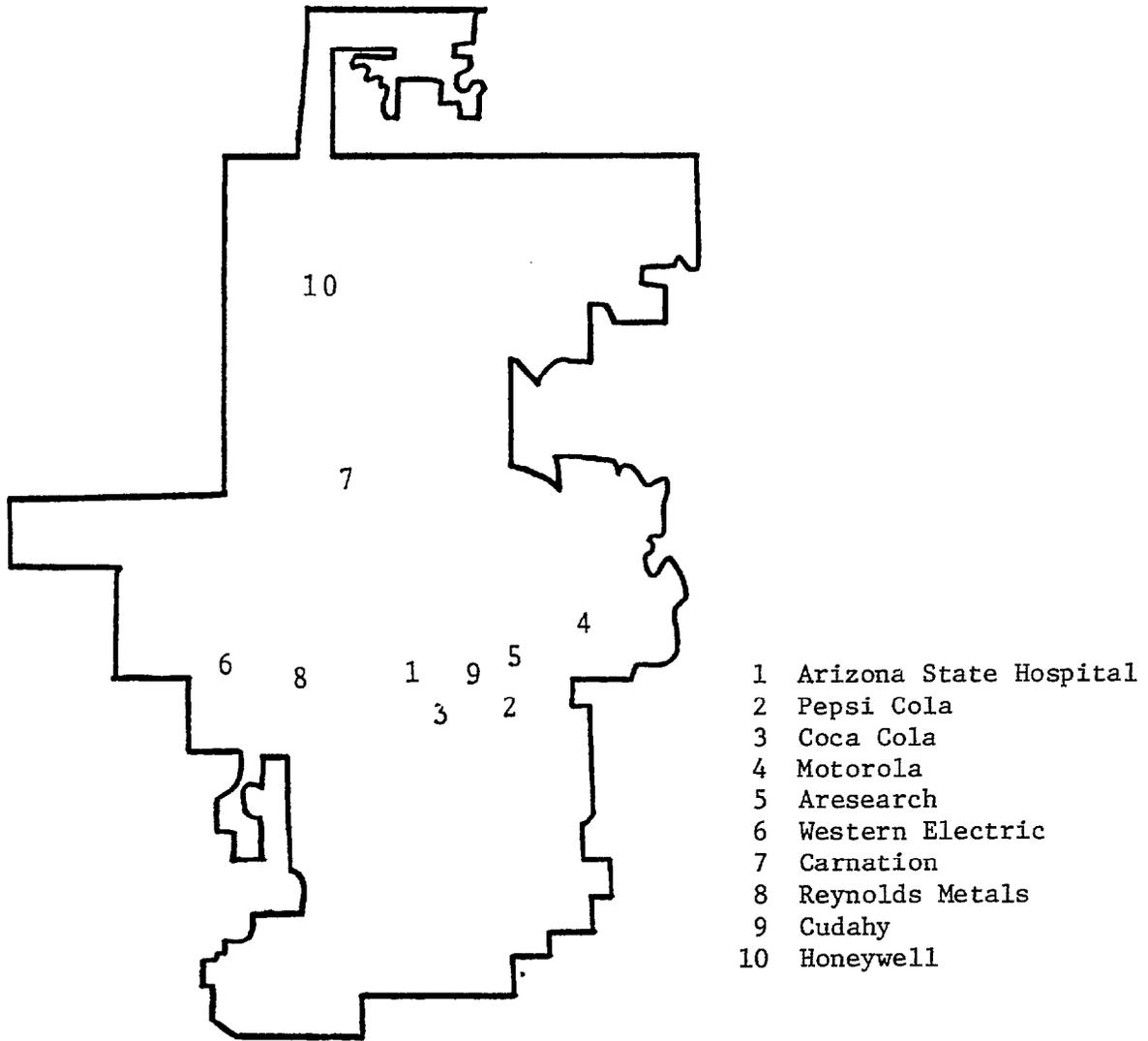


Figure 48. Phoenix Water Department major users.

treatment plant and some of the well fields. This location means that the water delivered to them travels only a short distance and does not require the added cost of boosting to reach the extremity of the system.

The average unit costs for all water supplied during the most recent year studied are given as follows:

	<u>\$/mil gal</u>
Support services-----	91
Acquisition-----	17
Treatment-----	47
Distribution-----	112
Interest-----	53
Total-----	320

## SECTION 12

### KENTON COUNTY WATER DISTRICT

The Kenton County Water District provides water to about 7,000 customers in the northwestern portion of Kenton County, Kentucky. The population in this area was 133,115 in 1974 and has shown only a slight increase over the past 10 years, allowing for the development of a relatively stable water utility. Some systems facts are shown in Table 98.

#### WATER SUPPLY SERVICE AREA

The water district provides water on a retail basis to all classes of customers in the service area shown in Figure 49. Treated water is supplied to 12 townships, an industrial park situated mainly outside the county, and unincorporated areas of Kenton County lying within the service area. In addition, water is supplied to the City of Florence and to the Boone County Airport, both located in Boone County but close to the population centers of Kenton County.

With a reasonably stable population, the emphasis is on maintaining the stability of the operating system from a cost/mil gal standpoint.

#### ORGANIZATION

Because the Kenton County Water District supplies water only, it is not intermingled with any other organization. The organization is headed by a general manager who reports directly to a three-man commission responsible for the operation of the water district.

Four divisions report to the general manager. Their responsibilities are: (1) treatment plant and laboratory operation and maintenance, (2) distribution system operations and maintenance, (3) accounting and collection, including meter service, and (4) engineering.

Because the organization is small (about 27 people), there is a tendency for one division to help another when the work load becomes heavy in a specific area. This does not affect the overall cost of the operation but may slightly shift cost allocations from one area to another. Figure 50 shows the organization of the Kenton County Water District.

TABLE 98. KENTON COUNTY WATER DISTRICT, BASIC FACTS (1974)

Item	Amount
Population:	
SMSA	1,424,596
County	133,155
Retail service area	7,000
Area of retail service area (sq miles)	40
Recognized customer classes (average no. of customers/year):	
Residential	12,773
Commercial	585
Industrial	59
Customer cities	1
Flat rate	0
Percent metered	100
Purchased water	None
Source water	100% surface
Pipe in system (miles)	157
Elevation of treatment plant (ft above mean sea level)	506
Elevation of service area (min-max ft)	520/910
Revenue-producing water (mil gal)	2,258.877
Treated water (pumpage from treatment plants +treated purchased water, mil gal)	2,356.97
Maximum day/maximum hour (MGD)	9/NA

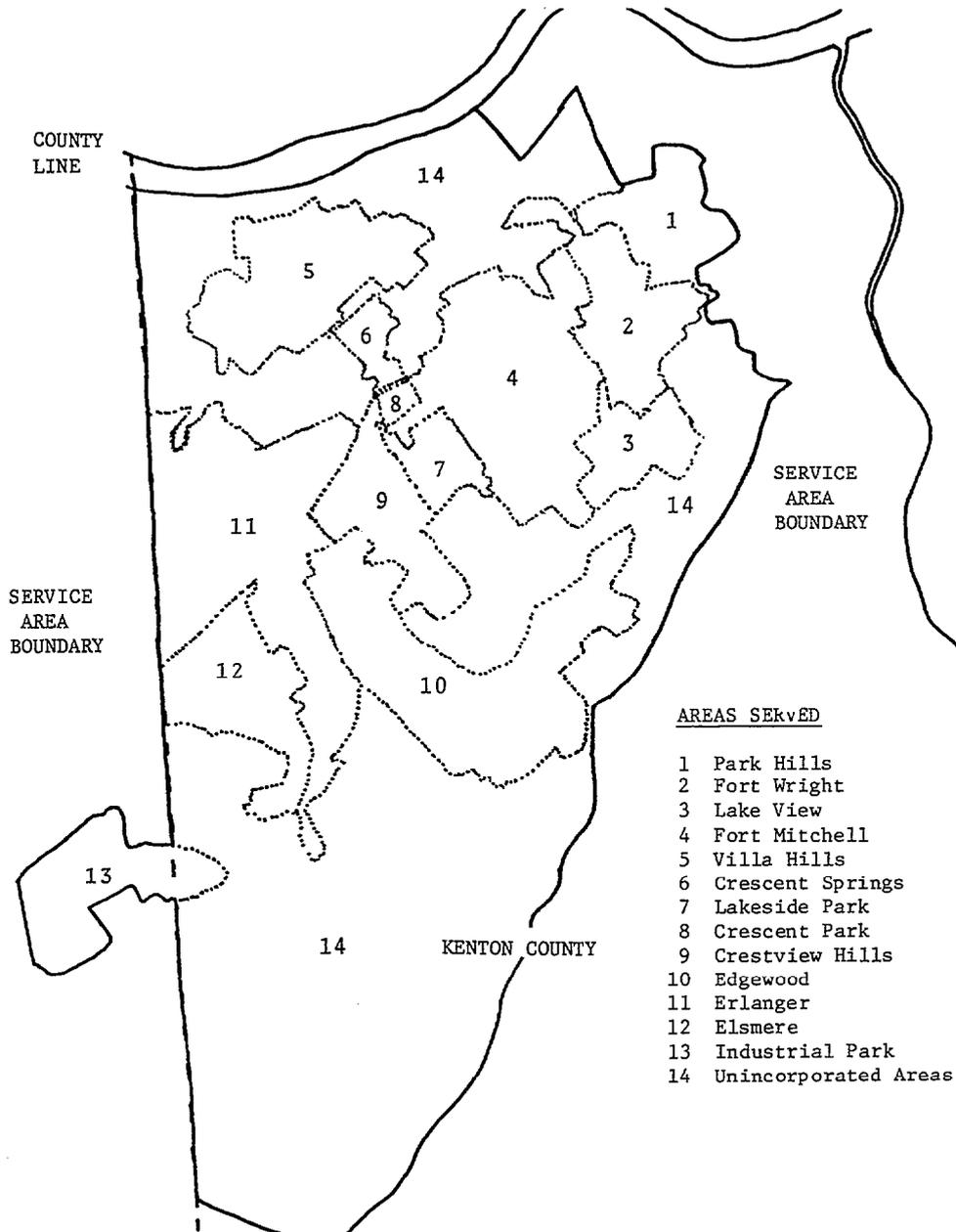


Figure 49. Kenton County Water District retail service area.

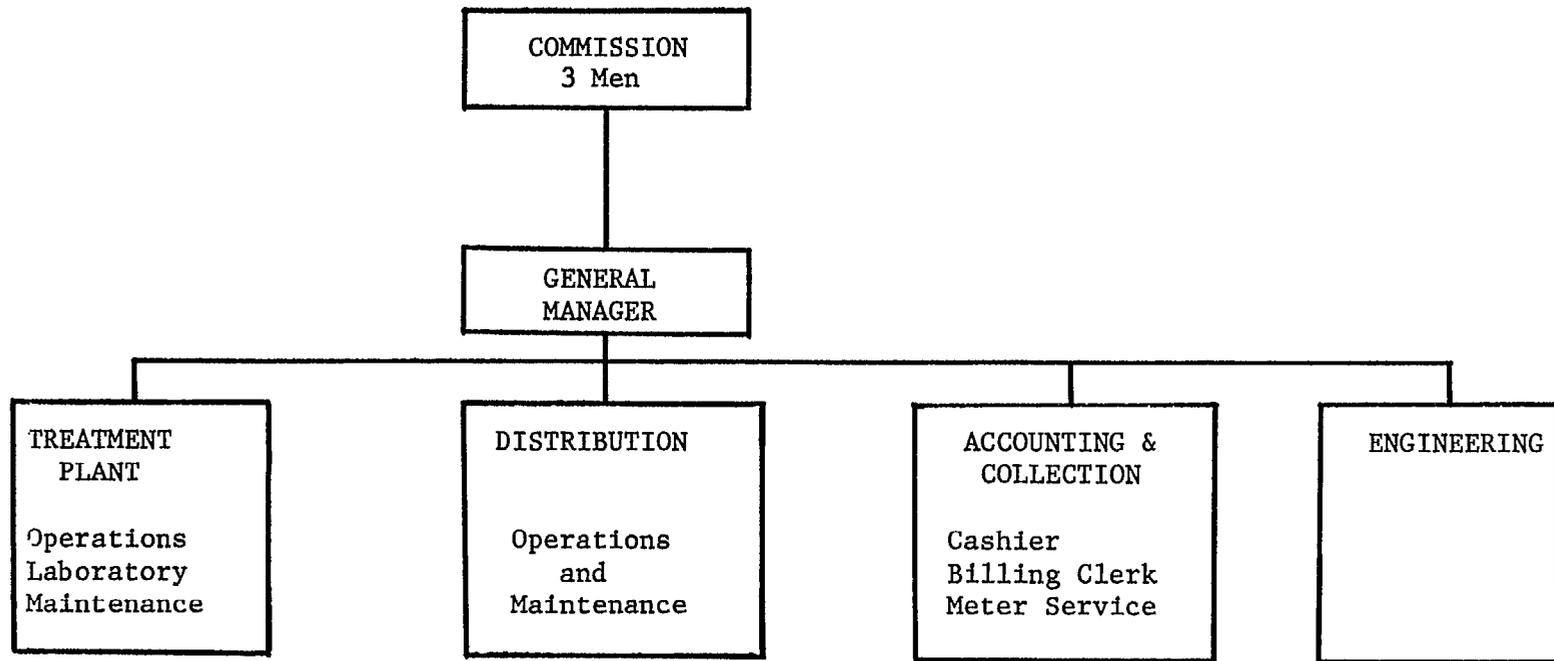


Figure 50. Kenton County Water District organizational chart.

## ACQUISITION

Raw water comes from the Licking River and is transported a short distance to a single treatment plant where all raw water is treated. Intake facilities are located on the bank of the Licking River, approximately 5 miles upstream from the Ohio River, within the pool of the Markland Dam. Normal pool elevation maintained by the dam provides a water depth of 25 ft at the intake. The intake structure is a reinforced concrete tower that houses three electrical vertical turbine pumps--one 3.0-MGD and two 9.0-MGD. The intake facility is equipped with removable bar screens, motorized intake grates, traveling water screen, and adequate muck removal equipment.

## TREATMENT

The treatment plant is located at the intersection of Grand and Howard Avenues in the city of Taylor Mill and performs three primary functions: clarification of raw water; removal of undesirable chemical characteristics (such as iron and manganese); and reduction of bacterial count. To accomplish these requirements, the plant includes facilities for storage and feeding of chlorine, alum, lime, activated carbon, and fluoride into the raw water. Basically, the plant cycle consists of prechlorination, chemical mixing, flocculation, clarification, filtration, and post-chlorination at a rated capacity of 12.0 MGD. There are eight mixed media filters. Figure 51 is a schematic diagram of the treatment facility.

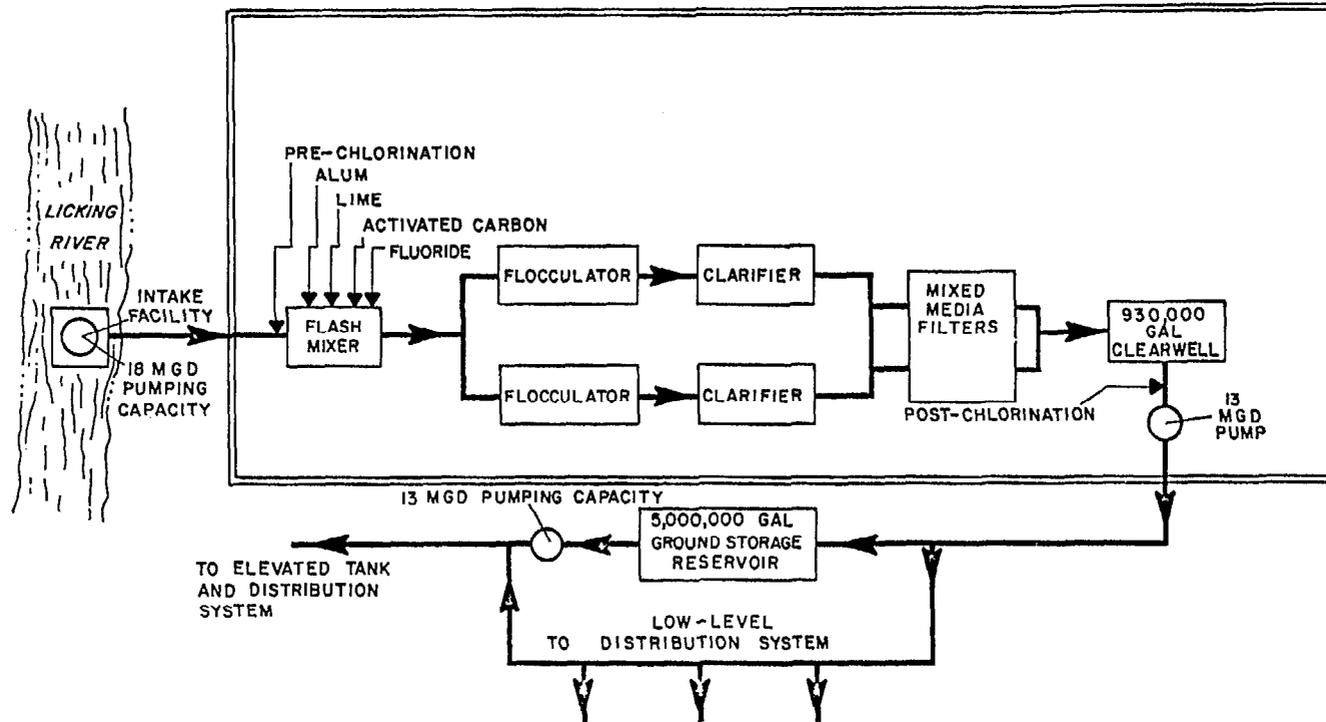
Physical, chemical, and bacteriological characteristics of the raw water vary greatly on a daily and seasonal basis, depending on numerous factors such as rainfall, temperature, flow rate, and the character of waste materials discharged upstream. Daily tests are run on samples of raw water, and the treatment process is modified as needed for changing conditions. Similarly, tests are run on the finished water samples to ensure that the objectives of the treatment process are met at all times.

## TRANSMISSION AND DISTRIBUTION

The distribution system consists of approximately 157 miles of pipe in the ground. The 24-in. transmission pipe leading from the treatment plant is rapidly decreased to a 12-in. and then an 8-inch main, which constitutes the bulk of the transmission system. The distribution system is operated on three pressure levels or gradients.

The first pressure level is fed from a 5.0 MGD storage tank by gravity or by the pumping capacity at the treatment plant, which consists of one 3.0-MGD and two 5.0-MGD vertical turbine pumps. The 5.0-MGD ground storage tank located on the highest ground of the first pressure level is filled directly from the treatment facility.

The second pressure level, which is the largest and serves most of the communities in the service area, is supplied by gravity from three elevated storage tanks or by the capacity of the main booster pump station located at Dudley Pike. The pump station has three 4.5-MGD vertical turbine pumps that



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Figure 51. Schematic diagram of the water treatment plant and distribution system for Kenton County Water District No. 1.

operate automatically based on the level existing in the elevated storage tanks. The pumps operate singly or in parallel, as required. The three elevated storage tanks have a combined capacity of 2.0 MGD.

The third pressure level is fed by gravity from two elevated storage tanks or by the two booster stations located on Turkey Foot Road at Lafayette Avenue. Each of these stations has a 1.0-MGD pump operated automatically off storage tank levels. The storage tanks have a combined capacity of 1.0 mil gal. Table 99 defines the storage capability of the Kenton County system.

#### COST ANALYSIS

The growth in consumer demand for water from 1965 through 1974 is illustrated in Figure 52.

Using the standard cost categories, data were collected and reported as shown in Tables 100, 101, and 102. Because a major portion of the operating budget was expended for labor, Table 103 was developed. The cost/man-hour increased by 52 percent over the 10-year period, whereas the man-hours required to produce 1 mil gal RPW decreased 40%. Thus, even though the hourly rate of pay increased significantly, the actual labor cost for producing 1 mil gal water decreased from \$132.99/mil gal to \$119.95/mil gal. The operating cost of production therefore did not increase as rapidly as the labor cost. In fact, the labor-related portion actually decreased. When it is no longer possible to gain increased efficiency with respect to manpower, the payroll cost will increase at least at the same rate as the labor cost.

Table 104 summarizes operating, depreciation, and interest expenses for the 10-year period of analysis. Table 105 computes capital and operating expense ratios. The operating expenses are those shown as the totals of the values in Table 100, the expenses incurred in the normal day-to-day operation of the system. The capital expenses are the total of periodic expenditures for major equipment and facilities plus the interest charged on money borrowed for those purposes.

A comparison of operating with capital expenses as a percent of the total cost shows that in the Kenton County system, more expenses are associated with operations than with capital. This 10-year trend resulted primarily from continued increases in the costs of items necessary to operations. Because only moderate capital costs were incurred during this period, the ratio of operating to capital expense maintained approximately the same relationship (70:30) throughout the 10 years studied.

The Kenton County system is relatively old; therefore, the capital depreciated was expended when costs were significantly lower than at present. On the other hand, the operating expense is in current dollars. This ratio will increase as capital investments are made by the utility. For example, a major capital expenditure may be required at the treatment facility to meet increasing demands. Should this occur, the ratio of capital expense to operating expense will increase significantly.

TABLE 99. KENTON COUNTY WATER DISTRICT STORAGE FACILITIES

Storage location	Type of storage	Base elevation (ft)	Overflow elevation (ft)	Capacity (mil gal)
Barrington Rd. in Lookout Heights - Fort Wright	Elevated tank	910.0	1,045.0	1.0
Dudley Pike	Ground storage tank	831.0	876.0	5.0
Dudley Pike in Edgewood	Elevated tank	890.0	1,045.0	0.5
Kenton Lands Rd. in Erlanger	Elevated tank	896.0	1,045.0	0.5
Industrial Park in Florence	Elevated tank	945.5	1,084.0	0.5
Oblique Street in Florence	Elevated tank	937.0	1,084.0	0.5

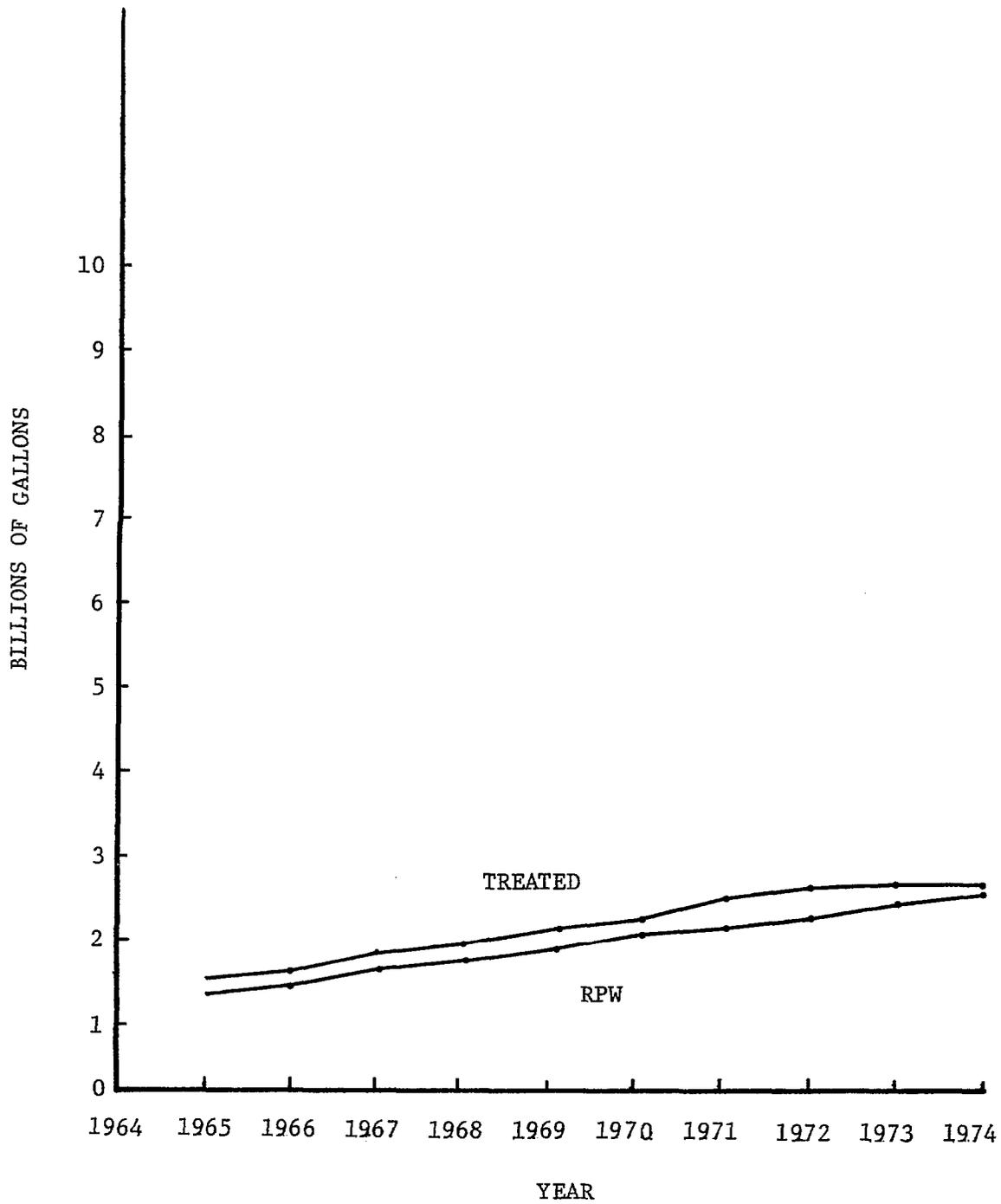


Figure 52. Kenton County Water District water flow: treated water versus RPW.

TABLE 100. KENTON COUNTY WATER DISTRICT ANNUAL OPERATING COSTS

Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
<b>Support services:</b>										
Administration	\$52,186	\$44,383	\$48,153	\$47,651	\$49,905	\$50,119	\$48,040	\$55,814	\$60,100	\$64,565
Accounting and collection	22,811	27,147	27,309	32,095	37,599	41,088	61,945	66,733	72,671	80,525
Engineering	12,797	20,964	11,877	14,224	17,886	20,372	23,747	26,120	28,037	27,738
Total support services	87,794	92,494	87,339	93,970	105,390	111,579	133,732	148,667	160,808	172,828
Acquisition:	2,360	1,482	3,730	1,284	2,556	2,443	2,474	10,062	2,110	924
<b>Treatment:</b>										
Supervision and labor	25,738	25,822	27,547	29,848	32,806	34,321	36,955	38,082	40,017	40,454
Chemicals	26,902	28,808	31,677	27,618	30,335	37,415	34,402	37,564	38,081	49,213
Other	28,271	31,396	34,674	36,577	41,029	43,734	43,751	46,906	44,922	47,743
Total treatment	80,911	86,025	93,898	94,043	104,170	115,470	115,108	122,552	123,020	137,410
<b>Power and pumping:</b>										
Supervision and labor	3,601	3,603	3,814	3,962	4,046	4,185	4,643	4,679	4,903	4,937
Power	58,166	72,084	81,840	86,351	91,954	107,263	122,451	130,910	134,983	171,595
Maintenance and other	8,785	9,241	10,450	10,959	11,625	13,145	12,890	15,685	14,784	17,053
Total power and pumping	70,552	84,928	96,104	101,272	107,625	124,593	139,984	151,274	154,670	193,585
<b>Transmission and distribution:</b>										
Supervision and labor	6,667	6,601	6,980	5,807	3,612	3,347	4,834	4,035	4,117	3,979
Maintenance	31,120	30,412	35,285	35,528	34,915	46,394	40,464	67,246	45,358	65,447
Other	19,688	21,370	24,079	26,519	28,682	28,174	31,801	27,005	42,777	40,281
Total transmission and distribution	57,475	58,384	66,144	67,854	67,209	77,915	77,099	98,286	92,252	109,707
Total operating cost	299,092	323,313	347,215	358,423	386,950	432,000	468,397	530,841	532,860	614,454

TABLE 101. KENTON COUNTY WATER DISTRICT UNIT OPERATING COST (\$/mil gal RPW)

Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
<b>Support services:</b>										
Administration	\$45.86	\$36.14	\$34.87	\$31.66	\$30.71	\$28.41	\$25.44	\$28.19	\$27.93	\$28.58
Accounting and collection	20.04	22.11	19.77	21.33	23.14	23.29	32.81	33.70	33.76	35.65
Engineering	11.25	17.07	8.60	9.45	11.01	11.55	12.58	13.19	13.03	12.28
Total support services	77.15	75.32	63.24	62.44	64.86	63.25	70.83	75.08	74.72	76.51
Acquisition:	2.07	1.21	2.70	0.85	1.57	1.38	1.31	5.08	0.98	0.41
<b>Treatment:</b>										
Supervision and labor	22.62	21.03	19.95	19.84	20.19	19.46	19.57	19.23	18.60	17.91
Chemicals	23.64	23.46	22.94	18.35	18.67	21.21	18.22	18.97	17.70	21.79
Other	24.84	25.56	25.10	24.30	25.24	24.79	23.18	23.69	20.87	21.13
Total treatment	71.10	70.05	67.99	62.49	64.10	65.46	60.97	61.89	57.17	60.83
<b>Power and pumping:</b>										
Supervision and labor	3.16	2.93	2.76	2.63	2.49	2.37	2.46	2.36	2.28	2.19
Power	51.12	58.70	59.26	57.38	56.59	60.81	64.85	66.12	62.72	75.96
Maintenance and other	7.72	7.53	7.57	7.28	7.15	7.45	6.83	7.92	6.87	7.55
Total power and pumping	62.00	69.16	69.59	67.29	66.23	70.63	74.14	76.40	71.87	85.69
<b>Transmission and distribution:</b>										
Supervision and labor	5.86	5.38	4.91	3.86	2.22	1.90	2.56	2.04	1.91	1.76
Maintenance	27.35	24.76	25.55	23.61	21.49	26.30	21.44	33.96	21.08	28.97
Other	17.30	17.40	17.44	17.62	17.65	15.97	16.84	13.64	19.88	17.83
Total transmission and distribution	50.51	47.54	47.90	45.09	41.36	44.17	40.84	49.64	42.87	48.56
<b>Total unit operating cost</b>	<b>262.82</b>	<b>263.28</b>	<b>251.42</b>	<b>238.15</b>	<b>238.12</b>	<b>244.90</b>	<b>248.09</b>	<b>268.10</b>	<b>247.61</b>	<b>272.00</b>