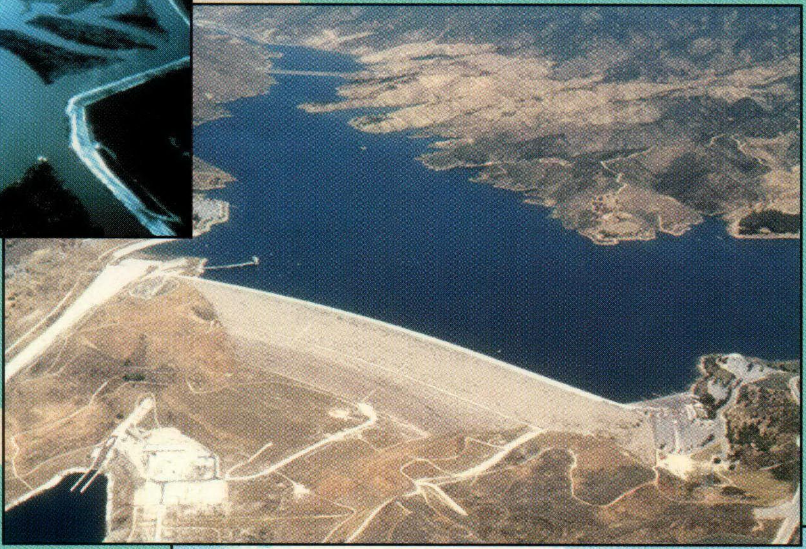

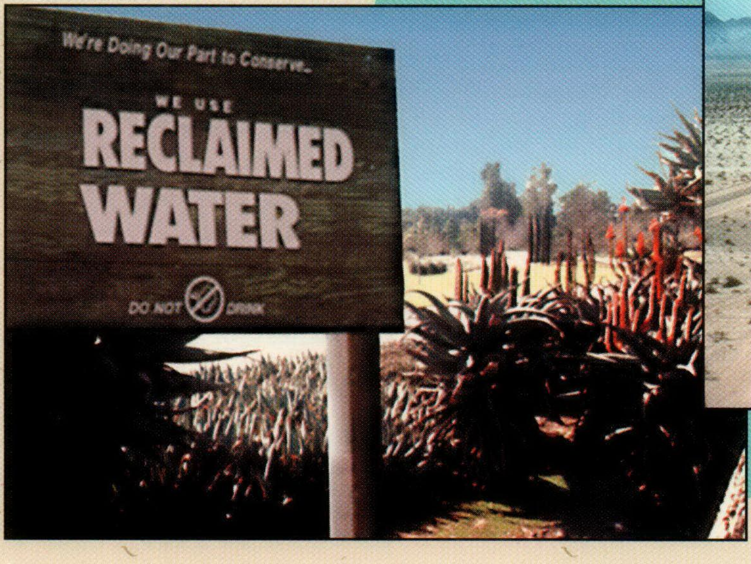

Southern California's Integrated Water Resources Plan

Volume 1: The Long-Term Resources Plan

Report Number 1107
March 1996

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

SOUTHERN CALIFORNIA'S INTEGRATED WATER RESOURCES PLAN

Volume 1: The Long-Term Resources Plan

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FOREWORD

There is no resource more important to the economic and social well-being of Southern California than water. In 1996, the Metropolitan Water District of Southern California (Metropolitan) celebrates 55 years of service providing imported water to a region comprising half of the population, jobs, and business of the State of California. Looking back, we can take great pride in accomplishments that are unparalleled in the water industry. And yet, there is little time to look backward. Particularly, when the future looks so different from the past.

During the last three years, Metropolitan, its member agencies, groundwater basin management agencies, and other water providers have participated in the development of an Integrated Resources Plan (IRP). This plan represents a dramatic shift in the way we look at water management now and into the future. It replaces exclusive dependence on Metropolitan for supplemental water with coordinated approaches developed in conjunction with local resources. It implements water conservation measures together with new supplies. And it searches for solutions that offer long-term reliability at the lowest possible cost to the region as a whole.

This change did not occur overnight. Since the 1980s, Metropolitan has gradually shifted from an exclusive supplier of imported water to becoming a regional water manager — providing not only imported water, but also supporting local resource development, conservation, and seasonal storage. The IRP represents the fulfillment of this new role for Metropolitan and the recognition that meeting Southern California's future water needs is a shared responsibility among many water providers.

The IRP represents both a process and a plan. As a process, it broke new ground in communication among the many water agencies and providers in the region. Most importantly, the process achieved the coordination of hundreds of important initiatives and projects that were being undertaken throughout Southern California. As a plan, it explicitly linked future supply reliability with the necessary resource and capital investments.

This report documents the product of this process and sets targets for improvements in every area of demand management and water supplies available to the region. It presents Metropolitan's commitments, as well as the contributions expected from local water providers. It is a picture of where we are today and a vision for where we want to be in the future. Through the coming years, it will be an important yardstick against which we can measure our progress and adjust our plans.

In January of 1996, Metropolitan's Board of Directors approved the IRP as a planning guideline to be used for resources and capital facility investments. We expect that adjustments to this plan will be necessary. In fact, the only certainty with long-range planning is that the future is often unpredictable and never exactly what was projected.

For this reason, the most important message of the IRP is that the water providers of Southern California must continue to work together in a collaborative open process of management and wise stewardship of our water and financial resources. Frequently, the competition for water leads to conflict and disagreement. That fact will likely never change. On the other hand, the IRP process has demonstrated that it is economically prudent to look for ways to replace conflict with cooperation, good intentions with commitments, and fragmented efforts with coordinated plans.

We congratulate the many hundreds of participants and contributors to this Integrated Resources Plan for their sustained level of effort. For Metropolitan's part, we pledge to fulfill our commitments to the IRP and will continue to participate in a new era of collaborative water management for Southern California.

John V. Foley
Chairman of the Board

John R. Wodraska
General Manager

ACKNOWLEDGMENTS

The consensus reached during the Integrated Resources Planning (IRP) process could not have been possible without the dedication of the participants of the IRP Workgroup, comprising of staff from Metropolitan, general managers and staff from Metropolitan's member agencies and sub-agencies, general managers and staff from the major groundwater basin management agencies, and technical consultants.

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Southern California's Integrated Water Resources Plan
Volume 1: The Long-Term Resources Plan

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SECTION 1 – INTRODUCTION

And more important . . . was one overmastering unity, the unity of drought. With local and minor exceptions, the lands beyond the 100th meridian received less than twenty inches of annual rainfall, and twenty inches was the minimum for unaided agriculture. That one simple fact was to be, and is still to be, more fecund of social and economic and institutional change in the West than all the acts of all the Presidents and Congresses from the Louisiana Purchase to the present. — Wallace Stegner[1]

Southern California's challenge in managing its water resources is driven by one of the most fundamental realities of the West — it is an arid region subject to drought. And yet, fulfilling this responsibility of providing a growing population with a safe and reliable water supply is no easy task, especially given the many diverse and competing interests for the region's water resources. Across the country, it is becoming very clear that traditional approaches to water supply planning are not well suited for the complex issues that face the water industry today. New approaches that take a broader perspective and involve the public in the decision-making process are being used by water agencies to solve the problems of supply shortages and water quality. This report summarizes one such approach, referred to as Integrated Resources Planning (IRP), that Southern California undertook in order to arrive at a comprehensive long-term water resources strategy to meet the needs of the region.

THE NEED FOR AN INTEGRATED RESOURCES PLAN

Southern California's Water Delivery System

Water in Southern California is provided through a complex system of infrastructure controlled by many different institutional entities. More than 300 public agencies and private companies provide water to approximately 16 million people living in a 5,200 square mile area. The Metropolitan Water District of Southern California (Metropolitan) is the primary wholesale provider of imported water for the region. Metropolitan was formed in 1928 under the Metropolitan Water District Act "for the purpose of developing, storing, and distributing water" to the residents of Southern California. Metropolitan's initial function was the construction and operation of the Colorado River Aqueduct to supplement local supplies. By the early 1970s Metropolitan was contracting for imported water from the California Department of Water Resources using the newly constructed

[1]Wallace Stegner, *Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West.* New York: Penguin, 1992, p. 214.

State Water Project facilities. Metropolitan serves 27 member agencies comprising 14 cities, 12 municipal water districts, and 1 county water authority (see Figure 1-1). Metropolitan's member agencies, in turn, serve customers in more than 145 cities and 94 unincorporated communities.

In addition to the region's water providers, groundwater basin agencies play a critical role in providing a reliable water supply to the region. These groundwater agencies are responsible for maintenance of the basins and ensure both water quantity and quality. Figure 1-2 presents the major groundwater basins in the region.

The water supply used by the residents in Southern California originates from many sources. About 1.36 million acre-feet per year (34 percent) of the region's average supply is developed locally using groundwater basins and surface reservoirs and diversions to capture natural runoff. Another 0.15 million acre-feet per year (4 percent) of supply is attributed to local water recycling projects that reclaim wastewater for groundwater recharge, irrigation, and direct industrial uses. Finally, about 2.39 million acre-feet per year (62 percent) is imported from three major supply systems (see Figure 1-3). The first of these imported systems, the Los Angeles Aqueducts, is operated by the City of Los Angeles and transports water from Mono Lake and Owens Valley down to Southern California. The second system, the Colorado River Aqueduct (CRA), was constructed by Metropolitan and imports water from the Colorado River to the region. The third major system, the State Water Project (SWP), moves water from the Sacramento-San Joaquin Delta via the California Aqueduct to Southern California.

Growing Demand for Water

About one out of every two Californians lives in Metropolitan's service area. During the 1980s more than 300,000 people were added to the service area each year as a result of a strong economy. And despite the severity of the recent economic recession, regional growth management plans project that Southern California's population will continue to grow by more than 200,000 people each year over the next 25 years, increasing from the current 15.7 million to over 21.5 million by the year 2020. Based on this projected growth, regional water demands under normal weather conditions are expected to increase from the current 3.6 million acre-feet to 4.9 million acre-feet by 2020. Above-normal demands, under hot and dry weather conditions, can be about 7 percent greater than normal-weather demands.

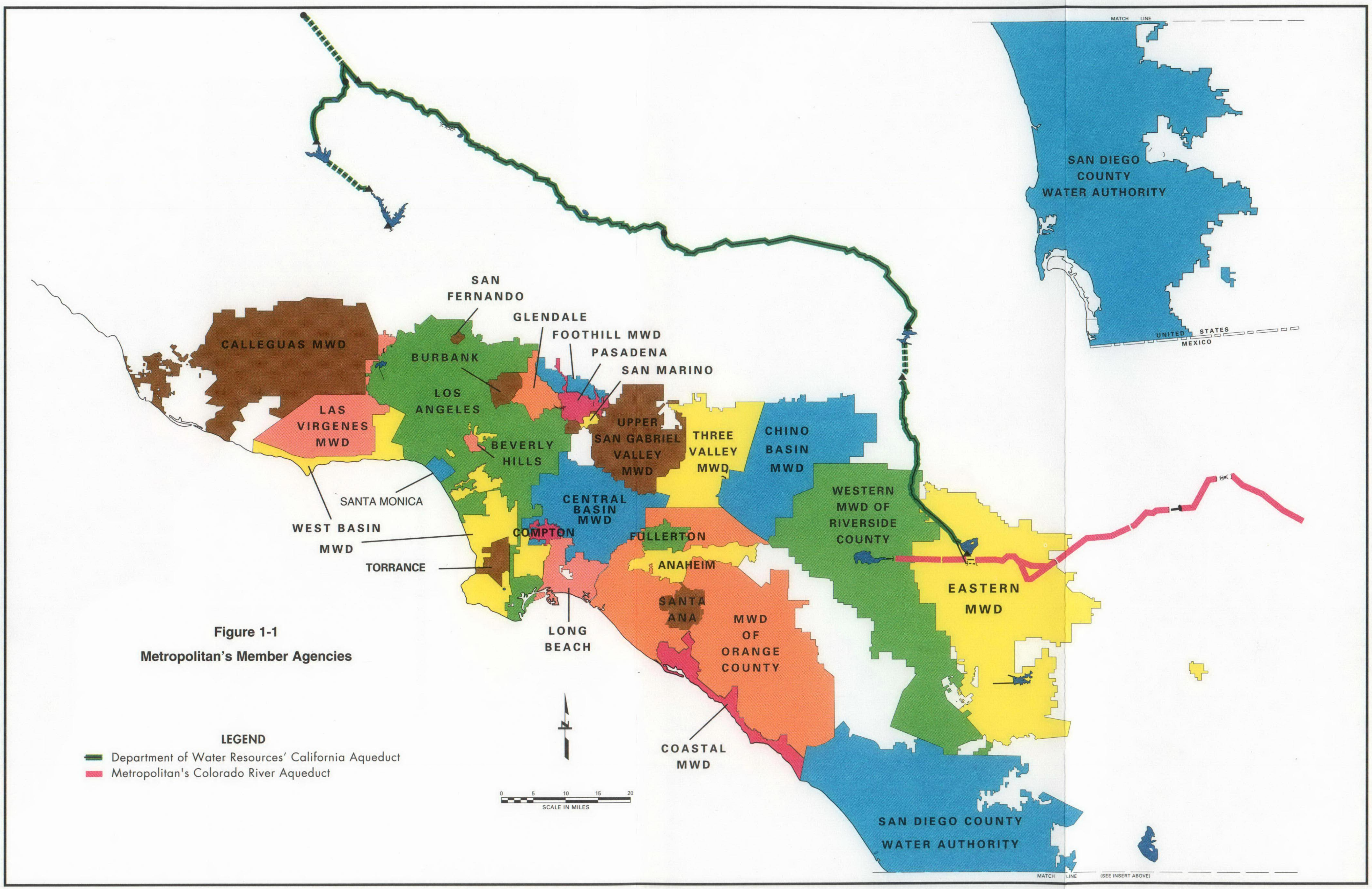


Figure 1-1
Metropolitan's Member Agencies

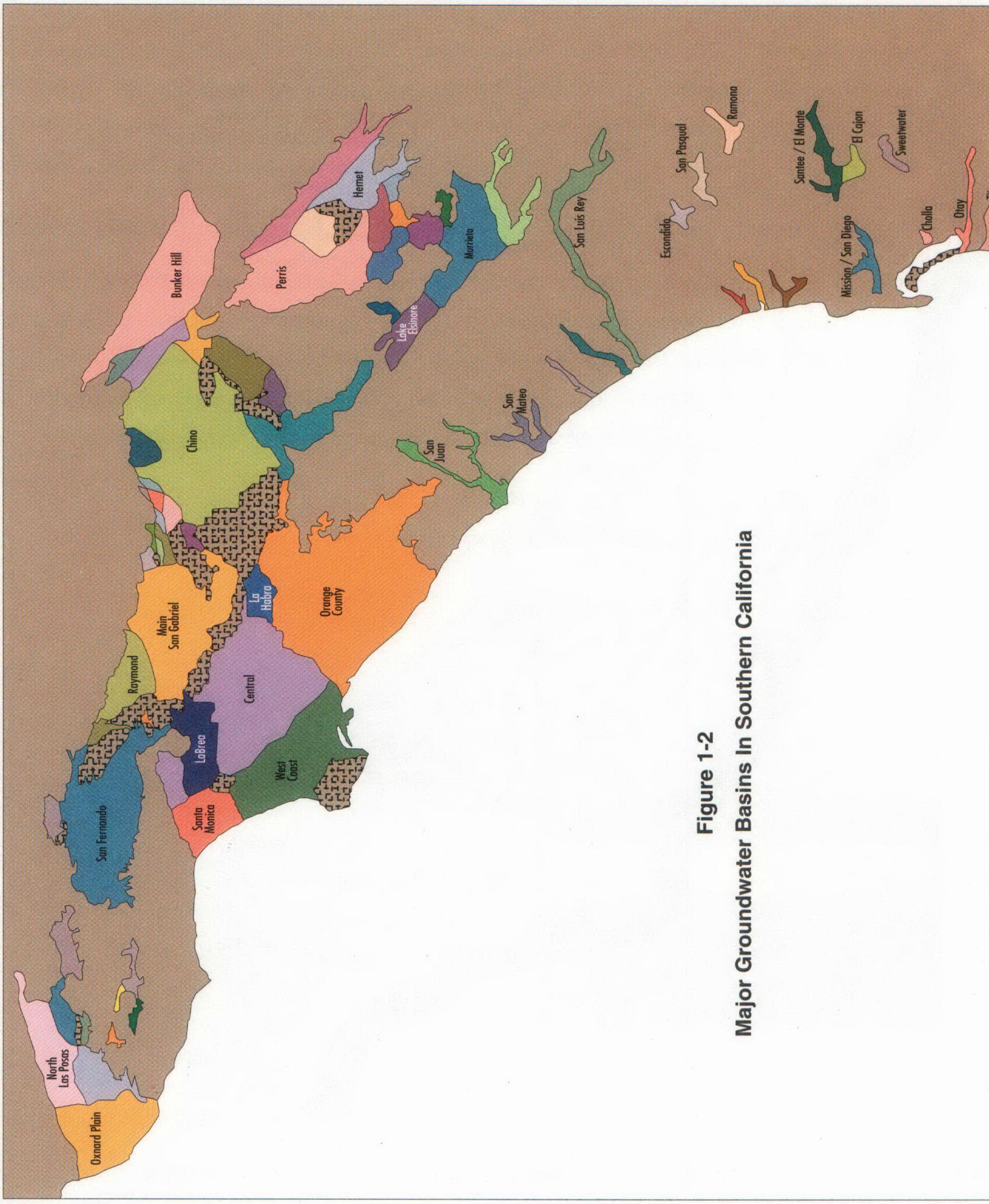


Figure 1-2
Major Groundwater Basins In Southern California

Figure 1-3
MAJOR WATER CONVEYANCE FACILITIES SERVING SOUTHERN CALIFORNIA

Competition for Existing Water Supplies

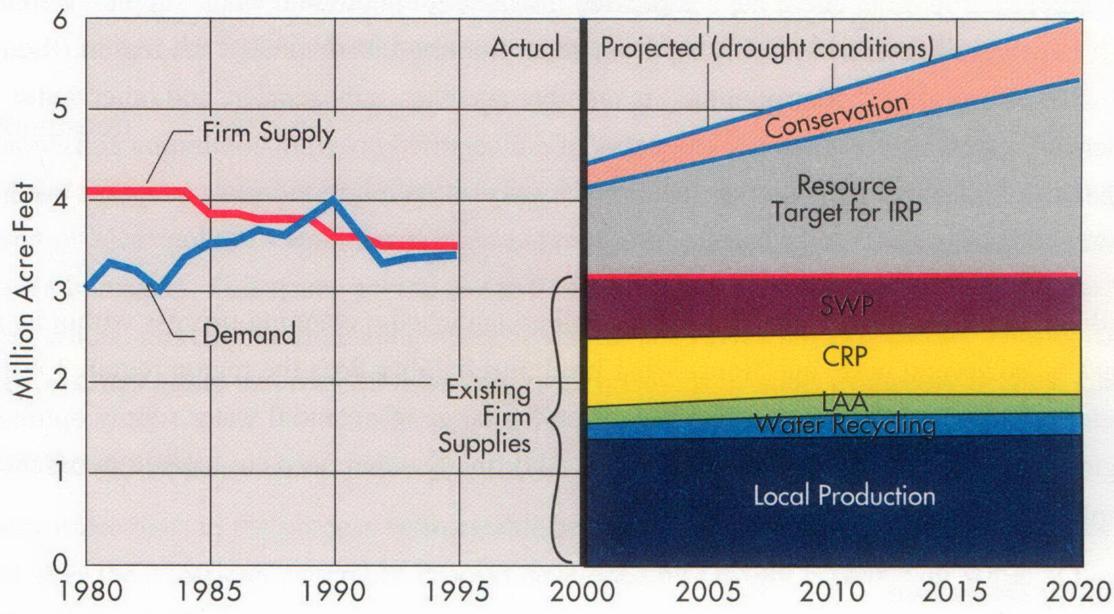
The ongoing competition for water to serve the urban, agricultural, and environmental needs of the Western states has resulted in significant uncertainties in the deliveries of firm water supply to Southern California from the Colorado River and the State Water Project. When coupled with the diverse and competing needs of locally developed water in the region, the problem of providing a reliable water supply becomes even more difficult.

Potential Consequences of No Action

If nothing is done to improve the region's water supply, future reliability could fall to 50 percent over the next 15 to 20 years — meaning some type of water shortage could occur in every other year (see Figure 1-4). This level of service would be devastating to Southern California's $450 billion economy, affecting half the state's population and jobs. And yet, recognizing the need for action is easy compared with the challenge of developing a cost-effective regional response.

Figure 1-4

Demand and Existing Firm Supplies



Cost of Redundant Investments

Given the circumstances, many water providers, including Metropolitan, have been planning investments in projects and programs to address future water needs for some time. So much so, in fact, that Southern California runs the risk of over-spending on its water needs — potentially creating an impact on the economy as significant as threatened shortages. What is needed is a coordinated and balanced regional response to growing demands.

Benefits of an Integrated Approach

With this realization, Metropolitan and its member agencies embarked on a 2½ year IRP process. The focus of this process was to collectively examine all of the available resource options, both local and imported, together with conservation — in order to develop a least-cost plan that meets the reliability and quality needs of the region. The product of this intensive effort is a 25-year resources plan that offers a realistic means of achieving a reliable and affordable water supply for Southern California into the next century.

The major objective for the IRP was developing a comprehensive water resources plan that ensures: (1) reliability, (2) affordability, (3) water quality, (4) diversity of supply, and (5) adaptability for the region, while recognizing the environmental, institutional, and political constraints to resource development.

THE IRP PROCESS

At one time, Metropolitan could have addressed the need for additional water supplies on its own, through largely unilateral actions relying upon water imported from outside the region. Today, coordinated efforts among Metropolitan, its member agencies, subagencies, and other water providers are essential to realizing the benefits of a diversified program combining conservation with the development of all potential sources of supply — local groundwater, recycled water, desalinated seawater, and imported supplies provided by Metropolitan.

To facilitate this coordinated approach, Metropolitan launched a planning process within its service area that asked several basic questions. What level of reliability does the region require? What is the preferred means of achieving reliability, given the range of potential water supply options? Can the region afford the desired level of reliability? And finally, what needs to happen in order to accomplish the preferred resource strategy?

Reliability Objective

The IRP process confirmed that Metropolitan's wholesale water supply reliability goal is both achievable and affordable. That goal basically stated that Metropolitan will provide all of the firm wholesale water demands to its member agencies in 98 out of 100 years, and only in the remaining years consider implementing a shortage allocation plan for imported supply deliveries.

Furthermore, when this level of wholesale reliability is combined with the coordinated approach proposed in this resources plan, the region will have the full capability to meet all retail-level water demands at all times.

Commitment to a Balanced Resource Strategy

One of the strengths of the IRP process is that it was designed to include a wide range of resource options and participants in the development of a strategy for meeting regional supply goals. Many of these options considered are clearly outside the direct control of Metropolitan and its member agencies. Nevertheless, they represent practical and cost-effective means of achieving regional goals. To realize these benefits, a high level of consensus and cooperation must be achieved among all participants — Metropolitan, its member agencies, other water resource agencies, and the public.

Participation from Throughout the Service Area

Because of the diverse needs and institutional arrangements in the region, the success of the Plan would only be achieved through an open and participatory process that involved the major stakeholders. The IRP process reached out to water managers, decision makers, interest groups, and individuals to obtain valuable input and guidance regarding the preferred water resource strategy, as well as to review the technical analyses supporting the decision-making process.

IRP Workgroup

Much of the technical guidance and direction for the IRP was provided by the IRP Workgroup, comprised of Metropolitan's staff, the member agency and sub-agency managers, and the groundwater basin managers. This group served as the de facto technical steering committee for the IRP, providing crucial direction, establishing needed criteria, and reviewing evaluations. During the entire process, this group met over 35 times and spent hundreds of hours evaluating detailed analyses.

Regional Assemblies

The major milestones in the process were established by a series of three regional assemblies — modeled after the American Assembly Process developed by Dwight Eisenhower while at Columbia University in the 1950s as a means to gain consensus on difficult policy issues. These three assemblies were held in October 1993, June 1994, and March 1995. What is remarkable about these regional assemblies is the fact that it represented the first time that Metropolitan's senior management, Board of Directors, and member agency managers convened to discuss regional water solutions. Participants at these assemblies also included general managers from the groundwater basin agencies and local retail water providers (sub-agencies), and invited public representatives. In total, over 150 assembly participants (most of which attended all three assemblies) provided input to the IRP process. Each assembly produced a written Assembly Statement documenting areas of consensus, as well as identifying those areas where divergent views remained unresolved and further analysis and evaluation was required.

Public Forums and Member Agency Sponsored Workshops

In addition to the IRP Workgroup and the three regional assemblies, broader public input to the planning process was obtained at six public forums and several member agency workshops addressing water resource issues and concerns. These forums and workshops were held throughout the region in order to gain input to the IRP process. Public forum attendees represented business, environmental, community, agricultural, and water interests inside and outside the region. In total, 450 individuals participated in these forums.

REPORT OUTLINE

The outcome of the IRP process is discussed in this series of reports entitled *Southern California's Integrated Water Resources Plan* and is made up of three volumes and an executive summary:

Volume 1 - The Long-Term Resources Plan
Volume 2 - Metropolitan's System Overview
Volume 3 - Technical Appendices

The purpose of Volume 1 is to describe the IRP process and methodology, and summarize the resulting resources plan. Section 2 presents the regional water demand forecast and identifies potential water shortages that could exist without future resource investments. Section 3 identifies the array of potential local resources, imported resources options, and long-term conservation efforts, that can be used to meet the regional goals. Section 3 also presents the technical evaluations that were conducted during the IRP in order to arrive at the region's preferred resources strategy. Section 4 identifies Metropolitan's role and commitment to the IRP, summarizing its capital improvement program and resource investments for the future. Different demand scenarios are also presented in Section 4, along with the possible impacts to future water rates. Finally, Section 5 recaps the resources plan, identifies the policy issues and guidelines, and summarizes the needed actions.

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, 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.

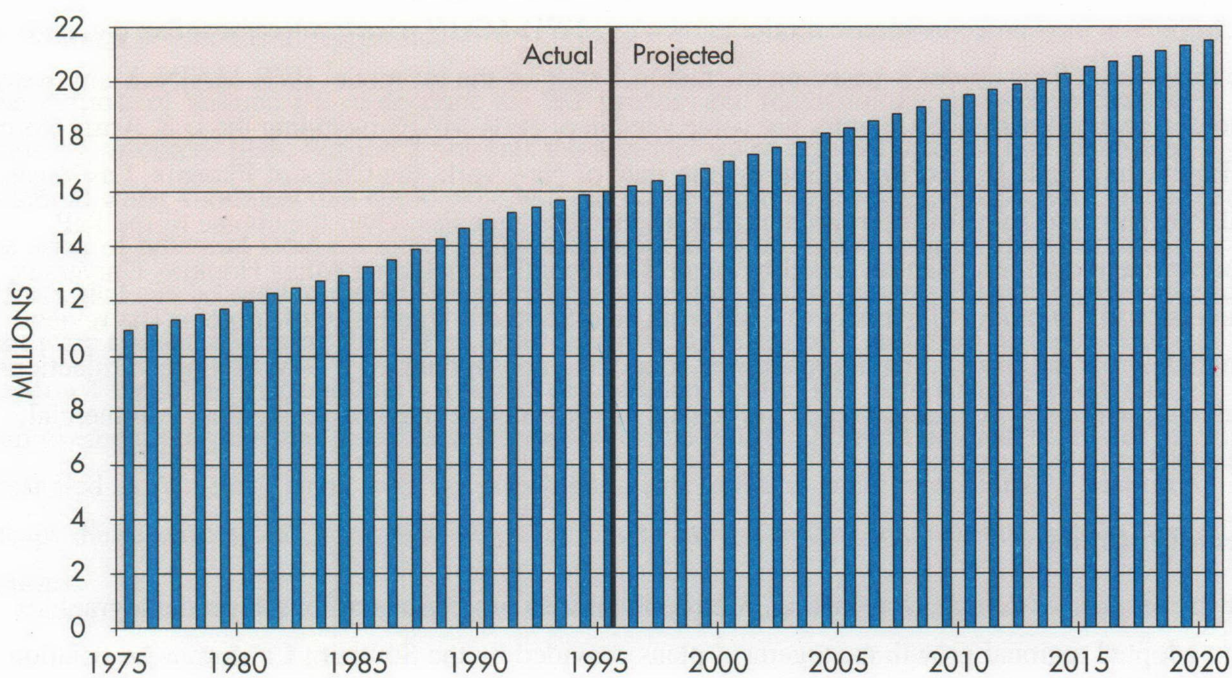
Population

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

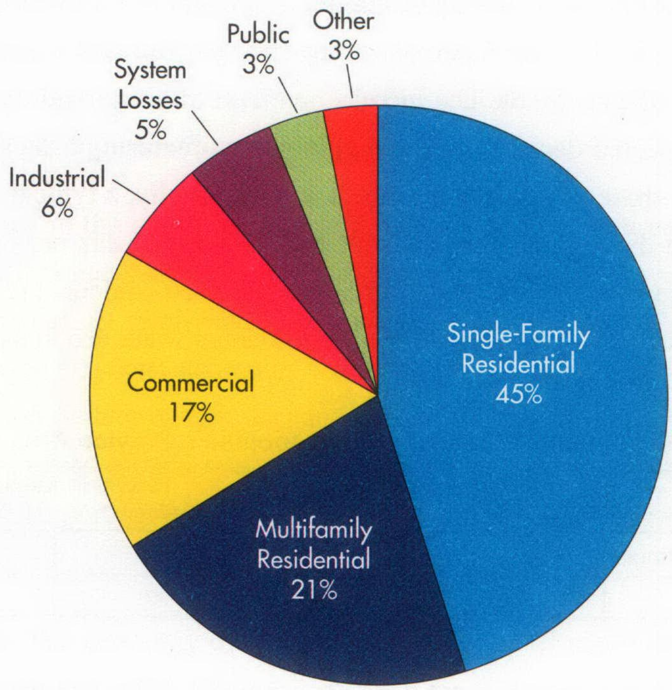
	Census		Projected
	1980	1990	2010
Commercial/Institutional Jobs (millions)	4.58	6.17	8.45
Industrial Jobs (millions)	1.31	1.32	1.29
Total Jobs (millions)	5.89	7.49	9.74
Ratio of Jobs to Population	0.49	0.51	0.50

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	Outdoor
Single-Family	465	65	35
Multifamily	265	82	18
Average	380	70	30

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.

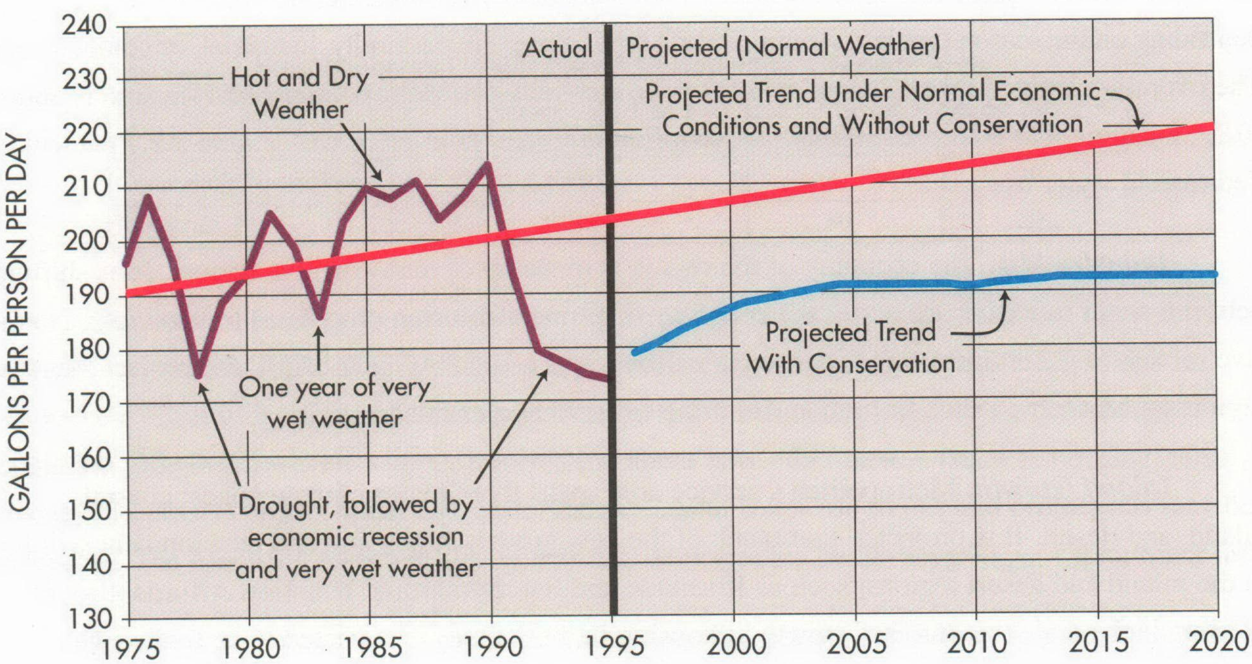
Water Conservation. The long-term water conservation efforts that are institutionalized in the BMPs will have the effect of decreasing per capita water use over time. It was assumed that the full implementation of conservation BMPs would occur by 2020, reducing urban demands by about 15 percent.

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



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.

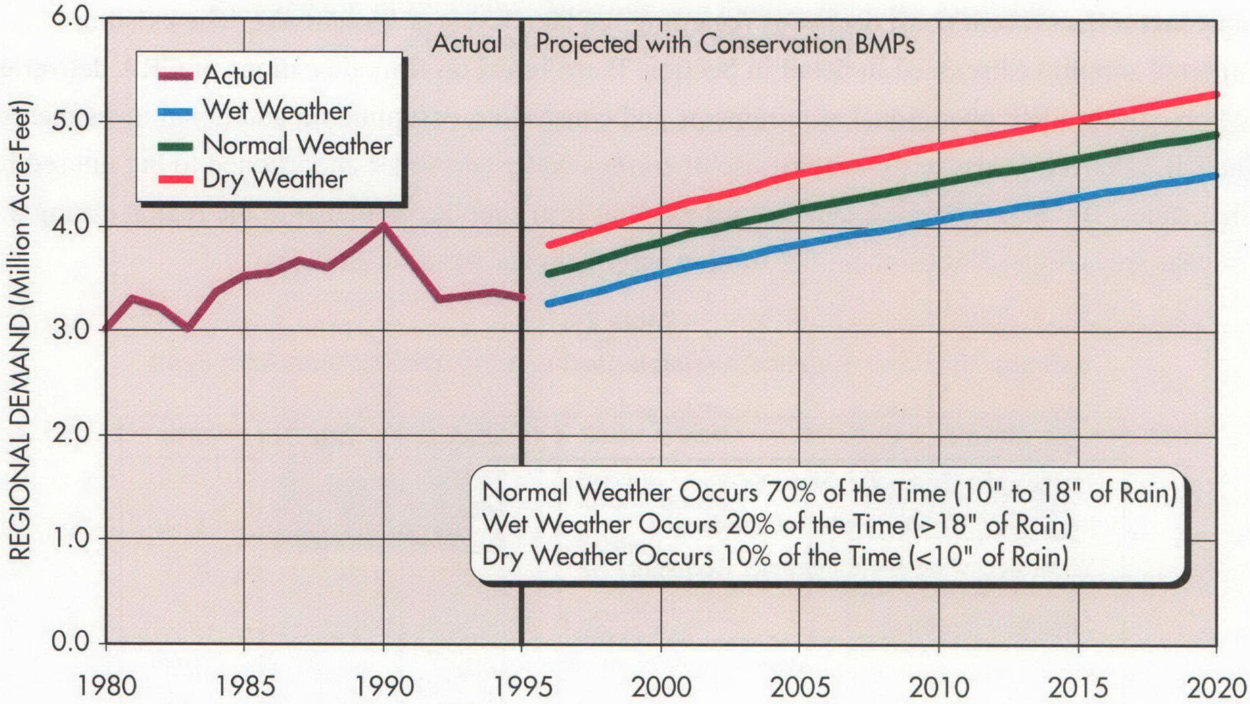
These projected demands include conservation BMPs, which are expected to save about 740,000 acre-feet per year (or 14 percent) by 2010 and 880,000 acre-feet per year (or 15 percent) by 2020. When projecting demands, it is also important to understand the variability caused by weather. Based on 70 years 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

Figure 2-4

Projected Retail Demands for Metropolitan's Service Area



additive because the historical hydrologic year that resulted in a dry condition for one resource may have left other water resources for the region undiminished. An example of this phenomenon occurred during the 1976-77 drought, when SWP supplies were very limited but Southern California was somewhat insulated from the severity of the drought since the CRA supplies were not as affected and the region had full use of its local groundwater basins. This lack of correlation in northern vs. southern hydrology makes it difficult to add independent dry year supplies. Adding the tenth percentile supply of the SWP to the tenth percentile supply of the CRA does not yield the tenth percentile of the sum of the SWP and CRA for Metropolitan. Because the IRP was designed to look at regional water supply reliability, it was determined that the regional surplus and shortage of water was a more appropriate measure of hydrologic conditions. This measurement is estimated, for a given year, by adding the sum of local and imported water supplies minus the regional demand.

Existing Regional Supplies

Table 2-6 presents a summary of the region's existing local and imported supplies that would be available during a dry year, which (for the purposes of this plan) are simultaneous yields resulting from the average of the top 10 percentile of supply shortages. The existing local supplies (discussed in detail in Section 3) are based on operational projects assuming an increase in the demand for existing recycled water projects. The assumptions regarding deliveries from the Los Angeles Aqueduct reflect recent court decisions regarding the lake levels at Mono Lake. The existing imported supplies (discussed in detail in Section 3) are based on firm allocations of CRA deliveries and on current SWP operational requirements and constraints, assuming no additional investments. The CRA deliveries also assume some use of surplus water and water apportioned to but unused by other states. Based on this assessment, total existing firm supplies available to the region during a dry year are estimated to be about 3.2 million acre-feet over the next 25 years.

Table 2-6
Existing Regional Supplies Available During a Dry Year (Million Acre-Feet)

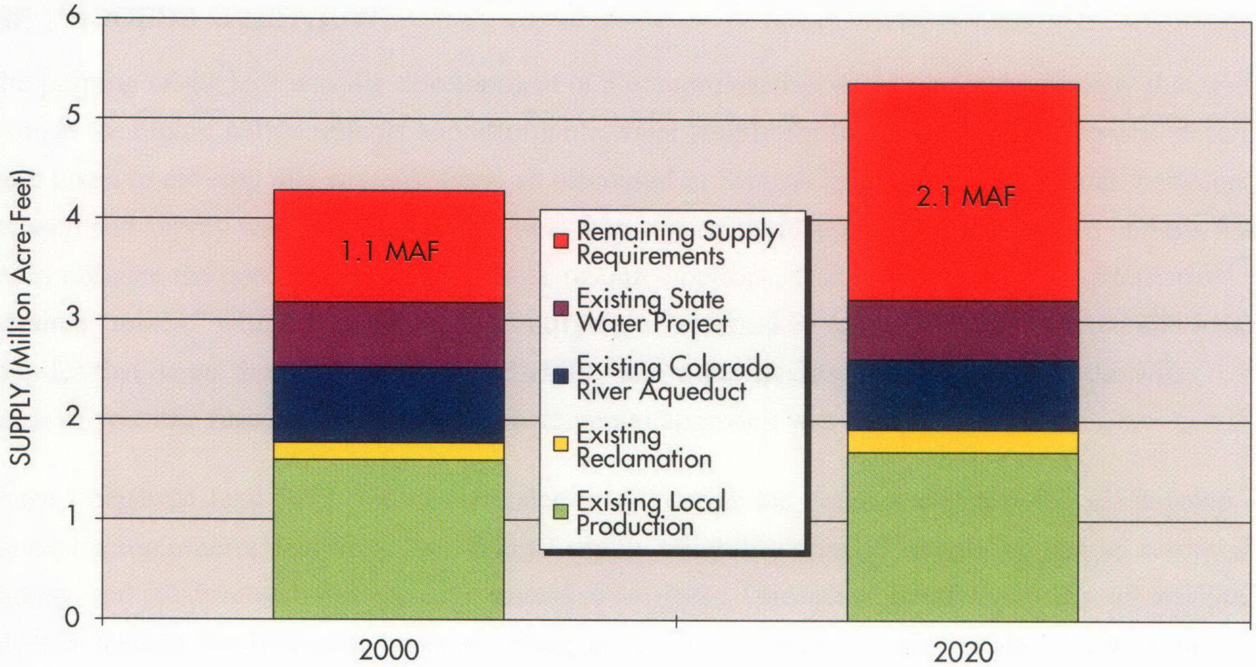
	2000	2010	2020
Locally Developed Supplies:			
Local Groundwater & Surface Production	1.37	1.42	1.43
Water Recycling & Groundwater Recovery	0.18	0.21	0.23
Imported Supplies:			
Los Angeles Aqueduct Supply	0.22	0.25	0.25
Colorado River Aqueduct	0.75	0.70	0.70
State Water Project	0.65	0.60	0.60
Total Regional Supplies:	3.17	3.18	3.21

Potential Supply Shortages With No Future Resource Investments

Comparing the existing supplies to the projected hot/dry weather retail demands results in potential water supply shortages of 1.1 million acre-feet in year 2000 and 2.1 million acre-feet in year 2020 (see Figure 2-5). The comparison of supplies and demands during wet and normal years also indicated that potential supply shortages could occur about 50 percent of the time by 2010. This estimated shortfall in supply assumes the full implementation of conservation BMPs. If these conservation measures were not implemented, the supply shortages would be about 1.3 million acre-feet by year 2000 and 2.7 million acre-feet by year 2020.

The analysis of potential water shortages identified the overall resource target to be developed during the IRP process. The important question, however, is "how will this overall resource target be accomplished — through local resource investments, imported supply investments, or some combination?" The following section describes the approach taken to identify potential supply resources needed to ensure a reliable and high-quality water supply for Southern California.

Figure 2-5
Comparison of Projected Demands and Exiting Supplies Available During a Dry Year (10% Likelihood)



*Assumes full implementation of conservation BMPs.

SECTION 3 – IRP PROCESS AND TECHNICAL APPROACH

IRP PROCESS OVERVIEW

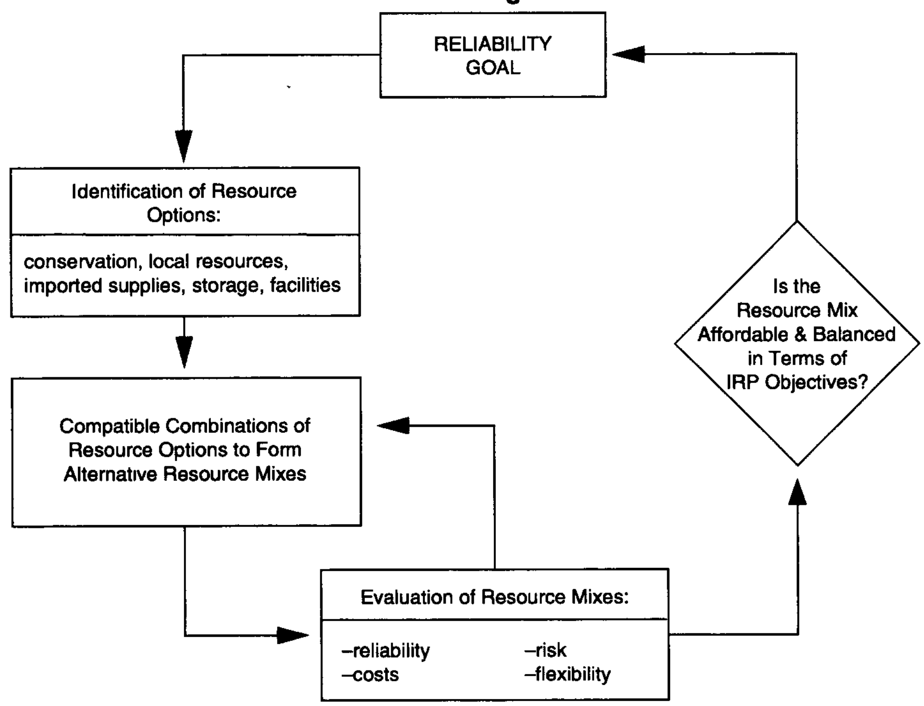
The purpose of the IRP was the development of a comprehensive water resources strategy that will provide the region with a reliable and affordable water supply for the next 25 years. Several steps were taken to develop this strategy. First, as discussed in Section 2, the potential shortfall between demand and supply was determined. The next step was to identify all possible resource options that could mitigate the potential shortages. These resource options were then grouped into alternative resource "mixes," with the objective of identifying a Preferred Resource Mix of imported and local supplies that meets the region's supply reliability and water quality goals. Because of the wide range of possible resource strategies, an incremental approach was taken.

Phase 1 began in June 1993 and was intended to: (1) define the issues and objectives; (2) develop the evaluation criteria, including the regional supply reliability goal; (3) identify potential resource options; and (4) develop broad resource strategies or mixes. Through an iterative process, all feasible resource options (conservation, water recycling, groundwater, imported supplies, etc.) were examined and combined into compatible strategies or mixes that met the desired objectives of reliability, affordability, reduced risk, water quality and others (see Figure 3-1). Three broad resource mixes resulted from the Phase 1 analysis: (1) an *Emphasis Import Mix*, which relied heavily on imported supplies to meet future demands; (2) an *Emphasis Local Mix*, which relied primarily on the development of local supplies to meet future demands; and (3) an *Intermediate Resource Mix* which included investments in both local and imported supply development. Water Conservation was an essential element in all three resource mixes.

Phase 2 began in June 1994 to develop Southern California's Preferred Resource Mix by building upon the analysis conducted in Phase 1. During Phase 2, the *Intermediate Resource Mix* was refined to meet the desired objectives of reliability, affordability, water quality, and reduced risk.

In addition to the extensive technical analyses, the IRP was designed to be an open and participatory process, which was instrumental in ensuring that the concerns of the major stakeholders in Southern California's water future were addressed. Figure 3-2 summarizes the major participatory elements of the IRP process.

Figure 3-1
The IRP Planning Process



The planning process solicited input from three major groups: (1) Metropolitan's Board; (2) the IRP Workgroup; and (3) interested members of the public including representatives from the environmental, agricultural, business, and civic communities (see Figure 3-2). Metropolitan's Board was responsible for initiating the process and developing the initial goals and objectives for the IRP. The IRP Workgroup, comprised of Metropolitan staff, member agency and sub-agency managers, and groundwater basin managers, served as the technical steering committee for the IRP process. This Workgroup met over 35 times and devoted hundreds of hours to reviewing information and providing technical guidance.

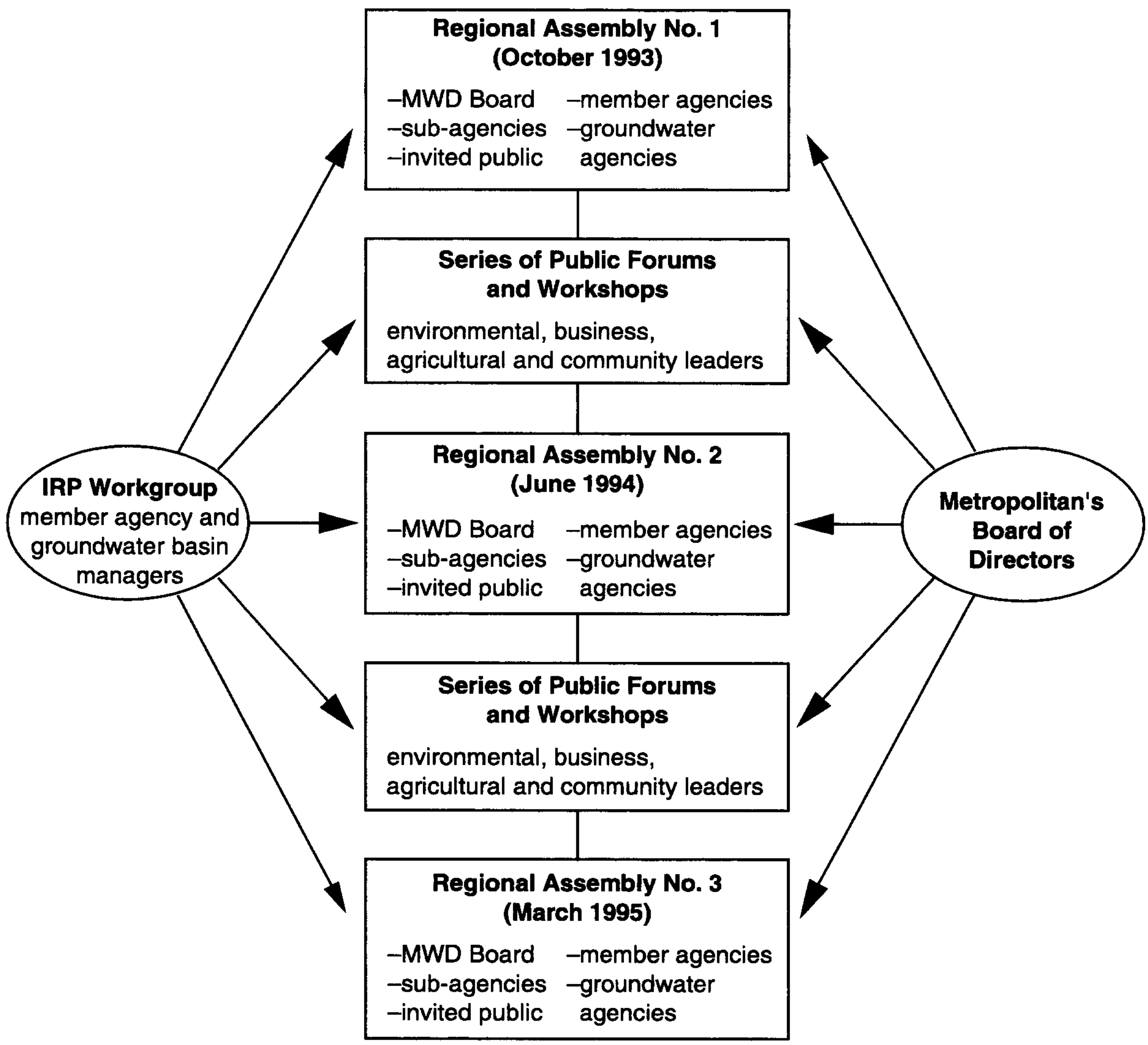
In addition to Metropolitan's Board and the IRP Workgroup, the process benefited from public input. Public participation to the IRP was achieved through a series of public forums (six in total) and several member agency sponsored workshops held throughout the region. In total, over 450 participants representing environmental, business, agricultural, community and water interests, provided crucial input to the process.

Finally, the major milestones of the IRP process were marked by three regional assemblies, modeled after the American Assembly Process developed by Dwight Eisenhower while at Columbia University in the 1950's as a means to gain consensus on difficult policy issues.

These regional assemblies represented the first time that Metropolitan's Board of Directors, senior management, and member agency managers convened to discuss regional water issues and solutions. Participants also included managers from the groundwater basin agencies, local retail water providers (sub-agencies), and invited public representatives. In total, over 150 assembly participants provided input to the IRP. The purpose of the regional assemblies was to gain consensus on resource policy issues, provide direction for future work, and to endorse regional objectives, principles, and strategies.

Figure 3-2

The IRP Participatory Process



IDENTIFICATION OF POTENTIAL RESOURCE OPTIONS

The overall resource needs were established by comparing projected water demands with existing supplies (see Section 2). Once the overall resource needs were established, the potential resource options that could be developed in order to achieve the region's reliability and water quality goals were identified. Data was collected for each resource option regarding supply yield, cost of development, and potential risk. This effort involved virtually all of Metropolitan's member agencies and required hundreds of hours of staff time. Data regarding imported supplies and regional infrastructure solutions were the prime responsibility of Metropolitan, while data regarding locally developed resources such as water recycling, groundwater recovery, and groundwater conjunctive use storage were provided by the local water providers. What follows is a summary of the available resources that could potentially be developed in order to meet the desired objectives of the IRP.

Water Conservation

The relationship between urban water conservation and the projection of water demands was discussed in Section 2. However, during the IRP, conservation was also considered as a supply option much like any other traditional supply project. It is important to define what is meant by water conservation as it relates to the IRP. In this context, conservation is defined as long-term programs that require investments in structural programs such as ultra-low-flush toilets, low-flow showerheads, or water efficient landscape irrigation technology — coupled with ongoing public education and information. This differs from short-term behavioral conservation such as rationing or penalty pricing used during droughts. Long-term conservation programs, by design, should not be intrusive or require draconian life-style changes. The conservation strategy evaluated in the IRP involves the implementation of cost-effective long-term programs that have long-lasting savings.

In September 1991, Metropolitan and other major California water agencies, together with the environmental community and other public interest groups, signed a landmark *Memorandum of Understanding Regarding Urban Water Conservation Best Management Practices (BMPs)*. The BMPs are conservation programs designed to be cost-effective over the long-term. The agreed upon water savings that result from the implementation of the BMPs were based on the best available data and are subject to revision as the state of knowledge improves. The major elements of the BMPs include: (1) increased plumbing efficiency through plumbing codes for new structures and retrofits for existing structures; (2) interior/exterior water audits and incentive programs for residential, industrial, and commercial/institutional customers; (3) distribution system leak detection and repair; (4) metering; (5) conservation pricing; (6) large landscape water conservation requirements for new developments; and (7) public education and information.

Based on the initial savings estimates for the BMPs, Metropolitan assessed the potential for cost-effective water conservation within its service area. Table 3-1 summarizes the existing and projected conservation savings that would result from the implementation of the BMPs. The category labeled "active" conservation represents savings requiring significant investments by water agencies in order to implement toilet and showerhead retrofit programs, landscape programs, commercial and industrial conservation, and distribution system leak repairs. Conservation savings resulting from "passive" programs, such as plumbing codes, ordinances, and pricing will require much less financial assistance from the water industry since these savings result from regulations or changes in behavior as a result of long-term price signals.

Table 3-1
Summary of Potential Water Conservation Savings from BMPs
(Acre-Feet per Year)

Type of Program	Year 2000	Year 2010	Year 2020
Existing Programs	250,000	250,000	250,000
Passive Programs *	80,000	145,000	190,000
Active Programs **	170,000	343,000	442,000
Total	500,000	738,000	882,000

* Represents savings from future plumbing codes, landscape ordinances, and pricing.
** Represents savings from future programs requiring significant financial support from water agencies.

Table 3-2 summarizes the projected costs associated with programmatic conservation programs. A summary of the potential risks involved with the development of conservation programs are shown in Table 3-3.

Table 3-2
Estimated Costs for Regional Implementation of Conservation BMPs
($1995)

Type of Program	Range of Costs ($/AF) *
Low-flow showerhead replacement	150-250
Ultra-low-flush toilet replacement	300-400
Residential water surveys and audits	300-500
Large turf area audits	350-600
Distribution leak detection/repair	250-350
Commercial/industrial conservation	300-650

* Represents costs of materials, installation, customer incentives, and overhead.

Table 3-3
Potential Risks Associated with Developing Conservation BMPs

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Savings Estimates: Estimates of savings are overstated and do not occur as planned.	Total conservation savings reduced.	– Better estimating techniques to establish base-line data.
Market Penetration: Potential that water providers and/or water customers will not adopt water conserving measures.	Total conservation savings reduced.	– Support aggressive public awareness campaigns. – Provide price incentives.
Code Requirements: Potential that plumbing codes and other conservation ordinances are not implemented or enforced.	Total conservation savings reduced.	– Foster political and community support for adoption and enforcement of effective plumbing codes and ordinances.

Local Groundwater and Surface Production

Local groundwater and surface production accounts for a significant portion of the service area's total supply. Virtually all of the major river systems in Southern California have been developed into a comprehensive system of dams, flood control channels, and percolation ponds. These facilities effectively store and divert most runoff for water supply and groundwater basin replenishment. It is estimated that over 80 percent of the major stream flow in Southern California is utilized for water supply purposes, with only the largest storms resulting in the discharge of storm-water to the ocean.

Groundwater Production

Groundwater supply in Southern California is one of the region's most valuable assets. In addition to supplying a basic source of water, groundwater basins provide a critical storage function that allows for reduced dependency on imported water during dry years and droughts, as well as during peak periods of demand during the summer season. Because groundwater basins contain such a large volume of stored water, it is possible to produce more water (for brief periods) than is naturally or artificially replenished. Within a given year, a groundwater basin can "over pump" in the summer and replenish its supplies during the winter months — accomplishing a seasonal "shift" in the demand for imported water. During a dry year or drought, replenishment deliveries can be curtailed, further reducing the demand for imported supplies. It is necessary, of course, to replenish "mined" groundwater supplies when imported water becomes available. However, for short periods, groundwater supplies are only limited by the capacity of production and distribution facilities. In the long-term, the capacity of replenishment facilities imposes another limitation on average annual production.

The major groundwater basins in Southern California provide an average annual supply of 1.32 million acre-feet. Most of this production is naturally recharged by surface runoff. About 130,000 acre-feet per year is replenished by Metropolitan using available imported water, while another 160,000 acre-feet is replenished through upstream recycling on the Santa Ana River and recycled water in Central/West Basin. As upstream Santa Ana recycling increases over time, it is anticipated that groundwater production will increase to about 1.40 million acre-feet by year 2020. Table 3-4 summarizes the current groundwater production by major basin.

Table 3-4

Local Annual Groundwater Production
(Acre-Feet per Year)

Groundwater Basin	Range of Production	Average Production	Average MWD Replenishment
Upper LA River Basins	65,000-140,000	90,000	-0-
Central and West Basins *	216,000-268,000	235,000	55,000
Main San Gabriel Basin	200,000-250,000	215,000	35,000
Chino Basin	122,000-156,000	140,000	10,000
Orange County Basin **	230,000-290,000	250,000	30,000
Raymond Basin	26,000-40,000	30,000	-0-
Southern Ventura County Basins	17,000-31,000	20,000	-0-
Riverside County Basins	305,000-380,000	335,000	-0-
Total	1,180,000-1,550,000	1,315,000	130,000

* Includes 50,000 acre-feet of recycled water replenishment.
** Includes 110,000 acre-feet of upstream Santa Ana recharge.

The cost of groundwater production is generally lower than imported supplies. The incremental cost of groundwater production usually consists of energy costs for pumping and basin assessment costs. Although these costs vary substantially from basin to basin, the average service area production cost is estimated to be about $150 per acre-foot.

The potential for future development of this source of water is dependent upon preventing the further contamination of groundwater supplies due to agricultural and industrial waste, treating and recovering contaminated groundwater supplies, and conjunctive use storage of imported supplies. These potential development solutions are discussed later in this section.

Surface Production

Local surface reservoir production provides an average annual supply of 135,000 acre-feet. Table 3-5 summarizes the major surface reservoir and diversion production used for supply purposes. Most of this supply is provided by local runoff. The costs associated with this production is difficult to estimate and varies significantly among member agencies. Assuming that a significant portion of infrastructure costs were incurred for flood control, it is likely that the average cost is under $150 per acre-foot. Although not discussed in detail in this report, local reservoir and surface diversion also provides the region with storage benefits for regulatory (seasonal peaking), emergency, and flood control purposes.

Table 3-5

Local Reservoir and Surface Diversion Production (Acre-Feet per Year)

Member Agency	Average Annual Production
San Diego County Water Authority	80,000
Chino Basin MWD	15,000
Upper San Gabriel MWD	14,000
Eastern MWD	10,000
MWD of Orange County	10,000
Three Valleys MWD	6,000
Total	135,000

Water Recycling and Groundwater Recovery

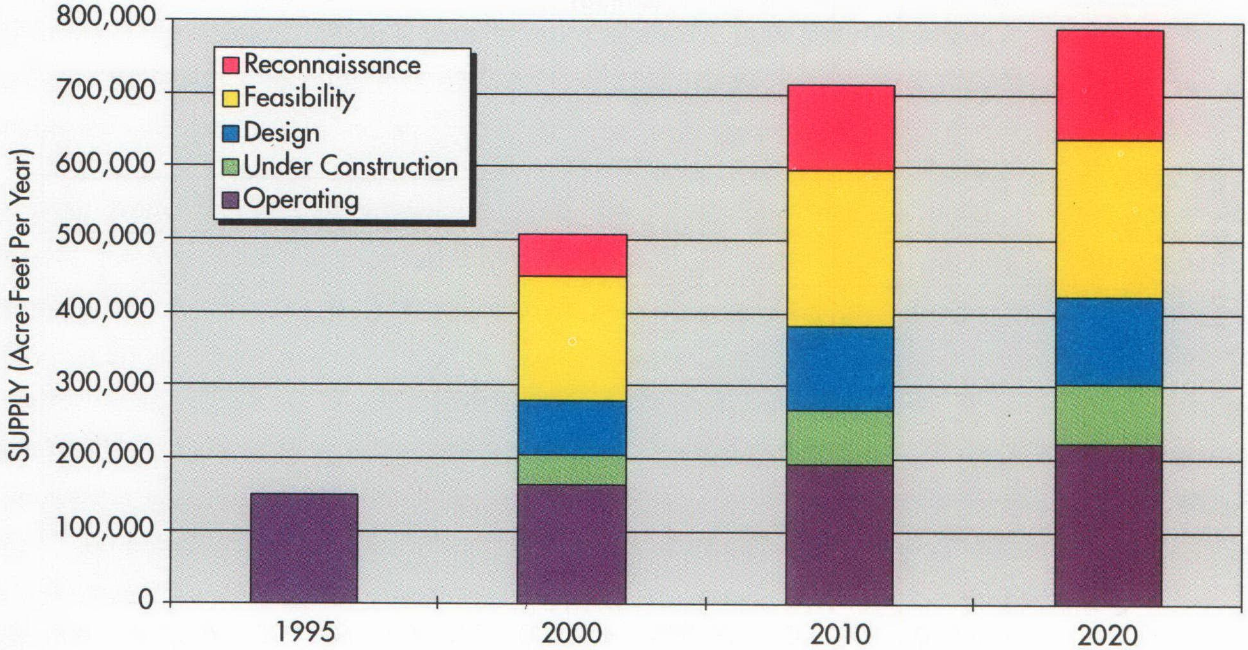
Water Recycling Projects

Water recycling (reclamation of wastewater to produce water which is safe and acceptable for various non-potable uses) is a technology which has provided a valuable source of water supply for Southern California. Since the 1970s, Southern California has been a leader in developing recycled water projects. As a result, reclaimed water is currently used for numerous applications including groundwater recharge, hydraulic barriers to seawater intrusion, landscape and agricultural irrigation, and direct use in industry. Because the water is produced every year, water recycling can improve reliability not only during a drought, but also during normal and wet years — because it allows for storage of available imported water.

Currently, some 80 local recycling projects are producing over 150,000 acre-feet per year of water supply (not including upstream Santa Ana recharge). It is estimated that these operational projects will provide about 220,000 acre-feet per year of water supply by year 2020. Another 80 potential recycling projects have been identified by member agencies. These potential projects were grouped according to their stage of development — construction, design, feasibility, and reconnaissance. If all of the projects identified by the local water agencies were developed, 800,000 acre-feet of annual supply could be obtained by year 2020. Figure 3-3 presents the existing and potential development of water recycling for the service area.

Figure 3-3

Existing and Potential Supply from Water Recycling



For the purposes of the IRP, the costs for recycled water supply include the additional capital costs, treatment, energy, distribution, and other O&M costs related to making the water safe and acceptable for non-potable use. The regulatory costs of wastewater disposal are not included in the supply cost, as these are regarded as sunk investments. The range of supply costs for water recycling vary from $50 per acre-foot to over $2,000 per acre-foot. This large range is due to differences in technologies used to reclaim the water and the proximity to users. For example, projects designed for groundwater recharge are often strategically located by basin spreading grounds — reducing the costs for distribution. However, projects that are designed for landscape irrigation or direct industrial uses will generally be higher in costs because of the extensive distribution system needed for delivery. Figure 3-4 shows the marginal cost and cumulative supply yield associated with the local projects. The potential risks associated with developing water recycling are shown in Table 3-6.

Figure 3-4

Comparison of Cost and Supply Yield for Water Recycling in Year 2020 ($1995)

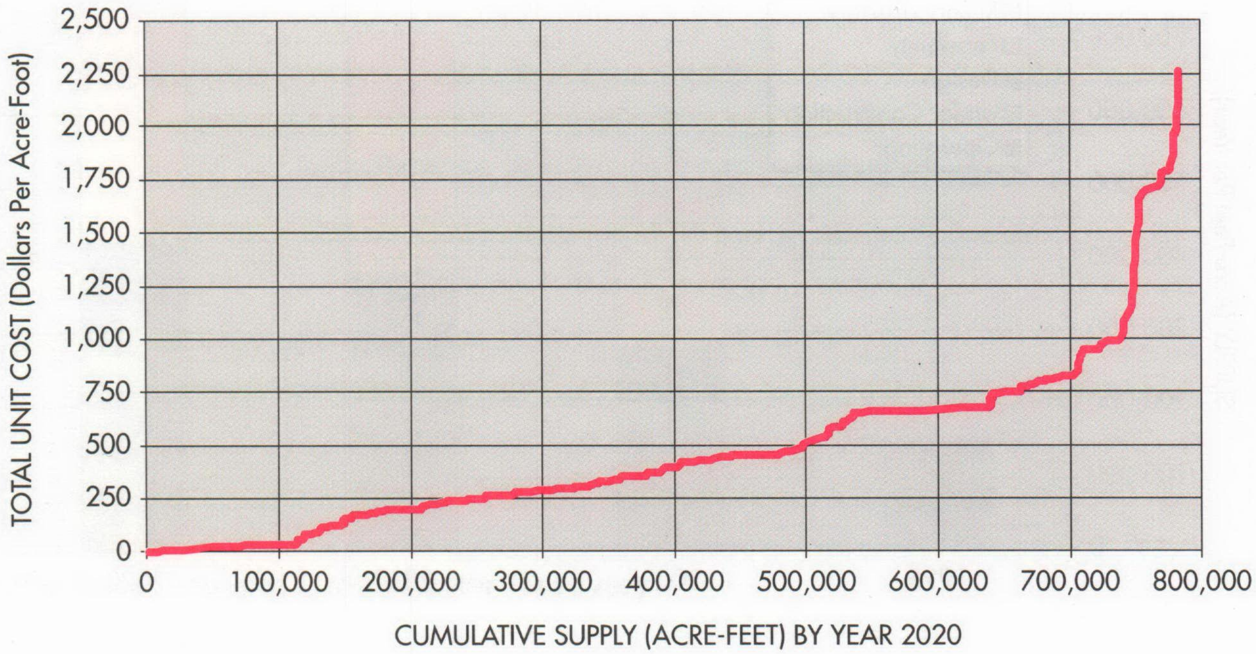


Table 3-6

Potential Risks Associated with Developing Water Recycling Projects

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Demand for Recycled Water: The demand for recycled water is not realized after project is built.	Shortfall in expected supply yield from projects.	– Provide adequate price incentives. – Continue public education. – Support ordinances requiring recycled water for certain uses. – Foster coordination among water, wastewater, groundwater, and flood control agencies.
Higher Salinity Levels: Limitations on recycled water for groundwater recharge and certain irrigation applications as a result of higher total dissolved solids in product water.	Shortfall in expected supply yield from projects or higher costs for additional treatment.	– As practicable, provide adequate blends of CRA and SWP imported supplies within service area. – Provide desalination treatment at affected recycled water projects.
Land-use and Facility Siting: Difficulty in siting major facilities.	Higher costs associated with mitigation or selection of more costly locations.	– Increase financial support.

Groundwater Recovery Projects

Recovery of contaminated groundwater supplies is an important resource strategy for Southern California. This resource option is usually more expensive than other resources — because it involves sophisticated technologies. However, some groundwater recovery may be necessary in order to prevent the contamination of cost-effective groundwater.

Six groundwater recovery projects are currently providing an average net supply of 13,000 acre-feet per year. Another 7 projects have been identified for implementation, providing an additional net supply of 28,000 acre-feet per year. Another 21 projects have been identified as potential projects, providing an additional 72,000 acre-feet of net supply per year. Finally, 18 projects are considered to be reconnaissance-level and could provide an additional 36,000 acre-feet per year. In all, approximately 150,000 acre-feet of net annual supply could be developed from treatment of contaminated groundwater supplies (see Figure 3-5). The costs associated with these projects range from $300 to over $1500 per acre-foot, with the average cost being about $750 per acre-foot. Table 3-7 summarizes the potential risks associated with the development of groundwater recovery projects.

Figure 3-5

Groundwater Recovery Supply Potential

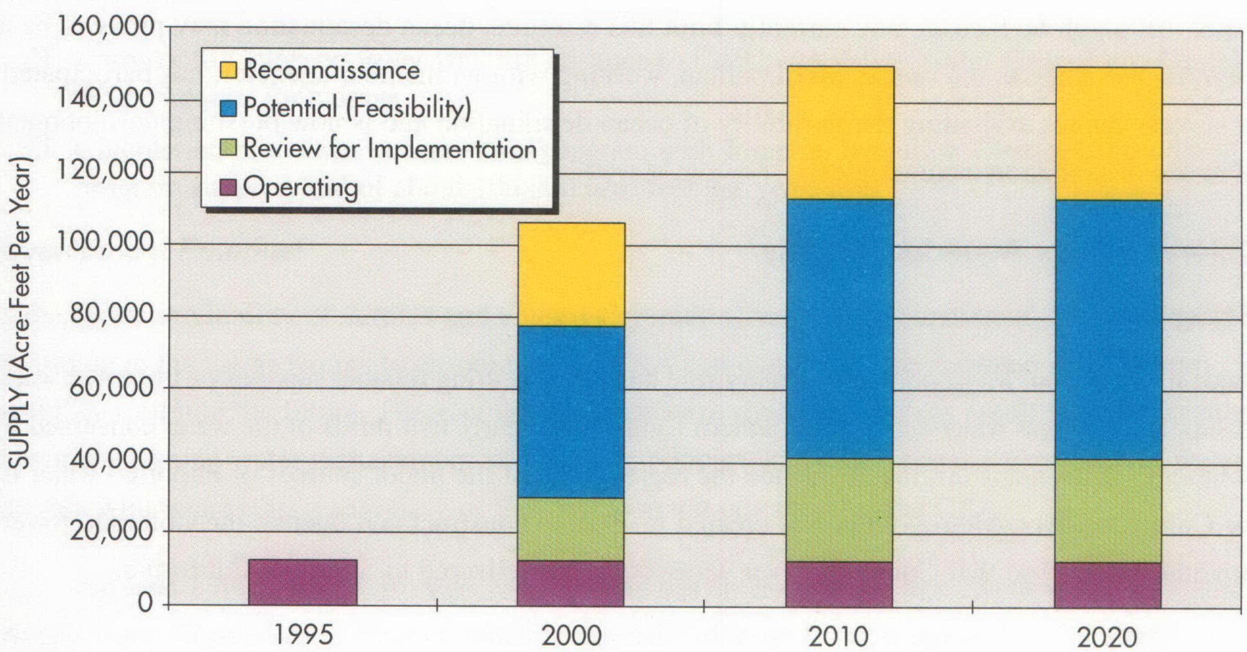


Table 3-7

Potential Risks Associated with Developing Groundwater Recovery Projects

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Water Quality Regulations: Potential for stringent new regulations for arsenic and radon, among others.	Increased costs associated with groundwater production.	– Provide necessary treatment at wells. – As practicable, blend poor quality water with higher quality water in local distribution systems.
Contamination: Potential for further TDS, nitrate, and organic chemical contamination.	Reduced groundwater production and/or increased costs.	– Provide necessary treatment. – As practicable, blend poor quality water with higher quality water in local distribution systems.

Ocean Desalination

The ocean represents a potentially abundant source of water supply. Although there is often public support for this resource, ocean desalination is currently limited by its high costs, environmental impacts of brine disposal, and siting considerations. Feasibility studies on potential projects indicate that about 200,000 acre-feet per year could be developed by 2010. Based on current technology, the costs for desalination of ocean water for potable uses ranges from $900 to $2,500 per acre-foot depending on the type of treatment and the distribution system that would be required to deliver the water. Although high costs may currently limit this resource, ocean desalination may prove to be an important strategy in the future. Metropolitan, working with its member agencies, has participated in several studies evaluating the feasibility of ocean desalination and is now pursuing development of ocean desalination technologies.

Colorado River Aqueduct Supply

Background

Since its inception, Metropolitan's primary role has been securing reliable supplies of imported water to supplement local water supply in Southern California. Nearly two-thirds of the water consumed by Southern Californians originates outside the region. One of the major sources of imported water is the Colorado River. Metropolitan was created in 1928 to construct and operate the Colorado River Aqueduct (CRA) so that Colorado River water could be delivered to Southern California.

Metropolitan has diverted water from the Colorado River since 1941 under water delivery contracts with the federal government. These contracts have allowed for the diversion of 1.21 million acre-feet each year, as well as 180,000 acre-feet per year of surplus water when available. The capacity of the CRA is 1,800 cubic feet per second or 1.30 million acre-feet per year. However, the typical maximum import capability of the CRA is considered to be 1.2 million acre-feet per year, allowing for system losses and adequate maintenance.

The average supply of Colorado River water would exceed user demands by 1.8 million acre-feet per year if diversions by agencies in Arizona, California, and Nevada were limited to 7.5 million acre-feet per year. Thus, additional needs of users in the Lower Basin can be met for a period of time.

In 1964, a U.S. Supreme Court decree, Arizona v. California, limited California's basic apportionment of Colorado River water to 4.4 million acre-feet per year. The Secretary of the Interior (Secretary) issued Criteria for Coordinated Long-range Operation of Colorado River Reservoirs in 1970. Under these criteria, Metropolitan's dependable supplies decreased to 0.52 million acre-feet per year, once the Central Arizona Project began operation in 1985. Since commencement of operation of the Central Arizona Project, Metropolitan has been able to continue diverting as much Colorado River water as needed to meet a portion of its service area's demands and storage objectives. This has been accomplished due to the availability of unused agricultural water, unused Arizona and Nevada apportionment, and surplus water. In addition, the following programs have and will continue to help ensure reliable CRA deliveries:

- Delivery of Colorado River water in advance to Coachella Valley Water District and Desert Water Agency for storage.
- Completion of a water conservation program with Imperial Irrigation District (IID) with a program supply yield of about 106,000 acre-feet per year.

Development Potential

As the future availability of surplus and unused Colorado River water is uncertain, Metropolitan is continuing to pursue programs to ensure that the CRA can continue to be operated at maximum capability well into the future. These programs emphasize strategies such as credit for conservation investments, sound water management and banking policies, and criteria to use surplus river water. The following represents a summary of this development potential for the CRA:

Arizona Underground Storage. Metropolitan has entered into an agreement with the Central Arizona Water Conservation District, wherein unused Colorado River water is stored underground in Arizona, potentially for the benefit of Metropolitan. To date, 89,000 acre-feet of water has been stored at an average cost to Metropolitan of about $99 per acre-foot. Metropolitan has the right to about 90 percent of this amount, contingent upon the declaration of a surplus on the Colorado River by the Secretary of the Interior. When Metropolitan is able to draw on this source, it can divert up to a maximum of 15,000 acre-feet in any one month. The stored water would be made available to Metropolitan by Arizona foregoing the use of part of its normal supply from the Central Arizona Project. Metropolitan has executed an amendment to the agreement that increases the total amount of water that can be stored to 300,000 acre-feet. Metropolitan plans to recover the stored water at times in the future when its CRA diversions may be limited. This water would generally be used after recovering water stored from the Palo Verde Test Land Fallowing Program and the proposed All American Canal Lining Project. The Southern Nevada Water Authority is also participating in the program.

Palo Verde Irrigation District Test Land Fallowing. Metropolitan entered into an agreement with the United States and the California agricultural agencies, and 63 individual agreements with farmers in the Palo Verde Valley, in which approximately 20,000 acres of farmland were fallowed between August 1992 and July 1994. During this period, 186,000 acre-feet of water was stored to Metropolitan's credit in Lake Mead. No evaporation is charged against the water in storage since it was projected that actual savings from the program would be more than ten percent greater than the amount of water placed in storage.

All American Canal Lining Project. Metropolitan has expressed an interest in providing funding to implement a conservation program which would consist of construction of a $120 million concrete-lined canal parallel to 23 miles of earthen All-American Canal with cooperation from the Imperial Irrigation District (IID) and Coachella Valley Water District. This project would yield about 68,000 AF of water per year, currently lost through seepage. In exchange for funding the canal construction, Metropolitan would have the opportunity to utilize the conserved water for 55 years with an option to renew the program for another 55 years. In December 1995, Imperial chose not to extend an agreement with Metropolitan by which Metropolitan would have provided funding for the Project.

Optimized Management of Colorado River Reservoirs. Metropolitan is pursuing an approach to optimize management of the Colorado River reservoirs, which would determine when surplus water is available and how unused water is allocated among Arizona, California, and Nevada. New reservoir operating criteria would also determine how reductions in Colorado River diversions would be required during times of shortage or when an entity uses more Colorado River water than entitled to. These changes in river operations are expected to make additional low-cost water available to Metropolitan with no impacts to other Colorado River water users.

Colorado River Banking. A proposal to utilize the vacant capacity in Colorado River reservoirs for water banking would permit Metropolitan and potentially other Colorado River users to store water for later use, thereby providing incentives for significant investments in conservation programs.

Lower Colorado River Habitat Management Planning. Metropolitan continues to participate in an ongoing effort to develop a multi-species habitat conservation program for the Lower Colorado River Basin. This program is intended to provide Metropolitan with regulatory certainty while working toward the conservation of habitat and toward the recovery of the species.

Salinity Management. Metropolitan continues to support implementation of the federal-state Colorado River Basin salinity control program to permit the State-adopted and U.S. Environmental Protection Agency approved salinity control standards to be met. The numeric criterion for total dissolved solids concentration is 747 milligrams per liter below Parker Dam.

The aggregate unit cost to Metropolitan for implementing the programs to guarantee water supply reliability is approximately $75 per acre-foot. The potential risks associated with CRA deliveries are summarized in Table 3-8.

Table 3-8
Potential Risks Associated with CRA Deliveries

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Environmental Regulations: Determination of adverse effects on sensitive species and designation of critical habitat within the Colorado River.	Possible changes to the current Colorado River reservoir and power plant operations resulting in reduced deliveries.	– Develop cooperative workgroups with other resource agencies. – Support and develop a multi-species habitat conservation plan for the Lower Colorado River.
Competition for Existing Entitlements: Increased regional demand for Colorado River water.	Interstate competition for implementation of conservation programs.	– Develop Colorado River management programs to permit flexibility. – Develop political support and consensus among participants.
High Salinity Levels: Higher salinity levels of imported water with greater reliance on CRA supplies.	Impacts to groundwater replenishment and water recycling projects, resulting in reduced demand for CRA supply.	– Support the Colorado River Basin Salinity Control Program – As practicable, blend CRA and SWP supplies. – As feasible, provide local desalination .

State Water Project Supplies

Background

The State Water Project (SWP) consists of a series of reservoirs, pump stations, and aqueducts constructed and operated by the California Department of Water Resources (DWR). The SWP supply represents the other primary imported water supply for Southern California, via deliveries from the California Aqueduct. The initial SWP facilities were completed in the early 1970s and consist of Oroville Reservoir, San Luis Reservoir, Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant), and the North Bay, South Bay, and California Aqueducts and their associated aqueduct pumping plants and terminal reservoirs. The State originally contracted with 32 agencies (currently 29) to ultimately deliver a planned 4.23 million acre-feet of water per year. Metropolitan is the largest SWP contractor, with a contract entitlement for 2.01 million acre-feet per year. The contract provides for construction of initial facilities, with additional facilities to be built as contractors' demands increase up to their full contract entitlements.

Issues concerning the SWP were among the most complex in the IRP process. The SWP supply offers some of the most significant opportunities for meeting the region's future supply needs. On the other hand, the ability to take advantage of these opportunities has been highly uncertain in recent years. Water supplied by the SWP flows through and is pumped from the Sacramento-San Joaquin Delta (Delta). Fishery populations in the Delta have been declining and are adversely affected by, among other factors, the location of the SWP export pumps in the southern Delta. To protect several fish species which are listed under the Endangered Species Act, additional operational constraints have been imposed on the SWP. Finding solutions to these complicated environmental problems in the Delta is not assured and may take some time to implement. However, if solutions are found, the potential for increased future supply from the SWP is considerable. SWP transportation facilities, which represent a fixed cost commitment for Metropolitan, have existing capacity to transport additional supplies, making the marginal cost of future SWP supplies very competitive.

Contractors' requests for SWP entitlement have been increasing, and in 1994, they reached 3.85 million acre-feet. While this level of request significantly exceeds the dependable yield from existing SWP facilities, the SWP has been able to meet all contractors' requests for entitlement water except during the drought periods in 1977, 1990 through 1992, and 1994. In addition, surplus water has been delivered to contractors in many years. SWP deliveries to Metropolitan reached a high in 1990 of 1.4 million acre-feet. Only during 1977 and 1991 was Metropolitan unable to receive its full requests for SWP delivery.

The quantity of SWP water available for delivery is controlled both by hydrology and operational considerations. SWP operations in the Delta are governed by standards established under the State Water Resources Control Board's (SWRCB) 1978 Water Rights Decision 1485 (D-1485). D-1485 requires compliance with water quality standards and flow requirements for the Delta and assigns responsibility to meet these standards exclusively to the SWP and Central Valley Project (CVP). In addition to D-1485, both proposed and actual operational constraints are resulting in reductions in SWP supplies. In 1992, the Governor directed the SWRCB and California Environmental Protection Agency (EPA) to develop interim standards for the Delta until long-term standards could be developed to replace D-1485. A Draft Water Rights Decision 1630 (D-1630) was released in 1993, but was not adopted. In the meantime, additional constraints on SWP and CVP operations have been imposed by the National Marine Fisheries Service (in 1992) to protect winter-run salmon; and by the U.S. Fish and Wildlife Service (in 1993) to protect Delta smelt.

In December 1994, consensus was reached among regulatory agencies, water users, and environmental interests on the Bay-Delta Accord, a three year agreement on interim standards for the Delta. At the time the IRP was initiated, and well into its development, the best estimate of future Delta standards and SWP operating constraints was based on D-1630. The Bay-Delta Accord, while providing more current Delta standards, was reached too late in the IRP process to be considered in the analyses. However, these new standards will be included when the IRP is updated.

A basic assumption for the IRP was that without any additional investments, SWP deliveries under D-1630 would decline to a level about one-half of D-1630. Under this scenario, dry year supplies available to Metropolitan would be about 600,000 acre-feet. Because water diverted from the Delta is low in total dissolved solids (TDS) relative to Colorado River supplies, SWP supplies not only improve reliability but also improve opportunities for water recycling and groundwater basin replenishment and storage.

Development Potential

Interim Delta Improvements. Potential supply development for the SWP includes interim Delta improvements that involve: (1) south Delta channel enlargements and construction of four barriers to improve south Delta flow circulation, and (2) installation of acoustic fish barriers on the Sacramento River at the Delta cross channel and at Georgiana Slough to keep fish from the central Delta. The interim improvements would enable the use of four additional pumps at Banks Pumping Plant when flow conditions allowed, and permit the relaxation of certain current operational constraints. It is also anticipated that these improvements would slow the decline of Delta fisheries. As a result, the expected supply yield would improve. It is anticipated that these facilities could be operational by 2000. The capital cost for this improvement is estimated to be about $125 million, with annual O&M costs of about $1.3 million. As a State Water Contractor, Metropolitan would pay only a portion of this cost. Although this solution is considered to be viable and cost-effective, it does not constitute a permanent solution to the Delta. As time goes on, deliveries would be expected to decrease without further commitments.

Full Delta Fix. As the overall demand for water increases and the need for low-salinity imported water intensifies, a long-term solution to the Delta becomes critical. It is expected that a Delta transfer facility would provide a long-term solution to Delta problems, increase supply reliability, reduce habitat impacts, and improve the water quality of Delta diversions. Although the specifics of a Delta fix are speculative, for the purposes of the IRP it was assumed to be similar in cost and operation to the Peripheral Canal. Removing the effects of the SWP export pumps from the southern Delta could eliminate or reduce the reverse flow conditions that negatively impact Delta fisheries and greatly improve the quality of the exported water. It was assumed that this improvement would be operational by year 2010. The capital costs are estimated to be $2.8 billion, with an annual O&M cost of about $10 million. Again, Metropolitan would pay only a portion of this cost.

South of Delta Storage. Finally, the potential exists for additional storage south of the Delta. This storage could include both reservoir projects and conjunctive use storage. The reliability of the SWP supply would increase significantly, especially during dry years, with the development of south of Delta storage. However, the benefits of the storage would only be maximized if a full Delta fix was implemented. The two DWR planning-level projects, Los Banos Grandes Reservoir and the Kern Water Bank, served as a basis for the reliability and cost estimates. Almost 3 million acre-feet of total storage capacity would be generated from such investments. The estimated costs for both storage projects are $2.4 billion for capital and $7 million annually for O&M.

Figure 3-6 summarizes the variability in SWP supplies available to Metropolitan by the year 2020 under the different investment strategies. If no investments were made, Metropolitan would receive less than 0.50 million acre-feet about 10 percent of the time, and never receive more than 1.0 million acre-feet. With Interim Delta improvements, Metropolitan would receive less than 0.80 million acre-feet about 10 percent of the time, and never receive more than 1.5 million acre-feet. With a full Delta fix, Metropolitan would receive less than 1.3 million acre-feet about 10 percent of the time, and be able to take its full entitlement deliveries of 2.0 million acre-feet about 50 percent of the time. Finally, South of Delta storage would allow Metropolitan to receive its full entitlement of 2.0 million acre-feet about 75 percent of the time.

Table 3-9 summarizes the potential risks associated with the SWP supplies.

Figure 3-6

Variability in SWP Supplies Available to Metropolitan Under Different Resource Investments (Year 2020)

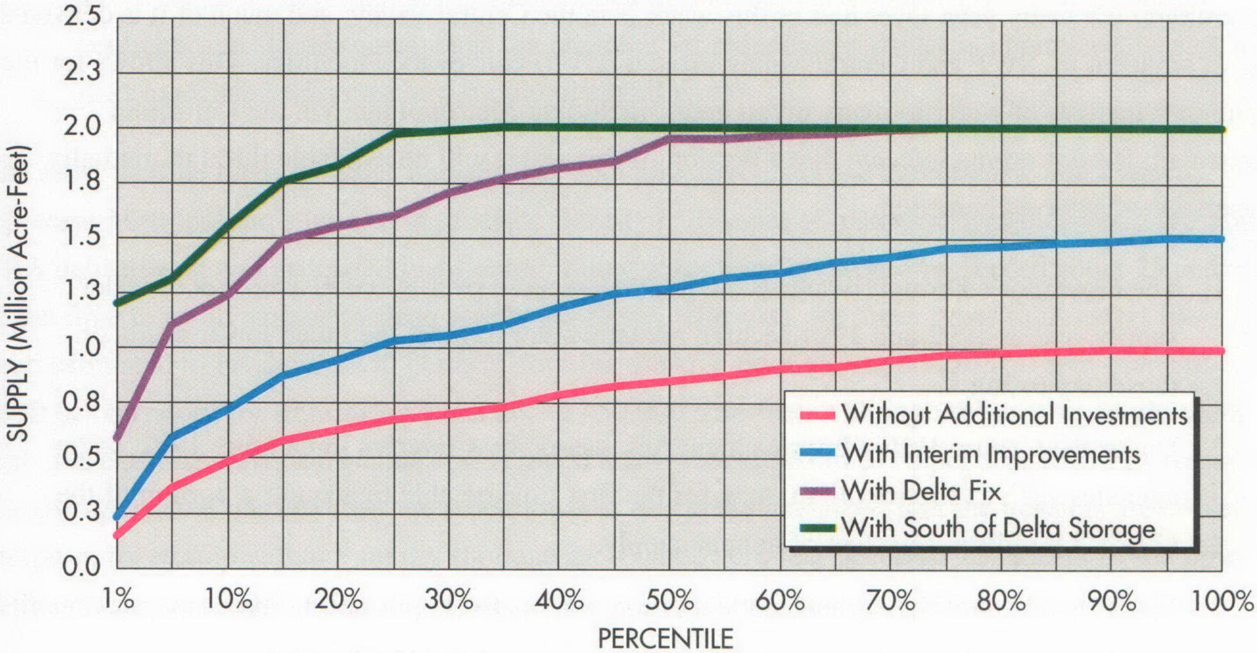


Table 3-9

Potential Risks Associated with SWP Deliveries

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Political Resistance: Organized political resistance to Delta improvements from various interest groups.	No additional supply obtained and loss of funds expended for planning and permitting.	– Maintain and strengthen North-South urban coalition. – Continue to participate in the CALFED process. – Public and business education.
Technology: Reliance on acoustic fish barriers are an unproven technology.	Could reduce expected supply yield from interim Delta improvements.	– Continue to test barriers before full implementation. – Develop other alternatives while long-term solution is pursued.
Regulatory: Reliance on channel improvements within aquatic habitat may not obtain ESA or CWA permitting.	No additional supply obtained and loss of funds expended for planning and permitting.	– Initiate and support a state-federal EIR/EIS process. – Develop and support a multi-species habitat conservation plan.

Voluntary Central Valley Water Transfers

Up to 27 million acre-feet of water (80 percent of California's developed water) is delivered for agricultural use every year. Over half of this water is in the Central Valley; and much of it is delivered by, or adjacent to, SWP and Central Valley Project (CVP) conveyance facilities. This allows for the voluntary transfer of water to many urban areas, including Metropolitan, via the California Aqueduct. Recent events indicate that a portion of this water will be available through mutually beneficial transfer agreements:

1. The Governor's Drought Water Bank in 1991 secured over 800,000 acre-feet of water supply, and in 1992 and 1994 secured enough water to meet the much lower needs of those requesting it.
2. Under the Central Valley Improvement Act, passed by Congress in October 1992, water agencies such as Metropolitan, may for the first time be able to acquire a portion of the CVP's 7.8 million acre-feet of annual supply.
3. Many members of the agricultural community are actively promoting the economic benefits resulting from the voluntary transfer of some of their entitlement water.

One of the most important aspects of any IRP is flexibility. A flexible strategy minimizes unnecessary or redundant investments (or stranded costs). The voluntary purchase of water between willing sellers and buyers can be an effective means of achieving flexibility. However, not all water transfers have the same effectiveness for ensuring flexibility. Within the IRP, several different types of water transfers were evaluated:

Core Transfers. Agreements to purchase a defined quantity of water every year, whether needed or not. These transfers have the benefit of more certainty in costs and supply, but tend to offset surplus imported water (available in most years) that is already paid for.

Spot Market Transfers. Water that is purchased only during the time of need (usually a drought). Payment for these transfers occurs only when water is needed, but there is usually greater uncertainty in terms of costs and availability of supply. An example of such a transfer was the 1991 Governor's Water Bank. An additional risk of spot market transfers is that the purchase may be subject to institutional limits or restricted access (e.g., requiring the purchasing agency to be in rationing before it is eligible to participate in the program).

Option Contracts and Storage Agreements. Agreements that specify the amount of water needed and the frequency or probability that the supply will be called upon (an option). These transfers have the best characteristics of both core and spot transfers. With option contracts and storage agreements the potential for redundant capacity is minimized, as are the risks associated with cost and supply availability.

The most flexible types of water transfers are spot and option/storage agreements, and as such, represent Metropolitan's long-term strategy. Based on 70 years of historical hydrology of SWP and CRA deliveries, it was estimated that Central Valley water transfers would be needed about 25 percent of the time to avoid summer season supply shortages. The costs for these types of transfers have been estimated to be about $250 per acre-foot for transfer amounts under 450,000 acre-feet and $450 per acre-foot for transfer amounts above 450,000 acre-feet. Although these costs might seem high, the equivalent average annual cost is much less — about $65 to $112 per acre-foot. The reason the average annual transfer costs are much lower is due to the likelihood that the transfers are needed. Suppose, for example, that a supply shortage of 400,000 acre-feet occurred 25 percent of the time. If transfers were used to offset this shortage, the average annual amount of transfers needed is:

$$400{,}000 \times 0.25 = 100{,}000 \text{ acre-feet}$$

Under a core transfer of 400,000 acre-feet, the costs would be higher because the payment is made regardless of whether the supply is needed. If the core transfer cost $250 per acre-foot, then the annual cost of that transfer would be:

$$\$250 \times 400{,}000 = \$100 \text{ million}$$

Alternatively, an option transfer requires an up-front payment (or premium) for the option to call the water, and a supply cost when the water is actually called. If the option cost was $50 per acre-foot every year and the supply cost was $250 per acre-foot (paid only when the water was delivered), then the average annual cost of that transfer would be:

$$(\$50 \times 400{,}000 \text{ AFY}) + [(\$250 \times 400{,}000 \text{ AFY}) \times 0.25] = \$45 \text{ million}$$

Storage

Storage is a critical element of Southern California's water resources strategy. Because Southern California experiences dramatic swings in weather and hydrology, storage is important to regulate those swings and mitigate against possible supply shortages. Simply put, storage provides a means of storing surplus water during normal and wet weather years for later use during dry years, when imported supplies are limited. Like water transfers, storage is a flexible supply. However, unlike many transfers, it can require large capital investments. When identifying the need for storage, it is important to understand the different benefits storage provides.

Emergency Storage

Southern California's three imported water conveyance systems (SWP, CRA, and Los Angeles Aqueducts) all cross the San Andreas Fault, where the probability of major earthquake is relatively high. Most experts believe that when a major quake occurs on this fault it could likely be a magnitude 8.0 or greater on the Richter Scale. Such a catastrophic event could render these vital conveyance systems useless for up to six months. It is also important to distinguish between the total volume (or capacity) needed and production. For emergency storage to be useful, it must be produced within a relatively short time period (less than six months).

Seasonal or Regulatory Storage

Seasonal storage or regulatory storage is needed every year in order to balance the seasonal demands for water and the seasonal availability of supplies. Even in normal weather years, when total annual supplies exceed demands, the summer season demand may not be met. With the use of storage, however, this seasonal imbalance can be regulated. As demands grow, so will the need for seasonal storage.

Carryover or Drought Storage

Water stored beyond a single year is available for droughts. The potential for this so called "carry-over" storage is large because of the vast storage capacity within the local groundwater basins. During the IRP, Metropolitan and its member agencies met with the groundwater basin agencies to assess the potential for groundwater conjunctive use storage. At the same time, the Association of Groundwater Agencies (AGWA) was created in order to work collectively on groundwater issues, including conjunctive use of imported water. Currently, AGWA is comprised of the six major basins in Southern California.

AGWA, in cooperation with Metropolitan, undertook a study to examine the potential for ground-water storage. Their findings indicated that up to 1.5 million acre-feet of total storage capacity could be dedicated to regional storage of imported supplies. Utilization of current facilities, along with some additional facilities, could result in about 350,000 acre-feet of additional groundwater production as a result of storing imported water. The costs associated with this use of groundwater storage ranges from $250 to $500 per acre-foot depending on the type of facilities needed.

In addition to the storage potential of the groundwater basins, Metropolitan's Eastside Reservoir Project was also evaluated to determine if its original planned timing and sizing was still appropriate given the change in resource mix potential. The site of the 800,000 acre-feet reservoir in Riverside County is strategically located to take advantage of available CRA and SWP deliveries. The cost for the Eastside Reservoir Project is estimated to be $1.9 billion in escalated dollars.

The evaluation of storage alternatives needs to address the potential trade-offs between groundwater and surface reservoir storage. Groundwater storage is usually very cost-effective and has the potential for large volumes of storage. However, groundwater storage is often limited by the production and spreading capacity of the local agencies and basin. While significant water may be stored in the ground, extraction may be relatively slow. In contrast, large regional reservoir projects are usually higher in costs, but benefit from the ability to quickly store and extract the available water.

PHASE 1 EVALUATIONS

The first regional assembly was the starting point for Phase 1 of the IRP. This "strategic plan" assembly set the stage for issues regarding the new challenges from Metropolitan's changing mission, affordability and financing strategies, governance, and criteria for the IRP. During the first assembly and subsequent meetings with the IRP Workgroup, a series of basic objectives were developed for the IRP:

1. Meet the reliability goal
2. Achieve the reliability in a least-cost manner
3. Minimize uncertainty and risks
4. Minimize environmental impacts
5. Ensure Flexibility

Development of Broad Resource Mixes

The major purpose for Phase 1 was the initial development and analysis of resource mixes, combinations of compatible resource options to form an overall strategy. Many of the resource options, especially local resources, had almost infinite development potentials. Developing all of the possible combinations of resource mixes and analyzing those mixes could have taken many years to complete. As a result, several broad resource mixes were developed in order to "bound" the problem and more quickly arrive at a direction for more detailed and refined evaluation. Although many different iterations of these broad resource mixes were evaluated, three alternative strategies emerged:

Emphasis on Local Resource Development

This resource mix included aggressive local investments in conservation (beyond the implementation of BMPs), water recycling, groundwater recovery, ocean desalination, and groundwater storage. While this mix relied on a full CRA delivery, it included only minimal investments for SWP supply and water transfers.

Emphasis on Imported Resource Development

This resource mix included aggressive investments in CRA, SWP supplies, and voluntary water transfers. While the mix included the full implementation of conservation BMPs and surface and groundwater storage investments, only existing supplies for water recycling, and groundwater recovery were assumed.

Intermediate Resource Development

This resource mix represented a balance between investments made to develop local resources and imported resources. The mix assumed a full CRA delivery and moderate investments for SWP supplies. The mix also included the full implementation of conservation BMPs and moderate investments for water recycling, groundwater recovery, and storage.

Evaluation of Resource Mixes

All of the resource mixes evaluated were designed to meet the same level of supply reliability. What differs among them are the costs associated with meeting that reliability, the risks associated with the resources, and the impacts to water quality.

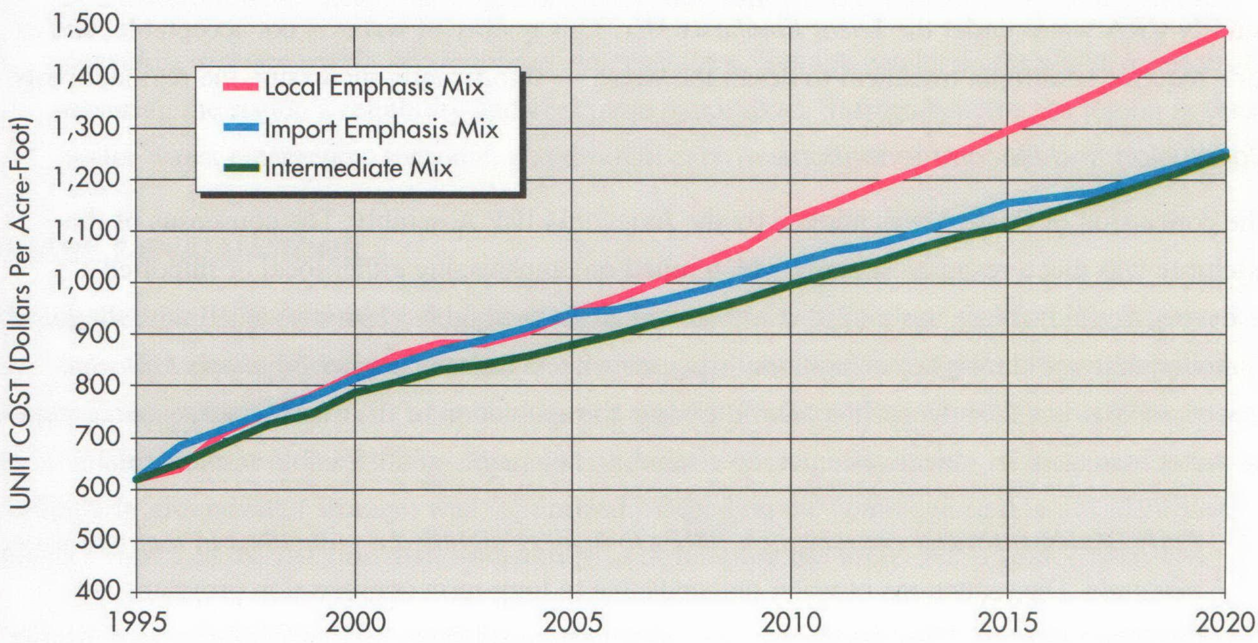
Cost

The average regional cost was used to evaluate the resource mixes, rather than using Metropolitan's wholesale costs. The regional cost includes Metropolitan's costs for resource development, regional infrastructure, and operating costs; as well as estimates of local resource development, infrastructure, and operating costs. The average unit cost of water for the region is derived by taking the total regional costs (Metropolitan and local) divided by the total retail-level demands. This average unit cost is the best measurement of overall affordability for the region. Figure 3-7 summarizes the projected region-wide average unit cost of water (dollars per acre-foot) for the three alternative resource mixes. The *Local Emphasis Mix* had the greatest overall regional cost (in escalated dollars) because of its heavy reliance on more expensive water recycling and desalination projects. The

Import Emphasis Mix was the second most costly alternative because of its heavy reliance on regional infrastructure. Even though the resource acquisition costs for imported water supplies are lower in costs than most local resources, the imported supplies require larger investments in regional infrastructure. The *Intermediate Mix* balances the higher costs of local resources with the higher costs of regional infrastructure for imported supplies in order to arrive at the lowest possible regional costs.

Figure 3-7

Average Regional Cost of Water (Escalated Dollars)



Water Quality

One of the more decisive evaluations that took place during the IRP focused on water quality. Although many aspects of water quality are important to Southern California, one characteristic received the most attention — salinity. Salinity or the amount of total dissolved solids (TDS) is important because source water high in salinity cannot be used for groundwater recharge (due to basin water quality limitations) or certain industrial and irrigation uses. In addition, if source water high in salinity is recycled, the effluent contains even greater amounts of TDS, potentially limiting the usefulness of supply produced through local projects. The TDS of the CRA supply currently averages 650 mg/L and is expected to increase to about 700 mg/L, even with planned salinity control measures for the Colorado River. The SWP supply, by comparison, has a TDS of about 350 mg/L.

Blending CRA and SWP waters improves the overall TDS for Metropolitan's member agencies. However, because of the configuration of Metropolitan's distribution system, it becomes increasingly difficult to provide adequate blends to each member agency when SWP supplies are limited. In fact, some member agencies can only receive SWP supply. Currently, member agencies are either receiving all SWP supply or a blend of CRA and SWP supply. The implementation of the *Import Emphasis Mix* would improve this situation because it brings down more SWP supplies. The implementation of the *Intermediate Mix* would maintain blends at today's level. However, implementation of the *Local Emphasis Mix* would result in reduced water quality. Many member agencies, such as San Diego CWA, MWDOC, Three Valleys MWD and much of Riverside County, would receive entirely CRA water under the *Local Emphasis Mix*. This quality of water is not acceptable, and as such requires additional treatment to desalt the water — significantly increasing the regional costs.

Conclusion and Recommendations

The conclusion of Phase 1 was marked by the June 1994 IRP Assembly. The consensus of the assembly was that a resource strategy which relied on emphasizing either local or imported resources would increase the overall risks to the region. The higher costs associated with the *Local Emphasis Mix* and the higher institutional risks associated with the *Import Emphasis Mix* were unacceptable to most of the participants. Based on the evaluation of the three broad resource mixes, six water management objectives emerged as common elements of all feasible resource plans.

1. *Fully implement water conservation BMPs to achieve significant reductions in regional water demands.* The reductions in water demands due to long-term conservation programs are necessary in every feasible resource mix alternative, and they constitute an important priority in the achievement of regional reliability goals.

2. *Make full use of economically feasible local water supplies, such as groundwater, reclaimed water, and desalinated water.* These local resources are most efficiently utilized as firm water supplies that produce a constant annual yield despite variations in hydrology. It is assumed that these local water supplies will be available even following a catastrophic event such as an earthquake.

3. *Maximize the use of deliveries from the Colorado River Aqueduct (CRA).* The CRA deliveries represent one of the most cost-effective supplies for the region, and should be maximized in any resource mix.

4. *Maintain and fully utilize dependable flows in the State Water Project.* Despite the challenge of resolving the complex issues in the Sacramento/San Joaquin Delta, there are significant advantages associated with realizing the benefits that can result from these investments, including cost-effective reliability and water quality.

5. *Optimize the use of Central Valley water transfers.* The ability to provide reliable deliveries of supplies to Southern California can be greatly enhanced through the acquisition of water transfers from the Central Valley. Using recently passed legislation, Metropolitan can continue seeking purchases of water through voluntary water marketing agreements under which water is transferred from agricultural uses in the Central Valley Project service area to urban uses.

6. *Maximize storage within Metropolitan's service area.* Storage can be a cost effective means to ensuring the region's reliability and should be maximized. Storage benefits the region in three major ways: emergency, seasonal, and drought carryover.

PHASE 2 EVALUATIONS

During the June 1994 Assembly, it became clear that the basis of Southern California's Preferred Resource Mix was an intermediate strategy consisting of both local and imported water supplies. Although the participants of the assembly agreed that the Preferred Resource Mix should be based on an intermediate resource strategy, there was a desire to ensure that the use of local resources, particularly groundwater storage, was "optimized." Based on the comments and issues identified during Phase 1 of the IRP, the major objectives in developing the Preferred Resource Mix were:

Ensure Reliability. The reliability goal of providing the full capability to meet all retail-level water demands under all foreseeable hydrologic events was one of the fundamental objectives of the Preferred Resource Mix.

Ensure Affordability. Another important objective was the goal of achieving the reliability in the least-cost manner for the entire region. The implementation of the Preferred Resource Mix should minimize increases in the average regional cost of providing a reliable and high quality water supply.

Ensure Water Quality. Although the Preferred Resource Mix needs to address many aspects of water quality, one characteristic is of particular importance — salinity. The water supply from the SWP is lower in overall salinity (total dissolved solids) than the supply from the CRA. Therefore, a sufficient blend of both these imported supplies is required in order to implement cost-effective local groundwater conjunctive use storage and water recycling projects.

Maintain Diversity. All of the resource options identified in the IRP have risks or uncertainties associated with cost, supply, or both. In order to minimize the overall risks associated with the long-term water resources plan, the diversification of resources is desirable. The concept commonly used in investment planning of "not putting all your eggs in one basket" is an appropriate analogy for wise resource planning. Further, since the success of one resource may be linked to the success of other resources, diversity can also play an important role in developing a sustainable regional plan.

Ensure Flexibility. The risk of stranded investments (costs which are incurred for facilities that are ultimately not needed due to changes in demands) should be minimized. Minimizing stranded investments allows for adaptability if future conditions change. In addition, avoiding (as much as possible) the development of unnecessary supply capacity during normal and wet weather years in order to improve supply reliability during droughts is another aspect of flexibility that reduces overall costs.

Incorporate Institutional/Environmental Constraints. The institutional, political, and environmental constraints in the development of a resource strategy are all important factors that need to be addressed. For example, although imported supplies may appear to be lower in costs than some local resources, the success of imported resources development may be difficult to achieve without a strong commitment to utilize feasible local resources (conservation, water recycling, and groundwater) first.

Least-Cost Planning

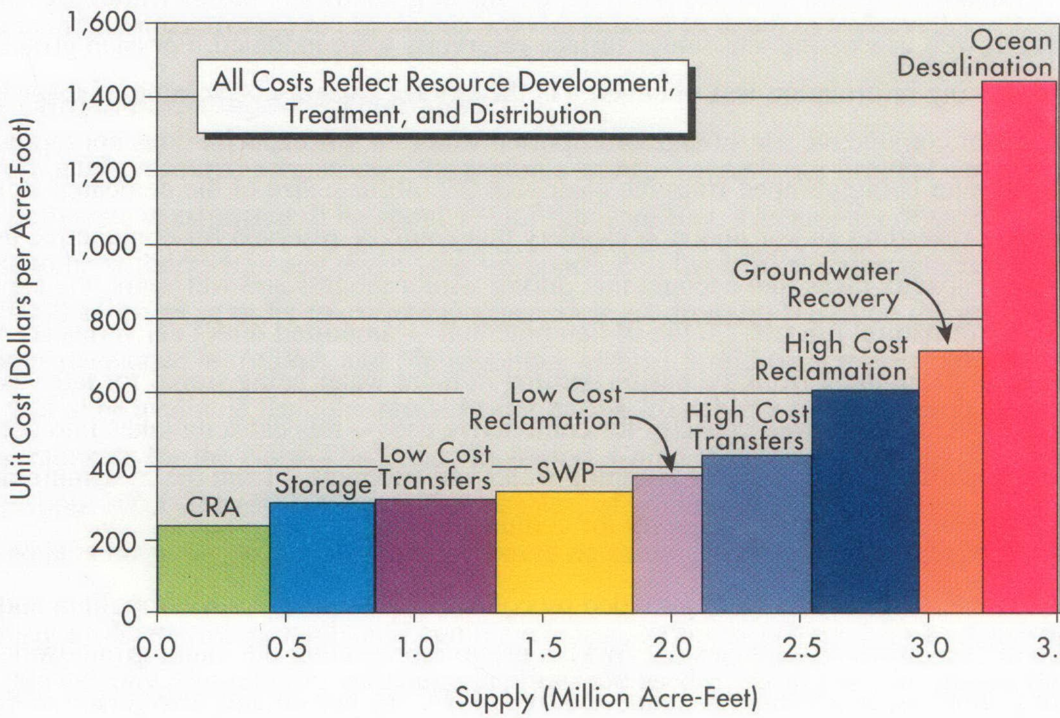
With these objectives in mind, the Phase 2 evaluation focused on the selection of a least-cost mix of resources to meet the additional supply needs identified in Section 2. The average incremental cost of developing dry year water supply for each resource was estimated and used to prioritize resource investments. The resource options were ranked in terms of their total unit costs (dollars per acre-foot) to help determine the appropriate resource targets for the Preferred Resource Mix. These unit costs included resource development (capital and acquisition) and O&M costs associated with treating, distributing and storing the water supply. Sunk costs (costs that must be incurred whether or not additional supplies are developed) were not included in the estimates. Examples of sunk costs include:

1. Costs for water recycling projects that are required by regulations for treatment of wastewater for disposal.
2. Environmental/regulatory costs for imported supplies that are needed to maintain existing levels of supply.
3. Supply costs related to emergency requirements.

In order to reflect the other objectives of the IRP, the supply yield for each resource was limited by several external constraints. Limitations in resource development (to incorporate risks, facility capacity, or environmental impacts) can be modeled in two ways: (1) limit the supply within a specified cost, or (2) increase the estimated cost to overcome the constraint. Both approaches should yield the same result. The approach used for the IRP was based on limiting the projected supply available within given estimates of costs. For example, the potential for CRA supply development, given a cost constraint that precludes construction of another aqueduct, was the capacity of the current aqueduct (1.3 million acre-feet per year). Another example was the limitation placed on Central Valley water transfers. While the total amount of Central Valley water transfers could reach about 800,000 acre-feet given the capacity in the California Aqueduct, water transfers were grouped into lower-cost and higher-cost categories based on institutional and environmental constraints — with the basic assumption that the more transfers the region needs during a drought, the higher the costs. Local projects for water recycling and groundwater recovery were categorized based on the expected supply and the marginal cost to produce the supply. A summary of the resources ranked by their unit costs and available dry year water supplies is presented in Figure 3-8.

Figure 3-8

Average Unit Cost of Resourcce Options (Dollars per Acre-Foot)



Groundwater and Surface Reservoir Storage Evaluation

Since substantial investments in local groundwater have already been made by local agencies, the marginal cost of basin storage is relatively low. As such, one of the major objectives for the IRP was to "optimize" the use of the local groundwater basins for regional storage. Unlike most other resources in which supply yield is known with some certainty, the supply benefit from storage requires more sophisticated evaluation based on the probability of surplus supplies.

To evaluate the variability and uncertainties associated with demands and supplies, Metropolitan developed a computer model known as IRPSIM. Using 70 years of monthly hydrology and weather, this model simulates future demands and supplies in order to estimate supply reliability (the frequency and magnitude of supply surplus and shortage). The model estimates the effects of random weather and hydrology on projected levels of demand and supply for the entire region. In doing so, it links historical hydrologic years for more realistic correlation — meaning that if 1933's weather was "mapped" over the year 2000's demands and supplies, it would match 1933 local weather with 1933 hydrology for SWP and CRA deliveries. The IRPSIM model keeps track of the total available surplus water for the region (on a monthly basis), the total storage capacity, and the monthly storage "put" and "take" conveyance that can be achieved using operational and system storage rules.

In order to evaluate the region's storage potential, the major groundwater basins within Metropolitan's service area, as well as existing and future surface reservoirs were modeled. For each groundwater basin, the following information was obtained: (1) the storage capacity or volume of space that could be used for conjunctive use storage of imported water — this capacity does not represent the production of water being pumped from the basin, but the ultimate size of the dedicated storage; (2) the monthly spreading and/or injection capacity that could be reserved for conjunctive use storage — this capacity takes into account that during winter months and wet years, the capacity would be used for natural run-off; (3) the in-lieu potential — imported direct deliveries are made available in-lieu of pumping from the basin resulting in more water being stored for later use; and (4) the monthly pumping or well capacity for conjunctive use — this capacity takes into account the basin's current monthly pattern for pumping water and subtracts it from the maximum monthly capacity to estimate the remaining capacity for conjunctive use.

The inputs to the storage model were provided by consultants working for Metropolitan and the Association of Groundwater Agencies (AGWA), a group representing the major groundwater basins in Southern California. In addition, as requested by AGWA, the consultants also reviewed the IRP-SIM model. Their extensive review indicated that the model accurately depicted the basic operations and storage potential of the major groundwater basins in the region and was an appropriate tool for assessing regional supply reliability.

In addition to the storage potential from the local groundwater basins, the major surface reservoirs (existing and planned) were included in the simulation model. The total capacity of storage available to Metropolitan from the existing DWR terminal reservoirs, Lake Mathews and Lake Skinner provide the region with emergency and regulatory storage (meeting part of the region's total storage requirements). As part of the Monterey Agreement, Metropolitan may "borrow" up to 220,000 acre-feet of Castaic and Perris reservoirs for drought carryover. However, the Monterey Agreement does not change the region's total storage needs. Metropolitan's planned Eastside Reservoir Project was also modeled to evaluate its original timing and sizing.

Storage requirements for the region include: (1) emergency; (2) drought carryover; and (3) seasonal. Emergency storage is critical because the region's imported water supply travels through three aqueducts that all cross the San Andreas fault, where most experts believe a major earthquake is long overdue. Seasonal or regulatory storage is required to match monthly and weekly patterns of demands and supplies. Although annual supplies from the SWP and CRA may be adequate to meet the annual demands, the monthly or weekly patterns of demands during the summer season may be greater than the supplies. Regulatory storage solves this seasonal problem. The region's emergency and seasonal/regulatory storage requirements were evaluated in detail in Volume 2.

Drought Carryover Storage Requirements

Based on monthly resource simulations, the region's storage capacity for drought carryover and seasonal deliveries is estimated to be about 1.9 million acre-feet. The amount of storage production that needs to be withdrawn in any given year (as opposed to the total storage capacity) is estimated to be 700,000 acre-feet in order to avoid shortages during a drought. Based on the groundwater assumptions developed by AGWA and Metropolitan, about 1.5 million acre-feet of total storage capacity would be available from the groundwater basins. To achieve this storage capacity, some capital investments for the North Las Posas, Raymond, Chino, and Orange County Basins would be required. About 300,000 to 400,000 acre-feet per year of additional groundwater production (beyond what is normally produced annually) could be made available for drought protection.

A significant problem with groundwater conjunctive use storage is getting the water into the basin. Much of the existing groundwater spreading facilities are used by local agencies during the winter months to capture the natural runoff, leaving little excess capacity for storing additional imported water for long-term purposes. If existing spreading facilities could be used during the summer months (when natural runoff is minimal), then more water could be stored for the region's benefit in the groundwater basins.

A benefit of the Eastside Reservoir Project is its ability to store surplus water during the winter, when the groundwater basins are using their spreading facilities to capture natural runoff, and deliver the water from the reservoir to the basins during the summer. The ability of the reservoir to move large quantities of imported water into and out of storage during short time periods is of great benefit to the region. Over 150,000 acre-feet per month can be moved in and out of the Eastside Reservoir Project. This ability to quickly move water is important because large quantities of surplus water from the SWP may only be available for short durations.

The results of the storage modeling indicate that when used together, the Eastside Reservoir Project and the groundwater basins can provide the region with about 2.3 million acre-feet of storage for emergency and drought protection (see Figure 3-9). Using 1967-1991 hydrology over projected demands and supplies shows how storage in the region is used. In this example, storage is building up during 1995 through 2005 (read from the right-hand side of the graph). During the summer of 2005, a drought (similar to the 1976-77 drought) occurs and the region's carryover storage level drops from 1.7 million acre-feet to about 0.8 million acre-feet. Wet years follow this drought event in 2007 and storage levels quickly climb to 2.2 million acre-feet. The period from 2015 to 2020 represents the region's last five year drought event (1986-1991), and storage levels drop to the emergency portion of Eastside Reservoir.

Table 3-10 summarizes the region's existing and potential surface and groundwater storage and identifies the additional storage requirements. The storage analysis reveals that about 800,000 acre-feet of additional storage is required for the region through the year 2020.

Table 3-10

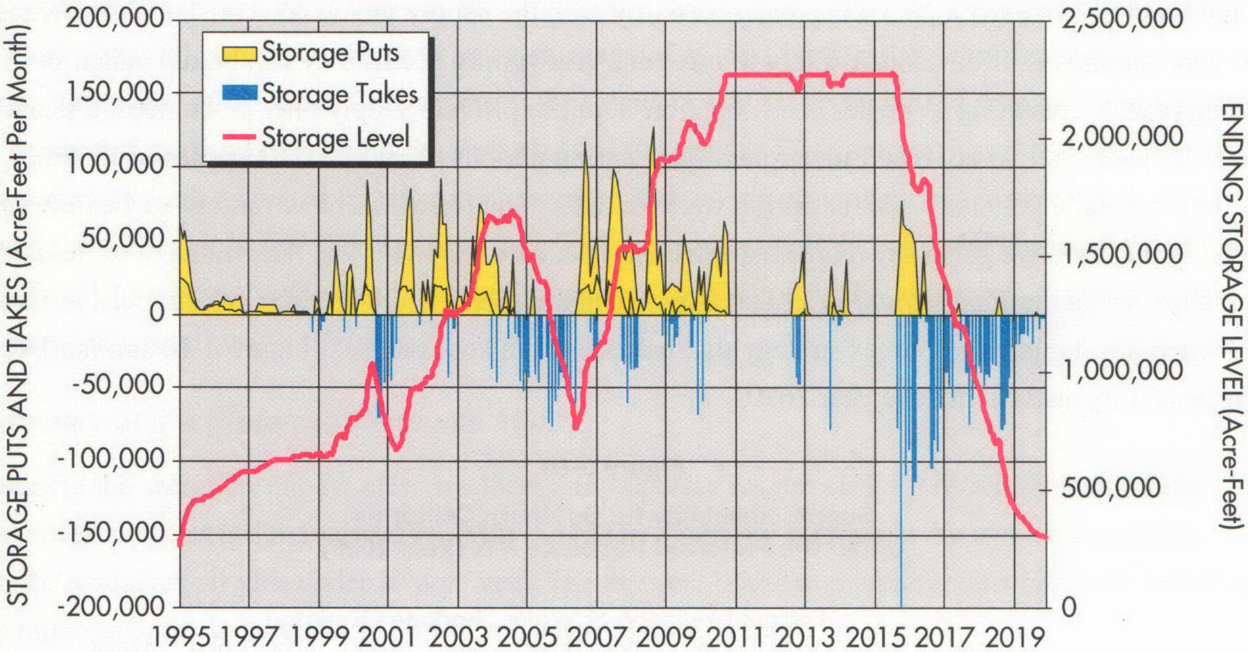
Southern California's Existing Regional Storage and Total Storage Requirements (Acre-Feet of Annual Storage Production)

Storage	Emergency Requirement	Seasonal/Regulatory Requirement	Drought Carryover Requirement
Existing Surface Reservoirs *	551,100	320,000	-0-
Groundwater Storage **	-0-	-0-	300,000
Total Regional Requirement	946,000	320,000	700,000
Remaining Storage Need	394,900	-0-	400,000

* Includes DWR terminal reservoirs and Metropolitan's Lake Mathews and Lake Skinner.
** Based on AGWA study of the potential for groundwater conjunctive use.

Figure 3-9

Carryover Storage Evaluation Using 1967-1991 Historical Hydrology



Developing the Preferred Resource Mix

The use of storage greatly reduces the potential water shortages identified in Section 2. However, future investments still need to be made in local supplies and Central Valley water transfers in order to meet the region's reliability goal. The remaining dry year water shortages after accounting for storage are estimated to be about 0.65 million acre-feet by year 2000 and 0.80 million acre-feet by year 2020. Based on a least-cost approach, and by limiting the amounts of Central Valley water transfers that Metropolitan could reasonably obtain during severe droughts, local targets for water recycling and groundwater recovery were developed. These resource targets include about 0.31 million acre-feet by year 2000 and 0.50 million acre-feet by year 2020. These targets were arrived at by conducting detailed reliability evaluations.

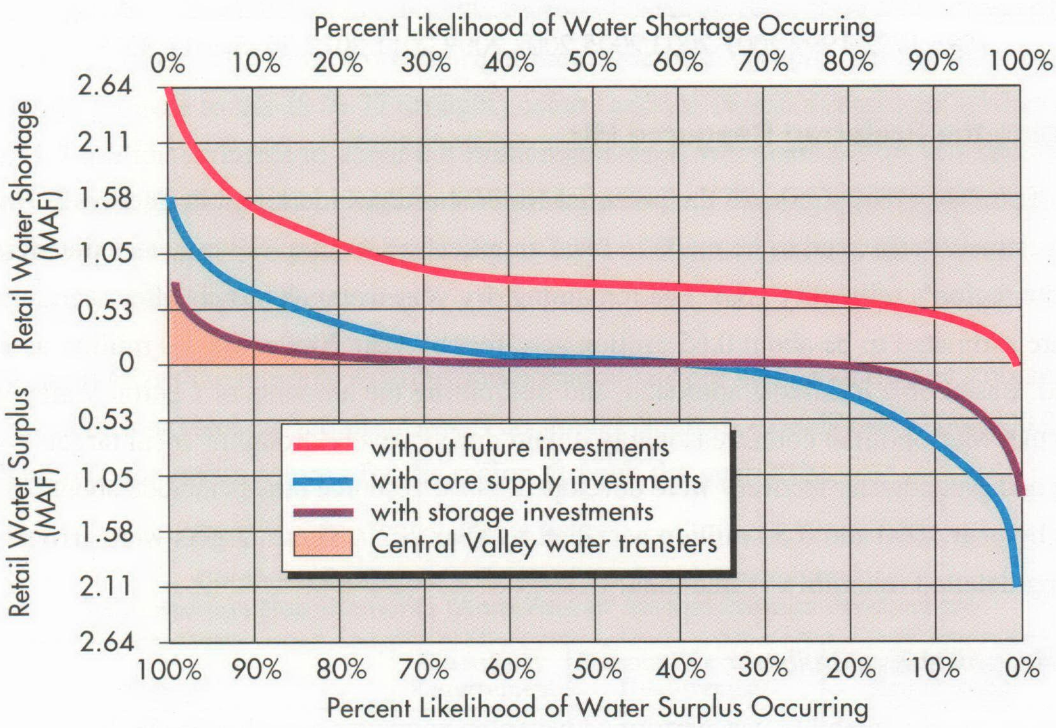
Supply Reliability Evaluation

Evaluation of supply reliability was performed using the computer model IRPSIM. Based on 70 years of historical hydrology from 1922 to 1991, estimates of water surplus and shortage were determined over the 25 year planning period. This reliability evaluation played a key role in determining the least-cost combination of local resources and Central Valley transfers. Specifically, the analysis was used to determine the appropriate amounts of core and flexible supplies.

Core supplies provide a certain amount of water all of the time, whether needed or not. Recycled water projects, safe yield groundwater production, and CRA supplies are examples of core supplies. The advantage of core supplies is greater certainty with the supply yield and cost. The disadvantage of core supplies is, if developed solely to meet dry year supply needs, they can be redundant in other years — resulting in higher costs. Flexible supplies provide supply only when needed (such as a dry year) and do not result in surplus water during periods of no need. Examples of flexible supplies include voluntary spot or option water transfers and storage. The advantage of flexible supplies is that they are generally more cost-effective than core supplies. The disadvantage of flexible supplies is that the supply yield is less certain. A combination of core and flexible supplies is needed when developing a resources strategy that balances both cost and risk. Figure 3-10 summarizes the reliability analysis for the year 2020.

Figure 3-10

Supply Reliability for Southern California Under the Preferred Resource Mix (Year 2020)



Notes:

1. Core supply investments include CRA and SWP imported supply development, water recycling, and groundwater recovery.

2. Storage investments include groundwater conjunctive use programs and construction of the Eastside Reservoir Project.

The reliability evaluation revealed that without future investments in local and imported supplies, the region could experience a supply shortage of at least 0.79 million acre-feet about 50 percent of the time (or once every other year). With core supply improvements, supply shortages are expected to occur about 40 percent of the time and a shortage of at least 0.79 million acre-feet could occur about 10 percent of the time. Core supply improvements also result in unused surplus water about 30 percent of the time (read from the lower half of the graph). With investments in storage, all retail water demands are achieved 80 percent of the time and the maximum amount of shortage is less than 1.05 million acre-feet. Storage also reduces the unused supply (surplus) by storing it for latter use. Finally, voluntary option and storage agreements for Central Valley water transfers eliminate all remaining retail water shortages.

Summary of the Preferred Resource Mix

Based on the selection of cost-effective local and imported resources, a Preferred Resource Mix was developed and is summarized in Table 3-11. The summary represents the available supplies that the resources provide under a "dry" year. The dry year does not represent the worst-case scenario, but rather a design criteria for planning, expected to occur about 1 in 10 years.

Table 3-11

Summary of Supplies Available During a Dry Year Under the Preferred Resource Mix

Dry Year Supply (Million Acre-Feet)	2000	2010	2020
Locally Developed Supplies:			
Local Production[1]	1.43	1.48	1.53
Water Recycling[2]	0.27	0.36	0.45
Groundwater Recovery	0.04	0.05	0.05
Local Groundwater Storage Production[3]	0.25	0.30	0.33
Metropolitan's Regional Supplies:			
Colorado River Aqueduct	1.20	1.20	1.20
State Water Project	0.75	0.97	1.35
MWD Storage & Water Transfers	0.34	0.49	0.46
Total Demand with Conservation BMPs[4]	4.28	4.85	5.37

[1] Includes groundwater and surface production and imported supplies from the Los Angeles Aqueducts.
[2] Does not include upstream Santa Ana recharge (which is included in local production).
[3] Represents the annual production, and not the total storage capacity (which is about 1.0 million acre-feet).
[4] Represents retail water demands under hot and dry weather conditions, assuming full implementation of conservation BMPs.

Regional Cost and Affordability

The graph indicates the likelihood of a water shortage (read from the top of the graph) and the estimated supply shortage (read from the upper left side of the graph) for the region. Given that retail water demands for the region during a dry year could be 5.3 million acre-feet by year 2020, a 10 percent retail shortage translates into 0.53 million acre-feet. Figure 3-10 also shows the likelihood of a water surplus (read from the bottom of the graph) and the estimated supply surplus (read from the lower left side of the graph) for the region.

One of the most important objectives of the IRP was development of an affordable resources plan. Assessing affordability required estimates of the total regional cost for the Preferred Resource Mix. The total regional cost was divided into: (1) imported supply development, (2) regional infrastructure and operations, (3) local supply development, and (4) local infrastructure and operations. The costs for imported supply development were based on estimates made by Metropolitan and the California Department of Water Resources. The costs for regional infrastructure and operations were based on Metropolitan's capital improvement plan developed in Volume 2 of this series of reports, entitled *Metropolitan's System Overview*. These costs reflect the latest projection of demands on Metropolitan based on the local resource targets identified in the regional plan. The costs for local supply development (conservation, water recycling, and groundwater programs) were based on local project information collected by the member agencies. Finally, the costs for local infrastructure and operations were estimated by evaluating the current breakdown of retail-level costs by local agencies. Generally, all costs were inflated using a 3 percent annual escalation factor. Figure 3-11 summarizes the average retail costs for the Preferred Resource Mix.

The cost analysis indicates that the region's average retail cost for water (dollars per acre-foot) will increase from its current level of $620 per acre-foot to $1,000 per acre-foot by 2010 and $1,250 per acre-foot by 2020, representing an average increase of about 4 percent per year in escalated dollars. In constant or real dollars (removing the escalation factor), the retail costs are excepted to increase by less than 2 percent per year over the next 25 years. Most of the increase in costs will occur over the next 10 years, as a result of regional infrastructure investments needed to improve reliability and water quality. Figure 3-12 summarizes the breakdown of the retail cost by major category. Most of the costs associated with providing Southern California's water supply will rest with the 350 local water providers (about 55 percent).

Figure 3-11

Average Retail Cost for Preferred Resource Mix

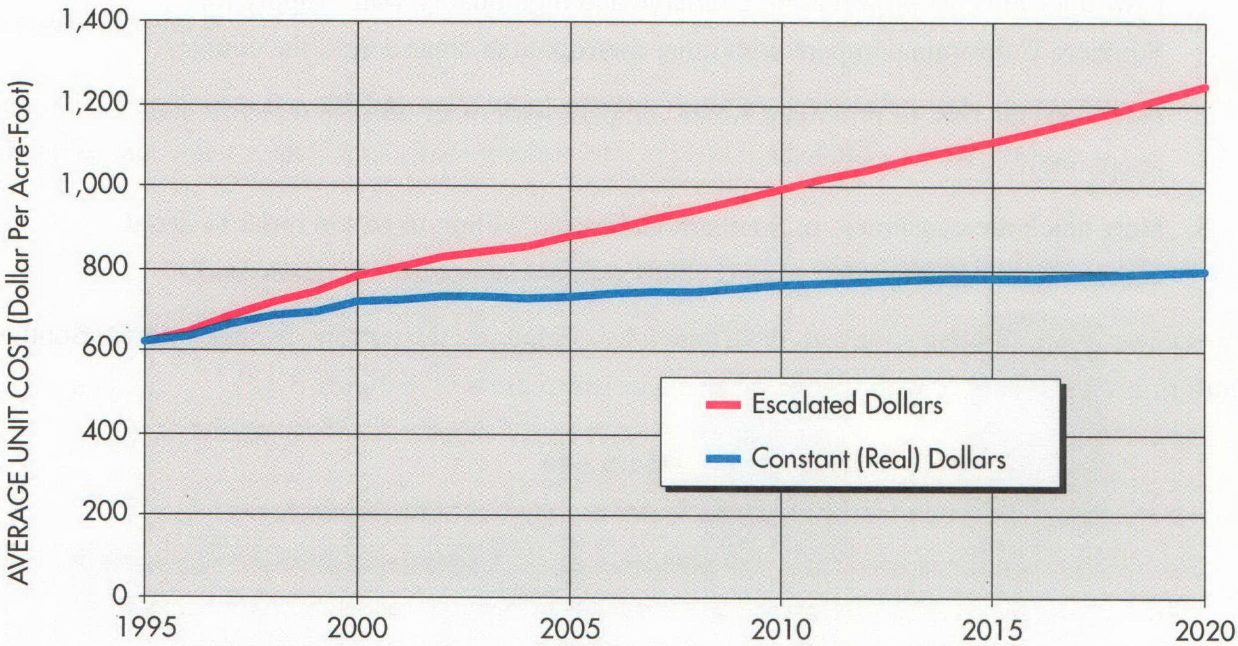
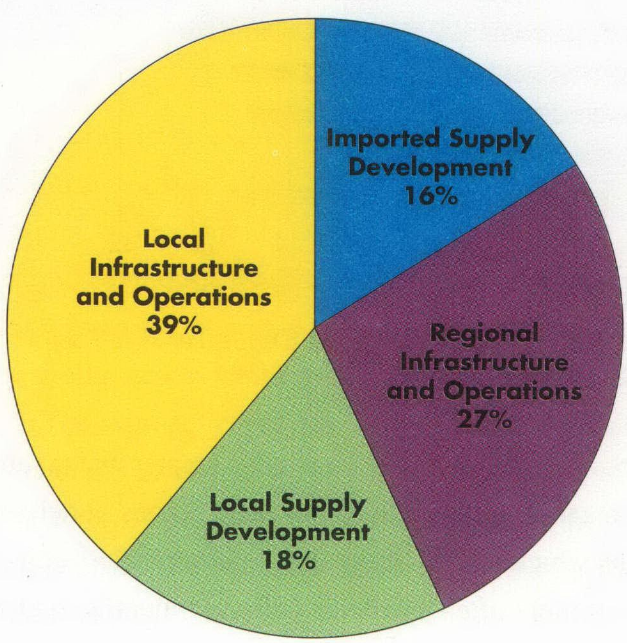


Figure 3-12

Breakdown of Average Retail Water Costs for the Preferred Resource Mix (Year 2005)



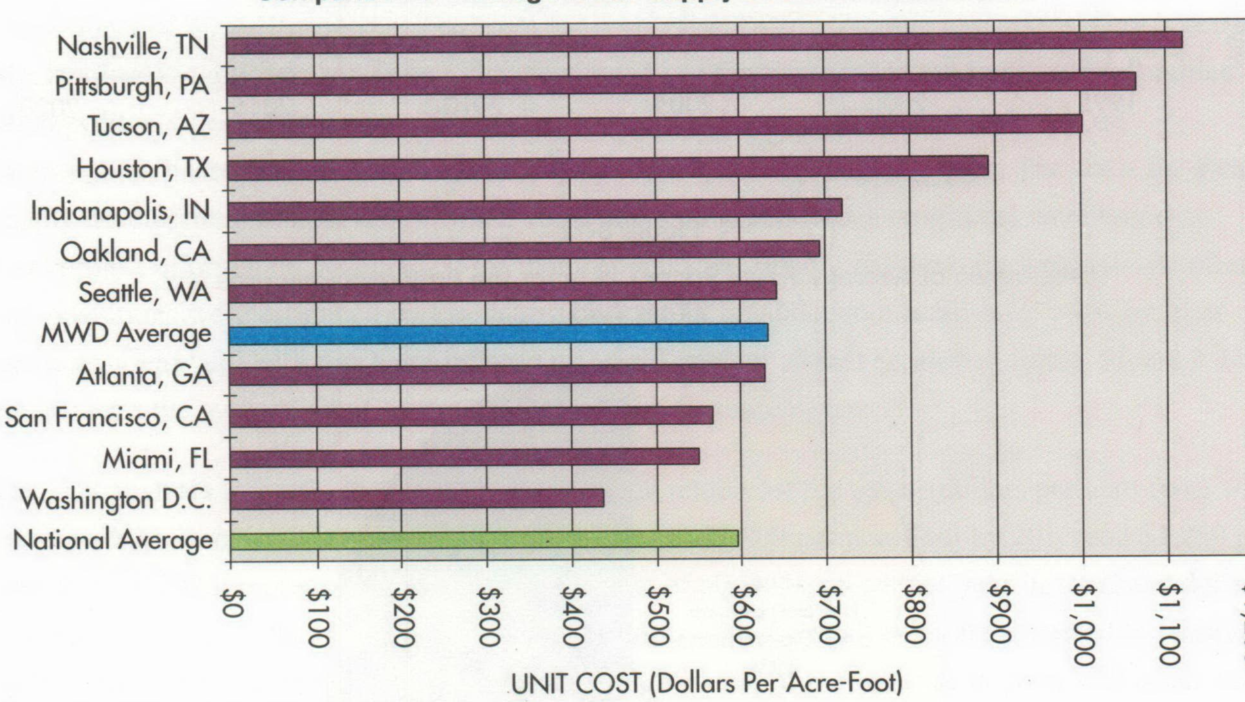
In assessing affordability, several questions were asked:

1. How does the cost of providing a reliable and high quality water supply for Southern California compare with other metropolitan areas across the country?
2. How does the cost of providing water compare with other utilities (electric, gas, telephone)?
3. How much are consumers in Southern California willing to pay in order to avoid chronic water shortages?

The answer to the first question was determined by comparing the current average cost for Southern California's water supply with that of other major urban areas (see Figure 3-13).

Figure 3-13

Comparison of Average Water Supply Costs for Urban Areas



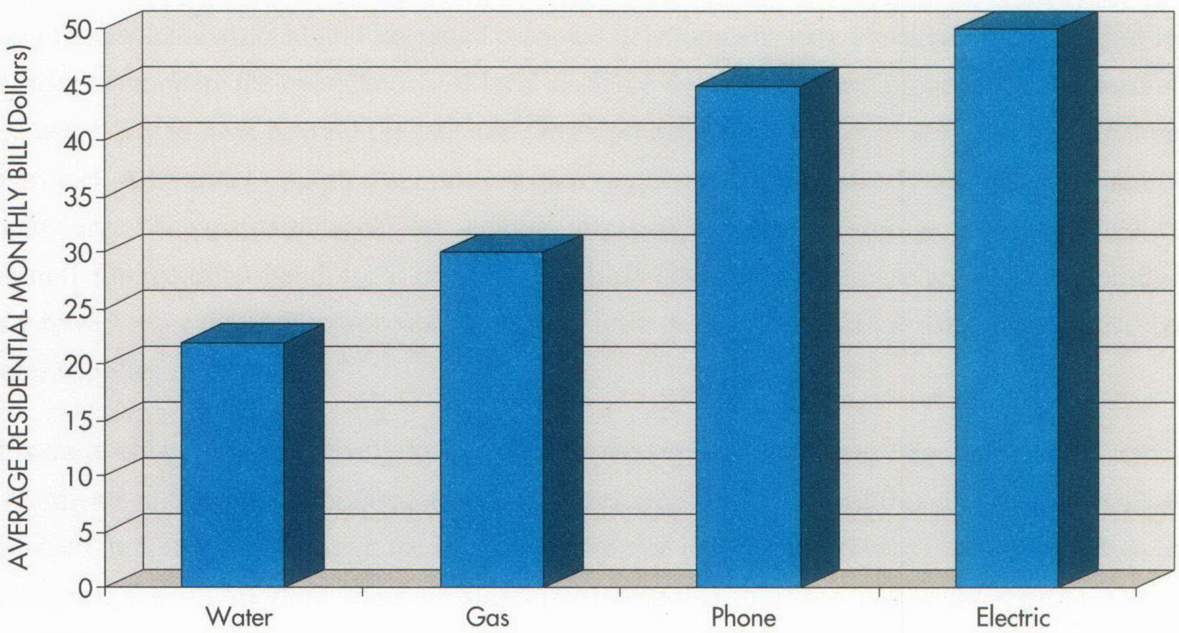
Source: Ernst & Young Water Rates Survey, 1994.

Based on this comparison, many other urban areas have greater water supply costs. In fact, many of these other water service areas experience frequent interruptions in deliveries, even though they have hydrologic conditions which are far better than Southern California. Mandatory restrictions or penalty pricing are imposed more often during the summer months in Oakland, New York, Washington D.C., Seattle, and major urban areas in Florida than they are for this region (only twice did Metropolitan ever have to impose mandatory restrictions in deliveries). Based on the analysis of reliability and cost of other metropolitan areas, the cost of Southern California's water supply compares favorably.

Figure 3-14 compares the average residential monthly bills for water and other major utilities, indicating that water makes up a small fraction of a typical household's yearly budget.

Figure 3-14

Comparison of Residential Monthly Utility Bills in Southern California



Finally, willingness to pay surveys can be useful to gauge customer's desires about reliability and affordability. In 1994, the California Urban Water Agencies (CUWA) conducted an extensive statewide contingent valuation survey of residential customers to find out their tolerance for chronic water shortages. This surveying technique posed realistic scenarios of water shortages with different magnitudes and frequencies in order to obtain the willingness to pay to avoid such shortages. The responses were surprisingly similar across California. Over 1,000 residents in Southern California were included in this survey. The average respondent for this region indicated that they would be willing to pay between $10 and $15 more per month (or $144 annually) to avoid water shortages similar to that experienced in 1991. According to the cost analysis of the Preferred Resource Mix, the average residential monthly cost would increase about $3 to $5 over the next 10 years — far below what respondents indicated they would pay for increased reliability.

SECTION 4 – METROPOLITAN'S ROLE IN THE INTEGRATED RESOURCES PLAN

TRADE-OFF BETWEEN REGIONAL COSTS AND LOCAL COSTS

Much of the IRP focused on trade-offs — costs vs. risk, local supplies vs. imported supplies, source water quality vs. additional treatment, etc. One of the significant trade-offs analyzed in the IRP was the expenditure of resource development funds at the local level vs. expenditures by Metropolitan. The relative costs of local and imported resource development vary considerably in several respects. In order to compare the overall costs of local resource development vs. imported supply development, it is necessary to look beyond the isolated development costs associated with an individual option or project. Additional imported supplies, which frequently have relatively low development costs, create large "downstream" needs for regional infrastructure such as storage, treatment, and transmission. On the other hand, local projects like those designed to increase groundwater production, may have higher development costs but require little or no additional infrastructure to distribute water supplies to customers.

This trade-off between relatively low-cost imported supplies requiring large regional infrastructure investments and relatively high-cost local supplies requiring little additional local infrastructure was analyzed in detail in arriving at the least-cost resource plan for the region. The implications of this trade-off are also important when considering Metropolitan's water management programs, designed to encourage cost-effective local resource development.

The regional savings and increased reliability resulting from the development of local resources, rather than exclusive dependence on Metropolitan for additional supplies, is the foundation supporting Metropolitan's historical willingness to provide financial incentives for local water resources development. The IRP process improved the quantification of the regional benefits resulting from local resources and provided additional information and analysis that serves as the basis of proposed program modifications and improvements to these programs.

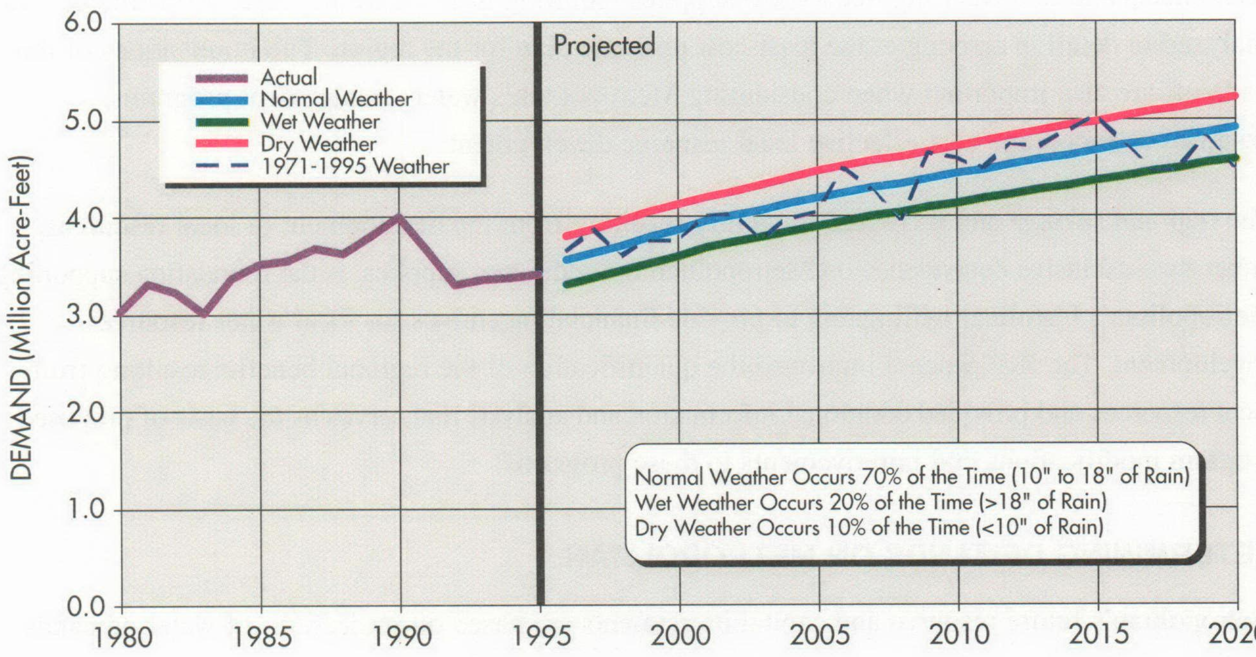
DETERMINING DEMANDS ON METROPOLITAN

Metropolitan's future resource and capital investments are based on projections of water demands for Metropolitan's system from the implementation of the Preferred Resource Mix. Demands on Metropolitan were determined based on: (1) projections of retail water demands for Metropolitan's service area; (2) projections of local supplies, including groundwater and surface reservoir production, Los Angeles Aqueduct deliveries, recycled water production; and (3) statistical variations of both retail demands and local supplies, based on 70 years of historical weather and hydrology data. See section 2 for a more detailed discussion of the methodology used to develop retail demand projections for the region.

In simple terms, forecast of water demands on Metropolitan are generated by taking projections of retail water demands and subtracting projections of local supplies. This approach is complicated because demands and supplies can vary substantially from year to year due to weather and hydrology. For example, retail demands can vary ± 7 percent from "normal" in any given year due to local weather conditions. But, because Metropolitan's supplies are the swing supply for the region as a whole, this variation in demand alone translates into a ± 14 percent change in Metropolitan's water sales.

Figure 4-1 presents the range in retail demands due to weather and demonstrates the possible variation in retail demands using 1971 through 1995 weather.

Figure 4-1
Projected Retail Demands



Local supplies can also vary substantially due to hydrologic conditions. The Los Angeles Aqueduct (LAA) deliveries, for example, have varied from 200,000 acre-feet per year to about 500,000 acre-feet per year due to runoff conditions in the Owens Valley. When runoff conditions in the Owens Valley are above-normal, LAA deliveries increase, reducing the City of Los Angeles's reliance on Metropolitan's system. Conversely, below-normal runoff in the Owens Valley increases the need for Metropolitan's deliveries. Likewise, local surface reservoir and groundwater basin production can be significantly affected by local runoff conditions.

Figures 4-2, 4-3 and 4-4 illustrate the range and variation in Los Angeles Aqueduct, surface reservoir and groundwater production respectively.

Together, variations in retail demands and local supplies can cause demands on Metropolitan to fluctuate from normal by as much as ± 20 percent in any given year. This is a possible range of about 800,000 acre-feet per year. Table 4-1 presents the forecast and range of demands on Metropolitan under three broad weather conditions: (1) wet conditions (over 18 inches of local rainfall), expected to occur 20 percent of the time; (2) normal conditions (10 to 18 inches of local rainfall), expected to occur 70 percent of the time; and (3) dry conditions (less than 10 inches of rainfall), expected to occur 10 percent of the time.

Figure 4-2

Los Angeles Aqueduct Deliveries

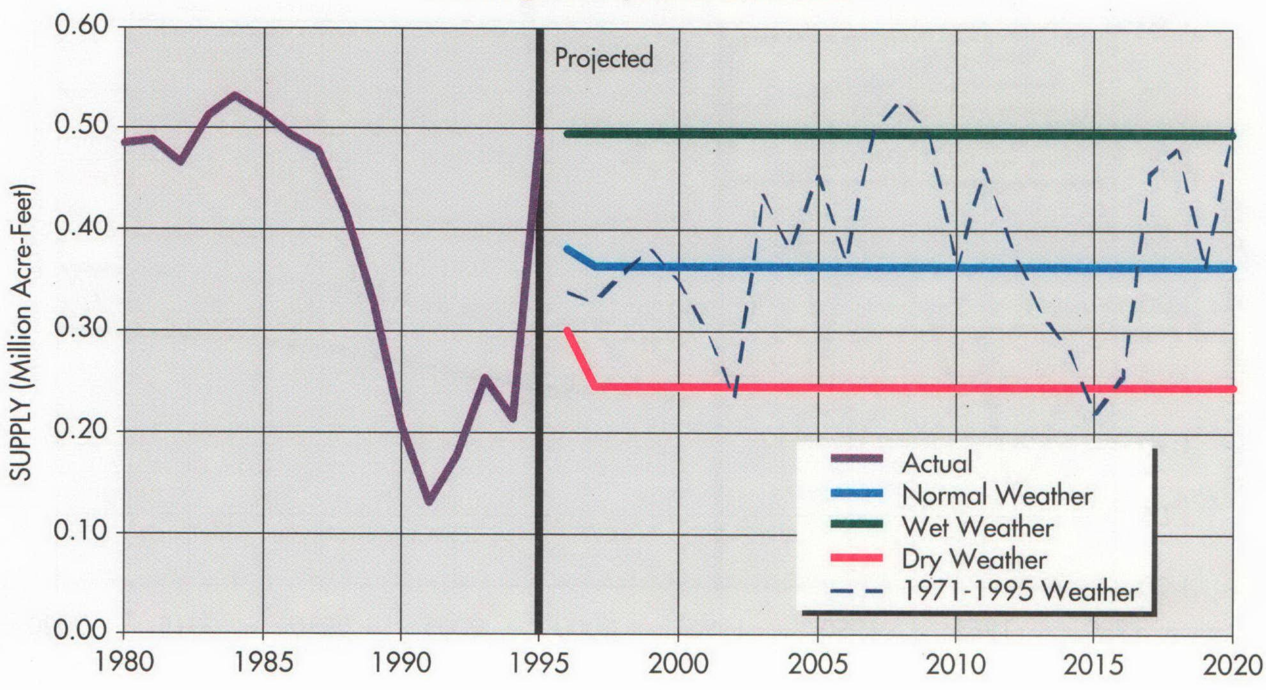


Figure 4-3

Local Surface Water Production

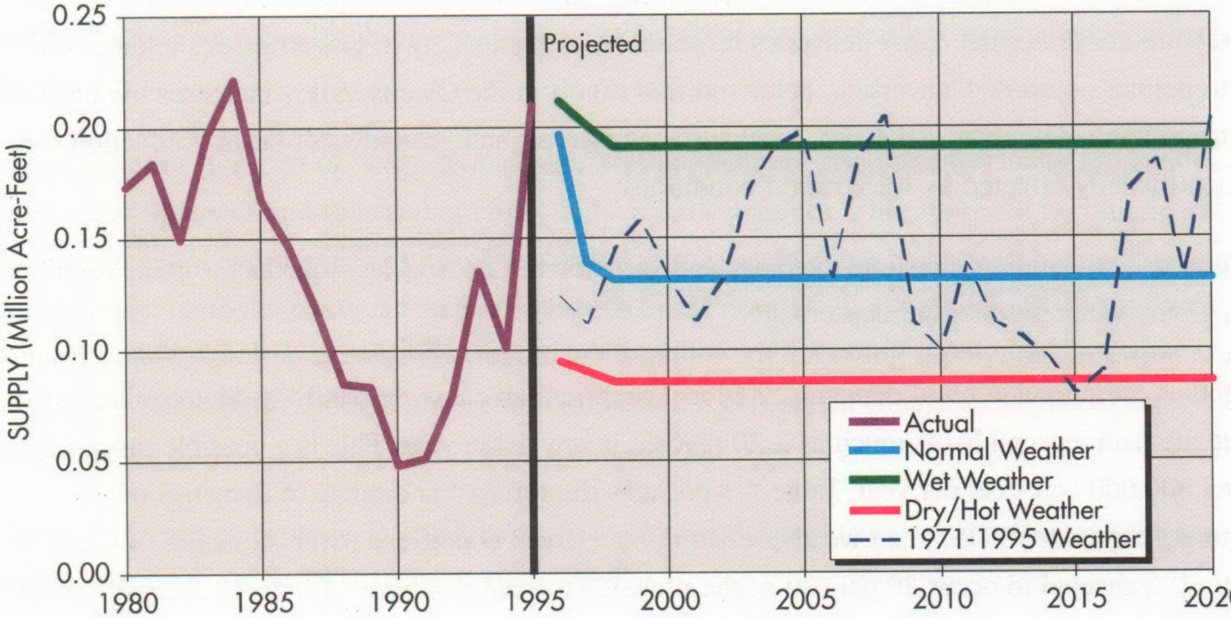


Figure 4-4

Local Groundwater Production

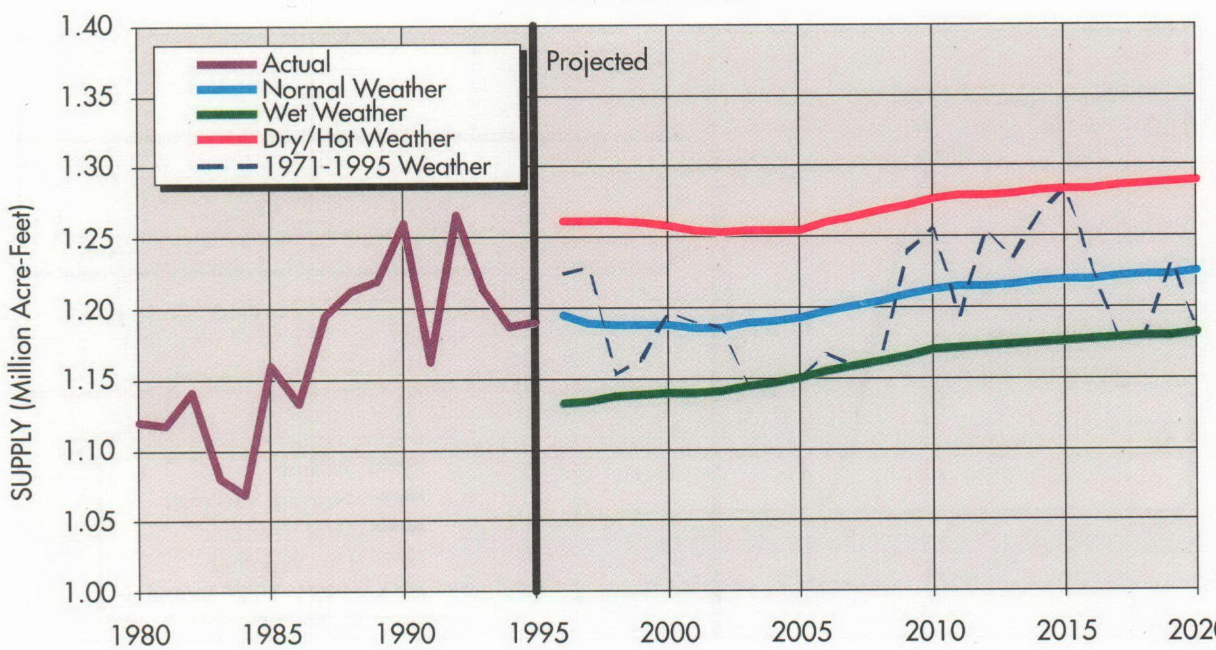


Table 4-1

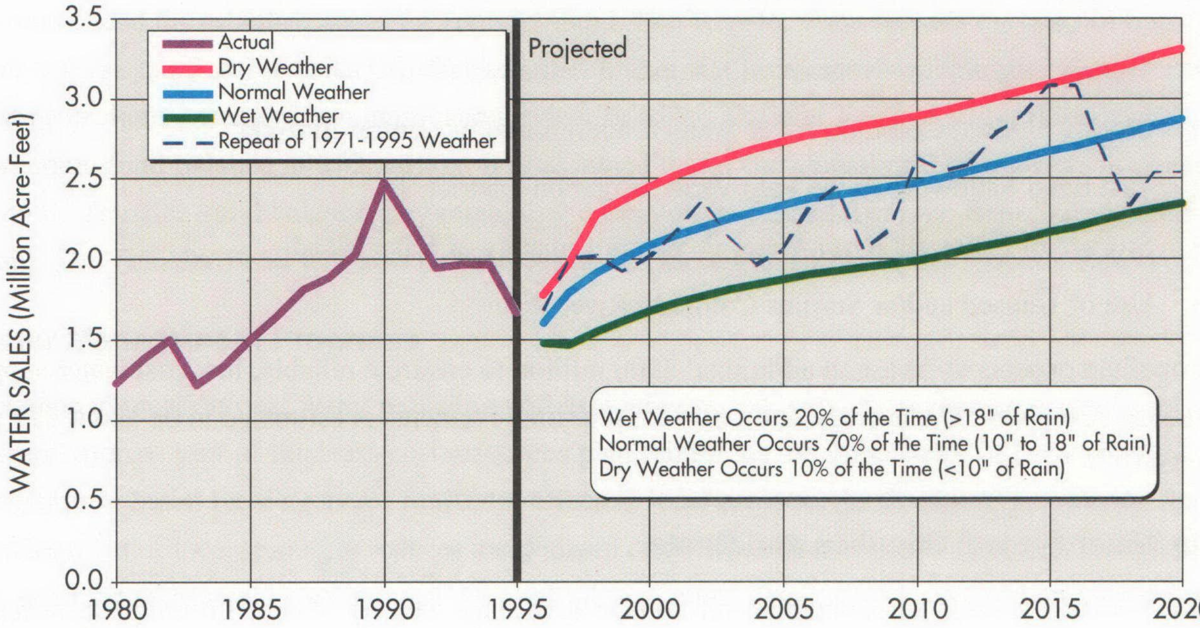
Total Demands on Metropolitan (Million Acre-Feet)

Fiscal Year	Wet Weather (20% of the Time)	Normal Weather (70% of the Time)	Dry/Hot Weather (10% of the Time)
1995-96	1.48	1.60	1.78
1999-00	1.68	2.08	2.45
2004-05	1.88	2.34	2.73
2009-10	2.00	2.48	2.89
2019-20	2.35	2.87	3.30

Figure 4-5 presents the demand forecast for Metropolitan's system and the range in demands under different weather conditions. The wet and dry weather condition bounds were generated using 70 different weather/hydrologic traces. To demonstrate the variability in Metropolitan's demands, a weather trace using 1971 to 1995 weather and hydrology is also shown in Figure 4-5.

Figure 4-5

Total Demands on Metropolitan



METROPOLITAN'S RESOURCES DEVELOPMENT AND INFRASTRUCTURE

The Preferred Resource Mix identified by the IRP process is an investment strategy that balances the risks and costs of securing a high quality, dependable water supply for the region between investments in imported supply resources and its associated regional infrastructure and, local supply resources. The following section briefly describes Metropolitan's estimated cost for each of the resource options within the Preferred Resource Mix . A detailed discussion of these resource options and the development of the Preferred Resource Mix is discussed in Section 3.

Colorado River Aqueduct Supplies and Costs

The CRA deliveries represent the least-cost source of imported water for the region. Power is the primary component of CRA costs. Current cost projections are based on existing Hoover Power Plant and Parker Power Plant arrangements. CRA power costs are expected to increase from approximately $30 million in 1996 to $50 million in 2005. As cost impacts associated with the potential sale of all or part of the Hoover and Parker generating facilities become more certain they will be incorporated into the long-term financial forecast.

In order to operate the CRA at full capacity, several programs are either in place or potentially being developed. These programs include:

- Water Conservation Program with Imperial Irrigation District
- Storing Unused Colorado River Water Underground in Central Arizona
- Test Land Fallowing in the Palo Verde Irrigation District
- Storage of Colorado River Water in Vacant Capacity of Lake Mead
- Use of Unused and/or Surplus Colorado River Water

Metropolitan expects to invest an additional $200 million to ensure a reliable, low cost water supply for the next 30 years. The average unit cost for these improvements is estimated to be about $75 per acre-foot.

State Water Project Supplies and Costs

Over the next 25 years, Metropolitan intends to take an average delivery of over 1.0 million acre-feet per year from the State Water Project (SWP) accounting for 24 percent of the retail demand in Southern California. To ensure that the SWP is a reliable supply resource in the future, the IRP assumed the need for interim Delta improvements (including South Delta channel enlargements and barriers, and acoustic fish barriers on the Sacramento River) followed by a long-term Delta solution. The annual cost to Metropolitan for interim Delta improvements is approximately $5 million. In the long-term, the single largest increase in total SWP costs is based on the estimate of Metropolitan's share of the additional debt service costs for a Delta transfer facility. By 2000, Metropolitan's share of the additional SWP debt service costs for a Delta facility are estimated to be $60 million, increasing to $78 million by 2010. However, existing capital costs will decrease over time as out-standing debt matures. Total SWP costs are expected to increase from $265 million in 1996 to $365 million by 2005.

Central Valley Water Transfers

Water transfers from the Central Valley are another critical component of the Preferred Resource Mix identified by the IRP. It is possible that even with improvements in the reliability of the SWP and development of local supplies, transfers may be needed as often as 25 percent of the time in order to meet the regional reliability goal. By 2005, in order to avoid a shortage in a drought situation, Metropolitan may have to expend as much as $105 million in a single year to purchase up to 300,000 acre-feet of water transfers.

To avoid large one-time rate increases needed to purchase transfers, the *Long-Range Finance Plan* recommended the establishment of a Transfer Fund. The Transfer Fund spreads the costs of transfers over several years and reduces the likelihood of a large rate increase in a single year. Long-term cost projections assume a maximum annual deposit to the Transfer Fund of $24 million with a maximum fund balance of $72 million. It is assumed that if the annual cost of transfers is greater than the Transfer Fund balance, any remaining costs will be funded from the Rate Stabilization Fund. The Transfer Fund will also be used to finance the initial filling of the Eastside Reservoir.

Water Management Programs

Reliance upon additional water recycling and groundwater recovery, groundwater storage, and conservation as part of the least-cost resources plan reinforces the importance of Metropolitan's programs to assist local agencies fund cost-effective local projects. As discussed previously, the development of local resources reduces the demand on Metropolitan's system and, therefore, reduces the need for additional investment in regional infrastructure. Total water management program costs are expected to increase from $29 million in 1996 to over $86 million in 2005, as yields from currently approved local projects increase, additional local projects are added to meet IRP resource targets, and the implementation of conservation Best Management Practices (BMPs) continues.

Conservation

Metropolitan's Conservation Credits Program (CCP), which pays local agencies up to $154 per acre-foot for conserved water, is used to help local agencies invest in water conservation projects. Through the CCP, over 890,000 low flow toilets and over 1.6 million low flow shower heads have been installed to date, saving approximately 44,000 acre-feet per year. In addition, the CCP is also developing commercial, industrial, and landscape programs. The total cost for the CCP is assumed to increase by 5 percent annually from the 1995-96 budget level of $18 million to $29 million by 2005. Detailed program budgets and implementation plans are being refined and developed as more becomes known about the effectiveness of conservation measures.

Local Resources Program

Water recycling and groundwater recovery are two important local resource components of the Preferred Resource Mix. The IRP identified the need for an additional 230,000 acre-feet per year of supply from water recycling by year 2020. The existing water recycling projects are providing about 160,000 acre-feet per year. To help local agencies develop water recycling and groundwater recovery projects, Metropolitan currently operates a Groundwater Recovery Program (GRP), which pays local agencies up to $250 per acre-foot for the recovery of contaminated groundwater; and a Local Projects Program (LPP), which pays local agencies $154 per acre-foot for recycled water. The LPP currently helps fund 40 local projects with an ultimate annual yield of 179,000 acre-feet. The GRP currently helps fund 9 local projects with an ultimate annual net yield of 30,000 acre-feet.

As part of the implementation of the IRP, it was proposed that the GRP and LPP be merged together into the Local Resources Program (LRP) and that the incentive payment for water recycling projects be increased to $250 per acre-foot. Under this proposed program structure all approved local recycling and groundwater recovery projects with costs greater than Metropolitan's treated basic rate (plus amortized New Demand Charge where applicable) will be paid on a sliding scale receiving up to $250 per acre-foot of production. The future costs for the LRP program are estimated to increase at an annual average rate of 43 percent from $10.3 million in Fiscal Year 1995-96 to $54.3 million by Fiscal Year 2004-05. However, Metropolitan's LRP costs are highly dependent upon local recycling production and therefore may increase at a slower rate due to slower development of local recycling production. In addition, some of the additional recycling needed to achieve the IRP goal may be produced by projects that do not require an incentive. The current estimate of future LRP costs assumes:

- Increasing yields of currently approved projects
- 14 of the 40 LPP projects convert to the LRP program

- 9 approved GRP projects continue to receive funding under their existing contracts
- 100 percent of the additional local project yield required to meet the IRP goal receives funding at the average incentive level

Local Storage Programs

To encourage local agencies to manage the groundwater resources in a manner that is beneficial to the region, Metropolitan created the Seasonal Storage Service program (SSS). The SSS provides imported water at an average discount of $125 per acre-foot during the winter season. This discount allows local agencies to pump more groundwater during the summer season (reducing peaks on Metropolitan's system) and during dry years when imported supplies are more scarce.

Metropolitan is also beginning to develop contractual conjunctive-use storage agreements with its member agencies. Over the next ten years it is expected that Metropolitan will spend $175 million helping member agencies construct additional extraction and recharge facilities. Capital costs for contractual groundwater storage projects are assumed to be debt financed with revenue bonds and are included as part of Metropolitan's debt service costs. The annual variable operating costs for conjunctive-use programs will vary with demand and the availability of supply. The average annual O&M cost for conjunctive use programs is estimated to be $3.3 million.

Regional Infrastructure Needs

In order to provide for the treatment, distribution and storage of imported supplies, Metropolitan is implementing a major 10-year Capital Improvement Program (CIP). This CIP is expected to invest more than $4.1 billion in regional infrastructure over the next 10 years. As part of this effort, significant investments have already been made in feasibility and planning studies, design work and construction. Volume 2, entitled *Metropolitan's System Overview*, provides a detailed report on the proposed timing, sizing and location of each of Metropolitan's regional infrastructure investments. The major components of the CIP are summarized below:

Eastside Reservoir Project

With a total design capacity of 800,000 acre-feet the Eastside Reservoir will provide 400,000 acre-feet of emergency storage and 400,000 acre-feet of carryover storage for the region. The Eastside Reservoir Project is expected to be completed in 1999 at a total project cost of $2.0 billion, of which $500 million has already been spent on property acquisition, environmental mitigation, and design. Also included in the total cost is about $300 million for project contingencies.

Inland Feeder Project

The Inland Feeder will increase Metropolitan's turnout capacity from the East Branch of the California Aqueduct by 1,000 cfs, moving water from DWR's Devil Canyon facility 43 miles south to the San Diego Canal and the Eastside Reservoir. Together with the Eastside Reservoir Project, the Inland Feeder will improve the region's storage and water quality by increasing the ability to bring down more State Water Project supplies into the service area. The Inland Feeder is expected to be completed by 2002 at a total project cost of $1.03 billion, of which about $135 million is for project contingencies.

Water Quality, Treatment, Conveyance and Groundwater Storage

The IRP identified the need for significant investments in regional water treatment facilities to upgrade existing facilities from conventional treatment processes to ozone treatment and to increase the total system treatment capacity and conveyance. Approximately $1.1 billion will be invested over the next ten years to: (1) retrofit the Jensen, Weymouth, Diemer and Skinner filtration plants for ozone treatment, (2) construct additional conveyance capacity for San Diego County, and (3) construct the Perris Filtration Plant. The IRP also identified the need for groundwater storage, and as such, through conjunctive use storage agreements about $175 million is expected to be invested in pumping and related storage facilities over the next 10 years.

Reliability, Rehabilitation and Administrative Facilities

Investments needed to maintain the existing regional infrastructure and ensure its ability to reliably meet future demands are expected to total $700 million by year 2005. Included in this amount is $150 million for a permanent administrative facility centrally located at Union Station in The City of Los Angeles.

Table 4-2 summarizes the total construction outlays for the proposed 10-year CIP as well as total anticipated expenditures over the 25-year period studied for the IRP. Figure 4-6 shows the projected total construction outlays over time.

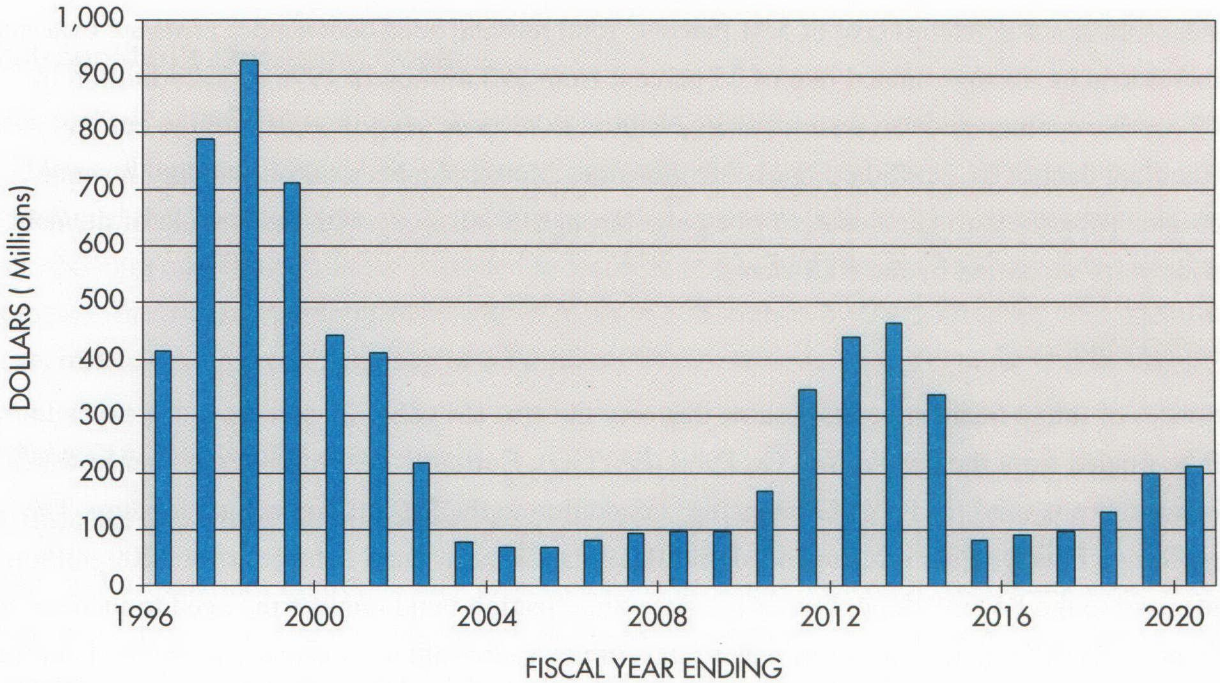
Table 4-2

Metropolitan's Anticipated Capital Expenditures (Escalated Dollars)

Project Description	10-Year CIP Costs (Millions)	25 Year CIP Costs (Millions)
Supply, Distribution, and Storage Projects		
Regional Water Management Facilities	2,345.2	2,453.3
Distribution Facilities	275.2	1,126.8
Other Projects	710.8	1,818.0
Water Treatment Projects		
New Major Water Treatment Facilities	42.4	907.2
Water Quality & Treatment (Existing Facilities)	760.3	762.1
Total	4,133.9	7,067.4

Figure 4-6

Projected Annual Construction Outlays



Financing Metropolitan's Capital Expenditures

In the long-term, 80 percent of Metropolitan's anticipated capital expenditures will be debt financed. The remaining 20 percent will be funded directly from water sales revenues. A detailed discussion of the alternative debt financing methods is provided in Metropolitan's *Long-Range Finance Plan.*

Debt Financing

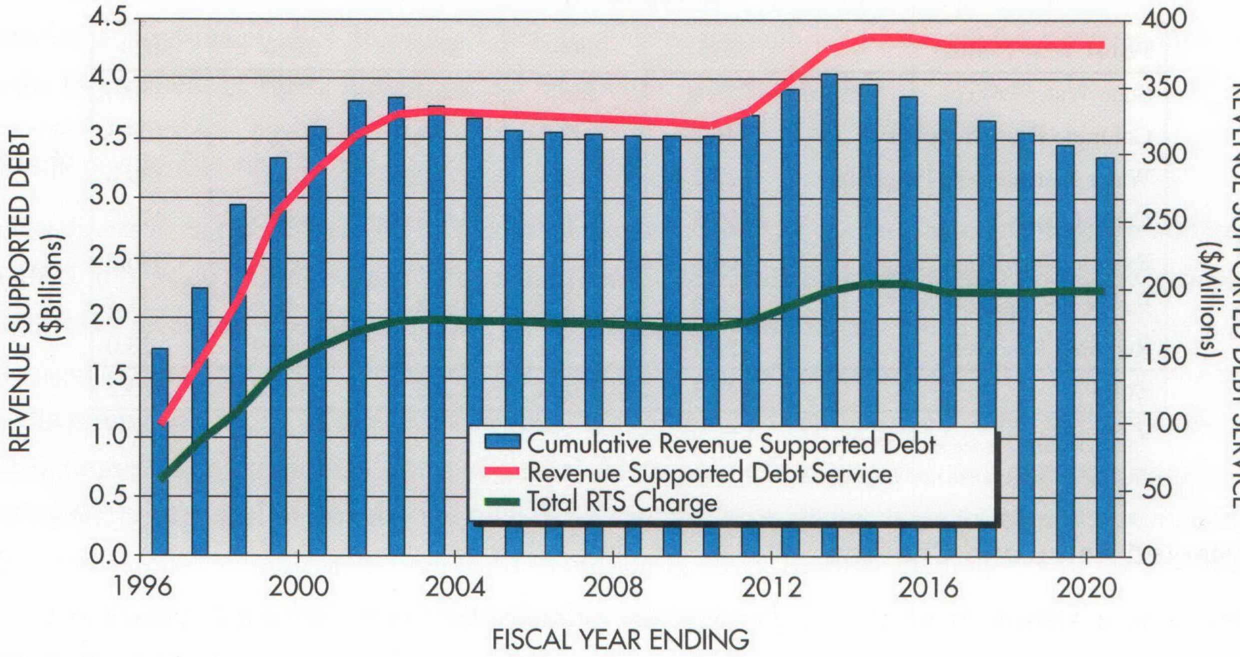
As recommended in the *Long Range Finance Plan*, fixed rate revenue bonds are expected to remain the primary means of financing Metropolitan's capital expenditures. Depending upon capital market conditions and the need for debt financing, a combination of fixed and variable rate revenue bonds along with commercial paper will be used to maintain low debt service costs without exposing Metropolitan to undue interest rate risk. To reduce Metropolitan's exposure to increases in interest rates, variable rate debt will not be allowed to exceed 15 percent of total outstanding debt. Current projections of debt service costs assume that interest rates increase by 25 basis points per year from their current levels of 6 percent (fixed) and 4 percent (variable) to 7.5 percent (fixed) and 5.5 percent (variable). Metropolitan's most recent debt sale of $175 million (1995 Series A Water Revenue Bonds) sold at a true interest cost of 5.91 percent. Total revenue bond debt service costs are expected to increase at an average annual rate of 25 percent from $93 million in 1996 to $329 million in 2005 as Metropolitan adds an additional $3.2 billion in revenue supported debt to the currently outstanding debt of $1.7 billion. Figure 4-7 illustrates Metropolitan's total outstanding revenue supported debt, the estimated debt service costs through 2020, along with the amount of the debt service costs supported by the RTS charge.

PAYGO Financing

Estimates of future financing costs assume that over the next ten years, 20 percent of the expenditures will be funded from the Pay As You Go Fund (PAYGO). Currently, $90 million per year in water sales revenues is used for PAYGO financing. In addition to the $90 million annual funding, The Long Range Finance Plan recommended that Rate Stabilization Fund balances over $200 million be transferred to the PAYGO fund. Use of the Rate Stabilization Fund reduces the need to increase the amount of PAYGO money raised by water rates, limits Metropolitan's exposure to external entities seeking supplemental revenue sources, and reduces Metropolitan's need for additional debt.

Figure 4-7

Outstanding Revenue Supported Debt



Metropolitan's Operating Costs

Metropolitan's 1996 budgeted general operating and maintenance costs, including operating equipment and lease obligations, total $199.7 million. Consistent with Metropolitan's cost containment goals it is assumed that annual increases in existing operating costs are held to 3 percent per year. At this rate, existing operating costs are expected to increase to $247 million by 2005. As new facilities come on line, future operating costs will increase to $36 million by 2005 bringing total operating costs to $283 million or 22 percent of total costs.

FINANCIAL IMPACTS

Projected Revenue Requirements

Table 4-3 summarizes Metropolitan's projected revenue requirements for each major cost category previously discussed. The implementation of the IRP is expected to increase Metropolitan's total expenditures by an average annual rate of 5.0 percent over the next 25 years.

Table 4-3

Metropolitan's Projected Expenditures ($millions)

Fiscal Year Ending	1995	2000	2005	2010	2020
State Water Project	216.6	328.7	364.5	425.7	510.6
Colorado River Supplies	46.2	42.8	54.0	68.2	109.3
Water Management Programs	22.1	65.3	82.9	105.1	109.6
Capital Costs [1]	228.5	436.8	477.0	491.5	473.2
Existing Operating Costs	206.0	223.5	247.2	286.4	386.2
Future Operating Costs [2]	0.0	9.0	38.3	46.4	71.3
Required Reserves	28.9	32.5	11.4	10.9	23.0
Total	748.3	1,138.6	1,275.3	1,434.2	1,683.2

[1] Includes debt service and PAYGO.

[2] O&M costs related to new facilities only.

Projected Rates and Charges

Projections of Metropolitan's rates and charges are estimated based upon expected demand levels, costs, and revenues generated from other sources. Metropolitan's funds are generated from diverse sources of revenues which are described below:

Property Taxes

Property tax revenue is used to service Metropolitan's outstanding general obligation debt and to pay for a portion of the State Water Project capital costs. Currently, property taxes generate approximately $80 million per year and are assessed at a rate of .0089 percent of assessed property values. Estimated increases in assessed values will increase property tax revenues to $91 million by 2005. After 2005, property tax revenue decreases as general obligation debt matures and the tax rate declines. By year 2023, Metropolitan's property tax authority will expire unless additional authority is approved by the voters.

Interest Income

Through the investment of unencumbered reserve funds and cash balances Metropolitan currently generates approximately $40 million per year in interest income that can be used to cover expenditures.

Hydro Power Sales Revenue

There are fifteen Hydro-electric plants within Metropolitan's distribution system that currently generate approximately $14 million per year in revenue through long-term contract power sales to the Department of Water Resources and Southern California Edison.

Readiness to Serve Charge

A Readiness to Serve Charge (RTS) was implemented as part of the new revenue structure adopted in 1995 to provide a firm revenue source and reduce Metropolitan's dependence on highly variable water sales revenues. The RTS supports the portion of the total revenue bond debt service that is allocated to existing users of Metropolitan's system. The rate of increase in the RTS charge is driven by the timing and sizing of the debt sales required to finance Metropolitan's anticipated capital expenditures and Metropolitan's cost of capital. Metropolitan's anticipated capital expenditures are currently expected to increase the total Readiness to Serve Charge at an average annual rate of 22 percent from $56 million in 1996 to $178 million in 2005. Because the majority of the construction outlays are expected to occur within the next ten years, the RTS charge will increase at a much slower rate after 2005 to approximately $200 million by 2020.

Although the RTS charge is projected to increase significantly over the next ten years, it is only one component of the overall increase in the average cost of water provided by Metropolitan. In the current forecast, the average cost of water imported by Metropolitan increases at an average annual rate of 3.3 percent over the next 25 years. Without the fixed revenues provided by the RTS Charge, the increase in the average cost of water would remain the same, however, the commodity rates would be higher, and higher Rate Stabilization Fund and Working Capital balances would be required to insure against reductions in water sales revenues due to wet weather.

Connection Maintenance Charge

A connection maintenance charge generates about $3 million per year in revenues. The connection maintenance charge is based on a rate of $50/cfs of connected capacity.

New Demand Charge

As part of the new revenue structure a New Demand Charge (NDC) was also implemented. The NDC is calculated as the present value unit cost for capital facilities needed to meet new demands and is assessed on every unit in excess of an initial base demand. The NDC is currently calculated to be $1621/acre-foot but was set in Fiscal Year 1995-96 at $1,000/acre-foot. Member agencies have the option of amortizing the NDC over 15 years at an interest rate equivalent to Metropolitan's weighted cost of capital. Revenue from the New Demand Charge will vary with the rate of demand growth among the member agencies and the level of the unit charge itself as it is set by the board. It is currently estimated that Metropolitan will be collecting $27 million in New Demand Charges by Fiscal Year 2004-05 as Member Agencies exceed their base demand. As demands continue to grow, New Demand Charge revenues are estimated to reach $103 million per year in Fiscal Year 2019-20. The projections of NDC revenues assume that all member agencies that incur a New Demand Charge elect to amortize the charge. A detailed discussion of the justification for and calculation of the New Demand Charge is provided in Report No. 1069 *Nexus Study in Support of Metropolitan's New Demand Charge*.

Treatment Surcharge

The revenue requirement used to determine the treatment surcharge is calculated as the sum of all costs associated with providing treated water service. These costs include operations, overhead, power, chemicals, and the debt service costs for existing and planned treatment facilities. The treatment surcharge is currently set at $82/acre-foot and is expected to increase to $97/acre-foot by Fiscal Year 2004-05. Most of the expected increase in the treatment surcharge revenue requirement is being driven by the debt service costs for ozone retrofit projects and the future O&M cost for ozone treatment. It is expected that growth in treated water sales will help minimize increases in the Treatment Surcharge.

Commodity Rates

Metropolitan's water sales revenue requirement is estimated as the difference between Metropolitan's total revenue requirement and the sum of all fixed or other revenues. The commodity rates that Metropolitan charges for basic, seasonal and agricultural deliveries are set based on the water sales revenue requirement and the expected level of demand for imported water assuming normal weather conditions. Table 4-4 summarizes Metropolitan's projected treated and untreated commodity rates for basic service through Fiscal Year 2019-20. Table 4-5 summarizes Metropolitan's projected revenue sources.

Table 4-4

Projected Commodity Rates for Basic Service
(Dollars Per Acre-Foot)

Fiscal Year	Treated	Untreated
1995-96	426	344
1999-00	457	375
2004-05	493	396
2009-10	500	398
2019-20	527	415

Table 4-5

Sources of Metropolitan's Revenue
($millions)

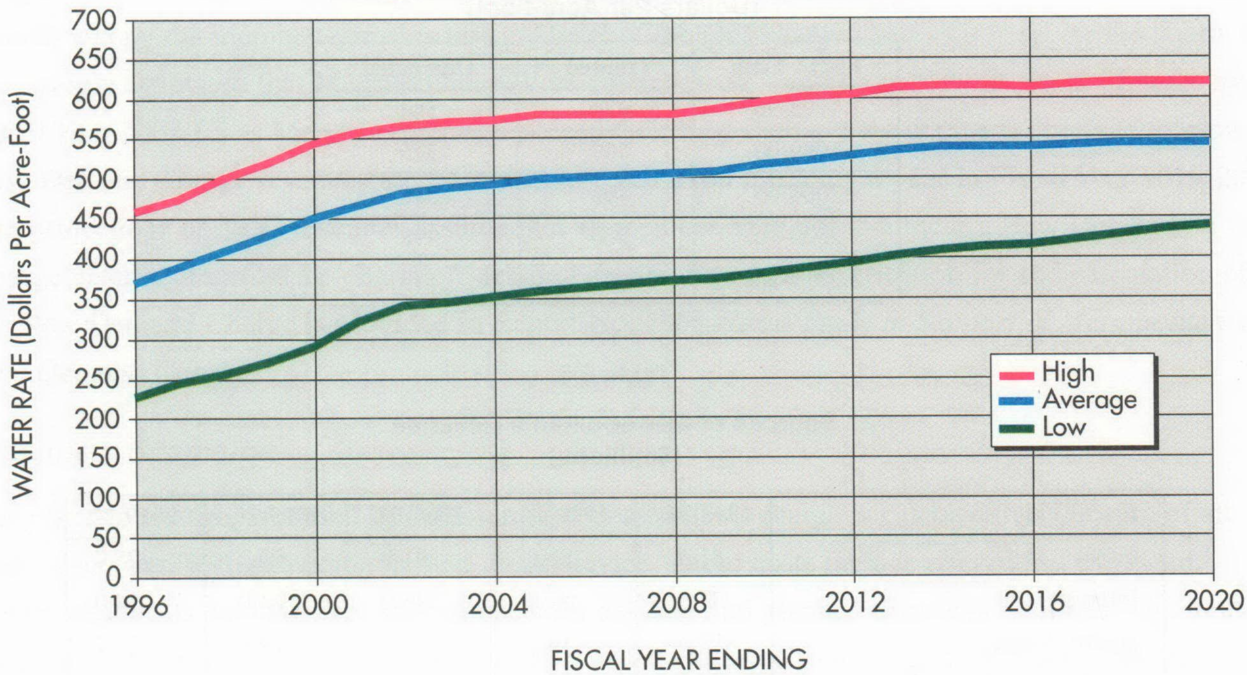
Fiscal Year	1995-96	1999-00	2004-05	2009-10	2019-20
Taxes	81.3	88.0	91.0	90.2	25.7
Interest	37.0	41.0	46.0	44.0	54.0
Hydro-Power	12.0	14.1	15.7	19.9	20.7
Readiness to Serve Charge	56.0	155.9	177.6	174.5	191.7
Connection Maintenance Charge	3.0	3.0	3.0	3.0	3.0
New Demand Charge	0.0	2.1	26.9	56.9	103.6
Treatment Surcharge	85.1	106.7	138.1	153.6	194.3
Water Sales Revenue	488.8	713.6	861.7	922.6	1,125.6
Rate Stabilization Fund	29.1	17.9	0.0	0.0	0.0
Total	792.3	1,142.3	1,360.0	1,464.7	1,718.6

Metropolitan's Effective Water Rate

Metropolitan's effective water rate is estimated by adding the rates and charges paid directly by the member agencies and dividing by the total expected water sales. Figure 4-8 presents the projected range in Metropolitan's effective rate among the member agencies. The average rate represents the average for the region. However, the effective water rates will vary among Metropolitan's member agencies depending upon the type of service provided (i.e. treated, untreated, basic, seasonal, agricultural) and the relative use of Metropolitan's distribution system. For example, member agencies that purchase primarily treated basic water to meet demands or member agencies that are growing and incurring a New Demand Charge will have higher effective rates than agencies that purchase untreated or seasonal water.

Figure 4-8

Range in Metropolitan's Effective Water Rate



Metropolitan's Financial Condition

Rate Stabilization Fund

Because of the variability in Metropolitan's water sales, Metropolitan maintains reserves in a Water Rate Stabilization Fund (Stabilization Fund). When sales are above-normal (dry periods), excess water sales revenue is generated and deposited into the Stabilization Fund. When sales are below normal due to wet weather, the Stabilization Fund serves as Metropolitan's first source of reserves and is used to cover revenue requirements that would otherwise require a rate increase. Over the next few years, the combination of increasing costs, low sales due to the recent wet period, and a desire to hold annual effective rate increases to less than 6 percent, are expected to result in a decrease in the Stabilization Fund balance. *The Long Range Finance Plan* recommended that the Rate Stabilization Fund be capped at $200 million and that any balances in excess of that amount be transferred to the PAYGO fund to reduce Metropolitan's future outstanding debt.

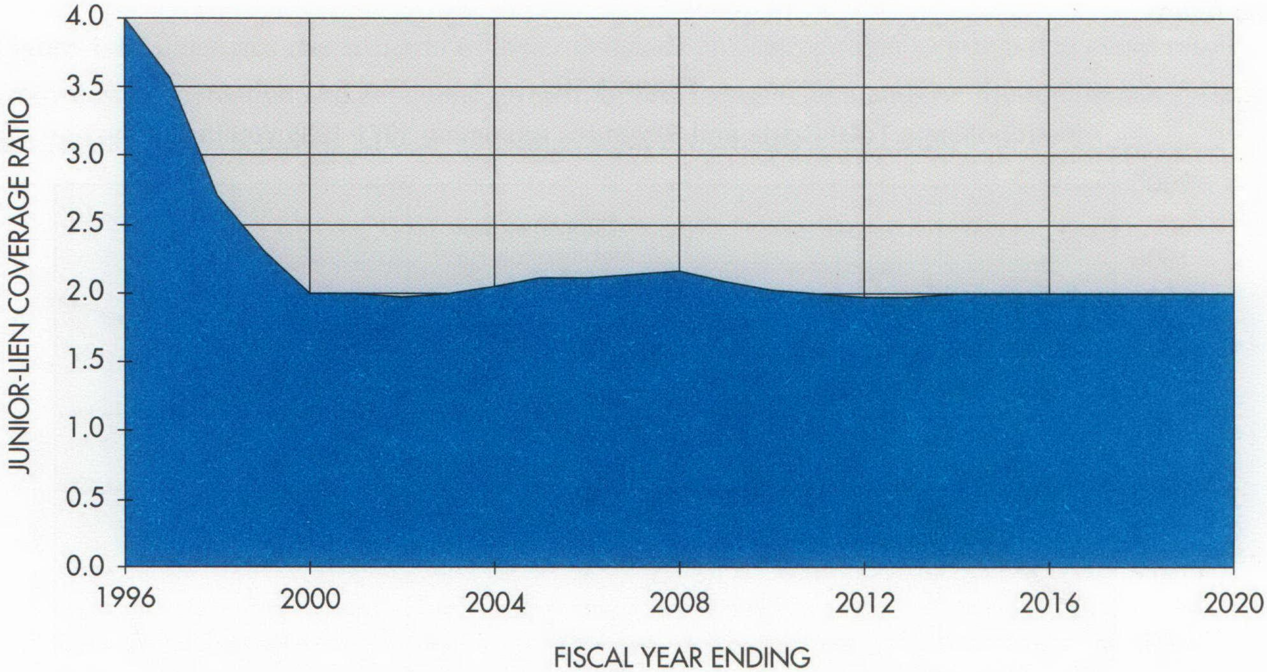
Debt Service Coverage

Metropolitan's bond covenants require that rates are set to generate revenues sufficient enough to maintain a minimum of 1.2 times debt service coverage at all times. Due to the variability in water sales revenue caused by weather and uncertainty in future costs, the projected Junior Lien Revenue

Bond debt service coverage ratio is not allowed to fall below 2.0 under normal weather conditions. Increasing debt service and operating costs are expected to decrease the coverage ratio from its estimated 1995-96 level of 4.0 to 2.0 by Fiscal Year 1999-00. Figure 4-9 shows the projected coverage ratio.

Figure 4-9

Junior Lien Revenue Bond Coverage Ratio



The previous discussion of Metropolitan's role in the IRP outlines a future path for achieving a high quality, reliable and affordable water supply for the region. However, the only thing certain about the future is that it will be different from than what was projected. Therefore, the Preferred Resource Mix and Metropolitan's investment strategy must be flexible and allow for adjustments should conditions change. To help identify possible changes and adjustment strategies, sensitivity analysis is regularly conducted. Two sensitivity analyses are provided as examples.

SENSITIVITY ANALYSIS

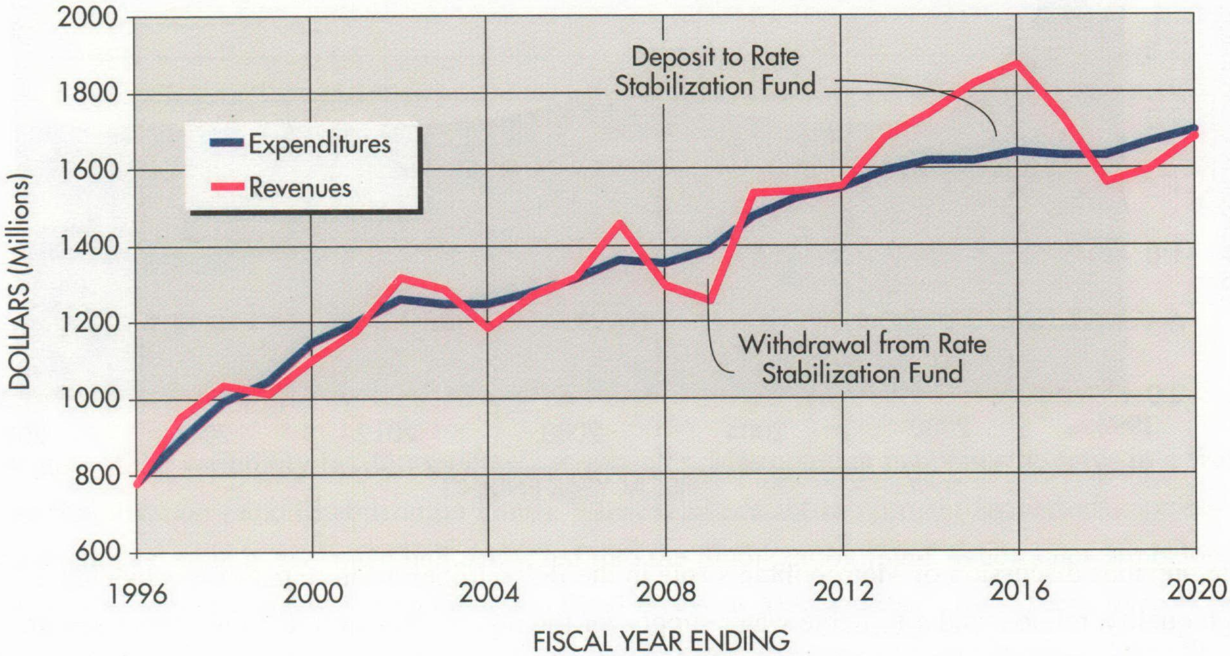
The following scenarios were constructed to demonstrate the financial impacts to Metropolitan if circumstances change. Metropolitan's rates are very sensitive to the level of demand on Metropolitan's system. Changes in water demands on Metropolitan's system can be attributed to either weather or structural changes in retail demands or local supply development.

Impacts of Weather

To evaluate the financial impacts associated with future variations in water sales, the effects of historical hydrologic and weather conditions are estimated and their impacts on future water sales revenues are evaluated. Figure 4-10 shows the difference between Metropolitan's projected total annual costs for the Preferred Resource Mix and the revenues that would be generated from the commodity rates shown in Table 4-5 if the weather conditions from 1971 to 1995 occurred in the future.

Figure 4-10

Metropolitan's Total Costs and Revenues Assuming 1971-1995 Weather



In the years where total revenues are less than total costs funds are withdrawn from the Rate Stabilization Fund in order to avoid rate increases due to wet weather. This is most evident in Fiscal Year 2007-08 where the effects of the extremely wet weather experienced during 1983 can be seen. Deposits are made to the fund in years where revenues exceed total costs. The higher demands that are driven by the hot and dry conditions of 1990 add to the Rate Stabilization Fund in Fiscal Year 2015-16 and will be carried forward for use in future wet periods.

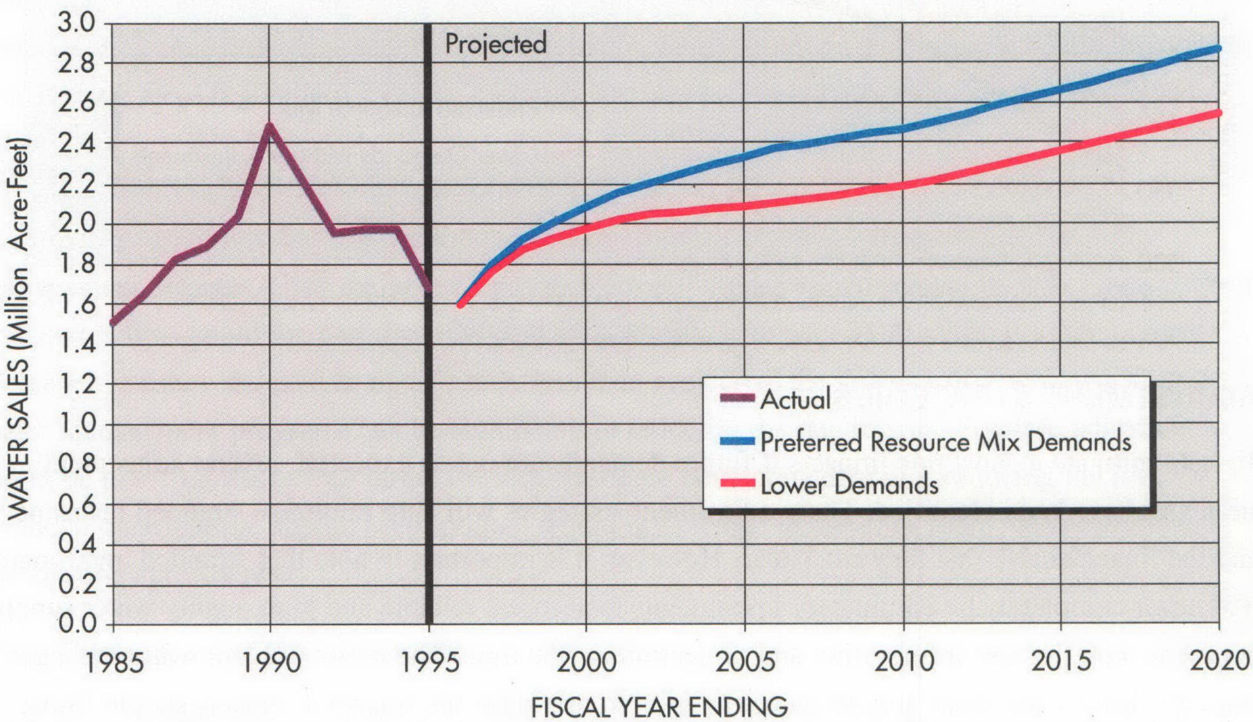
Impacts of Structural Changes

The demands on Metropolitan's system shown in Figure 4-5 reflect the expected range in demands under the Preferred Resource Mix investment strategy given the current SCAG and SANDAG projections of population and economic growth and expected local supply development. However, slower population and economic growth or greater than expected local supply development could decrease the expected demands on Metropolitan's system.

Figure 4-11 illustrates one scenario of lower demands on Metropolitan's system that could result from slower population and economic growth. In this scenario, demands on Metropolitan's system are 280,000 acre-feet lower in year 2005 than what is currently projected.

Figure 4-11

Total Demands on Metropolitan's System

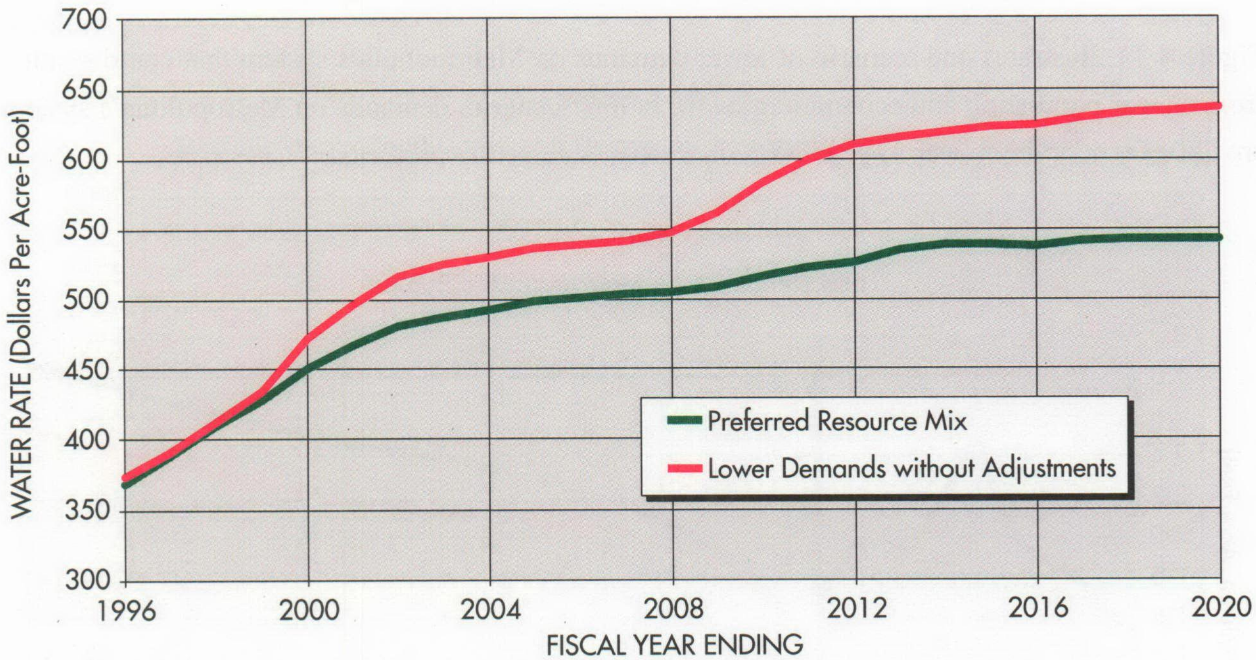


If demands on Metropolitan are lower than expected and no adjustments are made to hold down operating costs and defer investments in capital facilities and water management programs, Metropolitan's effective rate would be greater than what was shown under the Preferred Resource

Mix (see Figure 4-12). To compensate for the reduced revenues that result from lower demands and avoid greater rate increases, several adjustment strategies can be implemented to reduce or defer the cost increases associated with the implementation of the Preferred Resource Mix if conditions should change.

Figure 4-12

Impacts on Metropolitan's Effective Water Rate Under Lower Demands



ADJUSTMENT STRATEGIES

To help mitigate against rate impacts if future demands are not as expected, several adjustment strategies have been identified. These adjustment strategies will help minimize stranded investments and the financial risk that they can cause. However, it is important to note that stranded investments will never completely be eliminated. Investments to secure a reliable and high quality water supply are made with the best information and projections at the time. The best a prudent water manager can do is keep costs down and develop strategies to minimize the financial impacts should future conditions change.

Cost Cutting and Capital Planning

Metropolitan's opportunities for cost cutting adjustment strategies are: (1) deferring and/or down-sizing planned capital projects; (2) reducing future commitments for water management programs; and (3) continue to improve efficiency in annual operating costs.

Deferment of Capital Infrastructure

If future conditions change significantly, it may be necessary to defer planned capital infrastructure projects in order to reduce the financial risk to Metropolitan and its member agencies. During the IRP, Metropolitan's capital improvement program was analyzed to determine project timing and sensitivity to changes in demands. Projects that were mainly supply driven were the Eastside Reservoir Project and Inland Feeder. These projects provide water quality and emergency benefits that are not very sensitive to changes in demand. However, projects such as the Central Pool Augmentation Project and the San Diego Pipeline No. 6 were more sensitive to demands. Projects that are mainly driven by demand and that are not needed within the next several years represent opportunities for reassessment if demand conditions change. Projects that are supply driven can also be adjusted, however, the impact to reliability must also be addressed. For example, what are the impacts to water quality and the region's emergency storage if the Inland Feeder or Eastside Reservoir were deferred a number of years? In addition, Metropolitan's capital improvement program includes projects designed to meet regulatory requirements (such as water quality). The impacts to not meeting these regulations must be carefully analyzed if these types of projects are deferred.

Adjustments to Water Management Programs

Metropolitan is committed to the financial contributions of existing agreements for its water management projects. Over the next 15 years, Metropolitan is estimating that its water management program budget could increase from its current $22 million to over $100 million (a 370 percent increase). If future demand is significantly less than projected, the strategy of scaling-back on these water management programs can be significant in reducing the rate impact. Possible adjustments might be lowering the overall target for local resource development and/or reducing the level of financial contribution. Again, Metropolitan would not change the level of financial commitments for existing agreements.

Cost Reduction in O&M Expenses

Currently, Metropolitan's operating expenses are escalated at 3 percent per year. If inflation in the future was 3 percent than this would imply that Metropolitan is holding the line on O&M costs. As technology improves, it may be possible to operate at lower costs in the future. Another area for cost containment is the operating costs associated with the State Water Project. Currently, the Department of Water Resources uses a 5 percent annual escalation factor for operating costs. In the future it may be possible to reduce these costs, reducing Metropolitan's overall expenses. The magnitude of savings that are possible under these types of adjustments could be as high as about $150 million by 2020.

More analysis is being done on these cost cutting adjustment strategies and will be incorporated as the Preferred Resource Mix is implemented.

Financing and Pricing Techniques

Metropolitan will utilize both long-term and short-term debt instruments, investment of working capital, and fixed and variable rate debt to minimize the carrying costs of capital facilities. In addition, pricing strategies (along with fixed sources of revenue) will help mitigate the impact of member or sub-agencies leaving the system. While Metropolitan's pricing should reflect its marginal cost of supply, its goal is to remain the least-cost regional supplier.

Legal and Institutional Relationships

The historical relationship since the Laguna declaration has implied a contract for service between Metropolitan and its member agencies. Very simply, the implication of this relationship has been that Metropolitan would meet all supplemental needs of its member agencies so that duplicate imported water supply facilities are avoided. Over time, as regional demands have grown and the reliability of imported supplies and the adequacy of regional infrastructure have come into question, Metropolitan has been put in the position of having to provide standby service for the region without a firm commitment of revenue. Alternative service arrangements between Metropolitan and its members or sub agencies, including wheeling, storage service, and firm reliability contracts, are all options which can be used to mitigate the uncertainty surrounding supplies and demands and their associated cost and revenue streams. In the future, with increasing competitive pressures and alternative opportunities for member agencies to leave Metropolitan's system, Metropolitan must be prepared to change the current institutional relationships.

Section 5 – Implementation And Policy Issues

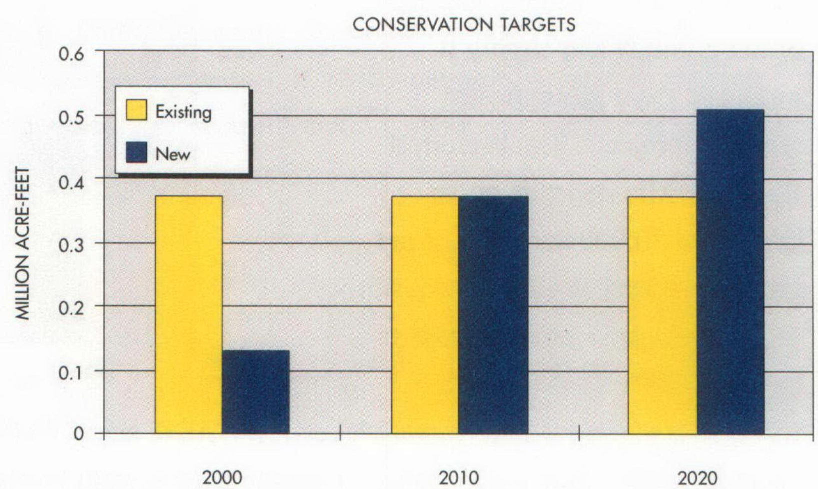
SUMMARY OF FINDINGS

The strategy reflected in the Preferred Resource Mix is based on the following basic objectives: (1) maximize the availability of low cost water delivered by the Colorado River Aqueduct; (2) provide adequate State Water Project supplies to meet reliability and water quality requirements; (3) fully utilize the existing potential for local groundwater conjunctive use and planned surface storage; (4) implement cost-effective water recycling and groundwater recovery projects identified by member agencies and other water providers, and (5) aggressively pursue voluntary water transfers.

Resource Targets

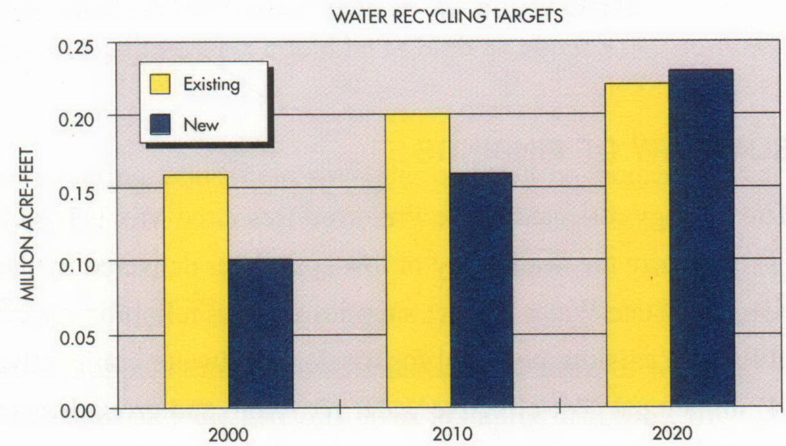
Specifically, the additional water savings and new sources of supply comprising the Preferred Resource Mix are as follows:

Conservation



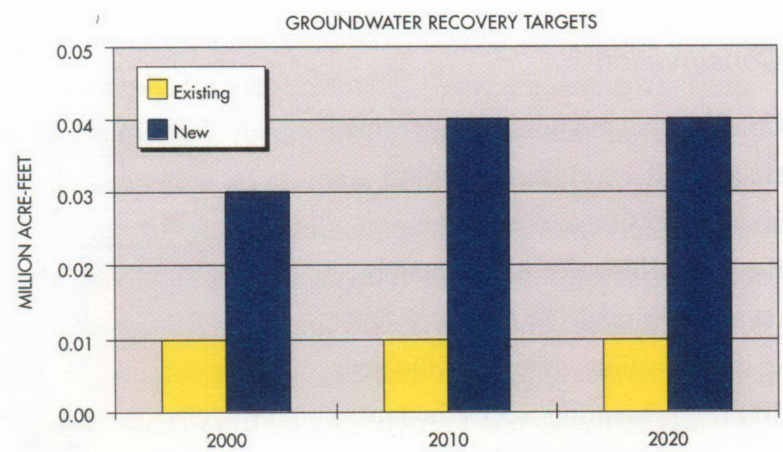
Conservation measures implemented since 1980 are currently saving about 370,000 acre-feet. The Preferred Resource Mix depends on an additional 130,000 acre-feet of conservation savings by the year 2000 (representing a 35% increase over current levels), of which about 89,000 acre-feet results from the implementation of new plumbing codes and ordinances. By 2020, about 512,000 acre-feet of additional conservation savings is needed (representing a 138 percent increase over current levels), of which about 235,000 acre-feet results from the implementation of plumbing codes and ordinances.

Water Recycling



Existing water recycling is providing the region with about 160,000 acre-feet per year of supply. These existing local projects are expected to increase their supply yield to about 220,000 acre-feet by 2020. The Preferred Resource Mix depends on an additional 100,000 acre-feet of new supply from water recycling by the year 2000 (representing an 63 percent increase from current levels). By the year 2020, about 230,000 acre-feet of additional supply is needed (representing a 180 percent increase over current levels).

Groundwater Recovery

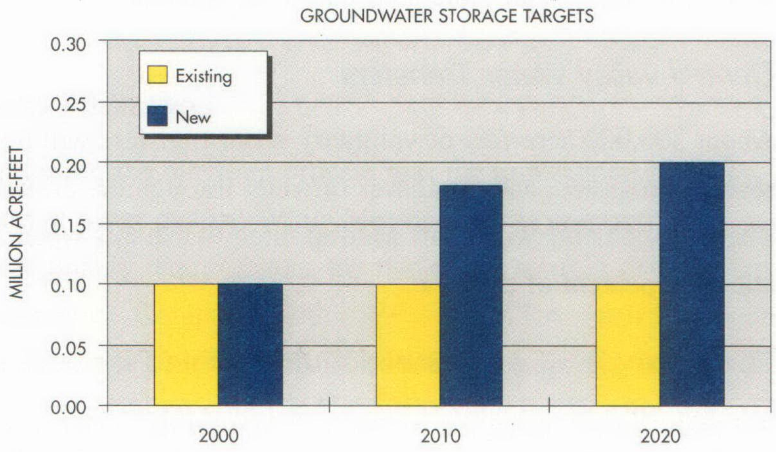


Currently, about 12,000 acre-feet of net groundwater supply is produced from groundwater recovery projects. The Preferred Resource Mix depends on an additional 30,000 acre-feet of net groundwater production as a result of groundwater recovery projects by year 2000, representing a 150 percent increase over current levels). By 2020, about 40,000 acre-feet of net production is needed (representing a 233 percent increase over current levels).

Regional Surface Reservoir Storage

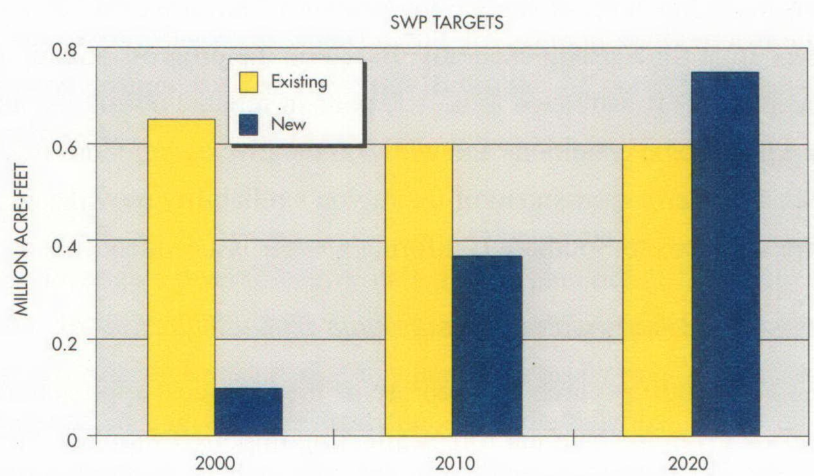
Existing surface reservoirs used by Metropolitan for seasonal and regulatory purposes include Lake Mathews and Lake Skinner. In addition, the region can use a portion of the storage in DWR's terminal reservoirs for emergency purposes. As a result of the recently negotiated Monterey Agreement, about 220,000 acre-feet of storage in these DWR terminal reservoirs can now be used by Metropolitan during dry years (carryover supply). While this agreement provides the region with more dry year supplies during droughts and added flexibility, it does not change the total storage requirements for the region. Metropolitan's 800,000 acre-feet Eastside Reservoir Project will be used to meet Southern California's remaining storage requirements, with 400,000 acre-feet dedicated to emergency purposes and 400,000 acre-feet dedicated to drought carryover.

Groundwater Conjunctive Use Storage



As a result of Metropolitan's Seasonal Storage Service pricing program, local agencies are currently storing available imported water in order to increase groundwater production during the summer season and dry years. It is estimated that an average of 100,000 acre-feet per year of groundwater supply is produced as a result of Metropolitan's existing discount pricing for winter season deliveries. The Preferred Resource Mix identifies the potential for 200,000 acre-feet of additional groundwater production during dry years. To accomplish this additional dry year production, about one million acre-feet of dedicated storage capacity within the local basins is required.

State Water Project



Existing SWP supply available to Metropolitan during a dry year is estimated to be about 650,000 acre-feet. The Preferred Resource Mix calls for an increased utilization of SWP supplies of about 700,000 acre-feet during a dry year by the year 2020. Progress towards achieving this SWP resource target has already been made. The recently negotiated Bay-Delta Accord provides additional flexibility in the system and calls for identification of a permanent solution within three years. Reliance on SWP supplies is critical to achieving the region's reliability goals and to provide water quality adequate to carry out local resource programs.

Colorado River Aqueduct

The CRA represents the region's least-cost imported supply and should be maximized in order to ensure reliability for all of Metropolitan's member agencies. To ensure that deliveries from the CRA are fully maximized at about 1.2 million acre-feet per year, Metropolitan has a strategy that includes reliability improvements such as changes in river operations, banking conserved and unused water, and possible land fallowing agreements.

Central Valley Water Transfers

About 300,000 acre-feet of voluntary water transfers will be developed through option agreements, storage programs, and purchases of water through the drought bank or other similar spot markets. These agreements will allow Metropolitan to use this water only when needed, estimated to be about 25 percent of the time.

The Strength of a Balanced and Flexible Plan

For many participants, the decision to support the water resources plan developed through the IRP process was based on the strengths and benefits it offered over other competing alternative strategies.

Achievement of 100% Reliability at the Retail Level

As stated above, the most important feature of the plan is the assurance it provides that full-service demands at the retail level can be satisfied under all foreseeable hydrologic conditions. The ability to achieve this level of service for Southern California's retail water customers provides a solid foundation for a strong economy. Based on the progress already made since the IRP, the region's water supply is estimated to be 100 percent reliable during the next ten years, even under the worst-case hydrologic conditions and with conservative assumptions regarding local resource development. This short-term assessment of the region's reliability provides great optimism regarding the long-term solutions to Southern California's water issues identified in the IRP.

Least-Cost Approach to Sustainable Reliability

The Preferred Resource Mix represents the least-cost approach to meeting the region's reliability goal — given the external forces affecting imported supplies. From a purely economic perspective, the development of local resources included in the plan, in some cases, may appear more costly than securing incremental supplies from imported sources or from agricultural water transfers. However, during the past decade, a new water management ethic has emerged in Southern

California that has provided the foundation for consensus solutions among urban, environmental, and agricultural interests throughout the state. This demonstrated commitment to stewardship will be an essential element in securing the statewide agreements necessary for long-term reliable supplies. In that context, this plan is the least-cost, sustainable approach to long-term regional reliability. Although the Preferred Resource Mix will require an average annual cost of $4 billion over the next 25 years to implement, the average unit cost will increase only by 4 percent annually (in escalated dollars).

Achievement of Regional Water Quality Objectives

A significant consideration that emerged during the planning process was the importance of SWP deliveries in managing the region's imported water quality. While Metropolitan is committed to meet or exceed all State and Federal water quality requirements, the two major sources of imported water have different water quality characteristics. Compared with SWP water, CRA water has much higher concentrations of salinity or total dissolved solids (TDS). The Preferred Resource Mix includes sufficient SWP supplies to allow for blending with CRA water throughout most of the service area. This blending is also critical to implementing the conjunctive use storage and water recycling programs identified in the IRP.

Reduced Risks Through Diversification

The IRP process identified many risks associated with additional local and imported supply development. The diversification of investments offered in the plan reduces the region's exposure to uncertainties of a given investment not performing up to expectations. It also reduces the potential impact of an emergency such as a major earthquake. The Preferred Resources Mix avoids the pitfalls of "putting all your eggs in one basket."

Flexibility to Adjust to Future Changes

Besides reducing the exposure to risk through a diversification strategy, the plan offers flexibility in response to uncertain future demands. Specifically, the plan's reliance on voluntary water transfer option agreements and local resource projects allows the region to adapt more easily than is possible with a program of fewer, large capital and core resource investments. With the balanced approach in the Preferred Resource Mix, as circumstances change, the pace of additional investments can change as well. And while Metropolitan is committed to following through with its financial commitments to any given local project, the plan provides the ability to adjust overall program commitments based on revised projections of need.

Metropolitan's Role and Responsibilities

The water resource strategy that has emerged from the IRP process has strengthened Metropolitan's unique role in regional water management. The successful implementation of the Preferred Resource Mix places a significant responsibility on Metropolitan to provide leadership in several important areas. These areas include: (1) providing the infrastructure needed to integrate imported and local sources of supply, (2) implementing water management programs that support the development of cost-effective local resources, (3) securing additional imported supplies through comprehensive programs that increase the availability of water delivered through the Colorado River Aqueduct and the State Water Project, (4) establishing a comprehensive management plan for dealing with periodic surplus and shortage conditions, and (5) developing a wheeling policy to allow member agencies to increase their local reliability without adversely impacting other members.

The regional benefits resulting from the implementation of the IRP are significant. The commitment to higher levels of conservation and local resources development allows Metropolitan to defer the capital improvements it would otherwise require to meet the demands of its member agencies. At one time, Metropolitan was planning a $6.0 billion capital improvement plan. The commitment to seeking the most cost-effective solutions to meeting the region's need during the IRP process as resulted in a revised $4.1 billion capital plan. This reduced capital program will contribute to lower rate increases at the regional level. Based on the IRP and latest water demand projections, Metropolitan is projecting its average cost of imported water to remain under $500 per acre-foot over the next 10 years.

These potential savings can only be realized if the conservation and local resources development components of the IRP are accomplished, and the overall targets established in the plan are achieved. Metropolitan, its member agencies and other water providers must all do their part if the benefits of the Preferred Mix are to be realized.

POLICY GUIDELINES

As the IRP Preferred Resource Mix moves toward implementation, specific water management programs will need to be developed, capital projects approved, and annual budgets prepared. To help guide Metropolitan in these endeavors, several policy objectives, business principles, and program guidelines have been agreed upon, and in some cases, formally adopted, during the IRP process.

Policy Objectives

Water Supply Reliability. Through the implementation of the Integrated Resources Plan, Metropolitan and its member agencies will have the full capability to meet full-service demands at the retail level at all times.

Affordability. Metropolitan shall provide affordable water service and will maintain its competitiveness by assuring that the average cost of Metropolitan's water will be less than $500 per acre-foot during the next ten years.

Balanced Approach. Metropolitan shall demonstrate stewardship by maintaining a resource mix which balances future investments in imported supply capability and local resource development and conservation, in order to reduce risks and assure national leadership.

Adaptability. Metropolitan commits to a resource development and financial strategy that is flexible and will provide financial security for Metropolitan and its member agencies, even if future conditions should change.

Business Principles

Financial Integrity. Investments by Metropolitan, member agencies, and other water providers resulting from the IRP should be accompanied by a mutual commitment of reliable revenue sources that recover the fixed capital and non-variable operating costs of those investments.

Fairness. Metropolitan should provide comparable access to reliable water service to each of its member agencies, recognizing that all member agencies have a beneficial interest in Metropolitan's delivery system and investments.

Equity & Value. Metropolitan's fees and charges for the delivery of water service should be set in a manner that establishes a clear and proportionate relationship between the cost of service and the value of benefits provided. A clear connection must be established between financial incentives and the benefit to the region.

Operating Integrity. The operating integrity of Metropolitan's delivery system should be maintained. The use of this delivery system for the transmission of non-Metropolitan supplies (wheeling) should be provided as long as there is no reduction in service (including water quality or capacity) to any member agency. Wheeling must not adversely impact the rates or charges to any other member agencies now or into the future.

Water Management and Conservation Program Guidelines

Water Management Programs

1. Regional benefits of both local storage and local projects programs should be measured by: (1) the reduction in capital investments due to a deferral and/or down-sizing of regional infrastructure; (2) the reduction in O & M expenditures needed for treatment and distribution of imported water; and (3) the reduction in expenditures associated with developing alternative regional supplies.

2. Metropolitan's investments for local storage and local projects programs should not exceed the regional benefits over the life of the project(s).

3. Metropolitan's investments for local storage and local projects programs should be sufficient to encourage the implementation of projects identified in the Preferred Resource Mix. Such investments and their associated payment schedules should also be flexible enough to meet the needs of each project.

4. Metropolitan's participation in local storage and local projects programs should not cause large fluctuations in Metropolitan's water rates.

5. Local storage must increase regional supplies during time of need. Specifically, water placed in local storage programs must be utilized during time of need without displacing dependable local supplies. The amount of water involved should be agreed to in advance when each storage and local projects program is established.

6. Local projects programs must increase regional supplies and provide measurable regional benefits.

7. Performance of local storage and local projects programs should be verifiable (e.g., deliveries into and withdrawals out of local storage should be accounted for by either direct measurement or by incorporation into a shortage management plan).

Conservation Program

1. Conservation projects should be designed to meet the IRP goals on a regional basis.

2. Recognizing that conservation occurs at the consumer level, the local water purveyor should sponsor the implementation of conservation measures. Metropolitan and the member agencies should work together to provide information, guidance, ideas, and incentives.

3. Metropolitan's pricing, financial incentives, and drought allocation methodologies should encourage the achievement of regional conservation goals, and any future water shortage allocations must recognize the "demand hardening" result of conservation programs.
4. Regional benefits of conservation projects should be measured by: (1) a reduction in capital investments due to a deferral and/or down-sizing of regional infrastructure; (2) a reduction in O&M expenditures needed for treatment and distribution of imported water; (3) a reduction in expenditures associated with developing alternative regional supplies; and (4) environmental benefits from reduced demands on the ecosystem.
5. Metropolitan's average level of investment for conservation projects should not exceed the regional benefits measured over the life of the project(s).
6. Conservation project savings must be verifiable and consistent in order to qualify for continuing Metropolitan investment. In partnership with member agencies and subagencies, Metropolitan will commit to pursuing evaluation studies to reliably define potential conservation savings and will continue to encourage studies of new or innovative conservation practices.
7. The region must devote a portion of the conservation investment to develop locally-implemented education programs. These programs need to be rigorously evaluated.
8. Metropolitan's investment in conservation projects should reflect equity among the member agencies. Agencies that conserved early should not be penalized for their initiative.
9. Metropolitan's participation in conservation incentives should not cause large fluctuations in Metropolitan's water rates. Metropolitan's involvement should be based on multi-year agreements for conservation.
10. Public and private partnerships to achieve conservation goals, implemented in cooperation with member agencies, should be included among conservation program measures. However, partnerships with the private sector should be based on a competitive system. Pay should be linked to performance.

Guidelines for the Development of Imported Supplies and Regional Storage

Colorado River Aqueduct. Because CRA supplies represent the region's least-cost imported resource, Metropolitan will take all necessary actions to assure that the Colorado River Aqueduct will be operated at full capacity for the benefit of all member agencies.

State Water Project. Because of the reliability and water quality benefits that the SWP supply provides, Metropolitan will support the CALFED process which establishes the essential coalition of urban, environmental and agricultural interests to reach long-term solutions for the Delta and operations of the SWP. Recent milestones, including the historic Bay-Delta Accord and Monterey Agreement, have resulted in significant operational improvements for the SWP system and set the stage for long-term solutions within a three year time frame.

Water Transfers. Metropolitan will pursue voluntary water transfers through options and storage agreements, the drought bank, or other similar spot markets at an affordable price to maximize the region's dry-year supply yield and optimize coordinated conjunctive-use operations.

Regional Storage. Additional surface reservoir storage in Metropolitan's service area is essential to maintain adequate emergency supplies should a major catastrophic event occur. Equally important, surface storage is needed to assure the effective conjunctive use storage of imported supplies and groundwater storage operations in order to provide additional dry year water supplies during periods of droughts. Although Metropolitan should continue to review its capital improvement program (CIP) in order to reduce the risks of "stranded" investments, all available evidence indicates that Metropolitan should proceed as planned with the construction of the 800,000 acre-feet Eastside Reservoir Project. This keystone project to the CIP will optimize imported supplies to meet emergency, drought, and regulatory requirements of the region, and to improve water quality blends and conjunctive use storage in the local groundwater basins.

PLANNING LEADS TO ACTION

The IRP process has produced many benefits for the region. It has fostered communications among a wide community of water providers, improved the region's understanding of the complex relationships that exist among water resource options, and provided an analytical framework for the evaluation of proposed resource projects and programs. Ultimately, however, the usefulness of the IRP will depend upon the ability to achieve regional goals in the real world of local decision-making, limited resources, and demanding schedules.

There is no value in arriving at a theoretical resources plan, if the analysis and understanding it provides fails to produce the required actions and programs. Bridging the gap between planning and implementation is always challenging. The actions needed to ensure that the Preferred Resource Mix achieves the goals and objectives identified during the IRP will require commitment from the region's water providers. Metropolitan and its member agencies have an enviable track record of taking the actions needed to achieve regional water reliability. Implementation of the recommendations resulting from the IRP process should continue in that tradition of following planning with effective action.