SECTION 3 - IRP PROCESS AND TECHNICAL APPROACH

IRP PROCESS OVERVIEW

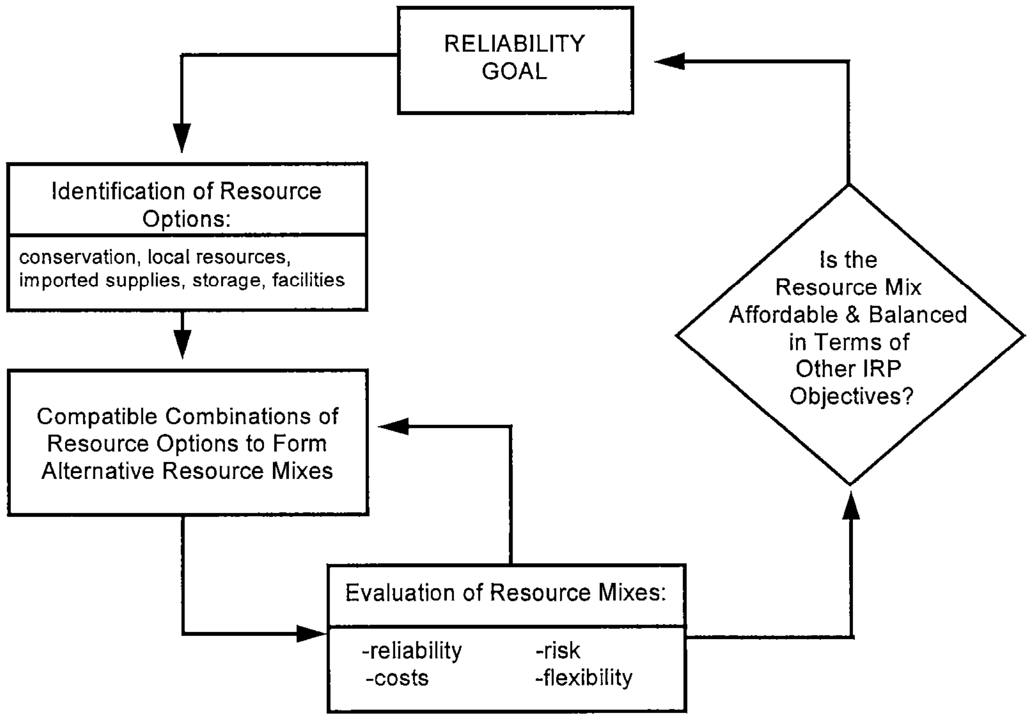
The purpose of the IRP was the development of a comprehensive water resources strategy that will provide the region with a reliable and affordable water supply for the next 25 years. Several steps were taken to develop this strategy. First, as discussed in Section 2, the potential shortfall between demand 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.

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

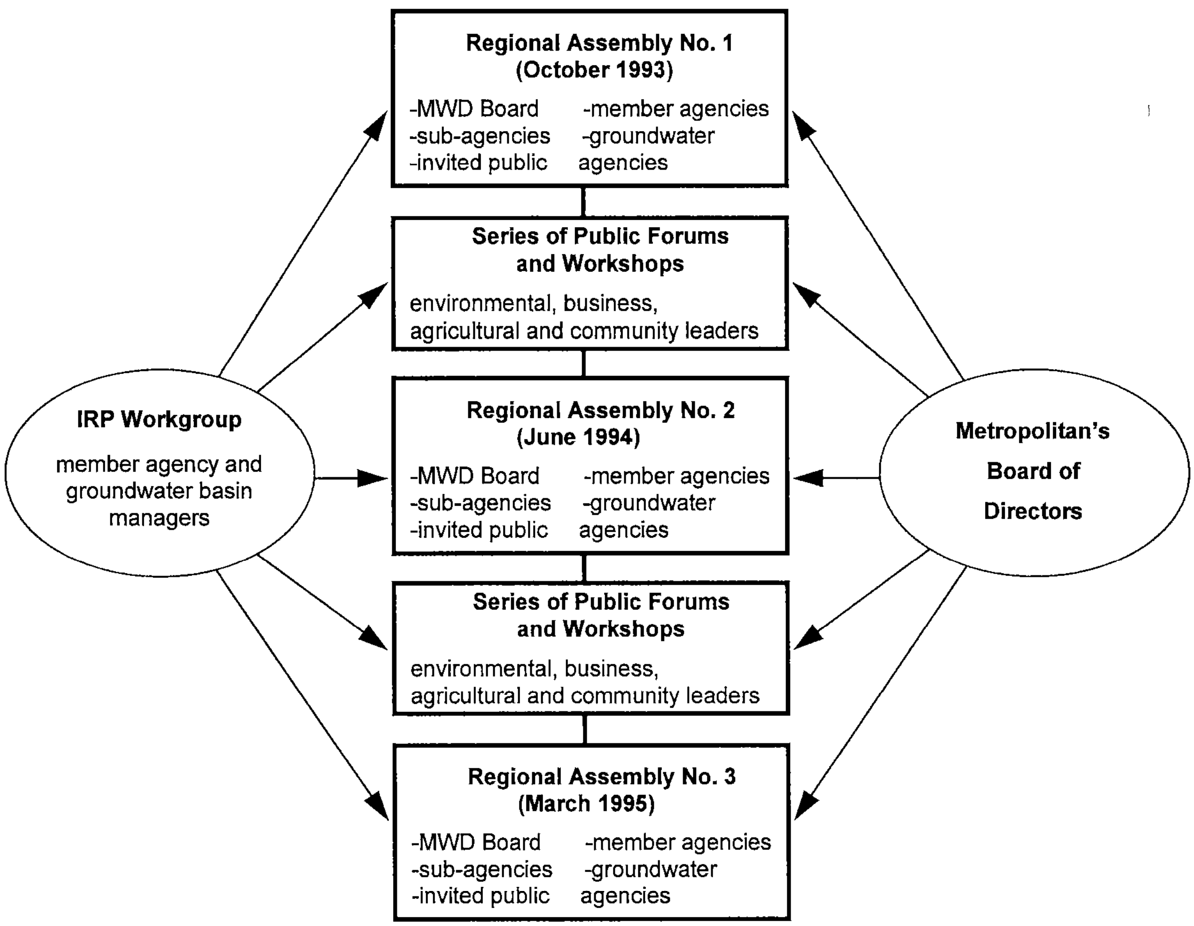


The planning process was solicited input from three major groups: (1) Metropolitan's Board; (2) the IRP Workgroup; and (3) interested members of the public including representatives from the environmental, agricultural, business, and civic communities (see Figure 3-2). Metropolitan's Board was responsible 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 stormwater 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

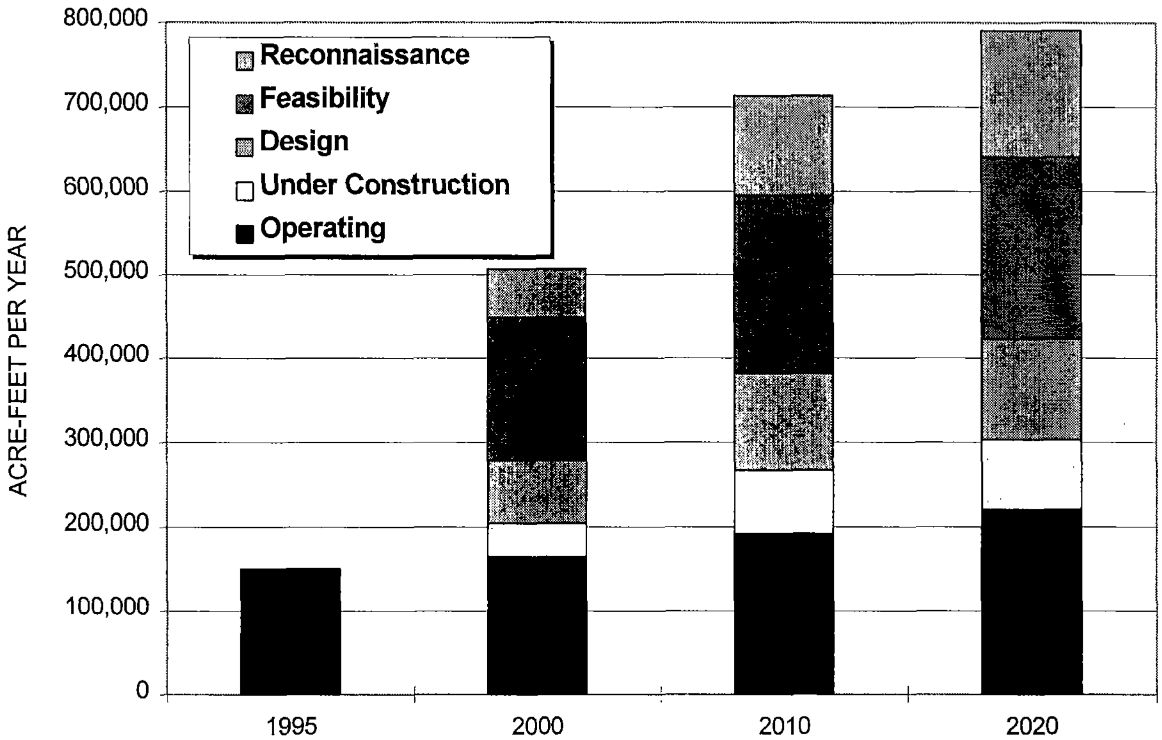
Water Recycling and Groundwater Recovery

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)

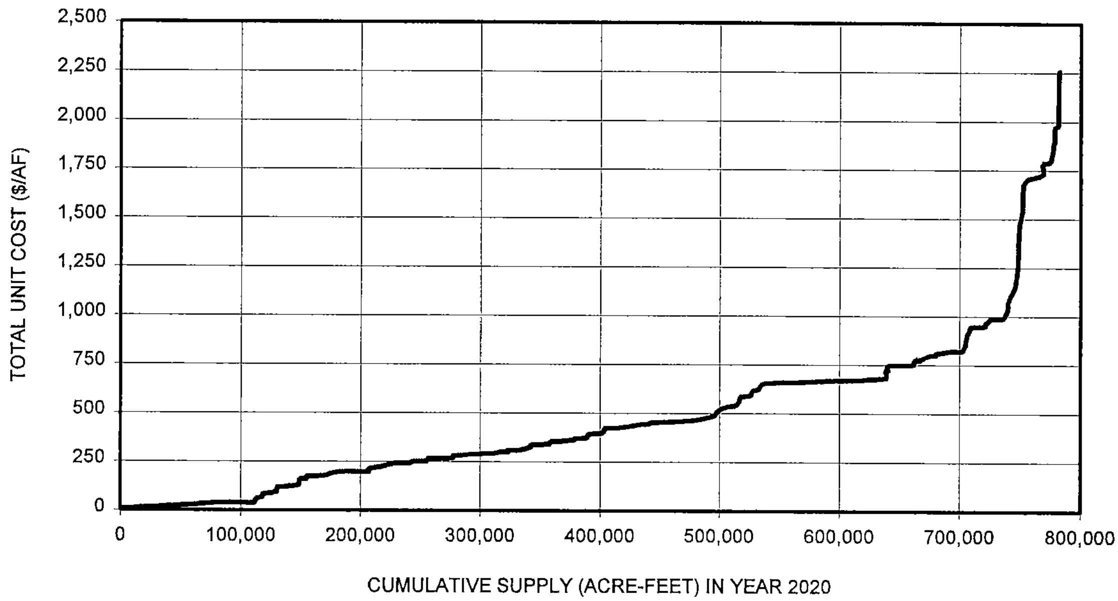


Table 3-6
Potential Risks Associated with Developing Water Recycling Projects

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

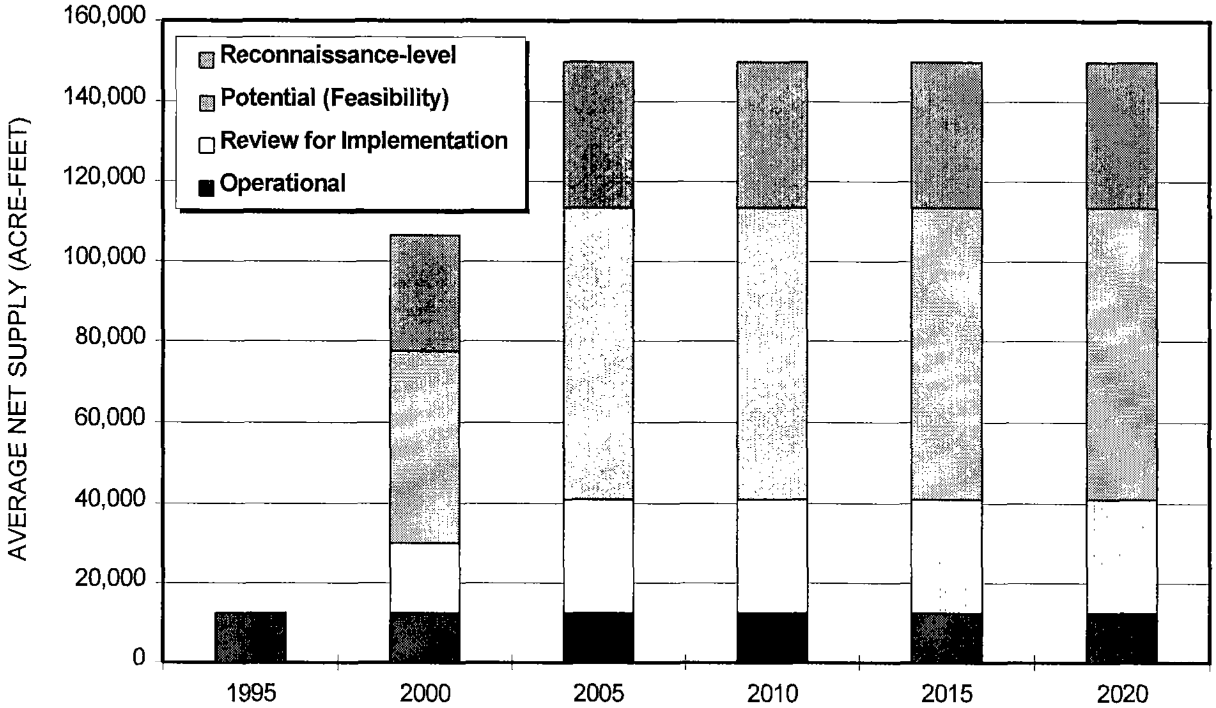


Table 3-7
Potential Risks Associated with Developing Groundwater Recovery Projects

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. To help evaluate the potential for ocean desalination, Metropolitan is constructing a small pilot demonstration plant.

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 formed in 1928 to construct and operate the Colorado River Aqueduct (CRA) so that deliveries of Colorado River water could be made to Southern California. Metropolitan has diverted water from the Colorado River since 1941 under water delivery contracts with the federal government. These contracts 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 adequate maintenance.

In 1964, a U.S. Supreme Court decree, Arizona vs. 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 0.53 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 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 agreements 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

In addition to the on-going projects, Metropolitan and other resource agencies are designing several new programs collectively known as "Reliability Plus." Once implemented, this partnership and programs will transform 30 years of uncertainty into 30 years of reliability. 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, which unused Colorado River water is stored underground in Arizona, potentially for the benefit of Metropolitan. To date, 50,000 acre-feet of water has been stored at a cost to Metropolitan of about $70 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 is made available to Metropolitan by Arizona foregoing the use of part of its normal supply from the river. Metropolitan has executed an amendment to the agreement that increases the total amount of water that can be stored by 200,000 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 has entered into a parent 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. A partnership between Metropolitan and the Southern Nevada Water Authority (SNWA) to implement a conservation program that constructs 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 canal would provide savings of about 68,000 AF of water per year, currently lost through seepage. In exchange for funding the canal construction, Metropolitan and the SNWA have the opportunity to utilize the conserved water for 55 years with an option to renew the program for another 55 years. The SNWA will provide $50 million of the funding for the All-American Canal and will receive 30,000 AF per year of the project's conserved water. This saved water also provides the impetus to develop other long-term agreements.

Optimized Management of Colorado River Reservoirs. An approach to optimize management of the Colorado River reservoirs, which would spell out when surplus water is available and how unused water is apportioned among Arizona, California, and Nevada. These changes in river operations are expected to make additional low-cost water available to Metropolitan and SNWA with no impacts to other Colorado River water users. Nevada would receive the first 60,000 acre-feet, California the second 60,000 acre-feet of unused Arizona apportionment, and they would both share amounts beyond this.

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

In aggregate, the unit costs to Metropolitan for implementing these reliability programs for the CRA range from $75 to $150 per acre-foot. The potential risks associated with CRA deliveries are summarized in Table 3-9.

Table 3-9
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 hydrologic operations of the Colorado River, resulting in reduced	- Develop cooperative workgroups with other resource agencies. - Support and develop a multi-species habitat conservation plan

	deliveries.	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 addition, the U.S. EPA has proposed further constraints on SWP and CVP operations.

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 an interim Delta improvements that involve: (1) south Delta channel enlargelments 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 the 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 the 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 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.

Figure 3-6
Variability in SWP Supplies Under Different Resource Investments

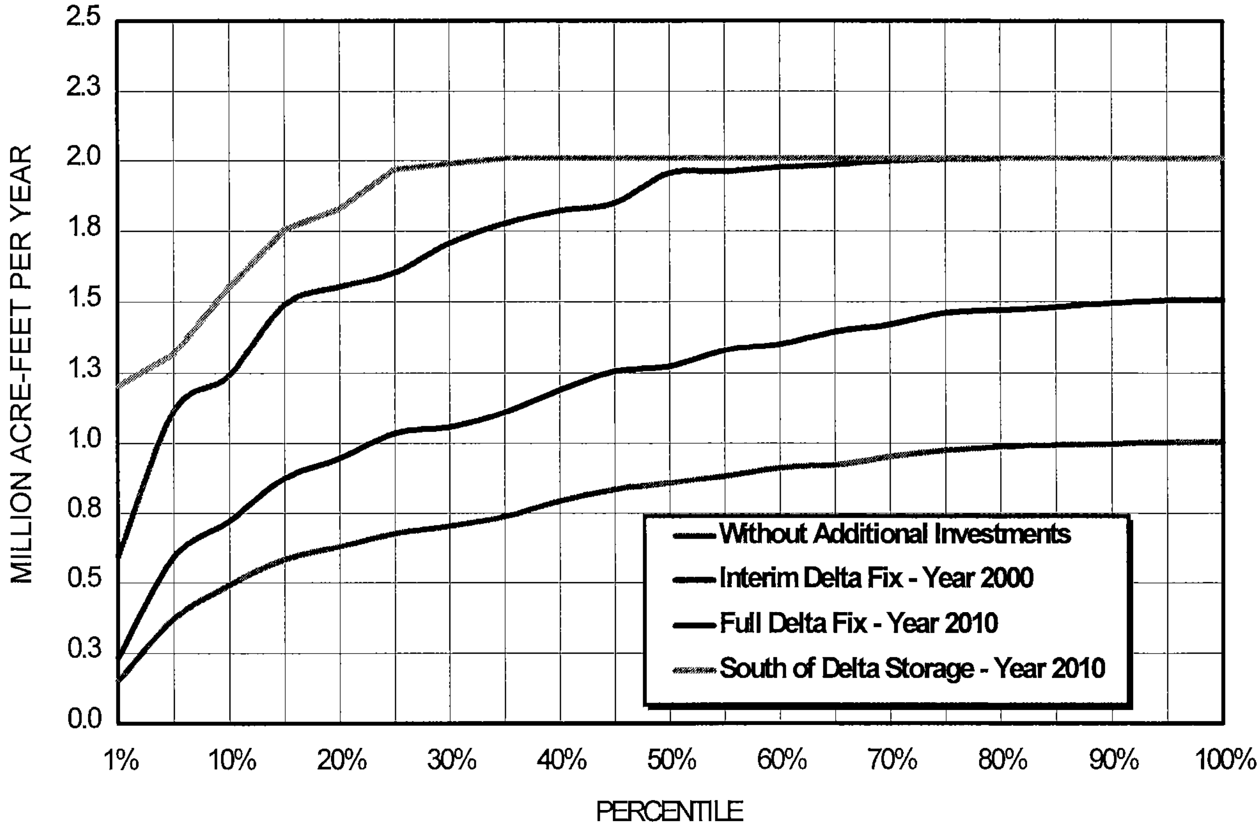


Table 3-9 summarizes the potential risks associated with the SWP supplies.

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:	No additional supply	- Initiate and support a state-federal

Reliance on channel improvements within aquatic habitat may not obtain ESA or CWA permitting.	obtained and loss of funds expended for planning and permitting.	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 "carryover" 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 groundwater 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.

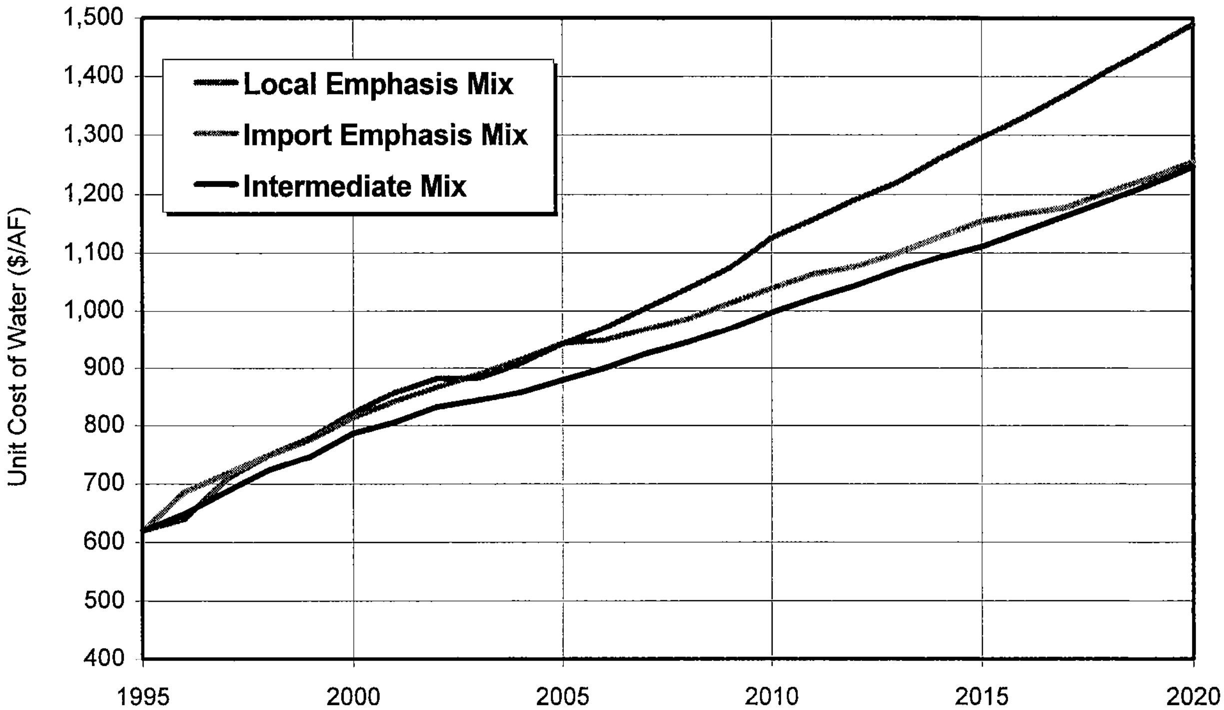
Evaluation of Resource Mixes

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:

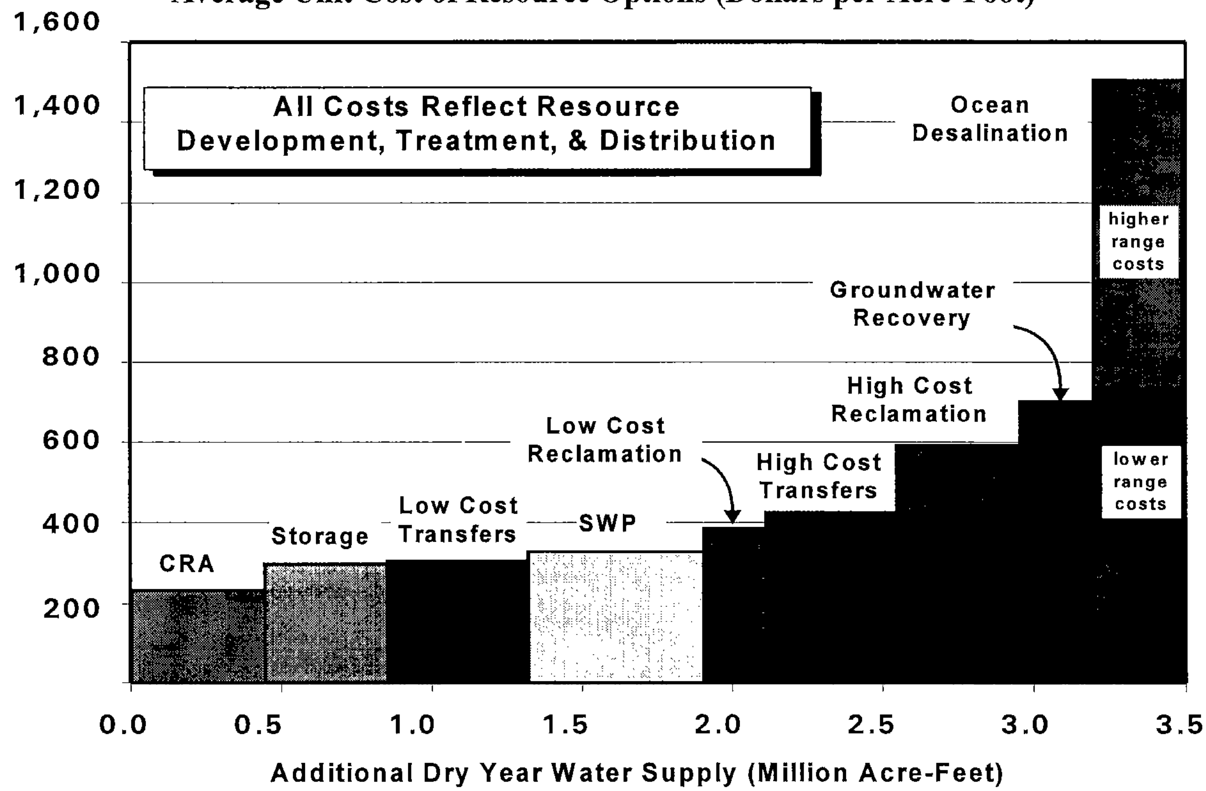
1. Costs for water recycling projects that are required by regulations for treatment of wastewater for disposal.

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 Resource 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 IRPSIM 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.

Figure 3-9
Carryover Storage Evaluation Using 1967-1991 Historical Hydrology

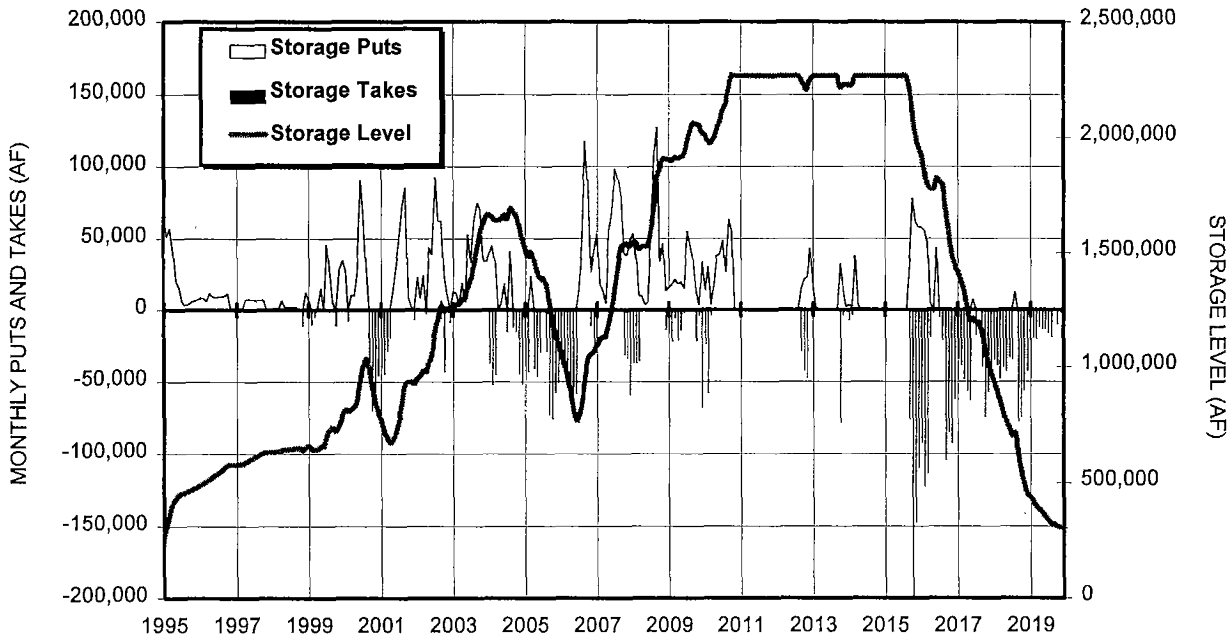


Table 3-10 summarizes the region's existing and potential surface and groundwater storage and identifies the additional storage requirements. The storage analysis reveals that about 800,000 acre-feet of additional storage is required for the region.

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.

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.

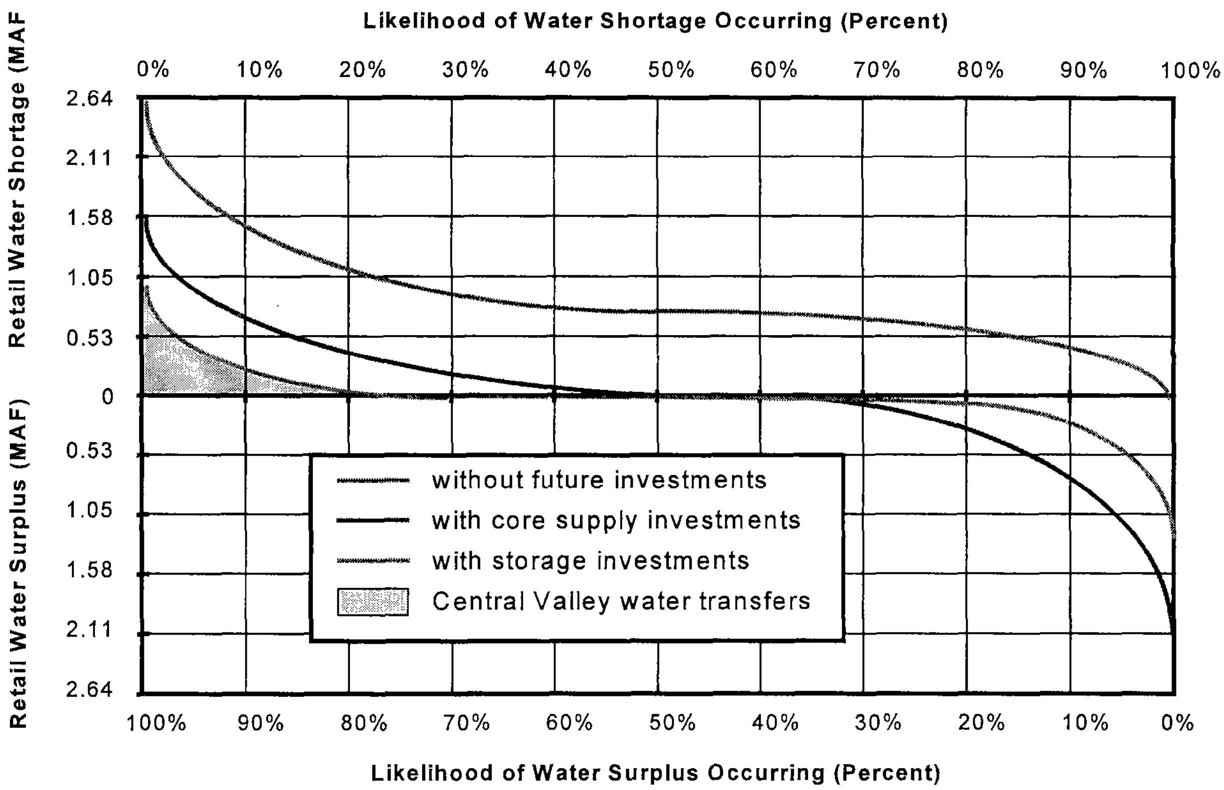
Supply Reliability Evaluation

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.

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 upper left side of the graph) for the region.

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

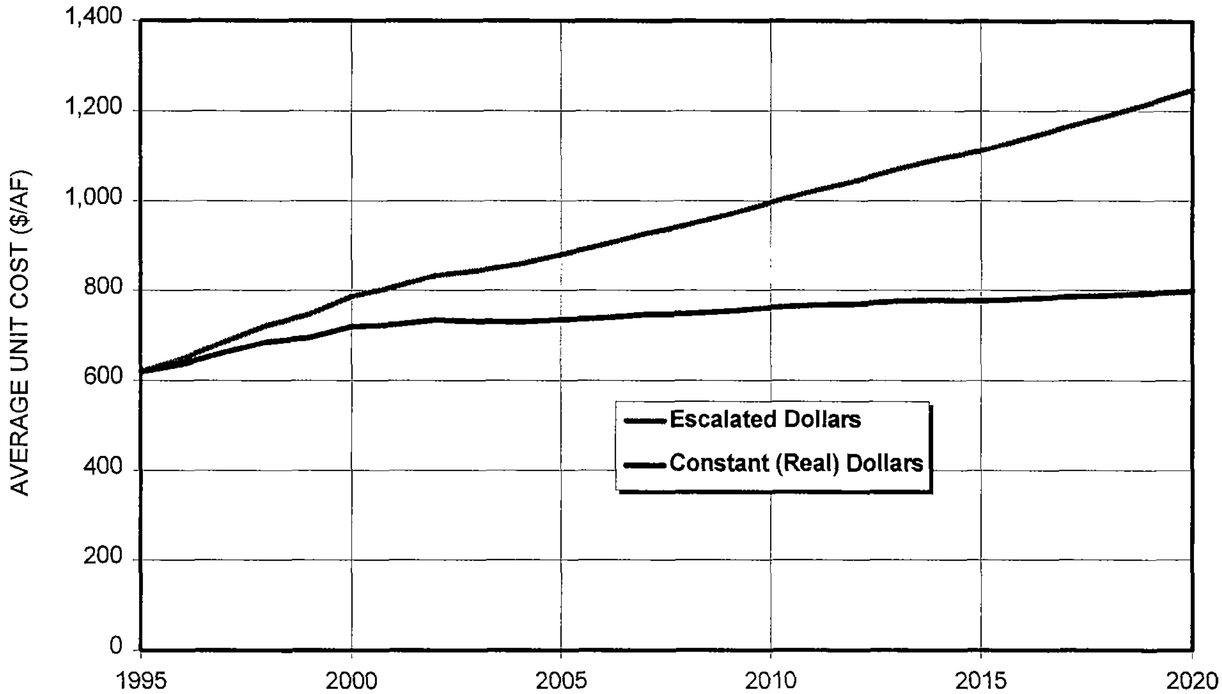
Dry Year Supply (Million Acre-Feet)	2000	2010	2020
Locally Developed Supplies:			
Local Production [1]	1.43	1.48	1.53
Water Recycling [2]	0.27	0.36	0.45
Groundwater Recovery	0.04	0.05	0.05
Local Groundwater Storage Production [3]	0.25	0.30	0.33
Metropolitan's Regional Supplies:			
Colorado River Aqueduct	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

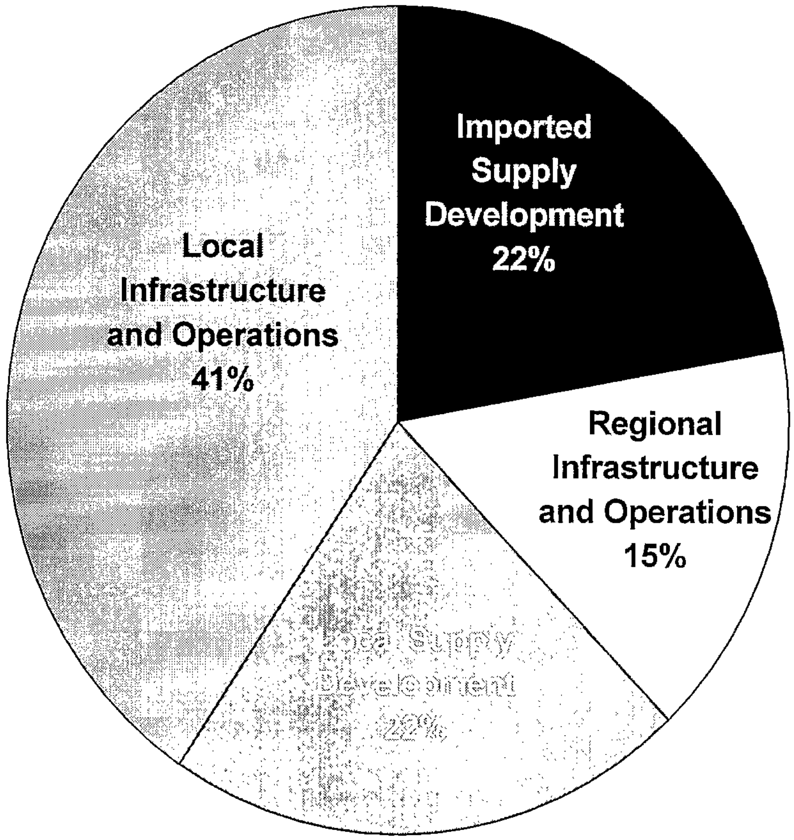
One of the most important objectives of the IRP was development of an affordable resources plan. Assessing affordability required estimates of the total regional cost for the Preferred Resource Mix. The total regional cost was divided into: (1) imported supply development, (2) regional infrastructure 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 regional costs under the Preferred Resource Mix.

Figure 3-11
Average Regional Cost for Preferred Resource Mix



The cost analysis indicates that the region's average cost for water (presented in 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 regional 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 regional 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 60 percent).

Figure 3-12
Breakdown of Regional Costs for the Preferred Resource Mix
Year 2005



In assessing affordability, several questions were asked:

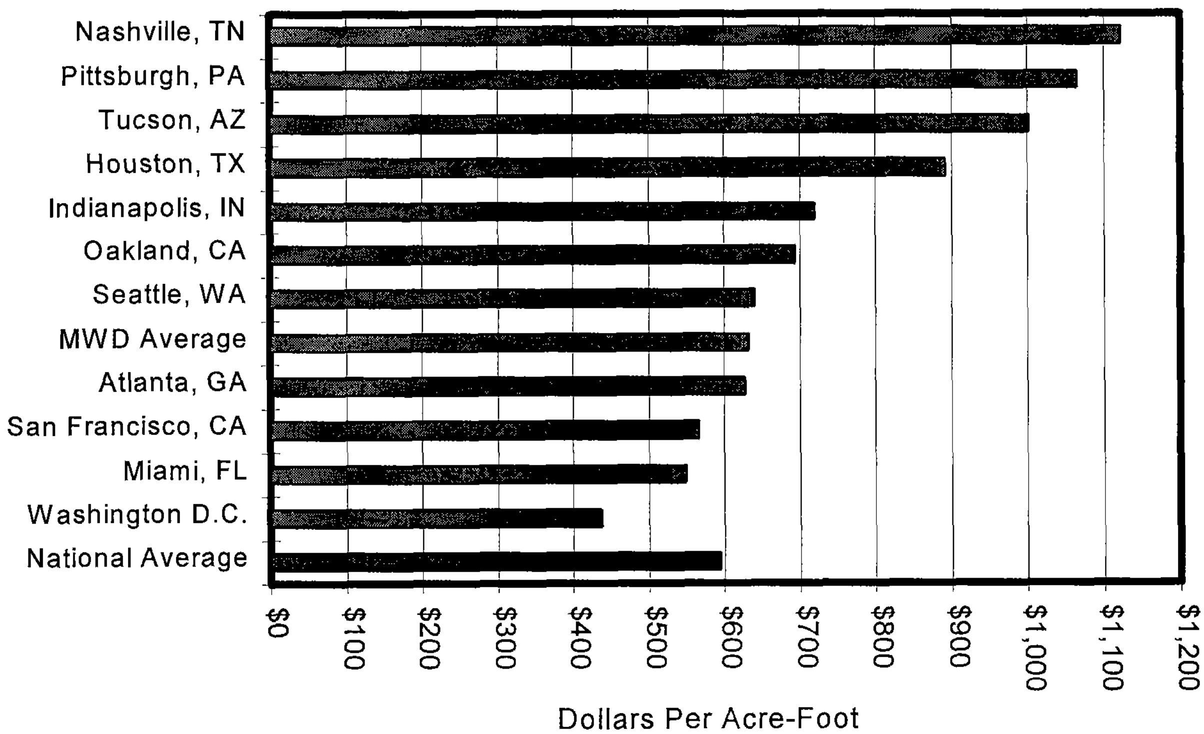
1. How does the cost of providing a reliable and high quality water supply for Southern California compare with other metropolitan areas across the country?

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

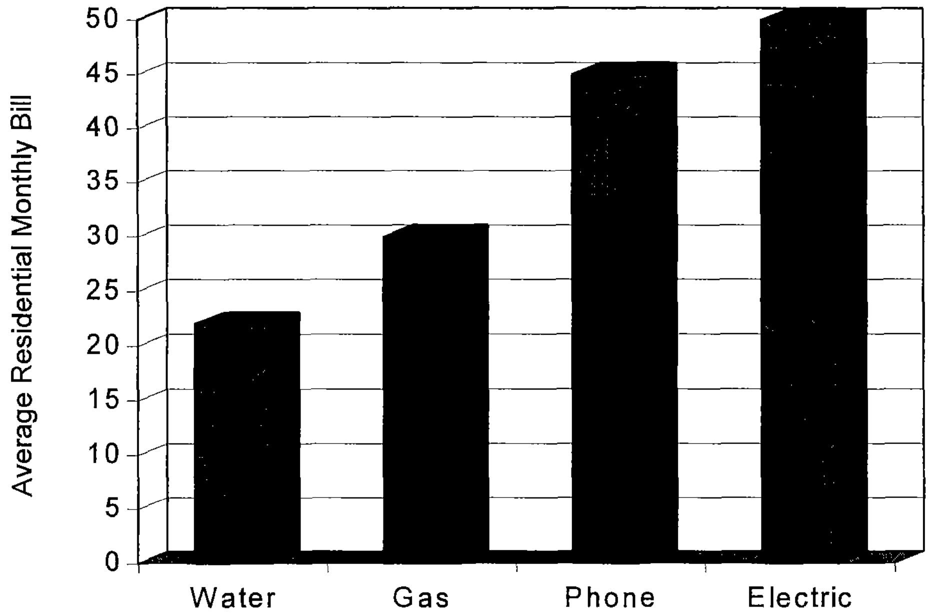


Source: Ernst & Young Water Rates Survey, 1994.

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 Average Water Supply Costs for Urban Areas



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 state-wide 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.