SOUTHERN CALIFORNIA'S INTEGRATED WATER RESOURCES PLAN

Volume 1: The Long-Term Resources Plan

Prepared by:

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SECTION 2 - PROJECTED DEMANDS AND EXISTING SUPPLIES

One of the first steps of the IRP was to determine Southern California's water needs and identify the frequency and magnitude of potential supply shortages. For this purpose, projections of retail water demands for the region were compared to existing firm supplies available during dry years. The potential shortfall in meeting the region's needs were used to develop a long-term resources plan.

REGIONAL DEMAND PROJECTIONS

Determining future supply requirements requires an accurate and defensible water demand forecast. There are many ways to project water demands, such as linear extrapolation, time-series analysis, per capita use estimates, and econometric approaches. Each approach has advantages and disadvantages. Advantages with linear extrapolation and per capita use estimates are savings in time and expense to produce the forecast. However, the disadvantages associated with these approaches are that they often produce inaccurate forecasts and are not very useful for sensitivity analysis. Econometric approaches statistically relate water demand with explanatory variables such as population, housing, employment, income, price, weather and others. These approaches are often more costly to develop but produce more accurate forecasts. In addition, the probabilities associated with the forecast results can be assessed with econometric forecasts.

Metropolitan uses an econometric model known as MWD-MAIN to help forecast urban demands at the retail level. This model is based on the national state-of-the-art model IWR-MAIN. Many water resource agencies across the country use some version of IWR-MAIN including the U.S. Army Corps of Engineers; the U.S. Geological Survey; the state of New York; the Cities of Phoenix, Las Vegas, and Portland; and some of Metropolitan's larger member agencies. Over the course of the IRP process, the model has been reviewed by several universities, including Johns Hopkins University, University of Colorado, University of California, and Southern University of Illinois. The reviews concluded that the forecasting approach was sound and appropriate. MWD-MAIN uses projections of demographic and economic trends to forecast urban water demand by residential, commercial, industrial, and public uses.

Demographics

For the purpose of demand forecasting, Metropolitan uses projections of long-term demographics from adopted regional growth management plans provided by the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG). Currently,

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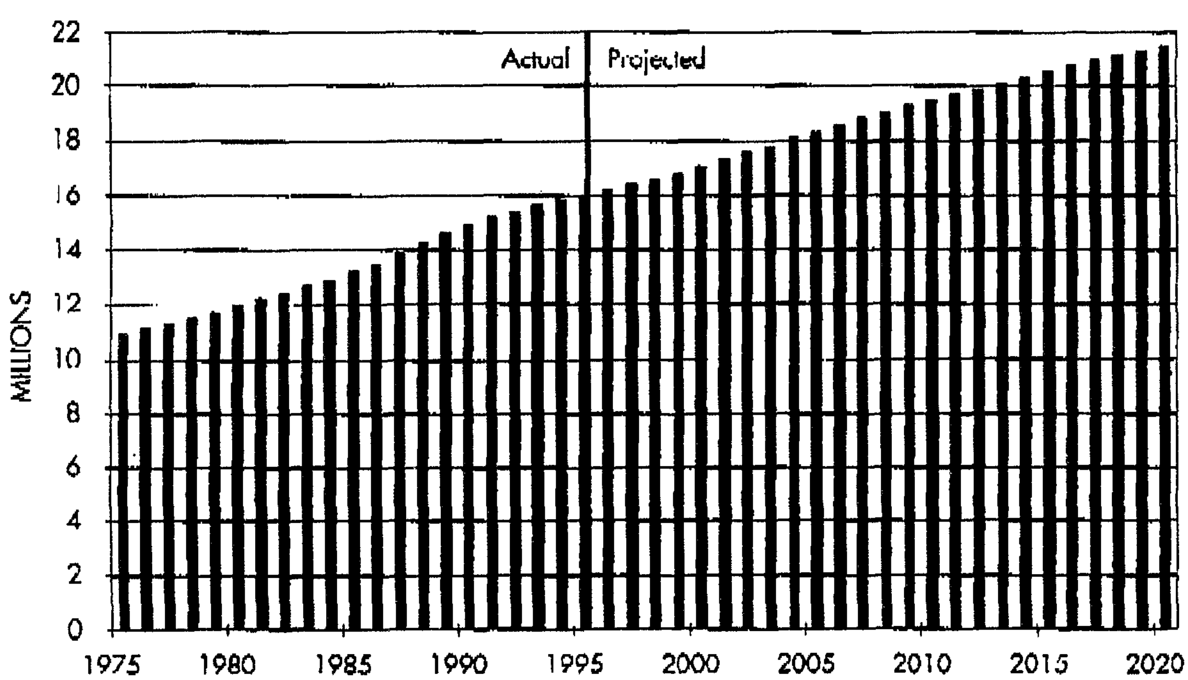
Metropolitan is referencing the Growth Management Element of the 1993 Regional Comprehensive Plan (RCP) developed by SCAG (adopted in September 1994) and the Preliminary Series 8 forecasts issued by SANDAG.

Population

Population is one of the most important overall indicators of growth used to project water needs. Historically, population growth in Metropolitan's service area averaged over 300,000 annually during the 1980s. Over 50 percent of this growth was due to net migration. In 1990, over 380,000 people were added to Metropolitan's service area, representing the largest annual growth ever. During the 1991 economic recession, Southern California's population growth decreased substantially. By 1995, population growth was just under 150,000. The recent economic recession and resulting decline in employment opportunities reversed the strong rates of net migration experienced during the 1980s, and is the primary reason why population growth has slowed.

Based on the latest 1993 population forecast, SCAG and SANDAG expect population to increase from the current 15.7 million to about 19.5 million by year 2010, and to 21.5 million by year 2020 (see Figure 2-1). This projection represents significantly lower annual growth rates than was

Figure 2-1
Population Projections in Metropolitan's Service Area



experienced during the 1970s and 1980s, averaging to about 200,000 persons per year. Other government agencies and private economic forecasting firms predict similar growth trends.

As with all projections of growth, there is certain to be some error in the population forecasts. Prior forecasts made by SCAG and SANDAG have fallen short of the actual growth by more than 15 percent.

Housing

In Metropolitan's service area, occupied households increased from 4.3 million in 1980 to 5.1 million in 1990. During this same period the average family size increased from 2.79 persons per household to 2.96 persons per household. Multifamily housing grew at a faster rate than single-family housing in the 1980s. In 1980, multifamily households accounted for 42 percent of total households, increasing to 44 percent by 1990.

In the short term, the recent recession has had a major impact on the housing market. Residential building permits in Southern California, a leading indicator of total housing, have fallen 78 percent from an annual peak of 162,000 in 1988 to a low of 35,000 in 1993. However, both the Construction Industry Research Board and the University of California Los Angeles Business Forecasting Project have projected a modest recovery in residential building permits for 1995.

According to SCAG and SANDAG draft growth management plans, total households in Metropolitan's service area will increase from 5.1 million in 1990 to 6.6 million in the year 2010. By 2010, multi-family households will make up 46 percent of total housing. Family size is projected to peak in year 2000 at 3.01 persons per household and then gradually decline to 2.98 persons per household by year 2010. These two demographic trends will result in less residential water use over time. Table 2-1 summarizes trends in housing in Metropolitan's service area.

Table 2-1
Housing Trends in Metropolitan's Service Area

	Census		Projected (SCAG/SANDAG)		
	1980	1990	2000	2010	2020
Single-Family Housing (millions)	2.52	2.85	3.18	3.55	3.93
Multifamily Housing (millions)	1.82	2.25	2.65	3.07	3.41
Total Housing (millions)	4.34	5.10	5.83	6.62	7.34
Family Size (persons per home)	2.79	2.96	3.01	2.98	2.96

Employment

Total jobs in Metropolitan's service area increased from 6.0 million in 1980 (56 percent of total jobs in the state) to 7.6 million by 1990 (55 percent of total jobs in the state). The fastest growing sectors of the economy during this period were services (7.9 percent annually) and construction (3.9 percent annually). Manufacturing jobs were one of the slowest growing sectors during the 1980's, increasing an average of 0.1 percent a year.

The severity and duration of the recent recession has had a tremendous impact on both the state's job base and the job base in Metropolitan's service area. Southern California has experienced severe job losses because of its traditionally volatile construction industry and the added impact of defense cutbacks on the region's large share of defense contractors and aerospace firms. These two unique factors, coupled with the recessionary pressures of downsizing and increased competition, have reduced the job base in Metropolitan's service area by an estimated 540,000 jobs since 1990. Job losses and the slow growth in housing caused by the recession have significantly reduced regional water use since 1990.

SCAG and SANDAG are projecting that jobs will begin to increase by 1995. By the year 2010, total jobs are expected to increase from 7.6 million in 1990 to 9.8 million. This growth reflects an average annual increase of 1.5 percent. Future job growth will be slower than that experienced during the 1980s, with the fastest growing sectors expected to be services (2.5 percent annually) and retail trade (2.0 percent annually). The manufacturing industry's share of the job base is expected to continue to decline gradually after the recession through the year 2010, decreasing 0.1 percent a year. Table 2-2 shows commercial and industrial jobs in Metropolitan's service area.

Table 2-2

Employment Trends in Metropolitan's Service Area

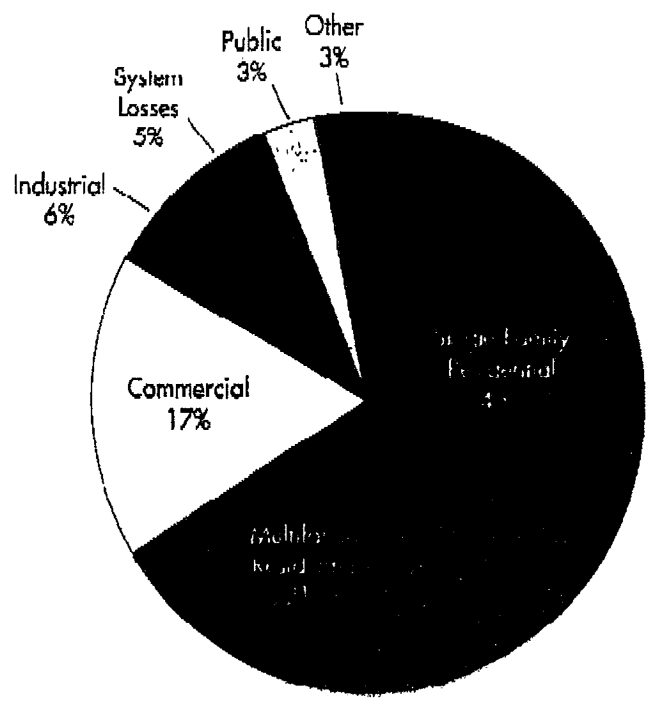
	Census 1980	Census 1990	Projected 2010
Commercial/Institutional Jobs (millions)	4.58	6.17	8.45
Industrial Jobs (millions)	1.31	1.32	1.29
Total Jobs (millions)	5.89	7.49	9.74
Ratio of Jobs to Population	0.49	0.51	0.50

Water Demand Characteristics

Typically, urban water use consists of residential, commercial, industrial, public, and other purposes which include fire fighting, line cleaning, and system losses. The largest sector of urban water use within Metropolitan's service area is residential, accounting for over 65 percent of the urban total. Commercial, industrial, public irrigation, and other uses (including system losses) follow in that order. Figure 2-2 shows the current breakdown of urban water use for Metropolitan.

Figure 2-2

Breakdown of Urban Water Use in Metropolitan's Service Area



On average, each household in Metropolitan's service area uses about 380 gallons per day, while each resident uses about 135 gallons per day. Nearly 70 percent of this water is used indoors, and irrigation and other outdoor uses consume 30 percent of residential water use (see Table 2-3).

Table 2-3

Residential Water Use in Metropolitan's Service Area

	Average Daily Use (Gallons per Household)	Percent of Annual Use Indoor	Percent of Annual Use Outdoor
Single-Family	465	65	35
Multifamily	265	82	18
Average	380	70	30

656,260 AF/yr

380

114 GAL/HOUSEHOLD x 5,100,000 HOUS

38
76
114

OR 38 GAL/PERSON OUTDOOR = x 15,700,000 ≈ 600 AG/D

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Commercial and institutional water demand includes water used by businesses, services, government, and institutions (such as hospitals, schools, and colleges). This sector currently accounts for about 17 percent of total urban water demand and is expected to increase its share to 18 percent by year 2010. In 1990, there were an estimated 345,000 commercial establishments in Metropolitan's service area, employing over 6.17 million people. Historically, each commercial/institutional establishment uses 1,480 gallons per day on average, while each employee consumes 92 gallons per day. Most commercial/institutional water is used indoors (71 percent), followed by outdoor uses (22 percent) and cooling water (7 percent).

Industrial (manufacturing) water use is the other major component of non-residential water use. In 1990, industrial water use accounted for 6 percent of urban water use and is expected to decrease to 5 percent of urban demand by year 2010. The increasing effect of conservation measures in the industrial sector and the expected decrease in the region's manufacturing base are the two factors that are reducing the future share of industrial water use. Historically, a typical industrial establishment uses 5,600 gallons per day on average, or about 127 gallons per day per employee. Nearly 80 percent of this water is used indoors. Other industrial water is used outdoors (12 percent) and for cooling water (8 percent). Table 2-4 summarizes the non-residential water use in the service area.

Table 2-4
Non-Residential Water Use in Metropolitan's Service Area

	Average Daily Use (Gallons per Establishment)	Percent of Annual Use	
		Indoor	Outdoor
Commercial/Institutional	1,480	71	29
Industrial	5,600	80	20

Urban water demand is often expressed as per capita water use (total urban water use divided by population served) in order to give changes in demand relative meaning through time, and from area to area. Examining per capita use trends can be helpful in normalizing water demands for population growth. However, without information about how other factors (such as housing, family, income, and others) impact water use, historical per capita water use trends and projections may be misleading. The following represents the effects that demographic trends have on per capita water use.

Family Size. Homes with lager family sizes (persons per household) use greater amounts of water use However, because a significant amount of household water use is fixed (such as landscaping), water use per person actually decreases as family size increases. The reverse is true if family size decreases over time. SCAG and SANDAG project that family size will continue to increase for the next 10-15 years and then gradually decrease.

Housing Mix. The type of housing (single-family vs. multifamily) has a major influence on residential water use. Single-family households typically use more water than multifamily households, because of additional water using appliances and more outdoor water use. In areas where multifamily housing is growing faster than single-family housing, per capita water use will decrease. SCAG and SANDAG project that, overall, the region's multifamily housing will increase at faster rates than single-family.

Income. Increases in personal income translate into additional water using appliances and greater outdoor water use, both of which increase per capita water use. SCAG projects that income will increase in real terms (above inflation) at about 1 percent over the next 10-15 years. SANDAG projects no real increase in income for its region over the next 10 15 years. Other forecasters (DOF, CCSCE and Census) project modest income growth for Southern California of about 1 to 2 percent, including the San Diego region.

Price. Increases in the real price of water leads to decreases in per capita water use. Price elasticity is the statistical measure of the change in demand that results when a change in price occurs. Based on ten years of retail water use data, demographic data, climate, and price of water and sewer service, price elasticity estimates were statistically estimated to be –0.13 to –0.27, depending on the season (winter or summer) and type of use (single-family, industrial, or commercial). The overall, weighted urban annual average price elasticity for Metropolitan's service area is about -0.22, meaning that a 10 percent real (above inflation) increase in price will lead to a 2.2 percent decrease in water use.

Industry Mix. The economy of the region is made up of many diverse sectors. Jobs shifting between water intensive sectors of the economy (e.g. manufacturing processes) to less water intensive sectors (e.g. services) can decrease per capita water use. SCAG and SANDAG project that the region's job base will shift from manufacturing to services and finance.

Inland Growth. Metropolitan's service area spans three major climate zones: coastal, inland, and desert. It is projected that much of the new growth in housing and development will be in the inland and desert regions, such as Riverside and San Bernardino counties. Affordability of housing is the major reason that growth in housing in these areas is expected to be higher than growth in other areas of the region. This factor tends to increase per capita water use as a whole, as water consumption in the desert region is higher than the coastal plains.

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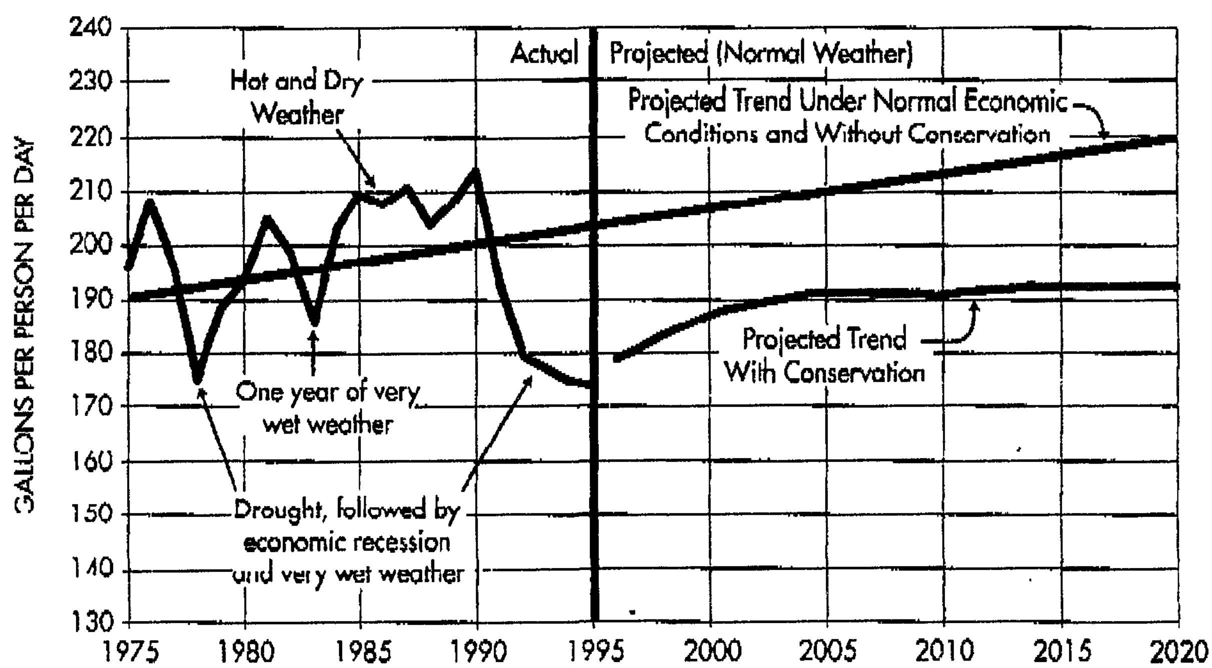
Water Conservation. The long-term water conservation efforts that are institutionalized in the BMPs will have the effect of decreasing per capita water use over time. It was assumed that the full implementation of conservation BMPs would occur by 2020, reducing urban demands by about 15 percent.

Water Demand Projections

Historically, about 180 to 215 gallons of water are consumed daily for municipal and industrial uses for every person living in Southern California. Most of this range in per capita water use is due to yearly weather. Figure 2-3 presents the historical and projected urban per capita water use from 1970 to 2020. These urban per capita use estimates are derived by dividing residential, commercial, industrial, and other urban water demands by population. This figure shows how historical weather and economic trends impact urban per capita water use.

Figure 2-3

Urban Per Capita Water Use in Metropolitan's Service Area



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Before the 1976-77 drought, per capita water use was about 210 gallons per person per day (gpcd). After the drought, per capita use fell to 175 gpcd. This 17 percent decrease occurred for three reasons: (1) drought conservation, (2) a mild economic recession, and (3) extremely wet weather following the drought. Once the economy and weather normalized, the per capita water use quickly returned to pre-drought levels. In 1983, cool and wet weather (one of the wettest years on record) was responsible for a 9 percent decrease in per capita use. A series of events similar to 1976-1978 occurred from 1991-1995 — these being, a major drought, followed by an economic recession and a series of wet years. However, these recent events were even more severe. In 1990, water demands in the service area were the highest ever as a result of a strong economy and hot and dry weather. During the 1991 drought, rationing lowered the per capita use from 215 gpcd to about 198 gpcd. Following the 1991 drought, a severe economic recession (one of California's worst) and 4 years of wet weather continued to lower per capita water use, representing an 18 percent decrease from 1990.

Metropolitan's water demand model projects that without future water conservation BMPs, per capita water use would increase to about 220 gpcd by year 2020, assuming normal weather conditions. The reason for the projected increase is due to: inland growth and expected increases in the standard of living — more homes with dishwashers and clothes-washers, etc. However, it is projected that future per capita water use can be held down to about 190 gpcd assuming the full implementation of conservation BMPs which include: (1) 1990 plumbing code enforcement, (2) toilet and shower-head retrofit programs; (3) landscaping ordinances; (4) commercial and industrial water audits; and (5) leak detection/repair.

Agricultural water demand in the region is projected based on land-use trends, urbanization, value of crops produced, and expected cost of supplying water. Based on these trends, it is expected that regional agricultural water needs will decrease from the 400,000 acre-feet observed in 1990 to about 280,000 acre-feet by 2020. It is projected that total water demands in the service area will increase from the current 3.5 million to 5.0 million acre-feet by 2020, under normal weather conditions (see Table 2-5).

Table 2-5
Projected Water Demands and Conservation (Million Acre-Feet)

	Observed 1990*	Projected (Normal Weather) 2000	2010	2020
Water Demands with Conservation:				
M&I Demands	3.600	3.660	4.168	4.644
Agricultural Demands	0.400	0.330	0.295	0.275
Total	4.000	3.990	4.463	4.919
Water Conservation (BMPs) Savings:				
1. 1980 to 1990 Programs	0.250	0.250	0.250	0.250
2. 1990 Plumbing Codes and Ordinances		0.089	0.157	0.235
3. Plumbing Retrofit Programs		0.080	0.185	0.203
4. Landscaping Programs		0.050	0.076	0.097
5. Commercial/Industrial Programs		0.014	0.027	0.045
6. Leak Detection/Repair		0.017	0.043	0.052
Total Savings	0.250	0.500	0.738	0.882

* 1990 had above-normal demands due to hot/dry weather. If 1990 had normal weather conditions, demands would have been 3.70 million acre feet.

These projected demands include conservation BMPs, which are expected to save about 740,000 acre-feet per year (or 14 percent) by 2010 and 880,000 acre-feet per year (or 15 percent) by 2020. When projecting demands, it is also important to understand the variability caused by weather. Based on 70 years of historical local weather, variations in total retail demands can be as much as ± 7 percent (see Figure 2-4). This variability represents an average for Metropolitan's service area. In the inland areas, such as Riverside and San Bernardino Counties, the variability due to weather is about ± 12 percent. In contrast, in the coastal areas of the District, the variability due to weather is about ± 5 percent.

EXISTING REGIONAL SUPPLIES

In order to develop a resources plan to reliably meet the future water needs for the region, it is necessary to provide an accurate assessment of the existing firm supplies available during dry years. To determine the potential shortfall between projected demand and existing firm supplies, a test or design year had to be defined. This design year, referred to in the IRP as "dry year," is a statistical measurement that accounts for the fact that Metropolitan and its member agencies receive water from hydrologically diverse and geographically widespread areas in California and the western region of the United States. Traditionally, water resources of the region were analyzed independently, each with its own definition for dry and wet year yields. However, these summary statistics are rarely