

TABLE 42. DALLAS WATER UTILITY LABOR COST ANALYSIS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total payroll (\$)*	2,039,838	2,187,844	3,126,940	3,468,600	3,936,236	4,398,157	5,148,817	5,688,610	6,102,292	6,296,936
Total hours on payroll	1,753,440	1,759,680	1,724,320	1,768,000	1,734,720	1,828,320	2,028,000	2,186,080	2,302,560	2,204,800
RPW (mil gal)	39,274	39,404	43,135	45,372	53,451	56,472	56,555	60,698	55,994	63,030
Total payroll/mil gal	51.94	71.51	72.49	76.45	73.64	77.88	91.04	93.39	108.98	99.90
Total hours/mil gal	44.65	44.66	39.97	38.97	32.45	32.38	35.86	38.02	41.12	34.98
Average cost/man-hour+	1.16	1.24	1.81	1.96	2.27	2.41	2.54	2.60	2.65	2.86

* Includes operations and maintenance payroll only.

+ Includes all water utility man-hours.

TABLE 43. DALLAS WATER UTILITY OPERATING AND CAPITAL COSTS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Operating expense	\$ 5,686,674	\$ 6,012,457	\$ 6,496,075	\$ 6,887,291	\$ 7,837,731	\$ 8,656,048	\$ 9,900,927	\$10,859,112	\$12,390,193	\$12,528,040
Depreciation	2,978,901	3,175,888	3,339,206	3,494,015	3,687,875	3,814,911	3,985,751	4,406,954	4,751,860	5,135,253
Interest	1,917,672	1,951,243	2,088,277	2,245,807	2,196,370	2,804,185	2,192,802	2,508,647	3,424,568	3,637,576
Total	10,583,253	11,139,588	11,923,558	12,627,113	13,721,976	14,555,144	16,079,480	17,774,713	20,566,621	21,300,869
Total unit cost/mil gal RPW	269.46	282.70	276.42	278.30	256.72	257.74	284.31	292.83	367.29	337.94

TABLE 44. DALLAS WATER UTILITY CAPITAL VERSUS OPERATING EXPENSE RATIOS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Operating cost (\$)	5,686,674	6,012,457	6,496,075	6,887,291	7,837,731	8,656,048	9,900,927	10,859,112	12,390,193	12,528,040
Capital cost (\$)	4,396,573	5,127,131	5,427,483	5,739,822	5,884,245	5,899,096	6,178,553	6,915,601	8,176,428	8,772,829
Total (\$)	10,583,253	11,139,568	11,923,558	12,627,113	13,721,976	14,555,144	16,079,480	17,774,713	20,566,621	21,300,869
Operating cost as % of total	53.73	53.97	54.48	54.54	57.11	59.47	61.57	61.09	60.24	58.81
Capital cost as % of total	46.27	46.03	45.52	46.46	42.89	40.53	38.43	38.91	39.76	41.19
Capital labor cost ratios	2.16	2.34	1.74	1.65	1.49	1.34	1.20	1.22	1.34	1.39

Locations of treatment plants and pump stations in the Dallas service area are shown in Figure 21. The Elm Fork and Bachman treatment plants contain seldom used, high-pressure pumps for moving water to the Lake June pump station, where all the water treated at East Side is pumped into the distribution system.

To analyze the impact of the cost of water as it moves from acquisition to treatment to the consumer, it is necessary to identify the capital and operating cost of each system component. Figure 22 is a schematic diagram of Figure 21 and shows the operating and capital cost for each of the system's major facilities. A linear assumption is made to demonstrate the accrual of costs/mil gal as water moves from one component of the system to another. For example, the acquisition cost of water going to the East Side treatment plant (Figure 21) is \$54.62/mil gal, the cost of treatment is \$78.08/mil gal, and the cost of pumping to Zone A is \$20.34/mil gal. This results in a cost of \$153.04/mil gal for water delivered to Zone A. As water passes through this zone, a transmission cost of \$41.01/mil gal is added.

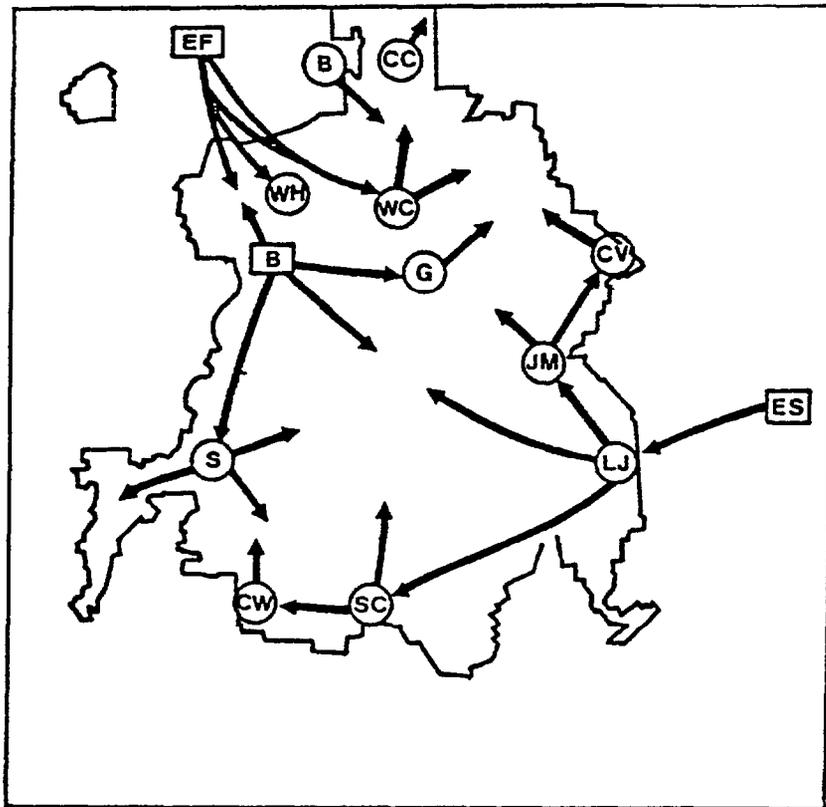
The schematic diagram shows the major water pathways as designated by 1, 2, or 3. The various cost zones are shown in column 1 of Table 45. According to the designation, for Zone 3A, the incremental cost is \$153.04. These incremental costs include distribution, interest, support services.

Calculation of the distribution cost is based on the assumption that these are constant throughout the system. Therefore, the total capital and operating cost for distribution is divided by the number of gallons of RPW in 1973, yielding the figure \$67.33/mil gal. The same approach is taken to calculate the interest and support services cost. When these costs are added, a total cost/mil gal for water delivered to a given zone results. For example, the total cost of water delivered in Zone 3A is \$361.55/mil gal. Columns 7 and 8 of the Table 45 contain the metered consumption for each zone and the estimated revenue.

Once these calculations are made and various cost zones established, costs versus charges for a given set of consumers can be examined. Table 46 summarizes rates charged by the City of Dallas for typical monthly water consumption.

Water costs for the 10 largest consumers served by the Dallas Utility are shown in Table 47. For utility bills including both water and sewer service charges, it was necessary to calculate the portion of the bill allocated directly to water.

By converting units used to mil gal and dividing the monthly water service charge by this amount, it is possible to determine the unit cost (\$/mil gal) paid by the consumer (Table 47). The actual allocated cost of delivering water to a specific consumer can be determined by comparing the location of each user with Table 45.



□ Treatment Plants	Elevation (ft above sea level)	○ Pump Stations	Elevation (ft above sea level)
EF Elm Fork	458	B Beltwood	622
B Bachman	456	CW Camp Wisdom	693
ES East Side	480	CC Cosa Crest	620
		G Greenville	609
		JM Jim Miller	521
		LJ Lake June	504
		SC Southcliff	586
		S Sunset	607
		WC Walcrest	627
		CV Casa View	562
		WH Walnut Hill	---

Figure 21. Dallas Water Utility treatment plants and pump stations (arrows depict general direction of water flow).

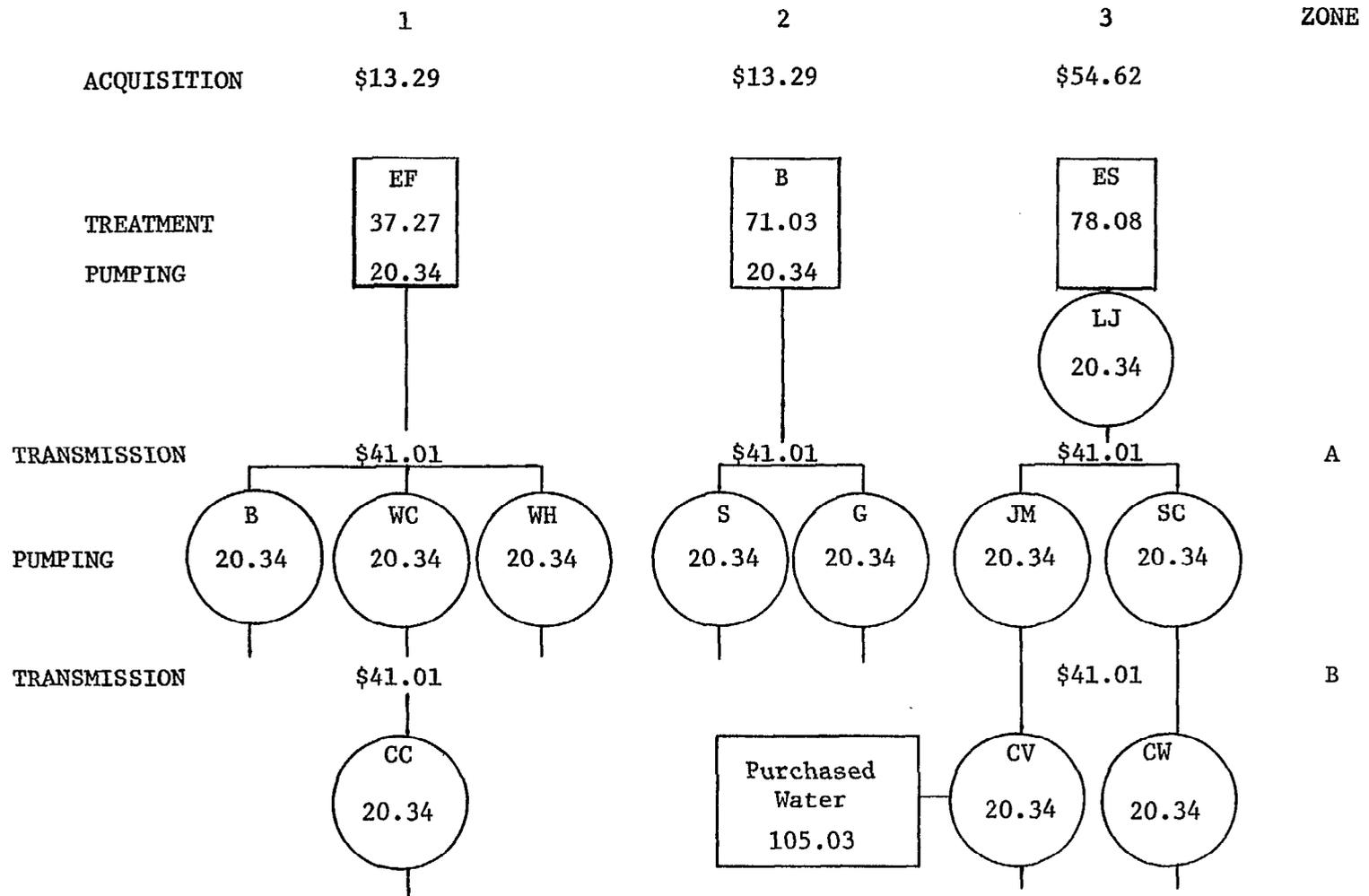


Figure 22. Dallas Water Utility allocation of capital and operating expenses to water system components (\$/mil gal RPW).

TABLE 45. DALLAS WATER UTILITY COSTS, CONSUMPTION, AND REVENUE, BY ZONE

Zone	Incremental costs (\$/mil gal)	Distribution costs (\$/mil gal)	Interest (\$/mil gal)	General services (\$/mil gal)	Total cost* (\$/mil gal)	RPW (mil gal)	Revenue
1 A	\$70.90	\$67.33	\$57.72	\$83.46	\$279.41	16,766	\$4,684,588.06
B	132.25	67.33	57.72	83.46	340.76	16,323	5,562,225.48
C	193.60	67.33					
C	193.60	67.33	57.72	83.46	402.11	223	89,670.53
2 A	104.66	67.33	57.72	83.46	313.17	7,872	2,465,274.24
B	166.01	67.33	57.72	83.46	374.52	6,854	2,566,960.08
3 A	153.04	67.33	57.72	83.46	361.55	4,212	1,522,848.60
B	214.39	67.33	57.72	83.46	422.90	6,936	2,933,234.40
C	275.74	67.33	57.72	83.46	484.25	1,287	623,299.75
CP	125.37	67.33	57.72	83.46	333.88	2,557	853,731.16
Total	---	---	---	---	---	63,030	21,301,762.30

* Average cost/zone is \$337.96/mil gal.

TABLE 46, TYPICAL MONTHLY RATES FOR THE DALLAS WATER UTILITY

Class*	Meter size (in.)	Gallons consumed	Amount billed	Unit cost (\$/mil gal)
Residential	5/8	10,000	\$6.12	\$612.00
Commercial	4	1,000,000	509.54	509.54
Industrial	---	25,000,000	5,316.00	212.64

* Multiply rates by 1.5 outside city limits.

TABLE 47. DALLAS WATER UTILITY COSTS FOR 10 MAJOR USERS

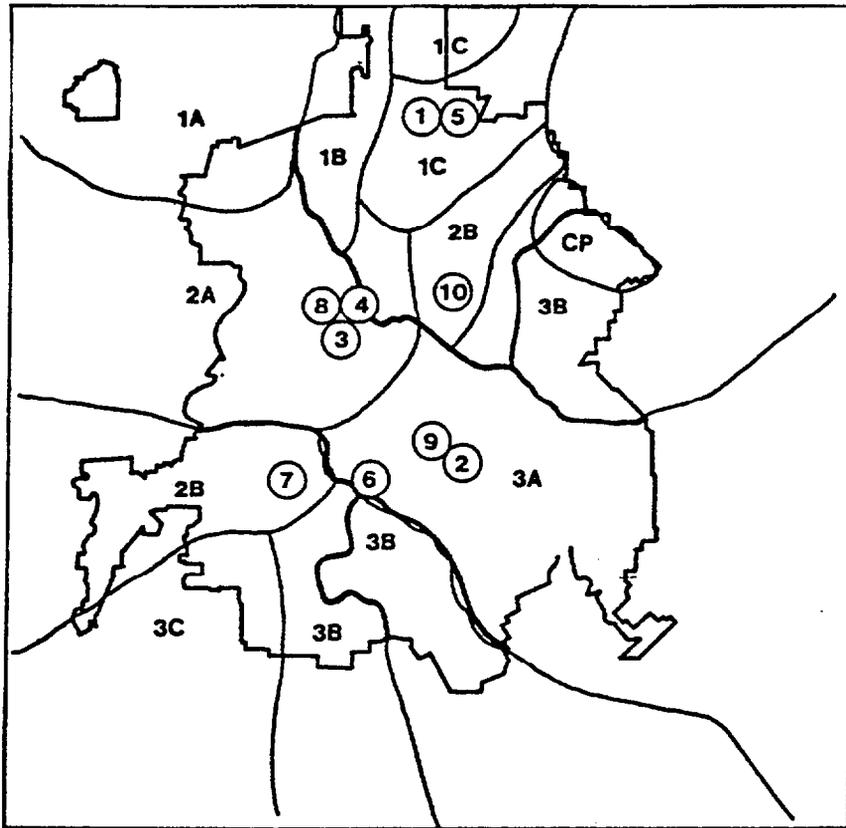
Major users	High or low month	Month	Units used (mil gal)	Amount allocated to water*	Unit charge (\$/mil gal)	Cost zone
Texas Instruments	High	9	103.5	\$18,487.62	\$178.56	1B
	Low	1	78.0	13,932.94	178.44	
Procter and Gamble	High	9	27.5	7,717.08	280.54	3A
	Low	10	19.0	5,385.77	284.09	
Standard Brands	High	8	20.5	3,627.54	177.30	2A
	Low	4	14.3	3,675.77	257.05	
Texas Instruments	High	8	21.3	6,036.12	282.80	2A
	Low	2	9.3	2,763.96	295.80	
Texas Instruments	High	11	12.3	2,177.15	177.00	1B
	Low	1	7.5	1,304.57	173.94	
Clevepak Corp.	High	9	---	---	---	3A
	Low	11	13.8	1,984.13	143.77	
Stokely Van Camp	High	8	10.0	2,435.82	243.82	2B
	Low	11	10.0	1,755.25	175.70	
Morton Foods	High	9	7.5	3,150.98	422.38	2A
	Low	1	3.6	603.12	169.89	
Diamond Shamrock	High	7	5.2	1,624.82	314.52	3A
	Low	10	2.7	1,021.39	373.88	
Dr. Pepper Co.	High	9	8.1	1,425.00	174.91	2B
	Low	3	5.5	1,390.57	254.68	

* Denotes portion of combined water and sewer bill allocated directly to water.

Locations of the major users by cost zone are shown in Figure 23. The majority of these consumers are located along the central low area of the distribution system and are served directly from the treatment facilities. Some users, such as two of the Texas Instruments plants (1 and 3 on Figure 23), are located a considerable distance from the treatment plants and require significant transportation of water. Table 48 shows the costs associated with water delivery by cost zone and the amount actually paid by the consumer.

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

	<u>\$/mil gal</u>
Support services-----	83
Acquisition-----	25
Treatment-----	52
Distribution-----	120
Interest-----	58
Total-----	338



<u>Identification Number</u>	<u>Major Users</u>	<u>Supply Area</u>
1	Texas Instruments	1B
2	Procter and Gamble	3A
3	Standard Brands	2A
4	Texas Instruments	2A
5	Texas Instruments	1B
6	Clevepak Corporation	3A
7	Stokely Van Camp	2B
8	Morton Foods	2A
9	Diamond Shamrock	3A
10	Dr. Pepper Co.	2B

Figure 23. Dallas Water Utility cost zones and location of major users.

TABLE 48. DALLAS WATER UTILITY'S COSTS AND REVENUES FOR MAJOR USERS

Major users	Amount paid for high and low use month (1973) (\$/mil gal)	Estimated delivery cost (\$/mil gal)
Texas Instruments	\$178.56 178.44	\$340.76
Procter and Gamble	280.54 284.09	361.55
Standard Brands	177.30 257.05	313.17
Texas Instruments	282.80 295.80	313.17
Texas Instruments	291.45 43.69	340.76
Clevepak Corporation	--- 143.77	361.55
Stokely Van Camp	243.82 175.70	374.52
Morton Foods	422.38 169.89	313.17
Diamond Shamrock	314.52 373.88	361.55
Dr. Pepper Co.	174.91 254.68	374.52

SECTION 8

SAN DIEGO WATER UTILITY

The City of San Diego is located in San Diego County, which makes up the San Diego SMSA. The retail service area is made up of the City of San Diego (except for the South Bay area) and a small number of retail customers in San Diego County. The San Diego County Water Authority purchases raw water from the Metropolitan Water District of Southern California at a price that covers the operating costs of the County Water Authority and the Metropolitan Water District. The San Diego Water Utility makes in-lieu-of-tax payments to the Metropolitan Water District and the San Diego County Authority to cover the capital cost of the aqueducts. System facts are included in Table 49.

SERVICE AREA

The San Diego Water Utility provides water service on a retail basis to all classes of customers within the San Diego city limits. Treated water is also supplied to the California-American Water Company, the City of Del Mar, and miscellaneous users outside the city. The California-American Water Company in turn supplies retail customers within the South Bay area of the city.

In 1974, the San Diego Water utility sold 3025.6 mil gal to the California-American Water Company, 306.8 mil gal to Del Mar, and 64.2 mil gal to miscellaneous users outside the city; in addition, 49,039.8 mil gal were delivered to the City of San Diego. The service area is shown in Figure 24.

ORGANIZATION

The organizational structure of the San Diego Water Utility is illustrated in Figure 25. Included in the Service Division's functions are design engineering, customer service, and administrative support. The Systems Division is responsible for installation and maintenance of hydrants, man-holes, valves, and mains. It is also responsible for hydraulic control, emergency services, systems engineering, utility plant checking, maps and records, meters, services and laterals, sewer main cleaning, and hydrology. The Water Quality Division is responsible for water supply, water treatment, wastewater collection and treatment, and the operation of the laboratory.

The water and wastewater functions of the San Diego Water Utility are combined at the division level, although separate accounts are maintained

TABLE 49. SAN DIEGO WATER UTILITY, BASIC FACTS (1974)

Item	Amount
Population:	
SMSA	1,562,100
County	1,562,100
Retail service area	761,916
Area of retail service area (sq miles)	Not available
Recognized customer classes:	
Single family domestic	139,378
Other domestic	24,953
Commercial	6,325
Industrial	234
Combined irrigation and domestic	42
Outside city services	60
Other utilities	5
Fire service	913
Flat rate (no. accounts)	135
Percent metered	100
Purchased water (raw, acre ft)	125,019.8
Source water	100% surface impoundments
Pipe in system (miles)	1,968
Elevation of treatment plants (ft above mean sea level):	
Alvarado	536
Otay	521
Miramar	715
Elevation of service area (min-max ft)	10/1020
Revenue-producing water (mil gal)	47,205
Treated water (flow from treatment plants, mil gal)	52,436
Maximum day/maximum hour (MGD)	212.61/N.A.

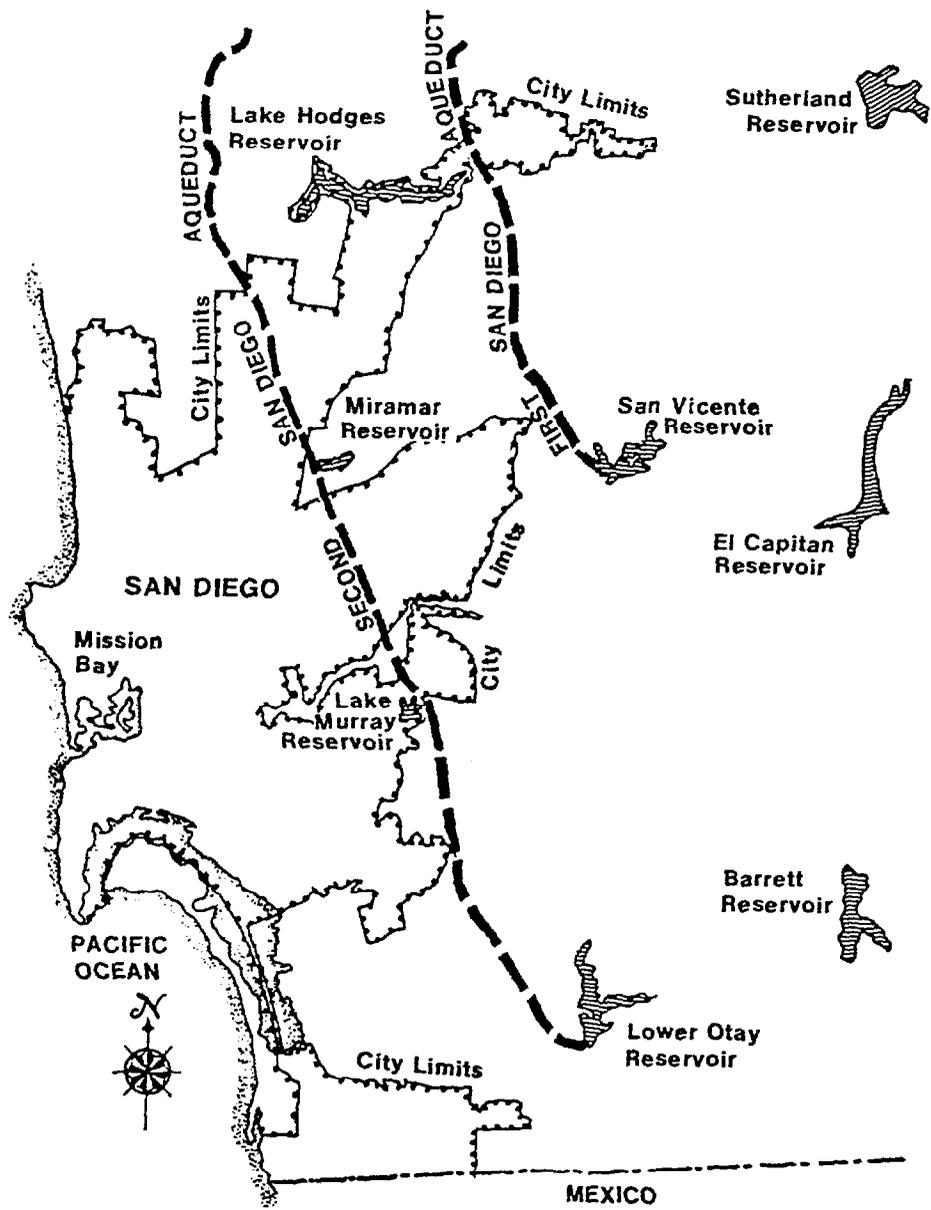


Figure 24. San Diego Water Utility reservoir system and service area.

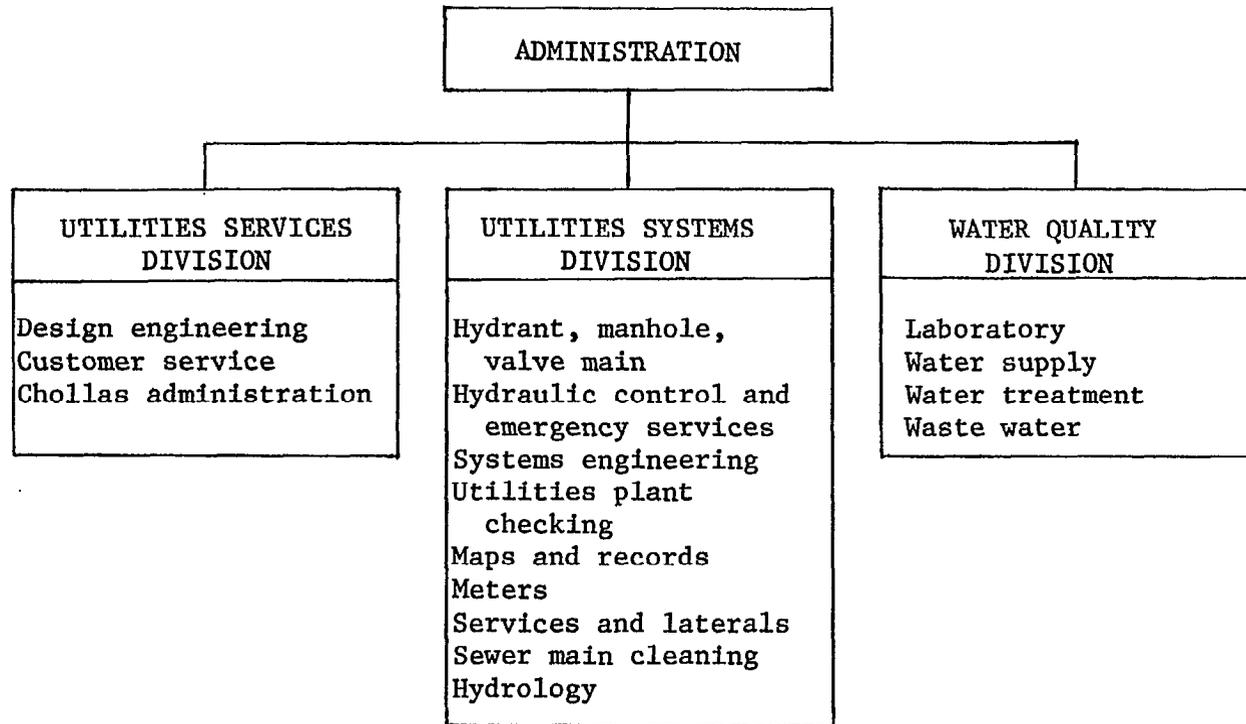


Figure 25. San Diego Water Utility organizational chart.

for water and sewer revenues and expenses. All bonds are clearly defined as either water or sewer bonds.

ACQUISITION

There are no permanent streams or natural lakes anywhere in the San Diego area, nor are there any extensive groundwater sources. For this reason, San Diego has developed a system of impounding reservoirs (Figure 24) divided into three geographical districts. Each series of watersheds or drainage basins extends from the summit of the mountains to the lowest dam. Parallel to the Mexican Border is the Cottonwood-Otay District, which includes Morena and Barrett reservoirs on the Cottonwood River, and the Dulgura Conduit and Upper and Lower Otay reservoirs on the Otay River.

To the north of the Cottonwood-Otay District lies the San Diego River, the largest river system in the county in terms of runoff. This watershed contains the Cuyomaca reservoir (which is owned by the Helix Irrigation District) and El Capitan and San Vicente reservoirs (owned by the City of San Diego). The San Dieguito River District, which includes Sutherland and Hodges reservoirs, is north of the Helix Irrigation District.

These reservoirs provide storage for local runoff and for imported water that flows down from the north through the two San Diego aqueducts. In 1974, 89.4% of the water used by the San Diego Water Utility was imported from the Colorado River. This percentage will drop as water is imported from the Feather River project in Northern California.

TREATMENT

Raw water treatment is accomplished by three treatment plants: the Alvarado plant, located at the Murray reservoir; the Miramar plant, located at Miramar reservoir; and the Otay plant, located at the Otay reservoir. The plants have a combined capacity of 66, 40, and 15 MGD, respectively.

The Alvarado treatment plant filters water that originates in the San Diego River system, including water originating from the El Capitan, San Vicente, and Murray reservoirs, and Colorado River water stored in the San Vicente and El Capitan reservoirs. Water from the San Diego aqueduct can also be processed at this plant.

The Miramar plant serves the northern section of the city and filters water transported from the Colorado River through the facilities of the Metropolitan Water District of Southern California and the San Diego County Water Authority. Miramar reservoir serves as a supplemental source of supply or in the event of an aqueduct failure.

The Otay plant serves the South Bay area of the city and treats water from the Cottonwood-Otay system and from the second San Diego aqueduct. Water from Morena and Barrett reservoirs is transferred to Otay when available and is treated after being pumped from the Otay reservoir.

The Alvarado, Miramar, and Otay treatment plants are similar in design, with separate mixing and settling basins with rapid sand filters. The Otay treatment plant combines the steps of mixing, coagulation, and sedimentation in one single basin and has pressure filters. Figure 26 is a flow diagram of the Alvarado plant.

TRANSMISSION AND DISTRIBUTION

The three treatment plants are located between 521 and 715 ft above sea level; however, most of the customers are located below these elevations and are supplied by gravity from the treatment plants. Pressure-reducing valves are required on trunk mains. The highest point in the distribution area is 1,020 ft above sea level. The higher elevations scattered throughout the distribution area are supplied through small pumping plants. Most of these areas are also equipped with elevated storage tanks or standpipes for the purpose of leveling out demand. There are currently 145 pressure-reducing stations, 33 pumping stations, 23 elevated storage tanks, and 74 pressure zones in the San Diego system.

The distribution storage reservoirs are built at strategic locations, allowing the filtration plants to be operated at a fairly constant rate. During periods of peak demand, the water flows back out of the reservoirs and augments the filtration plants. The system now has 20 covered storage reservoirs with a total capacity of 159.37 mil gal.

The standpipes and elevated storage tanks within the San Diego system serve a dual purpose--leveling out the demand on the pumping plants and maintaining adequate delivery pressures within the higher elevations of the distribution area. At present, there are 10 standpipes with a total storage capacity of 13.28 mil gal and 11 tanks with a total capacity of 3.05 mil gal in the San Diego system. Table 50 is a summary sheet of the facilities making up the storage system.

COST ANALYSIS

Figure 27 illustrates the steady growth in the production of water from 1965 through 1974, The cost analysis for each utility is based on RPW. Unit costs have been calculated by dividing cost for a given functional area by the amount of RPW supplied.

Tables 51, 52, and 53 contain the costs for treatment, acquisition, transmission and distribution, power and pumping, and support services, The "other" category under support services includes expenses of other city departments that relate to the water utility, contributions to the retirement fund, compensation insurance, other insurance and damage claims, uncollectable accounts, engineering, taxes, and general expenses.

Table 54 is an analysis of labor costs for San Diego and shows that although the unit cost of water based on labor input is rising, the number of manhours required to produce a million gallons is decreasing.. Table 55 shows

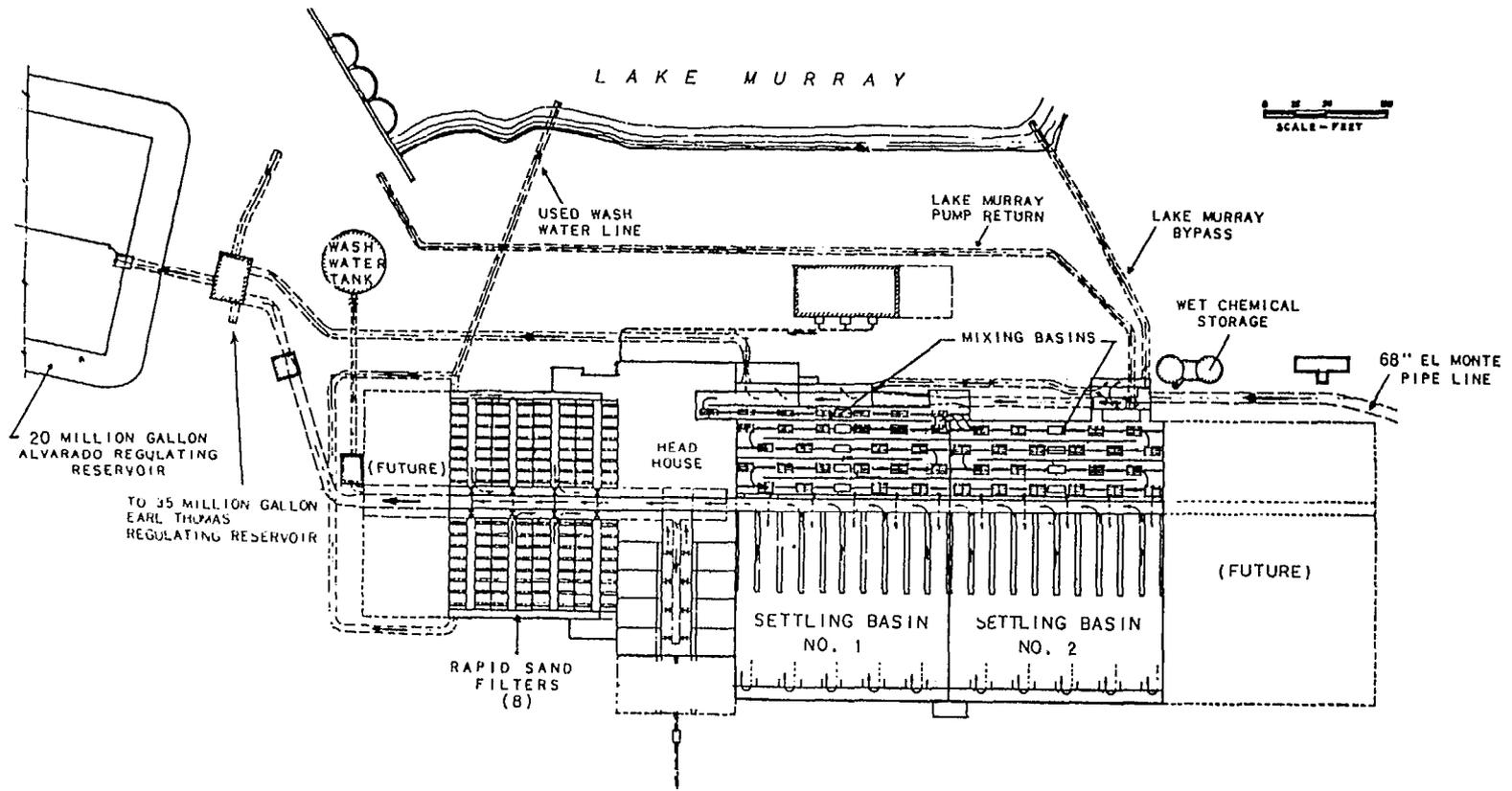


Figure 26. Flow diagram of the Alvarado filtration plant (Water Utilities Department, City of San Diego).

TABLE 50. SAN DIEGO WATER UTILITY STORAGE FACILITIES

Facility	Capacity (mil gal)	Facility	Capacity (mil gal)
Reservoirs (covered):		Standpipes:	
Alvarado	20.2	Camp Callan	2.0
Bayview	10.0	Catalina	1.5
Brown Field	1.0	Chesterton	0.99
Del Cerro	1.5	College Ranch	1.5
Earl Thomas	35.0	Emerald Hills	1.5
La Jolla CC Hts	0.5	Encanto	0.75
La Jolla Exchange	.99	Kearney Mesa	1.52
La Jolla View	.72	Lomita Village	0.77
Miramar Reg	20.0	Paradise Hills	0.75
Pacific Beach	2.4	Redwood Village	2.0
Point Loma	10.06		
Pomerado Park	5.2	Tanks:	
Penasquitos	5.0	Alvarado Wash	0.792
Rancho Bernardo	10.1	Brown Field	---
San Carlos	5.0	Climax	0.002
San Ysidro	1.2	College Hts.	0.50
Soledad	1.5	College Ranch	---
South San Diego	15.0	La Jolla CC	0.003
Torrey Pines	2.8	Miramar Wash	0.50
University Hts.	11.2	Paradise Hills #2	.003
		Point Loma Sewage	.050
		San Carlos	.002
		University Hts.	1.200

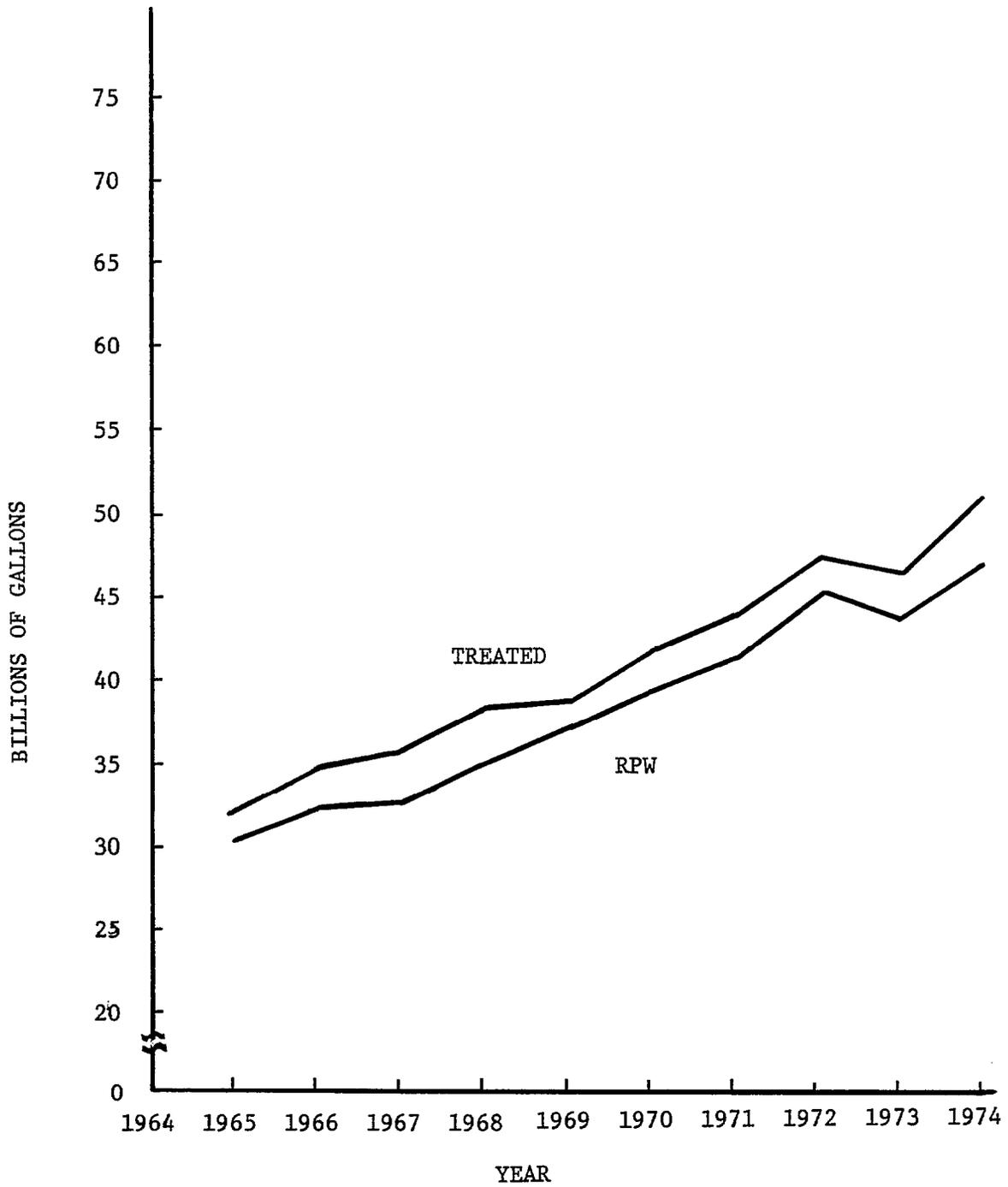


Figure 27. San Diego Water Utility water flow: treated water versus RPW.

TABLE 51. SAN DIEGO WATER UTILITY ANNUAL OPERATING COSTS

Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Support services:										
Administration	\$ 367,863	\$ 325,079	\$ 384,750	\$ 418,357	\$ 463,869	\$ 207,538	\$ 224,967	\$ 229,958	\$ 238,638	\$ 251,425
Accounting and collection	370,697	426,691	511,013	515,851	700,219	729,688	710,393	736,689	891,761	1,016,043
Other	918,736	959,086	1,077,771	1,277,882	1,510,889	1,829,757	2,150,856	2,321,519	2,730,463	3,151,995
Total support services	1,657,296	1,710,856	1,973,534	2,212,090	2,674,977	2,766,983	3,086,216	3,288,166	3,860,862	4,419,463
Acquisition:										
In lieu of taxes and payments	1,728,586	1,876,458	1,810,262	1,860,094	3,248,161	3,723,339	4,119,568	4,851,837	5,063,372	5,335,690
Purchase of water	2,883,918	2,609,532	2,940,944	3,578,306	4,468,675	4,361,873	4,996,429	7,164,875	8,793,815	7,026,638
Impounding/transmission	491,060	481,999	387,537	416,087	496,109	556,099	535,124	595,165	566,241	567,396
Other	138,905	172,797	234,227	130,223	-	-	-	-	-	-
Total acquisition	5,242,469	5,140,786	5,372,970	5,984,710	8,212,945	8,641,311	9,651,121	12,611,877	14,423,428	12,929,724
Treatment:	533,115	519,532	492,548	539,065	641,455	725,262	747,559	806,348	913,471	1,055,868
Power and pumping:										
Pumping	137,201	150,444	161,308	154,143	156,045	176,233	182,055	230,279	247,521	286,130
Other	20,367	20,499	25,034	22,802	24,310	35,738	49,520	50,961	52,312	59,646
Total power and pumping	157,568	170,943	186,342	176,945	180,355	211,970	231,575	281,240	299,833	345,776
Transmission and distribution:										
Mains	735,668	722,331	780,076	823,365	839,388	831,956	750,927	845,835	872,818	829,755
Services	263,070	296,901	254,223	242,644	303,581	246,315	284,585	307,020	341,075	347,245
Meters	530,141	451,292	403,633	535,480	496,501	410,400	486,078	582,627	608,068	671,878
Reservoirs and tanks	58,052	91,288	93,937	95,440	87,062	85,205	81,787	96,143	104,865	100,143
Other	280,117	249,610	286,003	298,567	323,098	409,434	617,586	535,013	530,370	528,999
Total transmission & distribution	1,867,048	1,811,422	1,817,872	1,995,496	2,049,630	1,983,310	2,220,963	2,366,638	2,457,196	2,478,020
Total operating cost	9,457,496	9,353,539	9,843,266	10,908,306	13,759,362	14,328,836	15,937,434	19,354,269	21,954,790	21,228,851

TABLE 52. SAN DIEGO WATER UTILITY OPERATING COSTS/(\$/MIL GAL RPW)

Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Support services:										
Administration	12.11	10.01	11.72	11.92	12.43	5.20	5.37	5.06	5.45	5.33
Accounting and collection	12.20	13.14	15.56	14.70	18.76	18.30	16.96	16.20	20.38	21.52
Other	30.25	29.54	32.82	36.42	40.47	45.89	51.34	51.04	62.39	66.77
Total support services	54.56	52.69	60.09	63.05	71.66	69.39	73.67	72.29	88.22	93.62
Acquisition:										
In lieu of taxes and payments	56.91	57.79	55.12	53.02	87.01	93.38	98.33	106.67	115.70	113.03
Purchase of water	94.95	80.37	89.55	101.99	119.71	109.39	119.26	157.53	200.94	148.85
Impounding/transmission	16.17	14.85	11.80	11.86	13.29	13.95	12.77	13.09	12.94	12.02
Other	4.57	5.32	7.13	3.71	-	-	-	-	-	-
Total acquisition	172.60	158.33	163.60	170.57	220.01	216.72	230.37	277.28	329.57	273.91
Treatment:	17.55	16.00	15.00	15.36	17.18	18.19	17.84	17.73	20.87	22.37
Power and pumping:										
Pumping	4.52	4.63	4.91	4.39	4.18	4.42	4.35	5.06	5.66	6.06
Other	0.67	0.63	0.76	0.65	0.65	0.90	1.18	1.12	1.20	1.26
Total power and pumping	5.19	5.26	5.67	5.04	4.83	5.32	5.53	6.18	6.85	7.32
Transmission and distribution:										
Mains	24.22	22.25	23.75	23.47	22.49	20.86	17.92	18.60	19.94	17.58
Services	8.66	9.14	7.74	6.92	8.13	6.18	6.79	6.75	7.79	7.36
Meters	17.45	13.90	12.29	15.26	13.30	10.29	11.60	12.81	13.89	14.23
Reservoirs and tanks	1.91	2.81	2.83	2.72	2.33	2.14	1.95	2.11	2.40	2.12
Other	9.22	7.69	8.71	8.51	8.66	10.27	14.74	11.76	12.12	11.21
Total transmission and distribution	61.47	55.79	55.35	56.87	54.91	49.74	53.01	52.03	56.15	52.49
Total operating cost	311.38	288.08	299.72	310.89	368.59	359.35	380.42	425.51	501.66	449.72

The above figures are not additive. They are obtained by dividing yearly mil gal RPW into the annual costs shown in the preceding Table.

TABLE 53. SAN DIEGO WATER UTILITY OPERATING COST CATEGORIES AS A PERCENT OF TOTAL OPERATING COST

Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Support services:										
Administration	3.89	3.48	3.91	3.84	3.37	1.45	1.41	1.19	1.09	1.18
Accounting and collection	3.91	4.56	5.19	4.73	5.09	5.09	4.46	3.81	4.06	4.79
Other	9.72	10.25	10.95	11.71	10.98	12.77	13.50	11.99	12.43	14.85
Total support services	17.52	18.29	20.05	20.28	19.44	19.31	19.36	16.99	17.58	20.82
Acquisition:										
In lieu of taxes and payments	18.27	20.06	18.39	17.05	23.61	25.98	25.85	25.07	23.06	25.13
Purchase of water	30.50	27.90	29.88	32.80	32.48	30.44	31.35	37.02	40.05	33.10
Impounding/transmission	5.19	5.15	3.94	3.81	3.61	3.88	3.36	3.08	2.58	2.67
Other	1.47	1.85	2.38	1.19	-	-	-	-	-	-
Total acquisition	55.43	54.96	54.59	54.86	59.69	60.31	60.56	65.16	65.70	60.91
Treatment:										
	5.64	5.55	5.00	4.94	4.66	5.06	4.69	4.17	4.16	4.97
Power and pumping:										
Pumping	1.45	1.61	1.64	1.41	1.13	1.23	1.14	1.19	1.13	1.35
Other	0.22	0.22	0.25	0.21	0.18	0.25	0.31	0.26	0.24	0.28
Total power and pumping	1.67	1.83	1.89	1.62	1.31	1.48	1.45	1.45	1.37	1.63
Transmission and distribution:										
Mains	7.78	7.72	7.92	7.55	6.10	5.81	4.71	4.37	3.98	3.91
Services	2.78	3.17	2.58	2.23	2.21	1.72	1.79	1.59	1.55	1.64
Meters	5.61	4.82	4.10	4.91	3.61	2.86	3.05	3.01	2.77	3.16
Reservoirs and tanks	0.61	0.98	0.95	0.87	0.63	0.59	0.51	0.50	0.48	0.47
Other	2.96	2.67	2.91	2.74	2.35	2.86	3.88	2.76	2.42	2.49
Total transmission and distribution	19.74	19.37	18.47	18.30	14.90	13.84	13.94	12.23	11.19	11.67
Total operating cost	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

TABLE 54. SAN DIEGO WATER UTILITY LABOR COST ANALYSIS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total payroll (\$)*	2,553,524	2,525,456	2,657,682	2,945,243	3,715,028	3,868,786	4,303,107	5,225,653	6,010,371	6,323,384
Total hours on payroll †	841,781.3	867,973.0*	844,954.9*	821,936.7	1,050,737.8	1,045,416.0	1,046,527.4	1,057,132.7	1,051,336.9	1,045,541.0
RPW (mil gal)	30,373	32,468	32,842	35,086	37,330	39,874	41,894	45,484	43,764	47,205
Total payroll/mil gal RPW	87.07	77.78	80.92	83.94	99.52	97.03	102.71	114.89	137.34	133.96
Total hours/mil gal RPW	27.71	26.73	19.95	23.43	28.15	26.22	24.98	23.24	24.02	22.15
Average cost/man-hour (\$) †	3.03	2.91	3.15	3.58	3.54	3.70	4.11	4.94	5.72	6.05

* Includes operation and maintenance payroll only.

† Includes all water utility man-hours.

TABLE 55. SAN DIEGO WATER UTILITY CAPITAL AND OPERATING COSTS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Operating expenses	\$ 9,457,496	\$ 9,353,539	\$ 8,843,266	\$10,908,306	\$13,759,362	\$14,328,836	\$15,937,434	\$19,354,269	\$21,954,790	\$21,228,851
Depreciation	2,572,669	2,496,354	2,526,851	2,676,098	2,627,145	2,811,573	2,532,092	2,768,889	2,578,850	2,778,632
Interest	664,684	621,896	580,202	539,381	498,747	459,194	421,966	385,204	350,645	317,516
Total	12,694,849	12,471,789	12,950,319	14,123,785	16,885,254	17,599,603	18,891,492	22,508,362	24,884,285	24,324,999
Total unit cost/ mil gal RPW	417.96	384.13	394.32	402.55	452.32	441.38	450.94	494.86	568.60	515.31

operating and capital cost expenditures, and Table 56 gives the percent of operating and capital cost as a function of total cost.

SYSTEM COSTS

The cost of each functional component of the San Diego Water Utility can be reaggregated and allocated against the physical components of the water delivery system. The arrows in Figure 28 show the direction of the flow of water from the treatment plants through booster pumping stations and pressure regulators to the 74 service areas across the city.

Operation and depreciation costs for each component of the system are shown in Figure 29. Total delivery costs of water to specific points within the distribution area are given in Table 57.

Table 58 establishes the monthly unit cost for water consumption in San Diego based on meter size and typical consumption rates. Most domestic, commercial, and industrial customers are billed bimonthly, although 5,000 customers are billed monthly.

Table 59 shows the six major customers of the San Diego Water Utility together with their high and low water use, the number of million gallons used during that time, and the amount they were billed for the service. These same users (Figure 30) are all located on the shores of San Diego Bay with the exception of the Torrey Pines Golf Course. The cost zones established for the San Diego Utility are also shown in Figure 30.

Table 60 compares the costs associated with delivery of water to the consumer versus the costs actually paid.

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

	<u>\$/mil gal</u>
Support services-----	96
Acquisition-----	277
Treatment-----	28
Distribution-----	106
Interest-----	7
Total-----	514

TABLE 56. SAN DIEGO WATER UTILITY CAPITAL VERSUS OPERATING EXPENSE RATIOS

Item	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Operating cost (\$)	9,457,496	9,353,539	9,843,266	10,908,306	13,759,362	14,328,836	15,937,434	19,354,269	21,954,790	21,228,851
Capital cost (\$)	3,237,353	3,118,250	3,107,053	3,215,479	3,125,892	3,270,767	2,954,058	3,154,093	2,929,495	3,096,148
Total cost (\$)	12,694,849	12,471,789	12,950,319	14,123,785	16,885,254	17,599,603	18,891,492	22,508,362	24,834,285	24,324,999
Operating cost as % of total	74.50	75.00	76.01	77.23	81.49	81.42	84.36	85.99	88.23	87.27
Capital cost as % of total	25.50	25.00	32.99	22.77	18.51	18.58	15.64	14.01	11.77	12.73

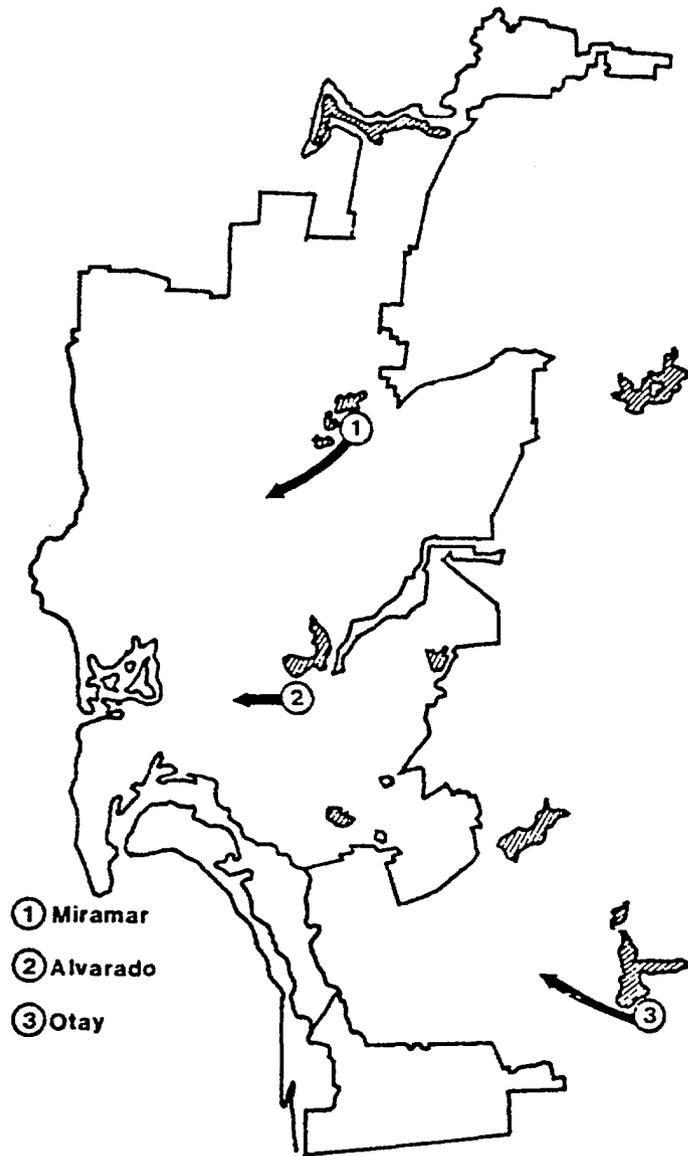


Figure 28. San Diego Water Utility facilities (arrows indicate general direction of water flow).

RESERVOIRS

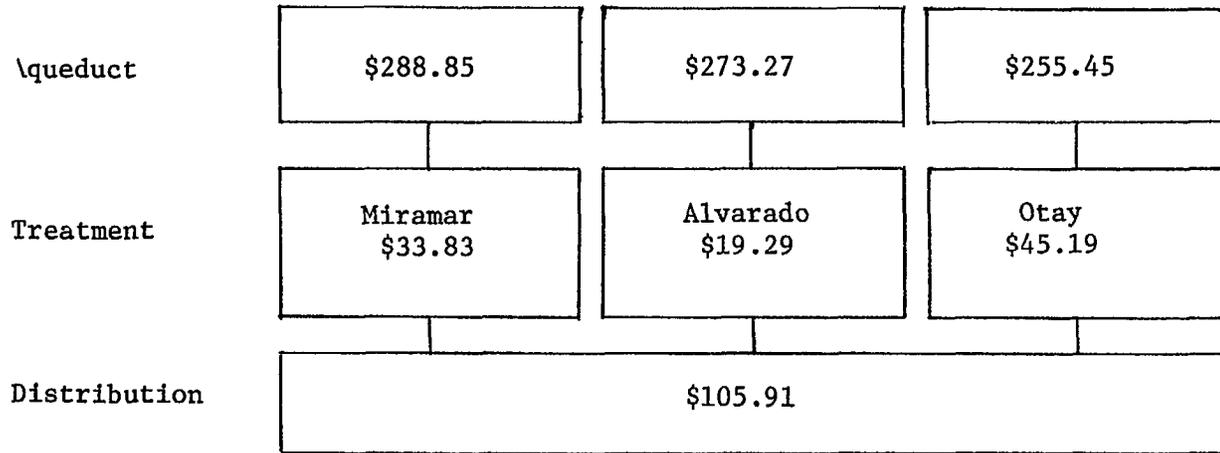


Figure 29. San Diego Water Utility capital and operating costs allocated to water system components (\$/mil gal RPW).

TABLE 57. COST ELEMENTS FOR SAN DIEGO SERVICE ZONES

Pathway No.	Incremental cost (\$/mil gal)	Distribution cost (\$/mil gal)	Interest (\$/mil gal)	Overhead (\$/mil gal)	Total cost (\$/mil gal)	RPW (mil gal)	Revenue
1	322.68	105.91	6.73	95.67	530.99	17,013	\$9,033,732.87
2	292.56	105.91	6.73	95.67	500.87	24,802	12,422,577.74
3	300.64	105.91	6.73	95.67	508.95	5,377	2,736,624.15
Total	---	---	---	---	---	47,192	24,192,934.76

TABLE 58. TYPICAL MONTHLY RATES FOR SAN DIEGO WATER UTILITIES

Class	Meter size (in.)	Gallons consumed	Amount billed	Unit cost (\$/mil gal)
Residential	5/8	10,000	\$3.91	\$391.00
Commercial	4	1,000,000	490.32	490.32
Industrial	10	25,000,000	10,158.05	406.32

TABLE 59. SAN DIEGO WATER UTILITY WATER COSTS FOR 6 MAJOR USERS

Major user	High or low month	Month	Units used (mil gal)	Amount billed	Unit charge (\$/mil gal)	Cost zone
Kelco Co.	High	Aug.	16.3	\$6,583	\$404.36	C
	Low	Dec.	7.5	3,134	420.67	
Navy Training	High	Dec.	25.0	10,376	414.37	B/C
	Low	Jan.	5.0	2,542	511.46	
USMC	High	Sept.	46.5	18,743	403.36	C
	Low	Aug.	18.4	7,765	423.16	
Convair	High	June	7.1	2,995	422.42	B
	Low	Dec.	3.3	1,524	459.03	
Solar Aircraft	High	June	15.2	6,167	405.19	B
	Low	July	6.8	2,890	423.75	
Torrey Pines	High	July	11.6	4,959	429.35	A
	Low	Jan.	1.2	923	762.80	

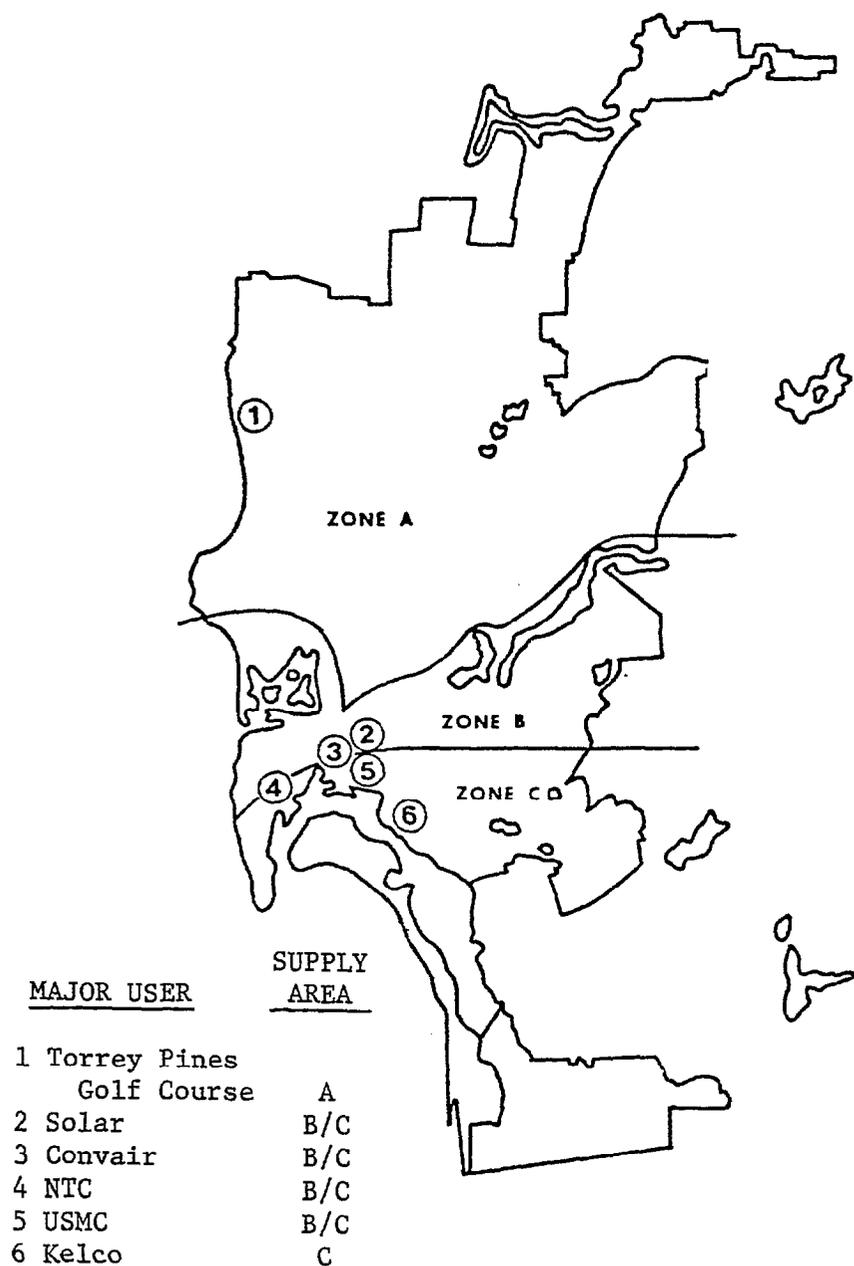


Figure 30. San Diego Water Utility major users and cost zones.

TABLE 60. COSTS AND REVENUES FOR THE SAN DIEGO WATER UTILITY'S 6 MAJOR USERS

Major user	Revenue collected (\$/mil gal)	Delivery cost (\$/mil gal)
Kelco Co.	\$404.36	\$515.86
	420.67	
Navy Training	414.37	505.21
	511.46	
USMC	403.36	505.21
	423.16	
Convair	422.42	505.21
	459.03	
Solar Aircraft	405.19	503.21
	423.75	
Torrey Pines	429.35	574.11
	762.80	

SECTION 9

NEW HAVEN WATER COMPANY

The New Haven Water Company provides water to the City of New Haven, Connecticut, and surrounding communities. The 1973 population served by the water company was 371,144. Ninety-five percent of the customers are metered. Over a 10-year period, there was an approximate 16% increase in water consumption, partly because of the acquisition of the Milford Water Company in 1966. Some systems facts are shown in Table 61.

The New Haven Water Company is an investor-owned utility and as such has some different characteristics from the majority of the utilities in this report, which are operated by counties or municipalities. One basic difference is that this utility incurs a liability for real estate and other taxes not incurred by publicly owned utilities.

WATER SUPPLY SERVICE AREA

The New Haven Water Company provides water on a retail basis to all classes of customers within the service area shown in Figure 31. Treated water is supplied to all or part of 12 towns. The major town in the service area is New Haven. As noted above, population and water consumption increased slightly over the 10-year period; but since 1966, water consumption has remained relatively stable.

ORGANIZATION

Although the utility does run a small forestry operation in the watershed, it operates as a system for the purpose of supplying water only and is not associated with any other organization. The water company is headed by a 12-member board of directors and is operated by the president who is a member of the board.

Four divisions report to the president (Figure 32): one is responsible for the engineering effort, one for the accounting and collection, one for all administration, and one for the operations of the system, including maintenance and meter reading.

ACQUISITION

Raw water comes from a series of reservoirs and wells. Approximately 5% of the total water is from the wells. Most of the reservoirs are located

TABLE 61. NEW RAVEN WATER COMPANY, BASIC FACTS.

Item	Amount
Population:	
SMSA	N.A.
county	N.A.
Retail Service Area	371,144
Area of retail service area (square miles)	316
Number of metered customers	84,167
Percent metered	95.4
Flat rate customers	4,104
Purchased water	None
Source water:	
Percent surface	95.6
Percent wells	4.4
Miles of Pipe in system	1,266
Elevation of treatment plant (ft above mean sea level):	
Whitney	30
Saltonstall	50
Elevation of service area (ft above mean sea level) min - max	0 - 525
Revenue-producing water (mil gal)	17,714
Treated Water (mil gal pumpage from treatment plants)	20,300
Max day/max hour - July 4, 1974 (MGD)	78.8/98.52

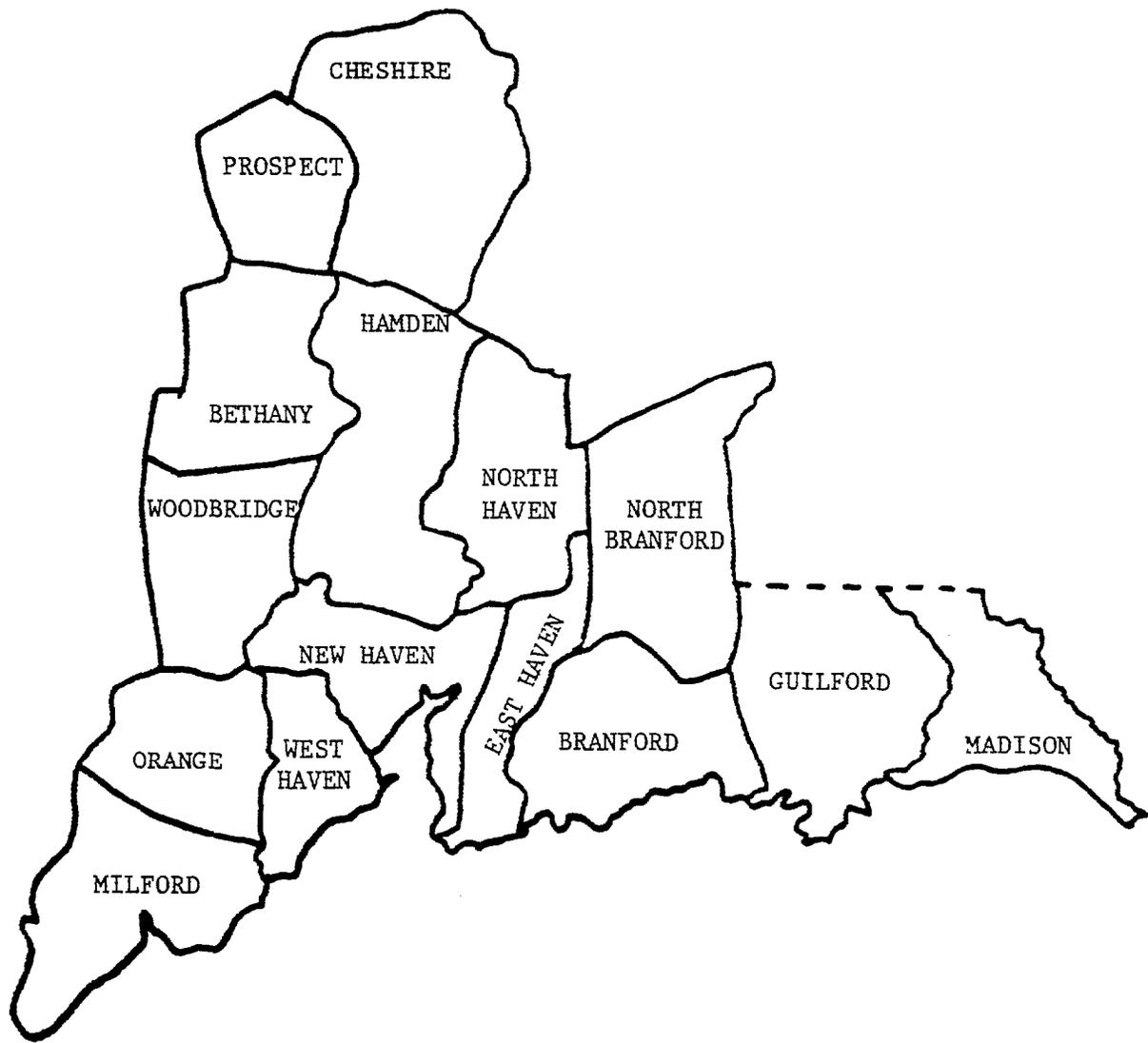


Figure 31. New Haven Water Company service area.

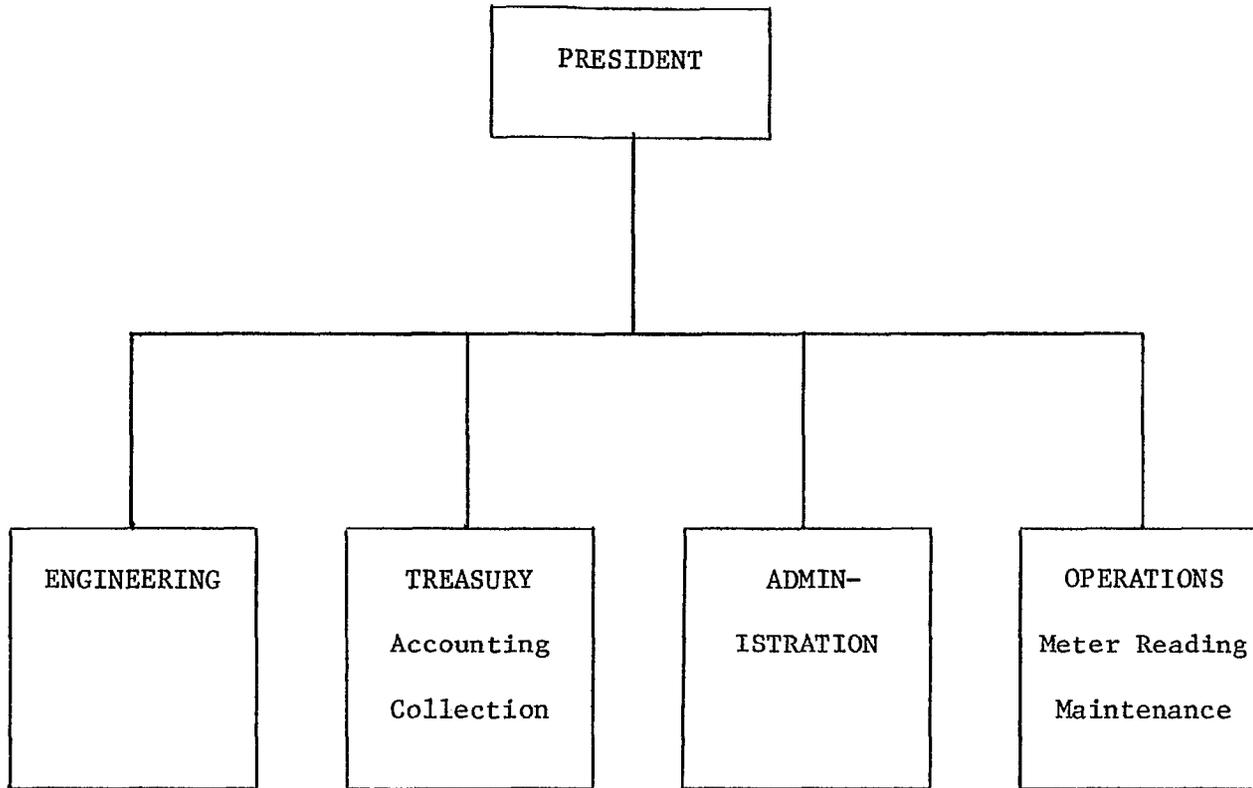


Figure 32. New Haven Water Company organizational chart.

within the service area, and others are located in townships to the east of the service area.

The company owns 26,000 acres of land located in 17 communities in Connecticut. Most of this land is associated with the reservoirs. All reservoirs are surrounded by a greenbelt and are fenced to control access. Rather than invest their money in treatment operations, the water company chose to invest in developing a quality water acquisition system that would require less treatment. Restoration of the area is a continuing vital part of the land operations, and this involves obtaining some lumber from the area around the reservoirs. Most of the logging, however, is a result of the trees becoming diseased. Revenues received from the operation help to lower the water rates charged to consumers.

Nine major intake facilities associated with the reservoir system and three intake facilities associated with well fields are geographically distributed over the service area, thus minimizing the transmission of potable water within the system.

The large land holdings result in sizable real estate property taxes. The company indicated it is considering the sale of some 16,500 acres not necessary to the water utility. The reason for this is that natural land filtration will no longer be adequate to provide water that meets the new and more stringent State and Federal water standards. Because water will have to be treated by filtration and other processes, the large holdings around the reservoirs are less desirable.

TREATMENT

As indicated, the company provides high quality source water naturally filtered. Chlorine is added as disinfectant at the various reservoir intakes and wells scattered throughout the system. Two small filter plants presently in operation filter approximately 7% of the reservoir water.

The New Haven Water Company recognizes that natural land filtration will not provide water of adequate quality to meet the standards presently under consideration. Because of this, the need for ownership of watershed lands is eliminated, and plans are underway to mechanically filter water at various treatment plants. One such plant is under construction at Lake Saltonstall in East Haven for an estimated \$5.5 million. Additional plants are anticipated to be operational within the next few years. Figure 33 shows locations of wells and treatment facilities.

Most of the source of supply is at a slightly higher elevation than the distribution area. In 1973, only 25.1% of the total draft was pumped from the source. All of the water pumped from reservoirs was pumped from Lake Whitney at the low service pumping station.

At present, only one slow sand filtration plant located at Lake Whitney is in operation, and it filters 12 MGD from that source only. An additional filtration plant with an 8-MGD capacity is under construction at Lake Saltonstall.

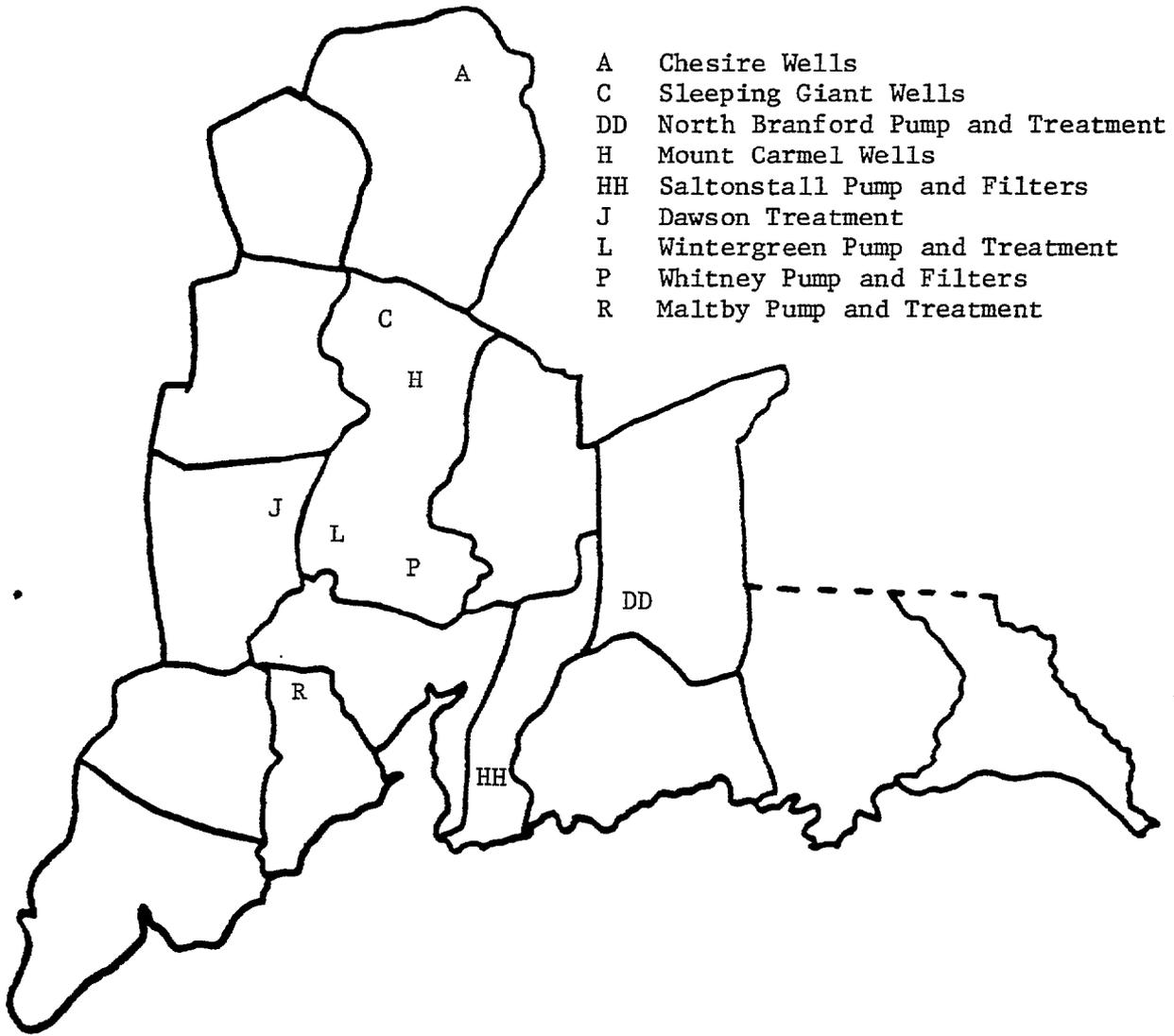


Figure 33. New Haven Water Company treatment facility locations.