Report

Integrated Resources Plan

Phase I Report

Final Draft

November 28, 1994

MWD
METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Pcroatters

MWD

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

November 28, 1994

To: IRP Work Group

From: Chief of Planning and Resources Division

Subject: IRP Phase I Report

Attached is a copy of the second draft of the IRP Phase I report. This report summarizes IRP activities through the June 1994 IRP Assembly. Work conducted since the assembly is part of the IRP Phase II and thus is not included in this report. For this reason, you may notice that some of the numbers in the report are different from recent findings reported from IRP Phase II. This reflects the ongoing refinement of the intermediate resource mix.

This draft should be considered to be a final draft of the IRP Phase I report. While this draft is complete, the reproduction quality of some of the figures is not of final report quality and will be improved for the report.

Your comments are important to us as we finalize the Phase I Report. Please forward your comments to Grace Chan at (213) 217-6798 by December 30, 1994.

Brian G. Thomas for

Debra C. Man

Attachment

cc: Board of Directors

Integrated Resources Plan

Phase I Report

Final Draft

November 28, 1994

MWD
METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Forward

This report summarizes the first phase of an ongoing process to establish and implement a water resource strategy for the service area of the Metropolitan Water District of Southern California (Metropolitan). This process, called an integrated resource planning process, uses the coordinated effort of all parties with a "stake" in solving regional water resource needs—Metropolitan, its Member Agencies, other water agencies, and community, business, environmental, and agricultural interests—to determine a least-cost solution to these needs. This first phase established the regional strategy, defining an affordable water supply reliability goal, governing business and water management principles, and preliminary water resource targets.

Clearly, the success of the integrated resource planning process depends on the people involved. While it is not possible in this space to give proper credit by name to all parties involved, the contributions of a few parties stand out. First, the IRP Workgroup composed of staff from Metropolitan, its Member Agencies, and the groundwater basin managers met regularly and worked diligently on providing and reviewing technical information and making preliminary decisions on the make-up of each resource mix. Next, staff of Metropolitan's Planning and Resources Division performed technical evaluations of supply reliability and cost, and provided overall management of the IRP process. The steering committee for the IRP Assembly digested the technical and qualitative IRP evaluations into concise issue papers for the consideration of Assembly participants. Finally, Camp Dresser & McKee Inc., the IRP Consultant, helped to facilitate the IRP process and prepared this report.

Table of Contents

MWD

Executive Summary

MWD

Executive Summary

Southern California's Water Supply Challenge

Southern California's water community is at a critical time in its history as a steward of water resources. The region faces a growing gap between its water requirements and its firm supplies. Increased environmental regulations and the attendant competition for water from outside the region have resulted in reduced supplies of imported water. At the same time, demand is rising within the region because of continued population growth. Shortages during 1991 highlighted the seriousness of the problem.

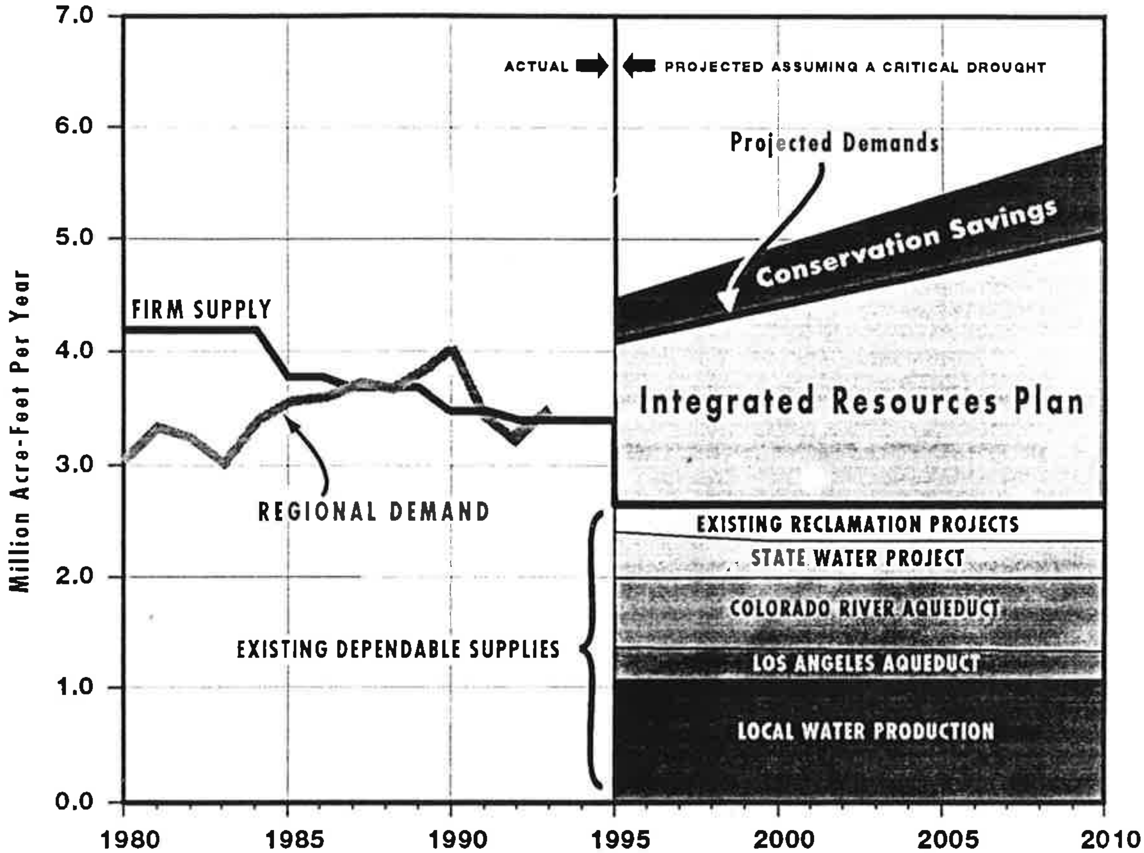
Southern California faces a growing gap between its firm water supplies and the water requirements of continued population growth

The water used in Southern California comes from a number of sources. About one-third of it is found locally. The rest of the region's water is imported from three sources -- the Colorado River, the Sacramento-San Joaquin River Delta, and the Owens Valley and Mono Basin (through the Los Angeles Aqueducts). The ability of Southern California to secure the same amount of imported water, much less a greater amount, is in question.

The population in Metropolitan's 5,149 square mile service area is forecast to increase from the current 15.7 million to about 19.5 million by year 2010, and to 21.5 million by year 2020. At present, between 195 and 215 gallons of water are consumed daily for municipal and industrial uses for every person living in Southern California. Since the 1970s, the region's total water demand has increased from about 2.8 million acre-feet per year to about 3.5 million acre-feet per year in 1993. Based on normal conditions and full implementation of water conservation measures, it is expected that regional demands will increase to just over 4.5 million acre-feet by year 2010, and to just over 5.0 million acre-feet by year 2020. During very hot and dry years, demands could be as high as 4.9 million acre-feet in 2010, and 5.6 million acre-feet in year 2020.

Figure ES-1 shows that the delivery of water to Southern California water consumers has been nearly 100 percent reliable in the past. However, as existing dependable water supplies continue to decrease, future reliability is uncertain. Even with a 15 percent reduction in demand due to full implementation of conservation measures, the reliability of water deliveries during a drought could fall to 50 percent by year 2000 without any additional water supply investments or improvements. This would mean that there

Figure ES-1
Water Supply and Demand: Critical Drought Year



would be some type of shortage, on average, every other year, and rationing in many of these years.

Current Resource Management Strategies

The agency that has traditionally had the lead role for meeting the region's supplemental imported water needs is the Metropolitan Water District of Southern California (Metropolitan), a special district created in 1928 under State enabling legislation. Metropolitan is a confederation of 27 Member Agencies which purchase wholesale water from Metropolitan, handle sub-regional distribution, and resell the water to other suppliers or directly to consumers. Metropolitan is governed by a 51 member Board of Directors appointed by their Member Agencies. The Directors are accountable to their appointing authorities, most of whom are elected officials. Metropolitan, through its staff, carries out many duties in connection with securing, storing, distributing, treating water, and financing those activities under Board policy for the region.

During the past two decades, Metropolitan has broadened its role as a supplier of imported water, to play a part in region-wide water management. Metropolitan has used financial incentives and other means to encourage its Member Agencies to develop alternative water supplies and to become less dependent on Metropolitan for water supplies. On their own and in response to Metropolitan's incentives, Member Agencies have developed additional groundwater resources, promoted conservation, developed water reclamation projects, and supported Metropolitan at the State and federal level to improve imported supplies.

The IRP Process

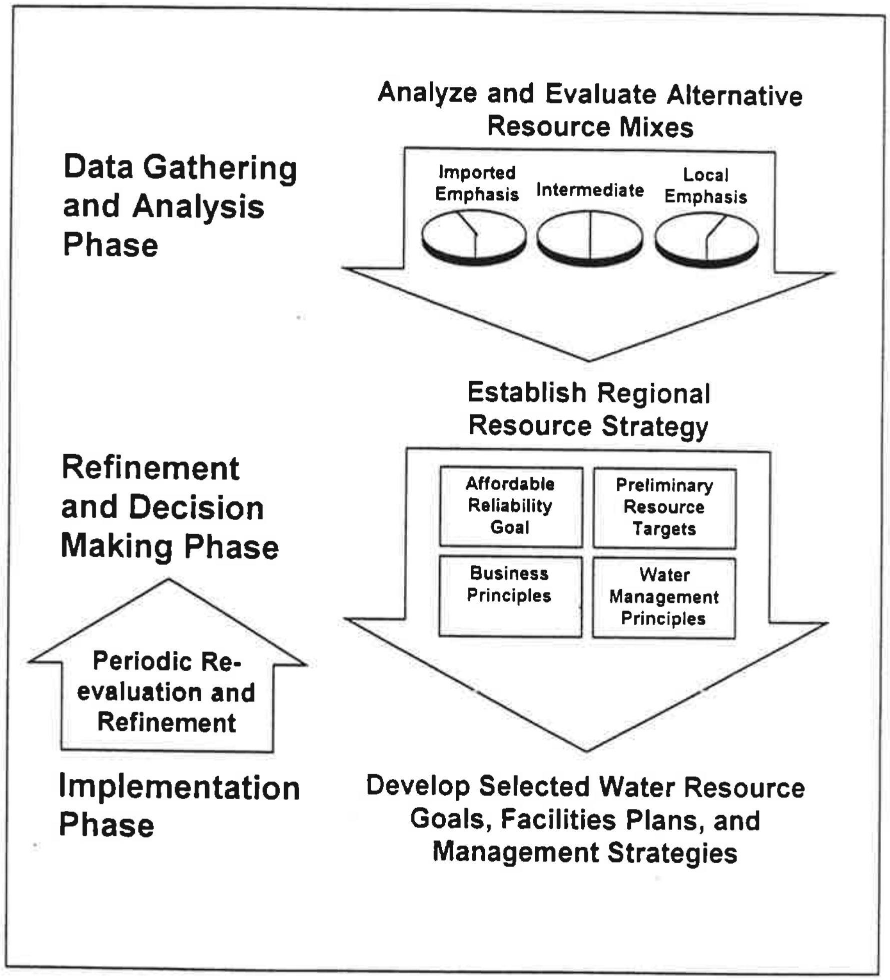
A unified and coordinated approach to water resources planning among all water providers is needed to meet the region's future water needs. To help facilitate this coordinated approach, Metropolitan, its Member Agencies, and other water agencies have embarked upon the first phase of an Integrated Resources Planning (IRP) process, a comprehensive evaluation of water supply options available to the region as a whole. In the broadest terms, the IRP process asks the questions: "What level of reliability does the region require?"; "What is the most desirable means of achieving reliability, given the range of potential water supply options?"; "Can the region afford the desired level of reliability?"; and "What needs to happen in order to accomplish the desired outcome?"

The IRP process presents a wide range of options and participants in the development of a strategy for reliably meeting regional water needs.

One of the most important strengths of the IRP process is that it is 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 are clearly outside of the direct control of Metropolitan and its Member Agencies. Nevertheless, they represent practical and cost-effective means of achieving regional goals. In order 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.

Figure ES-2 shows how a regional resource strategy is formulated with the IRP process. This report summarizes the data gathering and analysis phase and the refinement and decision-making phase. Because the questions raised during the IRP process are all related to one another, it is possible to begin the process almost anywhere and work around, iteratively, to cover all relevant issues and concerns. In Metropolitan's case, the IRP process identified resource mixes that could meet all of the wholesale water demands of Metropolitan's Member Agencies, except during the most severe droughts. At

Figure ES-2
Development of a Regional Resource Strategy



those times, say one year in 50, Metropolitan would deliver no less than 80 percent of the imported water needed to meet wholesale demands within its service area, with the difference made up by rationing or voluntary conservation measures.

The refinement and decision-making phase of the IRP process was designed to be open and participatory. Member Agencies and groundwater agencies were actively involved in reviewing the methodology and results and in establishing a technical framework. Also, three open forums and three local agency workshops were held throughout Southern California to review options and obtain input. The refinement and decision-making phase concluded with an Integrated Resource Plan Assembly in June 1994, where over 100 representatives of the region's water providers defined a regional resource strategy to guide future water supply planning. This strategy is currently being implemented.

Resource Mix from a Regional Perspective

The question posed by the IRP is where to put the emphasis along a continuum that covers three basic resource mix alternatives. At one end of the continuum is the strategy of enhancing local supplies, through very aggressive water reclamation, groundwater development, ocean desalination, and conservation beyond the current Best Management Practices (BMPs). At the other end is securing existing entitlements and additional imported water supplies through Delta improvements and south-of-Delta storage. Between these extremes is the strategy of balancing local and imported supplies, and storing seasonally available imported water in surface reservoirs and groundwater basins for use later during droughts and periods of high demand (a method referred to as "conjunctive use"). Table ES-1 describes the level of investment in each available resource option under each feasible resource mix.

The question posed by the IRP is where to put the emphasis along a continuum that covers three basic resource mix alternatives

Because each of these alternative resource mixes is comprised of simplified combinations of investments in facilities and programs, they are not intended to represent "optimal" resource plans. Rather, they reflect three broad approaches to meeting the region's reliability goal. They provide a useful foundation upon which to build general conclusions regarding supply reliability, cost, and uncertainty; and they can serve as a framework for both short-term and long-term resource strategies for the region. Once preliminary resource targets are developed, more detailed systems and operations analyses will be conducted in order to develop refined resources plans.

The evolution of water resource goals and facilities' plans through the ongoing implementation of IRP in Southern California should continue to be dynamic and iterative, always capable of adjusting the strategy to reflect the changing circumstances of the region's water resource environment. As decision makers and other stakeholders in the process evaluated the meaning and significance of the initial analytical outputs of the IRP process, several important considerations emerged:

- ***Alternative Resource Mixes are not Optimized Plans.*** The alternative resource mixes defined in the IRP process do not represent definitive or final choices regarding specific levels of resource development and proposed future facilities. The decision making process involves selecting a general direction and establishing preliminary targets based on those

Table ES-1
Initial Feasible Resource Mixes

Resource Levels	Imported Resource Emphasis	Intermediate Resource Mix	Local Resource Emphasis
Imported Resources			
State Water Project	very aggressive investments	aggressive investment	small investment
Colorado River Aqueduct	aggressive investment	aggressive investment	aggressive investment
Central Valley Water Transfers	aggressive investment (mainly needed in the near term)	moderate investment (mainly needed in the near term)	moderate investment (mainly needed in the long term)
Local Resources			
Local Production	maintain with existing conjunctive use	maintain with increased conjunctive use	maintain with increased conjunctive use
Recycling	current investment	aggressive investment	very aggressive investment
Groundwater Recovery	current investment	moderate investment	aggressive investment
Ocean Desalination	no investment	no investment	moderate investment
Conservation	aggressive investment	aggressive investment	very aggressive investment

broad conclusions supported by the analysis of alternative resource mixes.

- *Selection of a Regional Resource Strategy Should Address Uncertainties.* Both the selection of a resource development approach and the optimization of a specific strategy should address the uncertainties associated with each resource option and the overall resource mix.

- *Detailed Plans will Follow Establishment of a Regional Strategy.* Once a broad water resources strategy has been established, it can serve as the basis for developing detailed resource and facilities plans, designed to optimize the investment in future supplies and facilities.

Common Water Management Objectives

Based on the preliminary analysis of alternative resource mixes, six broad water management objectives emerge as common elements of all feasible options.

- *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.

Six broad water management objectives emerge as common elements of all feasible options

- *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.

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

- *Maintain and fully utilize base dependable flows in the State Water Project.* Despite the challenge of resolving the complex issues in the Sacramento/San Joaquin Delta (Delta), there are significant advantages associated with realizing the benefits that can result from these fixed investments.

- *Optimize the use of water transfers.* The ability to provide reliable deliveries of supplies to Southern California can be greatly enhanced through the acquisition of water transfers in the CRA, State Water Project (SWP), and the Central Valley systems. 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 (CVP) service area to urban uses.

- *Maximize storage within Metropolitan's service area.* Storage helps in three ways:

  1. Often, it is wetter in the winter (when water demand is lower) and is dryer in the summer (when demand increases). Storage is needed to

"seasonally shift" this water from when it is available (i.e., winter) to when it is needed (i.e., summer).

2. Over a series of years, total annual precipitation varies. Consecutive years with low precipitation may result in droughts. Storage helps save water from wetter years for use during dry periods or droughts.

3. Imported water supplies are all carried to Southern California by aqueducts that cross major fault lines. When a severe earthquake occurs, one or more of these aqueducts may be damaged, disrupting the supply of water. Current policy is to maintain emergency storage in Southern California to provide enough water to meet 75 percent of normal demand for six months.

A Regional Resource Strategy

The Refinement and Decision-Making Phase of the IRP process concluded at the three-day American Assembly on the Integrated Resource Plan convened in June 1994. Over 100 people participated in the Assembly, including members of Metropolitan's Board, Metropolitan's Member Agency managers, Metropolitan senior staff, groundwater agency managers, and representatives of retail subagencies that purchase water from Member Agencies. The Assembly focused on defining a regional resource strategy for meeting projected water demands through the year 2020. The main questions the Assembly addressed were which resource mix to emphasize, and how to implement it.

The IRP Assembly of Southern California's water community agreed to emphasize an intermediate resource mix and determined how to implement it

The Assembly participants agreed that the best resource combination for the region is an intermediate mix. However, in supporting an intermediate mix, the participants are supporting a general direction, not all of the specific items and goals included in the IRP analysis. This decision was based on two major factors: the cost to meet the region's reliability goal, and the ability of the mix to adapt to significant uncertainties associated with many resource options.

The general resource parameters suggested by the Assembly participants include:

1. Local supplies should be pursued to the point of technical and economic feasibility. The region should make full use of economically and environmentally feasible local water supplies (such as groundwater, reclamation, and desalination) as long as these are coupled with

maintaining and enhancing a dependable supply from the State Water Project (SWP).

2. Dependable supplies from the SWP have the potential to be highly economical and because of water quality considerations, are essential for successful implementation of local reclamation and groundwater storage programs.

3. The Domenigoni Valley Reservoir Project, the Inland Feeder, and groundwater and other local storage all work together to meet overall water supply, emergency storage, and water quality needs.

4. Supplies from the Colorado River Aqueduct should be maximized, but steps should be taken to address water quality impacts on local water resources development.

Cost and Affordability Issues

The IRP process estimated specific retail-level costs based on (1) future Metropolitan costs, (2) future local resource development costs, and (3) existing retail-level costs. Figure ES-3 shows that all three resource mixes have similar region-wide costs over the next ten years. Beyond that time, the cost of emphasizing local resources is substantially higher than the cost of the other mixes. To meet the region's supply reliability goal under the intermediate resource mix, retail costs will increase at an average rate of 1.5 to 3% in current (1993) dollars over the IRP planning period of 25 years. The IRP evaluation indicates that these cost increases appear affordable. Studies on willingness to pay for supply reliability indicate that residential customers are willing to pay about 50 percent more for water on average to avoid water supply shortages similar to the 1991 drought. Even though regional costs under the intermediate resource mix are affordable, certain member agencies may have higher costs than others. Figure ES-4 breaks average region-wide costs among the various Member Agencies under current financing provisions and arrangements. These costs, which can significantly change if financing changes, should be the basis for reevaluating financing responsibilities.

Uncertainty Considerations

The analytical phase of the IRP process presents an assessment of uncertainties associated with projecting demands and forecasting supplies. A number of other factors also influence the desirability of a specific resource mix. For instance, the preferred resource mix should provide supply flexibility and adaptability, achieve public acceptance, and satisfy environmental concerns as well as local economic considerations. The intermediate mix was selected because it provides the greatest diversity, adaptability, and flexibility.

Figure ES-3
Region-Wide Average Water Cost with Cost Range
(1993 Dollars)

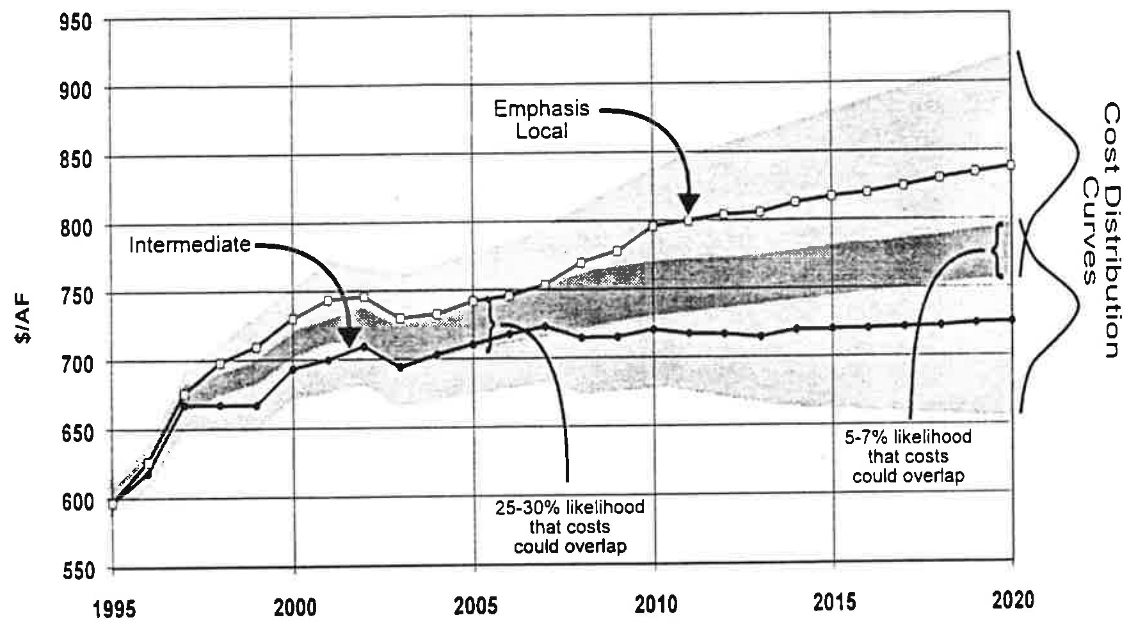
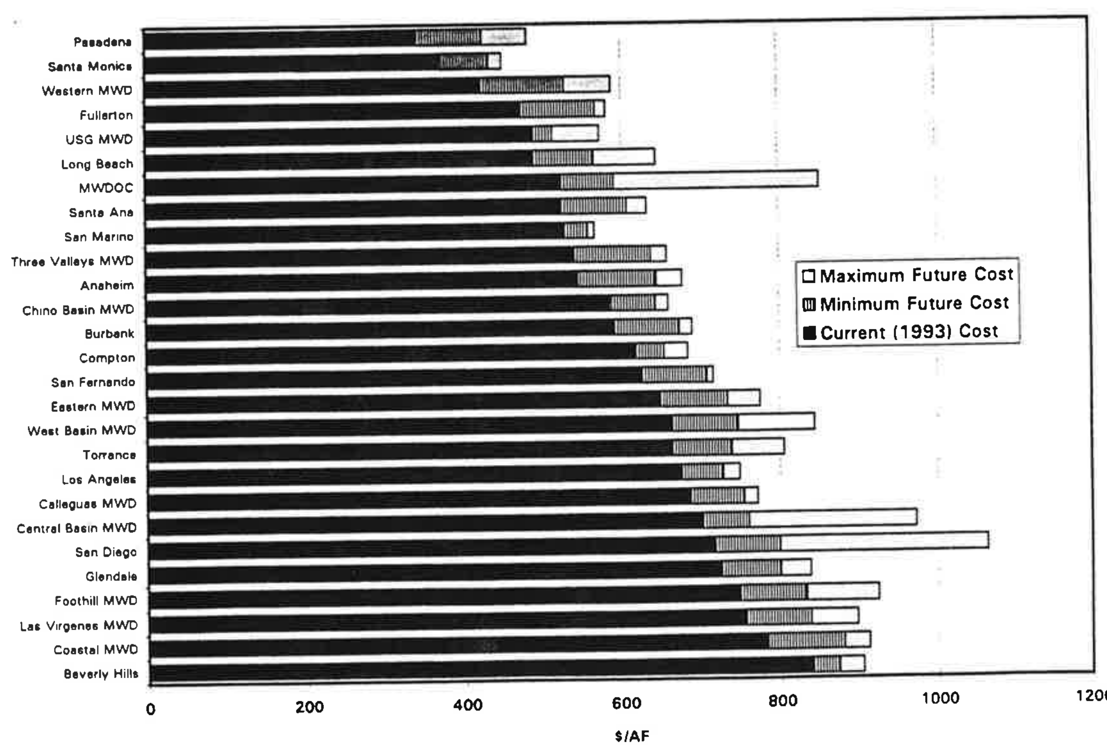


Figure ES-4
Average Cost of Water in Year 2010
(1993 Dollars)



MWD

Maintaining an appropriate mix which meets the reliability goal is a dynamic process requiring regular evaluation. Selecting preliminary resource targets consistent with an intermediate resource mix that affordably meets supply reliability goals must be directed by defined, accepted business and water management principles.

Business Principles

Metropolitan's Strategic Plan established a number of business principles to direct future investments in water resource system planning, facilities, and operation:

The intermediate resource mix will be implemented according to regional business and water management principles

- Resource investment decisions with ***financial integrity*** require a mutual commitment of reliable revenue sources.
- There must be ***fairness*** in access to reliable water service by all Member Agencies.
- Metropolitan's fees must consider ***equity*** in the cost of service and the ***value*** of the benefits provided.
- The ***operating integrity*** of Metropolitan's system should be maintained.
- Ongoing ***public participation*** is vital to the IRP process.

Water Management Principles and Preliminary Resource Targets

The intermediate resource mix sets a general direction in regional water resource planning, providing the greatest diversity, adaptability, and flexibility. Table ES-2 summarizes the key water management principles established at the IRP Assembly. Also summarized are the preliminary resource targets under the intermediate mix that correspond with each principle. In general, the region will pursue the following resource options under the intermediate mix:

- *Imported Supplies:* Use water conservation, conjunctive use, land fallowing and transfers to maximize available supplies from the Colorado River and State Water Project while long-term management plans for these resources are developed.
- *Local Resources:* Manage available local water supplies through water conservation, water reclamation, and groundwater recovery while exploring long-term viability of ocean desalination.

Table ES-2
Overview of Water Management Principles and Resource Targets

Resource Option	Regional Management Principle	Preliminary Resource Targets
Local Resources		
Water Conservation	■ All parties involved in water resource management share a responsibility to implement urban water conservation BMPs	■ Conserve at least 750,000 AFY by 2010
Water Reclamation	■ Implement reclamation projects throughout the region to increase efficient use of available water	■ Reclaim 505,000 AFY by 2010
Groundwater Recovery	■ Use unified management	■ Recover at least 50,000 AFY by 2010
Desalination	■ Support demonstration projects to evaluate "true" costs and benefits	■ Support pilot projects
Imported Supplies		
State Water Project	■ Maintain/Enhance Dependable Supply ■ Implement balanced, long-term Delta resource management program	■ Fully use SWP surpluses in groundwater conjunctive use programs
Colorado River Aqueduct	■ Provide full CRA deliveries through water conservation, conjunctive use, and land fallowing	■ Provide full CRA deliveries ■ Lower basin coalition to support multi-species habitat conservation/preservation
Central Valley Water Transfers	■ Promote necessary transfers while protecting environmental and rural communities	■ Voluntary transfers of at least 300,000 AFY by 2010
Water Supply Management		
Groundwater Storage	■ Manage groundwater basins conjunctively with available imported water ■ Coordinate groundwater basin management among all overlying communities	■ Develop at least 300,000 AFY of additional production and 1,000,000 AF of additional storage by 2010
Surface Storage	■ Provide regional surface storage and conveyance to meet a seven-day Metropolitan service outage and improve groundwater storage.	■ Establish Domenigoni Valley Reservoir and Inland Feeder projects as critical to meet water management objectives

Note: AF = acre-feet
AFY = acre-feet per year

Section 1
Integrated Resource Planning in Southern California

MWD

Section 1
Integrated Resource Planning in Southern California

1.1 Southern California's Water Supply Challenge

Southern California's water community is at a critical time in its history as a steward of water resources. The region faces a growing gap between its water requirements and its firm supplies. Increased environmental regulations and the attendant competition for water from outside the region have resulted in reduced supplies of imported water. At the same time, demand is rising within the region because of continued population growth. Since the 1970s, the total regional water demand in Metropolitan's 5,149 square mile service area has increased from about 2.8 million acre-feet per year to about 3.5 million acre-feet per year in 1993. Shortages during 1991 highlighted the seriousness of the problem.

The challenge is to provide reliable water supplies as demand increases and traditional sources of imported supplies diminish.

The water used in Southern California comes from a number of sources. About one-third of it is found locally. The rest of the region's water is imported from three sources -- the Colorado River, the Sacramento-San Joaquin River Delta, and the Owens Valley and Mono Basin (through the Los Angeles Aqueducts). The ability of Southern California to secure the same amount of imported water, much less a greater amount, is in question.

The delivery of water to Southern California water consumers has been nearly 100 percent reliable in the past. However, as existing firm water supplies continue to decrease, future reliability is uncertain. Even with a 15 percent reduction in demand due to full implementation of conservation measures, the reliability of water deliveries during a drought could fall to 50 percent by year 2000 without any additional water supply investments or improvements. This would mean that there would be some type of shortage, on average, every other year, and rationing in many of these years.

1.2 The Need for Integrated Resources Planning

The development of an Integrated Resources Planning (IRP) process is based upon the premise that a unified and coordinated approach to water resources planning among all water providers is needed to meet the region's future water needs. At one time, Metropolitan could accomplish its mission through largely unilateral actions that supplemented local supplies with water imported from outside the region. Today, coordinated efforts among Metropolitan, its Member Agencies, and other water providers are essential to realizing the benefits of a multifaceted program that combines conservation with the development of all potential sources of supply -- local groundwater, reclaimed water, desalinated seawater, as well as the imported supplies provided by Metropolitan.

To help facilitate this coordinated approach, Metropolitan, its Member Agencies, and other water agencies have embarked upon the first phase of a comprehensive evaluation of water supply options available to the region as a whole. In the broadest terms, the IRP process asks the questions: What level of reliability does the region require?"; "What is the most desirable means of achieving reliability, given the range of potential water supply options?"; "Can the region afford the desired level of reliability?"; and "What needs to happen in order to accomplish the desired outcome?"

One of the most important strengths of the IRP process is that it is 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 are clearly outside of the direct control of Metropolitan and its Member Agencies. Nevertheless, they represent practical and cost-effective means of achieving regional goals. In order 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.

1.3 Participants in the IRP Process

Southern California water providers deliver safe, reliable drinking water to the region from a wide variety of water sources. There are many water providers in the region, each playing an integral role in overall water resource management.

The IRP process includes all stakeholders in the southern California water picture

The Metropolitan Water District of Southern California

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 to build the Colorado River Aqueduct (CRA) to supplement local water supplies. In 1952, as plans for the State Water Project (SWP) were being developed, Metropolitan's Board of Directors adopted the Laguna Declaration, which declared that Metropolitan would procure and deliver all future supplies of supplemental water needed to meet increasing demands. Today, Metropolitan's service area includes most urbanized portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. Nearly 16 million people—half the population of California—live in Metropolitan's service area.

Member Agencies of Metropolitan

Metropolitan is composed of 27 Member Agencies—14 cities, 12 municipal water districts, and one county water authority. Metropolitan supplies its Member Agencies with treated and untreated water. The member agencies in turn, combine it with local water resources for delivery to their customers. Member Agencies vary in their dependence on Metropolitan—some are dependent on Metropolitan for virtually all their water, while others use Metropolitan's water only during peak periods, for groundwater replenishment, and/or as a backup supply.

In embarking upon the IRP process, Metropolitan and the Member Agencies have recognized a greater level of mutual reliance and interdependence is essential to meeting the region's future needs for water.

Groundwater Basin Managers

The major groundwater basins within Metropolitan's service area consist of both adjudicated and non-adjudicated basins. Adjudicated basins are managed by court-appointed watermasters in such a way that extractions are limited, or replenishment is provided when the safe yield of the basin or other groundwater management criteria are exceeded. In general terms, basin management plans include protection from seawater intrusion, water quality deterioration, and excessive lowering of water levels, while providing a hedge against water shortages. Natural groundwater replenishment may be augmented with reclaimed water or imported water provided by Metropolitan. Other groundwater basins are not adjudicated but are either managed by an agency such as Orange County Water District or a pumper's association to accomplish similar management objectives.

Public Forums

Metropolitan and the member agencies hosted six public forums and workshops to present IRP issues and to solicit comments and recommendations as part of the IRP process. Public forum attendees represented business, environmental, community, agricultural, and regional water interests.

1.4 Related Regional Programs and Activities

The IRP process is one of many planning initiatives underway in the region. Because IRP is intended to foster integration of efforts, these parallel initiatives provide additional input and insight into the issues raised in the IRP process.

Metropolitan Board Goals and Objectives

Metropolitan's Board of Directors is composed of 51 directors representing the Member Agencies. In 1992, the Board adopted the following mission statement:

> *The mission of the Metropolitan Water District of Southern California is to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way.*

After the mission statement was adopted, the Board established 14 goals that further defined how Metropolitan's mission will be accomplished, including the definition of a water supply and reliability goal. That goal states:

> *MWD will provide a reliable supply of water to its Member Agencies. Even under adverse hydrological conditions, there will be no more than a 20 percent supply reduction in any single year.*

Metropolitan's Strategic Plan

Metropolitan's preliminary strategic plan charts a course for accomplishing the goals of the Board and fulfilling the mission of Metropolitan as a steward of water resources. It is intended to clearly communicate that direction to Metropolitan's key stakeholders—its Member Agencies, employees, other governmental agencies, and the public. The strategic plan is an extensive document whose purpose is to translate Metropolitan's mission into measurable actions and commitments. The plan is based on several key commitments:

Metropolitan's Strategic Plan translates its mission into measurable actions and commitments. . .

- To provide an adequate and reliable supply of high-quality water to meet present and future needs.
- To collaboratively develop and implement with Member Agencies adequate and cost-effective supplies of high-quality water through an Integrated Resources Planning process that effectively balances local and imported water supply opportunities and regional financial affordability.
- To increase management productivity and reduce operational costs.

- To create a covenant with the Board that outlines the level of service and expected achievements, including timetables, against which management performance can be compared and evaluated.

- To review and update the Strategic Plan in conjunction with the annual budget process.

The preliminary Strategic Plan as approved by the Board in June 1993, sets forth a standard for the stewardship of resources needed to achieve an adequate and reliable water supply for Southern California. Implementation plans will be developed in several separate documents including the Long Range Finance Plan, the Integrated Resource Plan, the System Overview Study, the Information Systems Strategic Plan, the Annual Operating Plan, and the three-year rolling and annual budgets.

. . . including a commitment to an Integrated Resources Planning process.

In the context of its Guiding Principle addressing water, the Strategic Plan commits to the development of an IRP process. The IRP objective reads:

Metropolitan will maintain an integrated resources plan that encompasses all of the resources within the service area and balances least cost planning, environmental considerations, and risk and reliability factors to determine an appropriate mix of resources to achieve the level of service objective. Any feasible resource mix will require the continued investment in infrastructure facilities and for ongoing reclamation, groundwater, and conservation projects.

Strategic Plan Assembly

On October 29 and 30, 1993, Metropolitan convened a Strategic Plan Assembly attended by 86 Metropolitan Board Directors, Member Agency Managers, and Metropolitan senior staff. The Assembly was called to expand the level of participation in Metropolitan's strategic planning process. The Assembly adopted an Assembly Statement representing areas of general agreement among those attending. Portions of the Assembly Statement have an impact on the IRP process.

First, the Assembly Statement addressed the challenges arising from Metropolitan's changing mission. It discussed the complexity of implementing regional policies, including the lack of regional coordination of groundwater supplies, regional subsidization of local resource development, and Metropolitan rate structures used to promote regionally beneficial actions.

Next, the Assembly Statement addressed IRP selection criteria and resource mixes. Assembly participants also defined several guidelines for developing resource mixes:

- Metropolitan should continue its commitment to the SWP. As the largest user of the SWP, Metropolitan should spearhead a statewide alliance between urban, business, labor, community groups, environmental groups, agriculture, and water agencies. Such an alliance is seen as the only feasible way to resolve environmental issues in the Sacramento/San Joaquin Delta.

The Strategic Plan Assembly confirmed Metropolitan's leadership role in regional water supply issues.

- The Member Agencies, with the support of Metropolitan, should continue to develop local water sources as an integral part of any viable resource mix.

- Storage/conjunctive use projects (i.e. importing water during wet years and storing it for use in dry years) are critical to resolving regional water supply issues.

- Metropolitan should strengthen its leadership role in improved regional cooperation and coordination including establishing a liaison with Groundwater Basin Managers not formerly involved in the process.

Strategic Resources Assessment

Another important input to the IRP process results from work undertaken by Metropolitan and its Member Agencies in the Strategic Resources Assessment. The purpose of the Strategic Resources Assessment is the development of near-term water resources strategies that can be implemented at the local level by Member Agencies. Much of the data on local supply development used in the IRP process was originally developed by the Strategic Resource Assessment. Appendix D contains the Summary Report of the Strategic Resouces Assessment.

1.5 Overview of the IRP Interim Report

This report summarizes the IRP process completed to date, and presents alternative resource mixes that meet a consistent regional level of service objective.

The next section presents an overview of how the IRP process is conducted by Metropolitan staff (Section 2). Then, the report defines projected water demands (Section 3), potential local supply options (Section 4) and potential imported supply options (Section 5). Various resource strategies merging alternative levels of supply and water management to meet projected demand are then defined and evaluated (Sections 6 and 7). Finally, Section 8 recommends an appropriate strategy to guide short-term and long-term regional water management decisions.

Section 2
IRP Process and Schedule

MWD

Section 2
IRP Process

In concise terms, the IRP process allows the region's water providers to establish and implement a regional resource strategy that achieves regional reliability goals after considering the full range of options for meeting future water demands. To succeed, the IRP process relies on participation and input from the stakeholders in Southern California's water future. The IRP process should continue to be dynamic and iterative, always capable of adjusting strategy to reflect the changing circumstances of the region's water resource environment. This section discusses the region's supply reliability goal and how the IRP process has been applied to date for developing a future water resource strategy that meets this goal.

2.1 Defining a Regional Reliability Goal

The IRP process in Southern California starts with a definition of a desired level of wholesale water service (reliability) to Metropolitan's Member Agencies. This wholesale level of service, in turn, affects supply reliability to the retail customer.

Regional Reliability Goal

Percentage of Demand Served	*Percentage of the Time Achieved*
Wholesale	
80%	*100%*
100%	*90%*
Retail	
90%	*100%*
100%	*90%*

At present, Metropolitan's Board has committed to providing for all of the wholesale water demands of its Member Agencies, except during the most severe droughts. At those times, say one year in 50, Metropolitan would deliver no less than 80 percent of the imported water needed to meet wholesale demands within its service area, with the difference made up by rationing or voluntary conservation measures.

The reliability of water service to the retail customer is based on both imported and local water deliveries. Metropolitan's delivery of imported water currently meets 50 to 60 percent of total regional demand. If this trend continues, Metropolitan's reliability goal would allow its Member Agencies and water retailers to deliver on average no less than 90 percent of the water needed to meet the retail demands of the region. However, the reliability of water service to individual retail customers may vary depending on each Member Agency's and retailer's abilities to develop local resources and provide storage and other infrastructure improvements.

2.2 Developing a Regional Resource Strategy

IRP relies on a comprehensive, structured, participatory process to develop efficient and affordable resource strategies that meet customer demands. Although the region's water providers have been employing many of the elements of IRP in their water supply planning for many years, increasing financial constraints and sensitivity to the environmental impacts of supply development have encouraged the providers to institutionalize the IRP process, with Metropolitan providing a leadership role. As shown in Figure 2-1, developing a regional resource strategy using the IRP process is an iterative and on-going process, offering participants the ability to revise goals as the costs and characteristics of options become clear. The following sections provide an overview of how the IRP process applies to the first two phases of developing a regional resource strategy. Subsequent reports will describe the implementation phase.

Phases of the IRP Process

- *Data gathering and analysis*
- *Refinement and decision making*
- *Implementation*

2.3 Data Gathering and Analysis Phase

The first phase of the IRP process projects anticipated demand, defines possible resource options for meeting this demand, and examines different "mixes" of these resource options.

Defining Resource Options

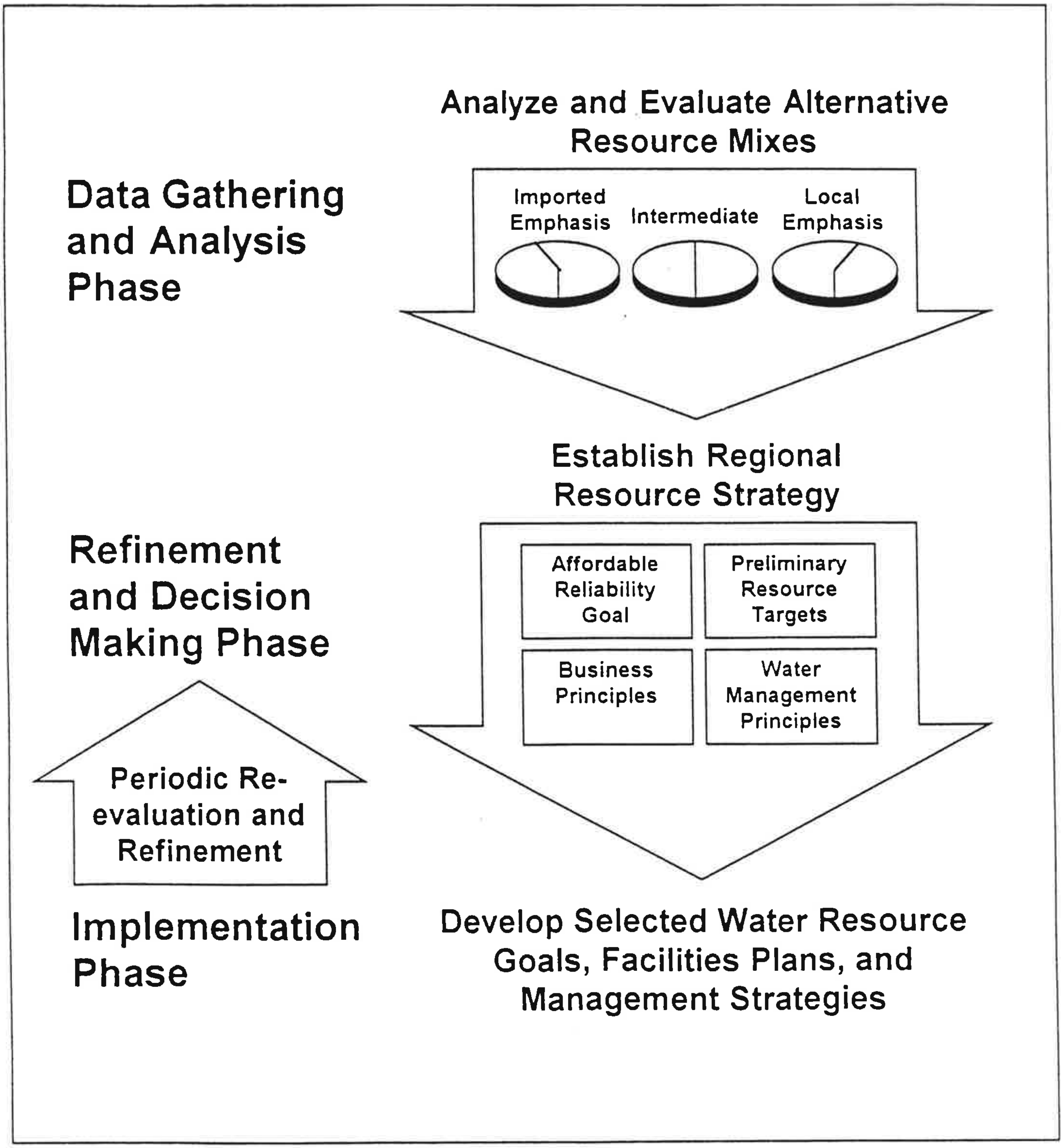
As a regional resources plan, the IRP process evaluates a range of possible alternatives to provide the additional supplies needed to meet future demands. The region has available a wide range of options that could expand upon imported supplies, local water resources, and demand management efforts. These options, which in many cases are complementary, include:

- *Imported Resources:* Increasing imported supplies through capital improvements to resolve environmental constraints, cooperative conservation programs, conjunctive use, land fallowing, and market purchases;

- *Local Resources:* Increasing local water resources through expanded reclamation, conservation, groundwater conjunctive use and recovery, and desalination;

- *Improved Management:* Investing in the expansion of groundwater conjunctive use and the construction of storage, distribution and treatment facilities to improve the management of all the region's water resources.

Figure 2-1
Development of a Regional Resource Strategy



Developing Resource Mixes

Within each of these broad categories of options, Metropolitan, its Member Agencies, and other water providers have jointly defined an initial set of "building blocks" reflecting increasingly aggressive investments. The IRP defines up to four levels of potential investment for each water supply option:

A resource mix is defined by selecting a particular level of investment for each resource option

- *Level 1* represents water supplies that can be provided by infrastructure and resource programs that currently exist or are already under construction.
- *Level 2* adds supplies resulting from projects and programs that agencies have taken steps to implement even though they are not currently under construction (i.e., projects either under design or where sufficient planning has occurred to indicate that the project/program is feasible).
- *Levels 3 and 4* represent the potential amount of water that can be provided during the planning horizon based on projects that may only be in the "concept" phase of development.

In attempting to establish a range of feasible options that can meet the current reliability goal, the resource "building blocks" are assembled into several different combinations -- each defined as an alternative "resource mix." Each resource mix is defined by selecting a particular level of investment (i.e., Level 1, 2, 3, or 4) for each resource option.

Initially, the IRP process focused on two extreme resource mixes. One extreme assumed that all future investments would be made in developing additional imported supplies. The other assumed that all future investments would be made in developing local supplies. Based on input from Metropolitan's Board of Directors, Member Agencies, and local groundwater basin managers, these extreme alternatives were replaced by three more balanced resource mixes: (1) an Imported Resource Emphasis (generally favors new investments in imported resources), (2) a Local Resource Emphasis (generally favors new investments in local resources), and (3) an Intermediate Resource Mix (a balance between new imported and local resources).

Evaluating Alternative Resource Mixes

Each resource mix was evaluated according to three criteria:

- Supply reliability
- Cost
- Uncertainty and other considerations

Evaluation of uncertainty qualitatively considered a number of other criteria affecting each resource option. These criteria, and their relative importance, were defined at the October 1993 Strategic Plan Assembly. A brief overview of each evaluation criterion follows.

Supply Reliability

Analytical evaluations focus on affordability differences among the resource mixes

Supply reliability is defined as the ability of the resource mix to meet the level of service objective under different hydrologic and weather conditions. Water supplies (especially the SWP) vary significantly from year to year due to hydrology. Water demands also vary from year to year based on weather. The difference between water supplies and demands for all possible variations due to hydrology and weather defines supply reliability. During hot and dry years—supply shortages are possible, and during cold and wet years— surplus in supplies are possible.

Costs

Costs include the total regional water costs for each resource mix. Costs are evaluated to determine the relative investment required for each alternative mix. During the first phase of the IRP analysis, costs do not differentiate between Metropolitan costs and local costs. Costs reflect total existing and future investments for each supply option in the resource mix, including capital and O&M costs. All costs are presented on a common basis.

Uncertainty and Other Considerations

While analytical IRP evaluations of supply reliability and cost present an assessment of the uncertainties associated with projecting demands and forecasting supplies, there are a number of other factors which influence the desirability of a specific resource mix. In addition to maintaining supply reliability and minimizing regional costs, the preferred resource mix should also satisfy a number of other criteria:

- *Environmental impacts address the effects that a resource strategy will have on the environment.* Resource options vary considerably in their perceived adverse and/or beneficial impacts on the environment.

- *Risk is the chance that specific investments will not deliver their expected yield.* There are several types of risk that could affect the feasibility or practicability of implementing a resource strategy, including political and institutional risks, regulatory risks, and market risks.

- *Flexibility in supplies refers to the ability to choose among alternative sources within the service area.* Each resource mix is evaluated on how diverse the mix is relative to other alternatives. Diversity tends to increase supply reliability during times of shortages. For example, Metropolitan and its Member Agencies avoided many of the hardships experienced by others during the six-year drought in California, largely due to the ability of the region to rely on Colorado River water and local sources of supply to offset the severe shortage in State Water Project water in 1991.

Uncertainty evaluations qualitatively examined several broad areas of concern about each resource option

- *Adaptability is the ease with which plans can be changed to address unforeseen circumstances.* Adaptability relates to how easily the resource mix can be altered to account for changes in planning assumptions regarding future demands, projected supplies, and other uncertainties.

- *Timing/Staging addresses the ability to develop resources and expend funds in a series of discrete steps.* The ability to develop resources in a phased approach allows for better synchronization between demand forecasts and supply capacity, and holds expenditures down in the short-term. On the other hand, phased improvements may make it more difficult to implement large scale strategies that might be more cost-effective in the long-term.

- *Equity is defined as the fair distribution of costs and benefits among Member Agencies in order to achieve regional efficiencies.* The equity criterion addresses the issues associated with a resource mix that may offer potential benefits at the regional level but adversely impact a specific Member Agency's ability to meet demands in a cost-effective manner. This criterion is intended to signal the need for the development of appropriate rate structure or contractual remedies to fairly distribute both the "gain" and "pain" of a cost-effective regional strategy.

- *Impact to local economy addresses the beneficial or detrimental consequences affecting the regional economy.* Each resource mix has a potential positive impact on the local economy, such as the creation of jobs and recreational opportunities within the service area. On the other hand, negative economic impacts may result from the disruption of commercial activities during construction or discontinuance of an existing project or program.

- *Public acceptance refers to the anticipated degree of public approval or opposition.* This criterion addresses the likely public response to the resource mix and the preservation of public trust values. Different resource strategies may have stronger public support or opposition than others.

In order to contribute to the evaluation of these broad areas of concern, the IRP methodology includes a review of the uncertainties related to each resource option.

2.4 Refinement and Decision Making Phase

During the refinement and decision making phase, the major stakeholders in Southern California's water future (i.e., Metropolitan's Board of Directors, Directors of its Member Agencies, representatives of other water providers, and representatives of community, business, agricultural, and environmental interests) weighed the findings of the data gathering and analysis phase, seeking to establish a regional resource strategy.

The resource strategy focuses on establishing a general direction and preliminary resource targets...

As decision makers and other stakeholders in the process evaluated the meaning and significance of the initial analytical outputs of the IRP process, several important considerations emerged:

- *Alternative Resource Mixes are not Optimized Plans.* The alternative resource mixes defined in the IRP process do not represent definitive or final choices regarding specific levels of resource development and proposed future facilities. The decision making process involves selecting a general direction and establishing preliminary targets based on those broad conclusions supported by the analysis of alternative resource mixes.

- *Selection of a Regional Resource Strategy Should Address Uncertainties.* Both the selection of a resource development approach and the optimization of a specific strategy should address the uncertainties associated with each resource option and the overall resource mix.

- *Detailed Plans will Follow Establishment of a Regional Strategy.* Once a broad water resources strategy has been established, it can serve as the basis for developing detailed resource and facilities plans, designed to optimize the investment in future supplies and facilities.

...with detailed resource and facility plans to follow

Two types of forum were used to conduct IRP refinement and decision making:

- *Public Forum and Workshops.* Metropolitan and the Member Agencies hosted six forums and workshops during May 1994 to present findings from the data collection and analysis phase and to solicit comments and recommendations. Approximately 400 people participated in these meetings.

- *The Integrated Resources Plan Assembly.* The June 1994 assembly brought together over 100 water leaders from across Southern California. Attendees included members of Metropolitan's Board of Directors, Member Agencies, Metropolitan senior staff, groundwater agency managers, and representatives of retail subagencies that purchase water from Member Agencies. Assembly members considered background papers on key issues defined by an Assembly Steering Committee. Members also considered reports from the six public forums and workshops. The Assembly prepared and adopted an Assembly Statement based on the positions and recommendations developed during the three day assembly.

The regional resource strategy defines water management and business principles, and preliminary resource targets that yield an affordable, reliable water supply.

Through these forums, a regional resource strategy is emerging, composed of four interrelated components:

- *An affordable reliability goal.* The analytical parts of the IRP process defined alternative resource mixes that met the region's supply reliability goal, and defined the regional cost to meet this goal under each mix. The affordability of this goal can then be based on projections of end-user cost increases, comparisons with other regional utility costs, and public surveys of rate payer willingness to pay to avoid shortages.

- *Preliminary resource targets.* IRP analyses examine how supply reliability and affordability varies under various levels of investment in resource options. These analyses are oriented toward defining those resource options that should be included in any resource mix, as well as resource decisions that need to be made soon so that the resource will be available when needed. These preliminary resource targets are intended to provide a foundation for defining optimal goals and facilities for a comprehensive regional resource plan.

- *Business principles.* Since the IRP is a regional planning process, a set of overall business principles is necessary to guide the participating water providers in the implementation of the IRP. These principles recognize existing legal and institutional responsibilities, and financial and operational requirements. Business principles serve to guide resource development, including Metropolitan incentive programs to support local resource development.

- ***Water management principles.*** The IRP process will define a balanced regional resource strategy that meets regional reliability and water quality goals at an affordable cost. Regional water management principles are intended to provide guidance in the implementation of recommended resource development and should be applied in a manner consistent with the business principles.

Section 3
Regional Water Use Characteristics and Demand Projections

MWD

Section 3
Regional Water Use Characteristics and Demand Projections

One of the principal purposes of the IRP is to determine how the region's water providers will reliably meet current demands, as well as expected future increases in demand. This section briefly discusses:

- The methodology for developing estimates of future water demands for the IRP process using projections of demographic and economic trends.
- Factors that influence water use.
- Historic and projected demographic and economic trends.
- Historic water use trends and characteristics.
- Forecasts of future water demands

3.1 Methodology for Projecting Water Demand

Planning for future water supply reliability requires detailed knowledge of the region and the factors that influence its water use characteristics. Metropolitan projects future water demands for the region by incorporating forecasts of population, housing, jobs and income provided by regional planning agencies into an econometric demand model known as MWD-MAIN.

The IRP projects future water demands using regional forecasts of population, housing, jobs and income

MWD-MAIN is based on the IWR-MAIN (Institute of Water Resources-Municipal and Industrial Needs) model originally developed for the U.S. Army Corps of Engineers. MWD-MAIN is regionally calibrated to reflect the specific water use characteristics of Metropolitan's service area. Over 50 unique study areas within Metropolitan's service area were used in the development of MWD-MAIN. For each study area, single-family and multi-family residential models of water demand were developed. In a similar manner, models of non-residential water use were developed for the commercial and industrial sectors of the economy. In addition, weather variations and their impact on future levels of demand were incorporated using 70 years of climate data.

The evaluation of water conservation plays an important role in IRP and is a major component of Metropolitan's water demand forecasting methodology.

In 1991, Metropolitan and 164 other parties signed a Memorandum of Understanding Regarding Urban Water Conservation in California (MOU) . With the signing of the MOU, Metropolitan and many of its Member Agencies committed to implementing several different long-term conservation measures, referred to as best management practices (BMPs). Water conservation for each BMP is estimated from a base level demand scenario that assumes no implementation of BMP's. Conservation measures included in the demands used for the IRP analysis are treated as a local resource option (See Section 4 for a complete description).

3.2 Factors that Influence Water Use

Urban water demand is often expressed as per capita water use (total urban water use divided by population served) in order to give the magnitude changes in demand relative meaning through time, and from area to area. There are several demographic, economic and climatic factors that influence water use. A brief description of these factors and their relationship to water use follows.

An increase in....	*Causes water demand to...*
Family size	*Decrease*
Multi-Family Housing	*Decrease*
Income	*Increase*
Service Businesses	*Decrease*
Inland Growth	*Increase*
Water Conservation	*Decrease*
Price	*Decrease*

- *Family Size.* Increasing family size translates into greater household 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 expands. The reverse is true if family size decreases over time.

- *Housing Mix.* The type of housing has a major influence on residential water use. Single-family households typically use more water than multi-family households, because of additional water using appliances and more outdoor water use. In areas where multi-family housing is growing faster than single-family housing, per capita water use will decrease.

- *Income.* Increases in income tend to translate into additional water using appliances and greater outdoor water use, both of which increase per capita 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 that require a great deal of washing or cooling) and less water intensive sectors (e.g. finance) can increase or decrease per capita water use depending upon which sectors are growing.

- *Inland Growth.* Metropolitan's service area spans three major climate zones: (1) coastal, (2) inland, and (3) desert. It is projected that much of the new growth in housing and development will be in the inland desert regions, such as Riverside and San Bernardino counties. Affordability of housing is the major reason that growth 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 inland desert is higher than the coastal plains.

- *Water Conservation.* The long-term water conservation efforts that are institutionalized in the BMP's along with existing conservation measures have the effect of decreasing per capita water use.

- *Price.* Increases in the price of water lead to decreases in per capita water use.

3.3 Demographic Trends and Projections

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.

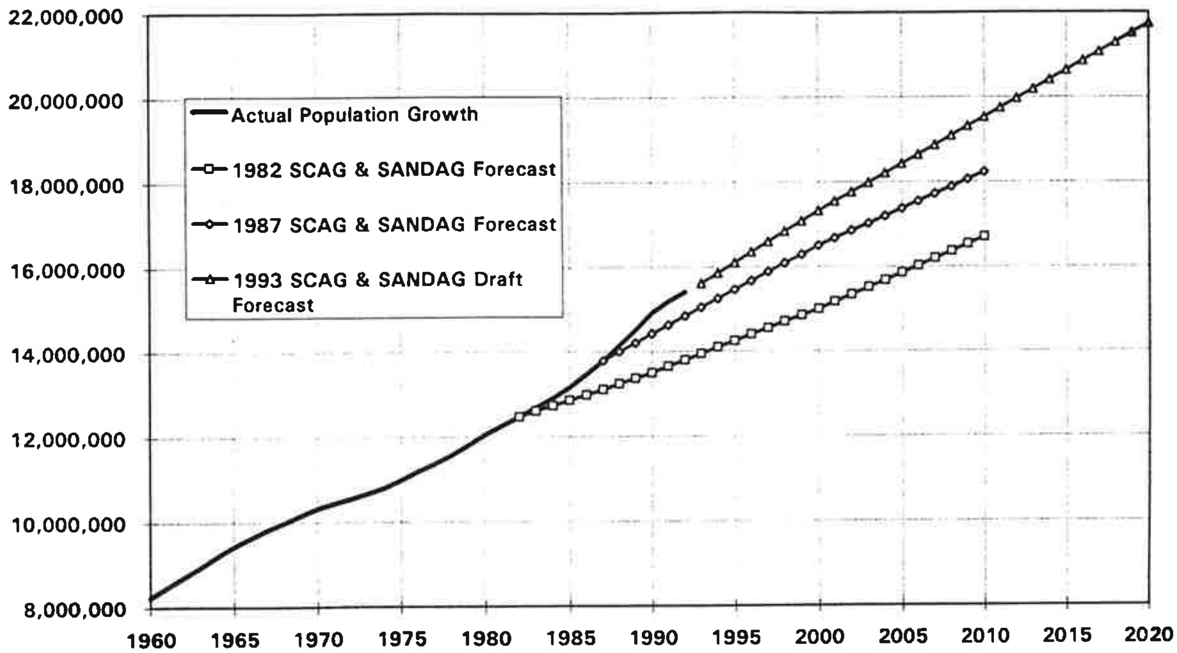
Population in Metropolitan's service area is projected to increase to about 19.5 million by 2010 and to 21.5 million by 2020

Population

Population is one of the most important overall indicators of growth used to project water needs. As with all projections of growth, there is certain to be some error in population forecasts. Figure 3-1 presents the actual population increase within Metropolitan's service area, together with current and prior forecasts made by SCAG and SANDAG. As demonstrated in the figure, prior forecasts by SCAG and SANDAG have fallen short of the actual growth by from 1 to 5 percent.

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. This represents a significantly

Figure 3-1
Population Forecasts for the Metropolitan Water District's Service Area



lower annual growth rate than experienced during the 1970s and 1980s. Other government agencies and private economic forecasting firms predict similar growth trends.

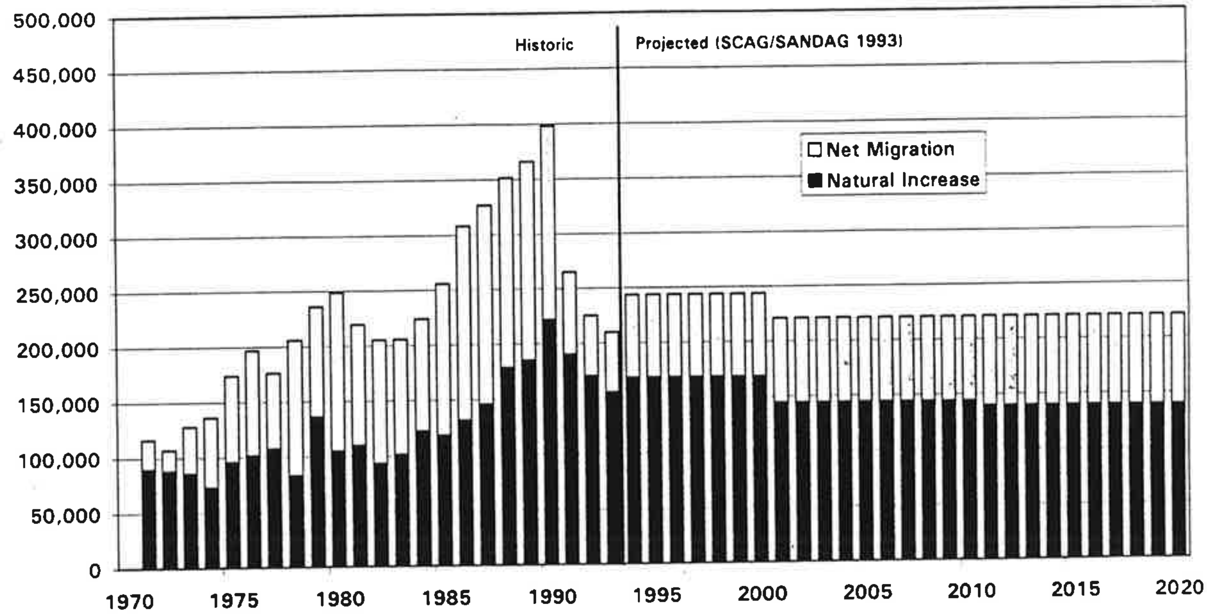
In addition to slowing the rate of population increase, the recent recession has had an impact on the components of population increase. The poor job market is the primary reason that net migration, which was the largest component of annual increase during the 1980s, has dropped off. Figure 3-2 illustrates historic and estimated annual rates of population increase between 1990 and 2020.

Given the likelihood that actual future population growth and increases in the total demand for water will not precisely track projected increases, the ability of a resource strategy to adapt to new and changing circumstances is an important consideration in evaluating the desirability of alternative resource mixes.

Housing

In Metropolitan's service area, occupied households increased at an average annual rate of 80,000—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. Multi-family housing grew at a faster rate than single-family housing in the 1980s, resulting in an increasing

Figure 3-2
Annual Population Growth in Metropolitan's Service Area



share of total households being made up of multi-family households. In 1980, multi-family 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 housing starts, have fallen 78 percent from an annual peak of 162,000 in 1988 to an estimated low of 35,000 in 1993. However, both the Construction Industry Research Board (CIRB) and the University of California Los Angeles Business Forecasting Project (UCLA-BFP) have forecast a modest recovery in residential building permits for 1994.

According to SCAG and SANDAG's draft growth management plans, total households in Metropolitan's service area will increase 30 percent—from 5.1 million in 1990 to 6.6 million in 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. Even though the demographic trends of increasing multi-family share and increasing household size are working to slow the rate of increase in residential water use, forecasts of water demand reveal that residential water use will remain the largest component of urban water use in Metropolitan's service area and will likely increase its share from current levels. Table 3-1 summarizes trends in housing in Metropolitan's service area.

Table 3-1
Regional Housing Trends

	1980	1990	2000	2010	2020
Single-Family Households (millions)	2.52	2.85	3.18	3.55	3.93
Multi-Family Households (millions)	1.82	2.25	2.65	3.07	3.41
Total Households (millions)	4.34	5.10	5.83	6.62	7.34
Family Size (persons per household)	2.79	2.96	3.01	2.98	2.96

Jobs

Total jobs in Metropolitan's service area increased at an average annual rate of 2.7 percent—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 large share of defense contractors and aerospace firms that are located in Southern California. These two unique factors, coupled with the regular recessionary pressures of down-sizing and increased competition, have reduced the job base in Metropolitan's service area by an estimated 640,000 jobs since 1990. Job losses and the slow growth in housing caused by the recession have significantly reduced regional water use since 1990.

Jobs are expected to begin to increase by 1995. By year 2010, total jobs are expected to increase 30 percent—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 being 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 year 2010, decreasing

0.1 percent a year. Table 3-2 shows commercial and industrial jobs in Metropolitan's service area.

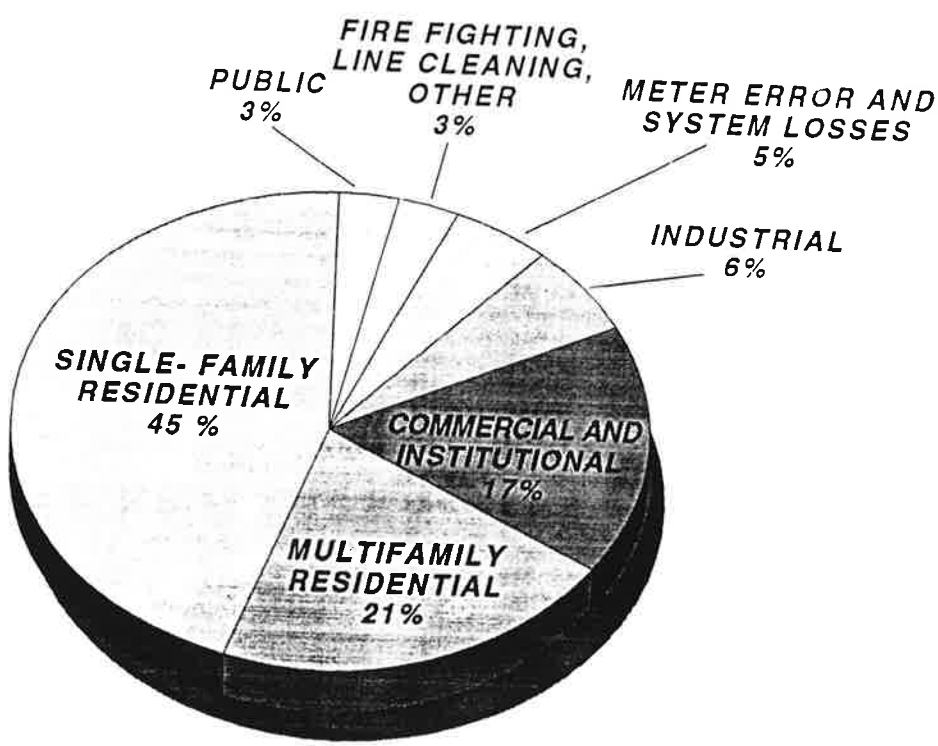
Table 3-2
Regional Jobs Data

	1980	1990	2010
Commercial Jobs	4.58	6.17	8.45
Industrial Jobs	1.31	1.32	1.29
Total Non-Farm Jobs	5.89	7.49	9.74

3.4 Historic Water Use 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 in 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 3-3 shows the current breakdown of urban water use for Metropolitan.

Figure 3-3
Municipal and Industrial Water Use



On average, each household in Metropolitan's service area historically 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.

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).

3.5 Water Demand Forecasts

At present, between 195 and 215 gallons of water are consumed daily for municipal and industrial uses for every person living in Southern California. In addition to urban uses, about 18 to 22 gallons of water per person are used for agricultural purposes, which represents just about 10 percent of the total demand in the region.

Regional water demands are projected to increase to 4.5 million acre-ft by 2010, and 5.0 million acre-ft by 2020 under normal weather condition.

Since the 1970s, the total regional water demand in Metropolitan's service area has increased from about 2.8 million acre-feet per year to about 3.5 million acre-feet per year in 1993. Generally, water demand increases as population grows. However, year to year variations in demands are caused by weather, droughts, and economic growth. Hot and dry weather can cause demands to be as much as 7 to 9 percent higher than "normal" demands. When droughts occur and supplies are limited, rationing of water can cause demands to be suppressed. In addition, economic cycles can cause significant variations in demand. For example, the current economic recession significantly reduced water demand due to a loss of jobs and slowdown in residential and commercial construction.

Figure 3-4 presents historic and projected water demands for Metropolitan's service area. Future baseline water demands are projected assuming "normal" conditions—"normal" meaning average weather and average economic growth. "Above normal" and "below normal" demand projections are estimated based on a range of weather conditions, demographic, and economic trends. Water demand projections also show the effect of conservation "best management practices" (BMPs), including price of water.

Figure 3-4 also indicates what the historic demand for water would have been if normal conditions existed from 1975 to 1993. Years that the actual historic demand were below the normal trend line were the result of cool and wet weather, drought rationing, and or economic recession. The period from 1991 through 1993 represented a combination of drought rationing, the effects of a severe economic recession, and cool and wet weather—resulting in a sharp decline in regional water demand.

Figure 3-4
Regional Water Demands in Metropolitan's Service Area

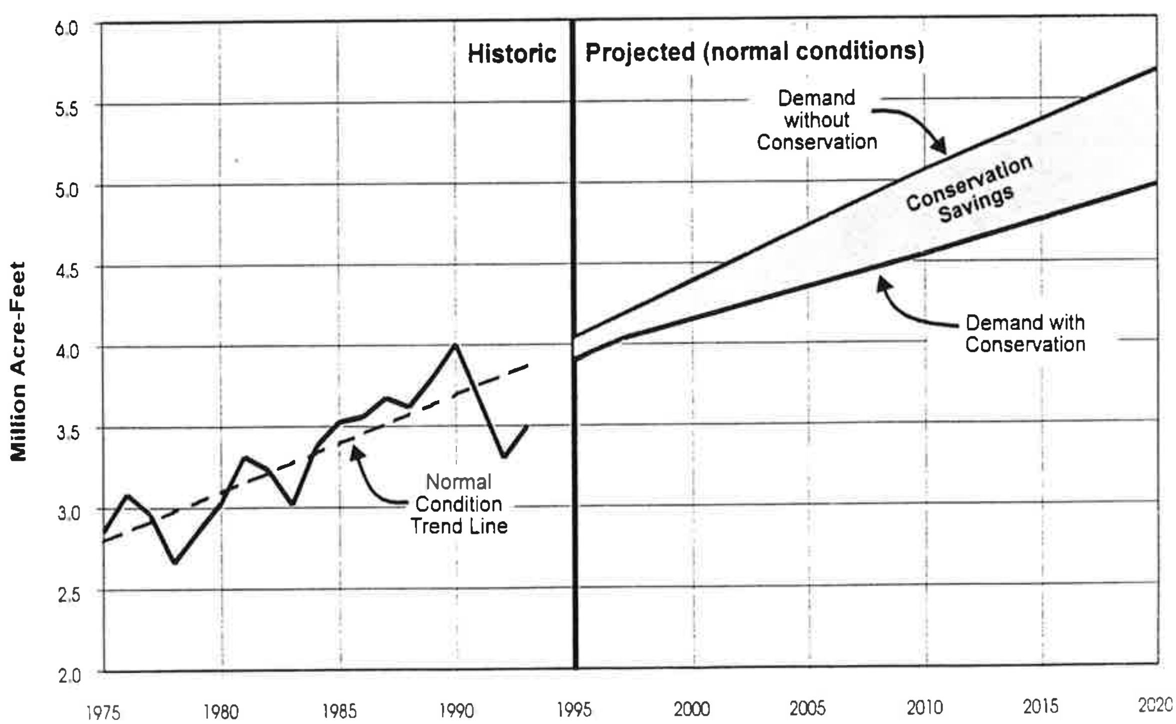
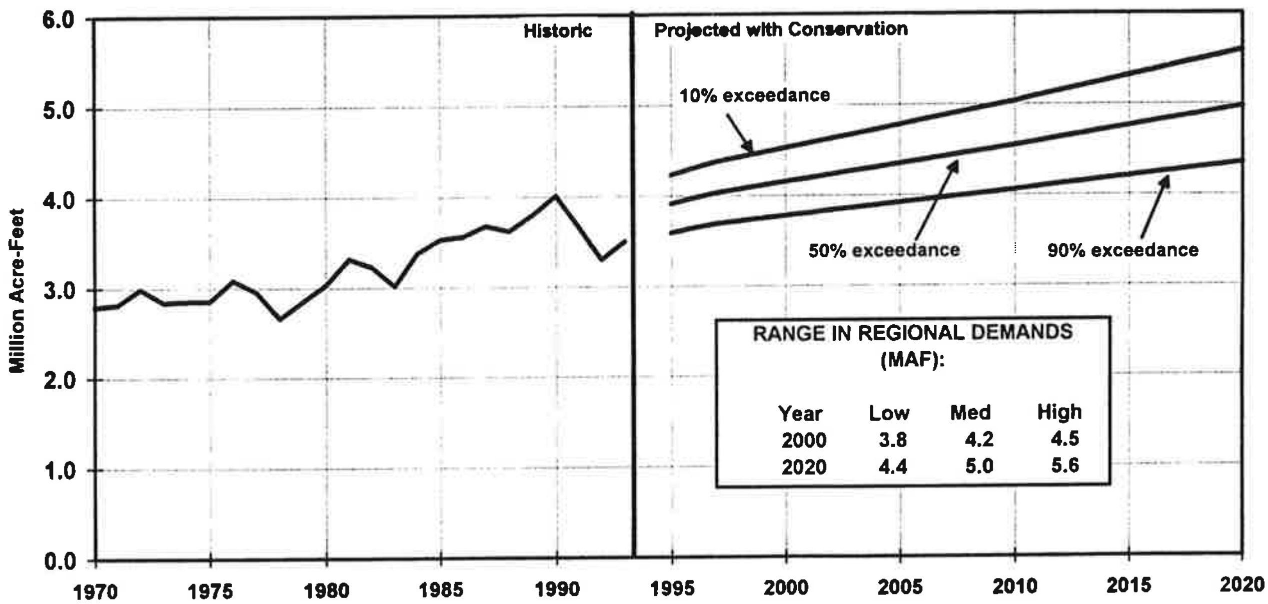


Figure 3-5 presents forecasts of total regional demand expressed as probabilities of exceedance. Based on normal conditions and full implementation of BMPs, it is expected that regional demands will increase to just over 4.5 million acre-feet by year 2010, and to just over 5.0 million acre-feet by year 2020. During very hot and dry years, demands could be as high as 4.9 million acre-feet in 2010, and 5.6 million acre-feet in year 2020.

Figure 3-5
Total Regional Water Demands in Metropolitan's Service Area



Section 4
Local Resource Options

MWD

Section 4
Local Resource Options

Local groundwater, surface water, and reclaimed water supplies provide about one-third of the water used today in the region. In the future, these supplies will increase in importance. For example, existing local surface runoff supplies could be further supplemented through recovery of currently unusable groundwater and use of reclaimed water. Furthermore, the ocean represents a potentially limitless source of water, but at a significantly higher cost than current water sources. This section describes each of the local supply options evaluated for the IRP, and presents potential levels of investment for each source.

4.1 Local Surface Runoff and Groundwater

Runoff from precipitation falling on local watersheds meets nearly one-third of the region's annual water demands. 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. This system effectively stores and diverts most runoff for water supply and groundwater basin replenishment. In fact, studies by the Los Angeles County Public Works Department have shown that over 80 percent of the Southern California major stream flows is retained for water supply. Only the largest storms cause freshwater discharges to the ocean.

Local Resource Options

- *Local Surface Runoff and Groundwater*
- *Groundwater Recovery*
- *Water Reclamation*
- *Water Conservation*
- *Ocean Desalination*
- *Los Angeles Aqueduct*

Surface Runoff Diversions

Currently, several Member Agencies or their subagencies divert runoff from local streams directly into local storage reservoirs or distribution systems. Most of these local reservoirs/diversions are operated seasonally, and the annual yield achieved in a specific year varies widely with climatic conditions. Since 1980, local surface supplies ranged from about 60,000 acre-ft/year to over 240,000 acre-ft/year.

Groundwater Production Capacity

Historic annual groundwater production within Metropolitan's service area has varied between 1.2 and 1.4 million acre-ft since 1980. This historic level of production is supported by 180,000 acre-feet of incidental and artificial recharge of reclaimed water and 140,000 acre-feet of imported supplies. Groundwater production levels can be increased by modifying operational rules of existing facilities, providing new facilities, recovering groundwater supplies with inadequate water quality, and/or using new sources of water for replenishment (e.g., reclaimed water, surplus imported water). Metropolitan staff has worked closely with the groundwater basin managers to define a range of potential increases in groundwater production capacities. At a minimum, groundwater production can be increased in dry years by optimizing the operation of existing and planned local facilities. During a typical dry year, optimizing groundwater production facilities could potentially increase production by about 398,000 acre-feet per year, to a total groundwater production of 1.8 million acre-feet per year. The groundwater basin managers also identified feasible new groundwater production and recharge facilities. If these facilities are implemented, groundwater production during a dry year could potentially increase by about 691,000 acre-feet per year, to a total groundwater production of 2.1 million acre-feet per year.

Local Surface and Groundwater Resources

- *Historic Surface Runoff Diversions: 0.06 to 0.24 million acre-ft/yr*
- *Historic Groundwater Production: 1.2 to 1.4 million acre-ft/yr*
- *Potential Groundwater Production: up to 2.1 million acre-ft/yr*

Groundwater Recharge and Replenishment

Groundwater replenishment occurs both naturally and within constructed groundwater recharge and replenishment facilities. More than 70 of these facilities are located within Metropolitan's service area. Replenishment facilities percolate or inject storm waters, reclaimed water, and/or imported water. Also, in-lieu replenishment may occur, i.e., available imported water is used in-lieu of groundwater, storing the groundwater for times when imported water is not available. The various groundwater basin managers indicated that the replenishment capacity of existing facilities is sufficient to support the lower range of increased groundwater production. Therefore, the availability of imported water and Metropolitan's system capacity are the limiting factors on groundwater replenishment in Metropolitan's service area.

4.2 Groundwater Recovery

Over 80,000 acre-feet of the average historical annual groundwater production has been lost because of degraded groundwater quality, mostly due to high mineral content (principally nitrates and total dissolved solids). Recently, trace amounts of organic chemicals have appeared, affecting up to 50 percent of the existing wells in local groundwater basins. Metropolitan and its Member Agencies are aggressively exploring treatment alternatives that could recover these groundwater supplies, helping to protect existing supply as well as meet future demand.

Metropolitan's Groundwater Recovery Program (GRP) supports local projects that recover contaminated groundwater and improve water supply reliability. To qualify for Metropolitan funding, a groundwater recovery project must increase local supplies and meet strict criteria (e.g., cost, sustained increases in production, sound basin management). GRP projects may produce either treated or untreated groundwater. Untreated groundwater may, for example, be used for landscape irrigation.

Currently, total GRP participation is limited to 200,000 acre-feet per year. Participating agencies are responsible for development and operation of all facilities and marketing the project water. Metropolitan may provide financial assistance on a per acre-foot basis of actual project yield up to a maximum contribution incentive of $250 per acre-foot.

Metropolitan and its Member Agencies are exploring treatment options to recover up to 200,000 acre-ft per year of groundwater production

Levels of Investment

Fifty-two groundwater recovery projects are currently at some level of planning by the Member Agencies. Appendix B lists these projects. Figure 4-1 presents the net groundwater recovery supply. Each level of investment is defined as follows:

Level 1

The thirteen Level 1 projects are currently being implemented and are expected to be operational by 1998. When operational, these projects represent an additional annual production of 59,000 acre-feet, with an average replenishment of 18,000 acre-feet per year to sustain this production. The net increase in supply is, therefore, 41,000 acre feet per year. The total capital cost required to implement these projects is about $183 million.

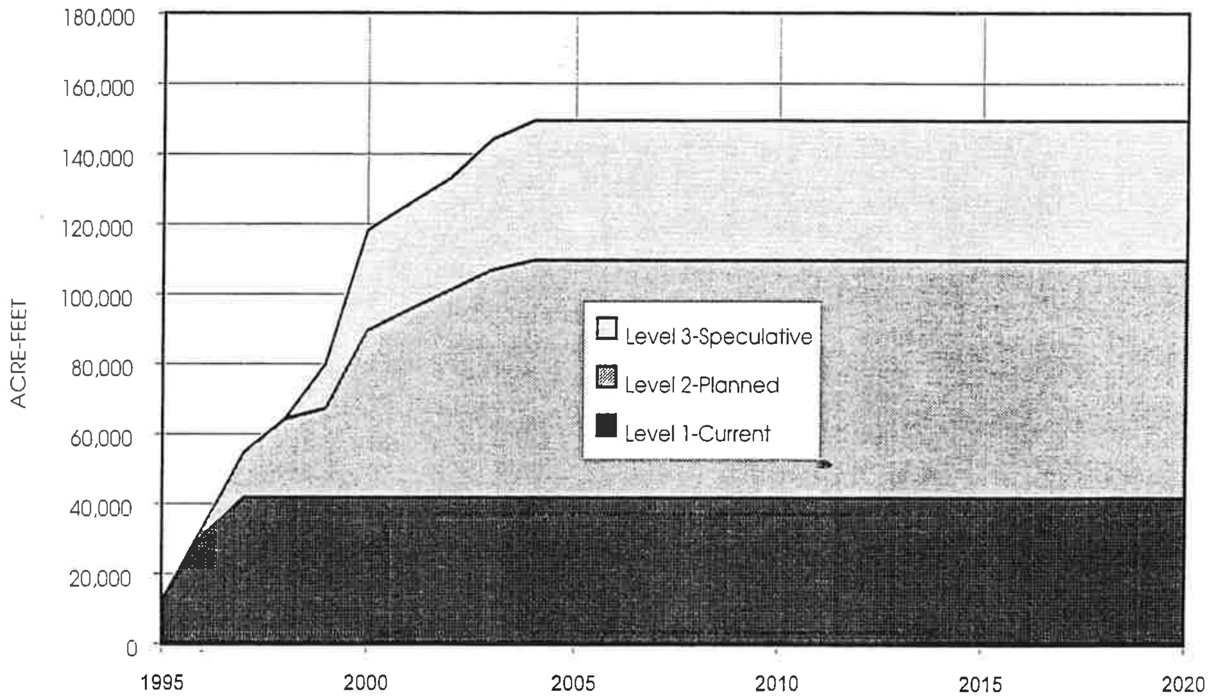
Groundwater Recovery Levels of Investment

- *Level 1: 41,000 acre-ft by 1998*
- *Level 2: 113,000 acre-ft by 2005*
- *Level 3: 149,000 acre-ft by 2005*

Level 2

Twenty-one additional projects could be implemented between 1996 and 2005. These projects will represent an additional 111,000 acre-feet of annual production, on average, with 39,000 acre-feet of replenishment needed each year to sustain this production. The total capital cost required to implement these projects is about $268 million.

Figure 4-1
Net Groundwater Recovery Supply



Level 3

Implementation of the remaining 18 groundwater recovery projects is speculative. As currently envisioned, however, these projects could recover an additional 82,000 acre-feet per year of groundwater, with 46,000 acre-feet of this production needed to replenish existing supplies. If implemented, these projects should become operational between 1998 and 2004, at a total capital cost of $200 million.

4.3 Water Reclamation

Water reclaimed from wastewater has been used in the region for many years to supplement local and imported supplies. Water reclamation projects involve treating wastewater to a level which is acceptable and safe for many non-potable applications. Today, a portion of the water needs for landscape and agricultural irrigation, groundwater recharge, and commercial and industrial applications within the region are met by reclaimed water.

The largest use of reclaimed water in Southern California is for groundwater recharge. In addition, reclaimed water is used to control seawater intrusion by providing a hydraulic barrier. Also, many golf courses, cemeteries, school yards, parks, street medians, and freeways in Southern California are irrigated with reclaimed water. Industrial applications of reclaimed water include power plant cooling water, boiler makeup water, and process water. Other reclamation projects in Southern California include innovative uses such as toilet flushing in high rise buildings and residential landscaping.

In 1982, Metropolitan's Board of Directors initiated the Local Projects Program (LPP) to provide financial support to reclaimed water projects that increase the use of reclaimed water and thus decrease demand on imported sources. Metropolitan provides financial incentives to qualifying projects based on the actual amount of reclaimed water delivered by the project. Currently, the LPP provides a financial contribution of $154 per acre-foot of reclaimed water produced and used within Metropolitan's service area. The goal of the LPP is to assist in the development of up to 200,000 acre-feet per year of reclaimed water by the year 2000.

Reclaimed water is currently used for groundwater recharge, seawater intrusion control, landscape irrigation and non-potable industrial and commercial uses.

Currently, the LPP includes 36 reclaimed water projects with a total projected ultimate yield of about 170,000 acre-feet per year. Twenty-six of these projects are in operation and receiving the LPP incentive. Since the inception of the LPP, Metropolitan has provided about $16 million in LPP incentives for the production of over 110,000 acre-feet of reclaimed water. Metropolitan is prepared to spend about $30 million annually by the year 2000 to support water reclamation through the LPP.

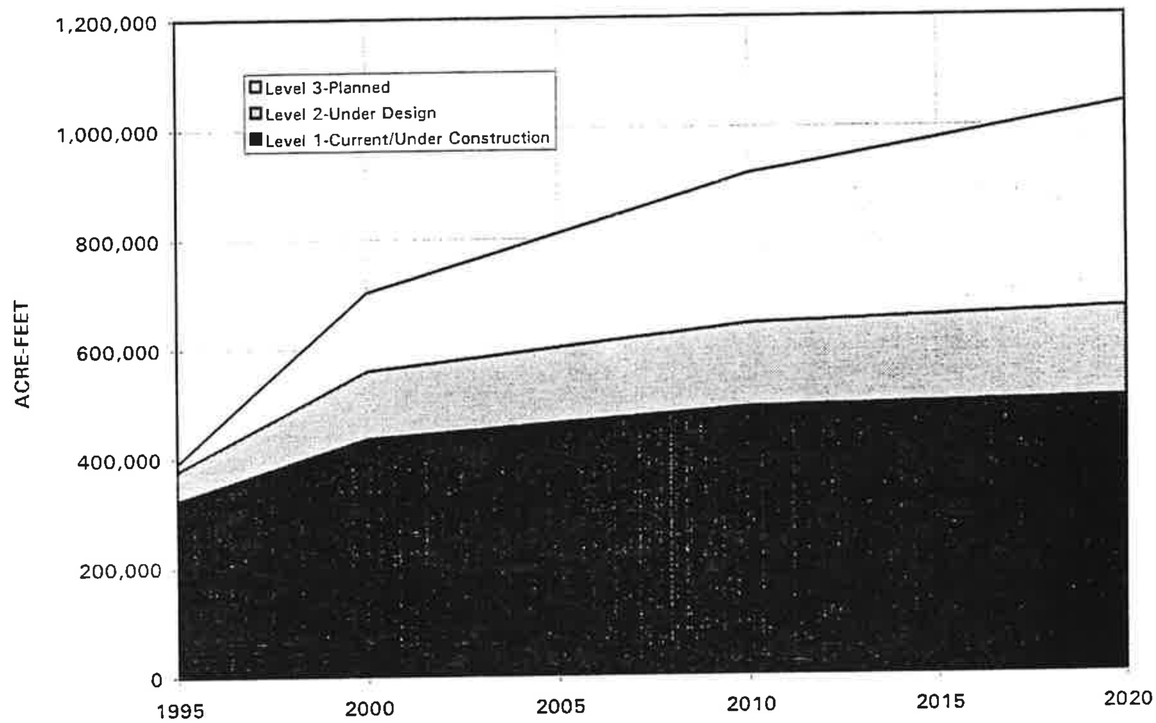
Levels of Investment

Figure 4-2 presents the levels of investment for water reclamation used in the IRP. The appendix lists the existing/proposed water reclamation projects that make up each potential level of investment.

Level 1

Level 1 represents water reclamation projects that are currently operational or under construction. There are 86 specific projects and incidental recharge of reclaimed water in the Santa Ana River that comprise this level of investment. The 1993 annual yield of 341,000 acre-feet is projected to reach 502,000 acre-feet by the year 2020. The total fixed costs of all Level 1 reclamation projects is estimated at $491 million.

Figure 4-2
Water Reclamation Study



Water Reclamation Levels of Investment (acre-ft/yr):

Level	*Short-Term*	*Long-Term*
1	436,000	502,000
2	559,000	666,000
3	703,000	1,040,000

Level 2

There are 23 water reclamation projects currently being designed by the Member Agencies. By the year 2000, the annual yield of these projects is projected to be 123,000 acre-feet, increasing to 164,000 acre-feet by the year 2020. Total fixed costs of all Level 2 reclamation projects is estimated at $494 million.

Level 3

The Member Agencies are currently planning another 47 water reclamation projects that could be operational between now and the year 2020. By the year 2000, the annual yield of these projects is projected to be 144,000 acre-feet, increasing to 374,000 acre-feet by the year 2020. Total fixed costs of all Level 3 reclamation projects is estimated at $690 million.

4.4 Water Conservation

Metropolitan's water conservation programs effectively contribute to the supply augmentation of locally-produced water by decreasing demands. Under MWD Administrative Code Section 4209, Metropolitan may develop and implement water conservation programs and/or enter into agreements on water conservation programs with other public agencies and organizations. Three water conservation objectives have been established by Section 4209:

- Eliminating wasteful water use practices,
- Providing information about cost-effective conservation practices, and
- Implementing additional water conservation practices.

The Northern and Southern California water communities and various public interest groups have agreed to jointly implement the 16 water conservation BMPs shown in Table 4-1. Through this agreement, known as the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU), Metropolitan and its Member Agencies expect to save 740,000 acre-feet per year by 2010.

Table 4-1
The Urban Water Conservation BMPs

- Water audits and incentives
  - Residential
  - Government
  - Institutional
  - Large landscaped areas
  - Distribution Systems
  - Commercial/Industrial water use review
- Water-efficient plumbing
  - New and retrofit plumbing
  - Ultra low flush toilets
  - Code enforcement
- Water metering and pricing
  - Metering with commodity rates
  - Conservation pricing
  - Financial incentives
- Water conservation requirements
  - Landscaped areas
  - Commercial/Industrial users
  - Water waste prohibition
- Education/Outreach
  - Public information
  - School education
- Distribution System Administration
  - Leak detection and repair
  - Water conservation coordinator

To date, Metropolitan, its Member Agencies, and subagencies have committed significant financial resources to implementing the urban water conservation BMPs and researching and evaluating the effectiveness of these BMPs. Table 4-2 lists the expected cost range for regional implementation of selected BMPs.

In order to achieve effective long-term water conservation, Metropolitan has established the Conservation Credits Program (CCP). In this program, Metropolitan pays either one-half the cost of qualifying water conservation projects or the equivalent of $154 per acre-foot of water saved. Since its inception in 1988, the CCP has provided $39 million of assistance to participating agencies. Table 4-3 lists several projects funded through the Conservation Credits Program. Most of these programs target the residential sector and involve measures (e.g. ultra-low flush toilets and showerhead replacement) that consistently yield high water savings for a minimum investment.

Levels of Investment

Three levels of investment were established by the IRP process for water conservation programs:

Water Conservation Levels of Investment

- *Level 1: 250,000 acre-ft/yr since 1980*
- *Level 2: 888,000 acre-ft/yr by 2020*
- *Level 3: 1,100,000 acre-ft/yr by 2020*

Level 1

Existing water conservation includes water savings due to the 1980 plumbing codes and plumbing retrofits that occurred from 1980 to 1990. It also includes savings that result from aggressive public information/education programs.

These existing measures have resulted in an annual conservation savings of about 250,000 acre-feet.

Level 2

Under Level 2, existing water conservation programs will be expanded to include full implementation of the conservation BMPs. These BMPs are projected to increase the annual water savings through conservation to between 720,000 and 750,000 acre-feet per year by the year 2010, and about 888,000 acre-feet per year by the year 2020.

Level 3

This level represents more aggressive levels of water conservation BMPs, assuming almost full participation by water customers by the year 2020. Under level 3, savings attributed to water conservation are expected to reach between 1.0 and 1.1 million acre-feet per year by the year 2020.

Table 4-2
Estimated Costs for Regional Implementation of the Urban Water Conservation Best Management Practices

Best Management Practice	Range of Costs ($/Acre-feet)
Low-flow showerhead replacement	150-250
Ultra-low-flush toilet replacement	300-400
Residential indoor/outdoor water surveys	350-500
Large turf areas audits	350-600
Residential landscape water audits	300-500
Distribution system water audit/leak detection	250-350
Commercial/Industrial conservation	300-600

Table 4-3
Approved Conservation Credits Programs

City/ Agency	Type of Program	Estimated Water Savings (AF)		Total Project Cost ($)	MWD Credits ($)	Consultant Cost ($)[2]
		Annual	Total[1]			
Pasadena	Residential indoor/outdoor survey	90	450	272,000	33,900 (13%)[3]	19,000
Irvine Ranch Water District	Residential retrofit/survey	135	675	270,000	135,000 (50%)	120,000
Pasadena	Residential kit retrofit	1,000	5,000	802,000	375,000 (47%)	100,000
Santa Monica	Toilet retrofit	935	7,900	2,362,000	600,000 (25%)	110,000
San Diego	Residential kit retrofit	1,400	7,000	1,075,000	525,000 (44%)	74,000
San Diego CWA	Large turf survey	1,000	5,000	285,000	142,500 (50%)	60,000
Los Angeles DWP	Toilet retrofit	250	2,500	900,000	185,250 (21%)	50,000
Los Angeles DWP	Residential kit retrofit	2,560	12,800	2,200,000	1,100,000 (50%)	140,000
Total		7,370	41,325	8,166,000	3,096,650	673,000

[1] The Conservation Credits Program uses only the savings during the first five years for establishing the total amount of credit for all programs except toilet retrofits. In this case, a 10-year period is used.
[2] Includes the cost of extensive research studies to measure the effects of the program on water use and consumer behavior.
[3] Percent of total project cost.

Ocean desalination represents a potentially unlimited source of water if high O & M costs and environmental concerns can be resolved

4.5 Ocean Desalination

Ocean desalination, while largely untested in Southern California, represents a potentially unlimited source of water supply. Like water reclamation, ocean desalination also enjoys a relatively high level of public approval and is a secure supply, once developed. On the other hand, the current technology continues to be constrained by high O&M costs, as well as by environmental concerns regarding brine disposal and siting considerations.

Metropolitan has participated in several studies that evaluated the feasibility of ocean desalination, and is now pursuing the development of ocean desalination technologies. Metropolitan plans to build, operate, and test a small ocean desalination plant to provide a means of conducting research and development of advanced desalination processes. The results from operation of the small demonstration plant would be used to evaluate the viability of a full-scale demonstration plant.

Levels of Investment

Figure 4-3 presents the expected desalination supplies. Many of the resource mixes evaluated in the IRP did not consider large-scale coastal desalination facilities due to cost constraints and uncertainties in technologies. However, small and mid-sized desalination were included.

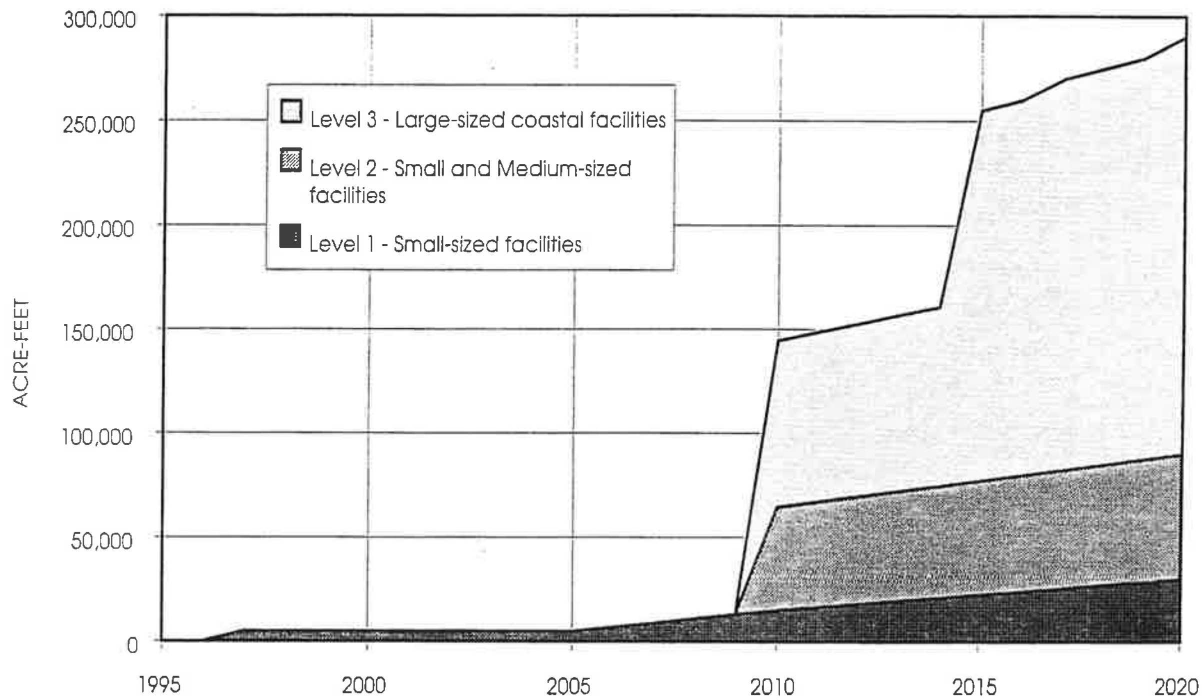
4.6 Los Angeles Aqueduct Supplies

The Los Angeles Aqueduct (LAA) consist of two parallel aqueducts that import water from the Owens Valley and the Mono Basin to the City of Los Angeles. Since the completion of the second aqueduct in 1970, an average of 450,000 acre-feet per year has been imported to the City. Deliveries are significantly lower during drier periods. Today, it appears unlikely that the historical supply will be maintained for two reasons—restricted diversions from the Mono Basin and groundwater management policies in the Owens Valley.

Historical Los Angeles Aqueduct supplies are constrained by ongoing concerns on water diversion from the Mono/Owens basins

Streams in the Mono Basin flow to Mono Lake, a saline lake with no natural outlet. The Lake is a major breeding site for California gulls, and an important stopover on a major waterbird migration route. The water level of Mono Lake has dropped 40 feet since Los Angeles began diverting water from the basin in 1941. Falling lake levels have caused concern about the lake's ecosystem and have led to on-going litigation that seeks to reduce Los Angeles' 90,000 acre-feet per year diversion from the Mono Basin.

Figure 4-3
Ocean Desalination Supplies



In September, 1994, Los Angeles settled this litigation by agreeing to cease water transfers from the Mono Basin until the elevation of Mono Lake increased to 6,377 feet, and to limit future transfers enough to maintain Mono Lake at an elevation of 6,391 feet.

Groundwater management policies in the Owens Valley also affect annual supply. The City annually negotiates with Inyo County to determine the amount of groundwater pumping for total use, both in-basin and export. To date, the City has not entered into a long term negotiated agreement with Inyo County on groundwater management.

The recent Mono Lake agreement significantly reduces the probability that the full capacity of the LAA will be utilized in the future. Groundwater replenishment and moderate development in the Mono Basin and the Owens Valley may further reduce available water supplies for import. Finally, variations in climatic conditions of this arid region diminish the reliability of this supply.

Levels of Investment

Based on information provided by the Los Angeles Department of Water and Power, the average annual yield of the LAA will likely decrease from its historical average in the future. Thus, only one level of investment is envisioned. Under this investment level, the IRP assumes that average annual supplies available through the LAA will recover from current drought supply levels (about 250,000 acre-feet) to about 380,000 acre-feet. In any particular year, hydrologic variation may decrease the available annual supply by as much as 50 percent of its average annual yield.

Section 5
Imported Supply Options

MWD

Section 5
Imported Supply Options

Since its establishment, Metropolitan's primary role has been securing reliable supplies of imported water to supplement water supply needs in Southern California. Nearly two-thirds of the water consumed by Southern Californians originates outside the region. Imported water is essential to the region. Every Member Agency uses imported water to some degree, with Beverly Hills, Burbank, Las Virgenes MWD, and San Diego CWA meeting over 90 percent of their demand using imported water supplied by Metropolitan.

Since its establishment, Metropolitan's primary role has been securing reliable supplies of imported water.

Figure 5-1 shows the major water conveyance facilities in California. The primary conveyance facilities used to import water to Metropolitan are the Colorado River Aqueduct (CRA) and the State Water Project (SWP) via the California Aqueduct. This section presents an overview and discussion of imported supply options available to the region through Metropolitan, and defines increasingly aggressive levels of potential investment for each water supply option. The specific projects/programs under each level of investment are presented to describe the general emphasis of that level, and to define a reasonable range of potential supply and cost.

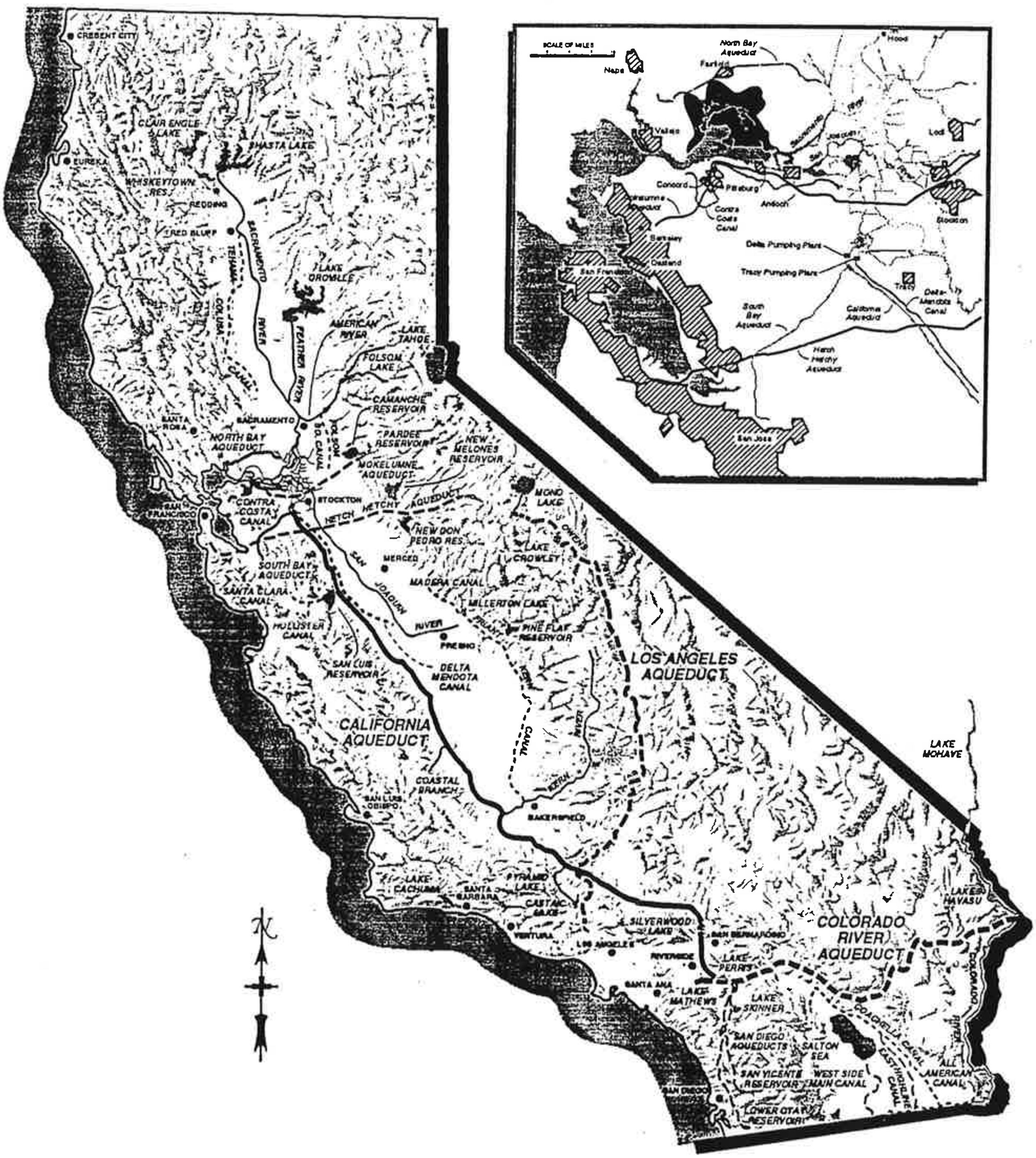
5.1 State Water Project Supplies

Issues Concerning the SWP

Issues concerning the State Water Project (SWP) are among the most complex in the IRP process. The SWP 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 is highly uncertain.

SWP water 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. Implementation of solutions to these complicated environmental problems in the Delta is by no means a certainty and may take some time to fully execute. If these solutions can be achieved, the potential for increased future supply from the SWP is significant. SWP transportation facilities, which are already being paid for, currently have adequate unused capacity to transport additional supplies.

Figure 5-1
Major Water Conveyance Facilities in California



LEGEND

- FEDERAL AQUEDUCT
- STATE AQUEDUCT
- LOCAL AQUEDUCT

SWP Contract and Existing Facilities

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.

Metropolitan's SWP contract entitlement is 2 million acre-ft per year

From a facilities perspective, the SWP is a series of reservoirs, pump stations, and aqueducts constructed and operated by the California Department of Water Resources (DWR). The initial SWP facilities were all 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. None of the additional facilities that were planned have been completed, with the exception of the installation of four additional pumps at the Banks Pumping Plant.

SWP Supplies and Supply Uncertainty

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. The years when Metropolitan received less SWP water than it wanted were 1991 and 1992, with the least SWP delivery in 1991 of 381,000 acre-feet.

Water quality and fisheries concerns are constraining available SWP Supplies

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, however, additional constraints on SWP and CVP operations have been imposed since 1992, by the National Marine Fisheries Service to protect winter-run salmon, and since 1993, by the U.S. Fish and Wildlife Service to protect Delta smelt. In addition, the U.S. EPA has proposed further constraints on SWP and CVP operations.

Metropolitan has a large fixed-cost obligation for SWP facilities

Economic Considerations

Reductions in SWP supplies could have serious economic consequences for Metropolitan. This is because SWP contractors are obligated by contract to repay their share of the financial obligation for construction of existing SWP facilities, regardless of the amount of water delivered. Metropolitan has a large fixed-cost obligation which results both from its contract for nearly half of total SWP entitlement, and from its location at the end of the aqueduct system, which requires extensive water conveyance facilities.

Water Quality

Water diverted from the Delta is low in total dissolved solids (TDS) relative to Colorado River supplies. Availability of additional Delta water would improve opportunities for water reclamation and groundwater basin management throughout the service area due to its lower TDS. On the other hand, water diverted from the Banks Pumping Plant contains high levels of disinfection by-product precursors. In order to comply with pending U.S. EPA drinking water standards for disinfection by-products, alternative disinfection technologies at Metropolitan's filtration plants would, in the absence of improvements in the Delta, most likely be required. Implementation of Delta improvements which include moving the diversion for SWP exports from the southern Delta, would greatly reduce the presence of disinfection by-product precursors in SWP supplies.

Resolving environmental issues in the Delta can yield large quantities of relatively low-cost water

Reducing Uncertainty

Metropolitan continues to be involved in efforts contributing to the resolution of environmental problems in the Delta that will reduce the amount of uncertainty in Delta water supplies. Relationships between urban water agencies and environmental interests have been formed to work on various water-related environmental issues. Products of these alliances include: (1) statewide agreements by urban water agencies and environmental interests on urban water conservation measures BMPs; (2) passage of landmark federal environmental restoration and water transfer legislation—Central Valley Project Improvement Act (Title XXXIV of Public Law 102-575); (3) support for new State water transfer legislation; and (4) support for interim Bay/Delta standards as an initial step toward environmental restoration. In addition, Metropolitan is participating in a coalition of Northern and Southern California urban water agencies which is responding to the proposed U.S. EPA regulations for the Delta. In an effort to expedite solutions to Delta issues, this coalition has developed an alternative to the proposed regulations that is receiving widespread support.

Once the environmental issues in the Delta are resolved, large volumes of relatively low-cost imported water supplies would be accessible in an environmentally benign manner. This would allow increased use of the existing SWP infrastructure that Metropolitan already pays for, through increased SWP deliveries, voluntary Central Valley water transfers and exchange programs, and storage of wet-period water.

Levels of Investment

Estimates of SWP supply for each level of resource development are based on DWRSIM model simulations of: (1) 70 years of historical hydrologic data, (2) the operation of specific facilities that make up each level of investment, and (3) a water demand set at the full SWP entitlement of 4.2 million acre-feet per year (with a demand of 2.01 million acre-feet per year for Metropolitan).

Level I

Under Level 1, no new SWP investments would occur. It was assumed that without the completion of any Delta improvements, Delta fishery problems would continue, resulting in the imposition of additional constraints on SWP operations, and the reduction of SWP supplies. The quantity of future SWP supplies under these conditions is difficult to project, due to uncertainty regarding the future state of Delta fisheries and the potential for additional operational constraints.

SWP Level I Facts

- *No new SWP Facilities*
- *Yield assumed to decline*

Under Level 1, it was assumed that supplies in 1995 would be equivalent to deliveries that would be available if the SWP was operated in accordance with D-1630. While D-1630 has not been adopted, it is a reasonable surrogate for current operational constraints. For this analysis, it was assumed that with no additional SWP levels of investment, SWP supplies would be reduced from this level over a ten-year period to a level set at one half of the supplies available under D-1630.

For these reduced supply levels (i.e. from year 2005 on), annual SWP deliveries to Metropolitan could not, by definition, be greater than one half of its entitlement, or one million acre-feet. Based on Level 1 facilities and the assumed operational constraints, this level of delivery would be possible only about 30 percent of the time. Ten percent of the time, deliveries to Metropolitan would be less than 500,000 acre-feet per year.

Under Metropolitan's contract with the State, Metropolitan must continue to pay its share of fixed costs for existing facilities. These fixed costs will reach $300 million in 1996, and decline to about $170 million by the year 2020, as existing debt is repaid. Variable costs will increase to $75 per acre-foot by the year 2000, and about $100 per acre-foot by 2020. Escalations in variable costs for purchased power are offset somewhat by revenue from the sale of power generated by SWP facilities.

Level 2

Level 2 consists of interim improvements in the Delta. For the IRP, this is assumed to include: (1) Delta channel enlargements and barriers in the south Delta to improve flow circulation, and (2) acoustic fish barriers on the Sacramento River at the Delta Cross Channel and at Georgiana Slough. It is assumed that these improvements would slow the decline of Delta fisheries. Interim improvements would allow use of the four additional pumps at Banks Pumping Plant when flow conditions permitted, and allow relaxation of certain constraints currently placed on SWP operations. As a result, yield under Level 2 would be higher than under Level 1. It is assumed that Level 2 would result in an increase in SWP yield, and without additional SWP levels of investment, would be followed by a gradual reduction occurring at a slower rate than with Level 1 facilities.

SWP Level 2 Facts

- *Interim Delta improvements including channel enlargements and acoustic fish barriers*
- *Yield assumed to temporarily increase and to decline slower than Level 1*
- *$125 million capital cost (escalated to Year 1997)*
- *$1.3 million annual O&M cost*

Construction for Level 2 improvements is assumed to begin in 1997. Capital costs for Level 2 are assumed to be $120 million for south Delta improvements, based on DWR staff estimates; and $5 million for the acoustic fish barriers, based on fishery biologist estimates. Both of the costs are based on current estimates, escalated to 1997 at six percent interest. Annual operation and maintenance costs are assumed to be $100,000 and $1.2 million for south Delta improvements and the fish barriers, respectively.

Level 3

Level 3 consists of a Delta water transfer facility. While the purpose of this Delta facility is to provide a long-term solution to Delta problems, the specific facilities and/or programs that make up this solution are speculative. For the IRP analysis, the Delta facility is assumed to be similar in cost and operation to the Peripheral Canal. The major benefit of such a facility results from removing the effects of the SWP export pumps from the southern Delta. This could eliminate or reduce reverse flow conditions that negatively impact Delta fisheries and improve the quality of water exported from the Delta.

SWP Level 3 Facts

- *Remove effects of SWP export pumps from southern Delta*
- *Yield reaches Metropolitan's full entitlement 3 out of 5 years*
- *$2.8 billion capital cost (escalated to Year 2000)*
- *$10 million annual O&M cost*

SWP supplies for Level 3 were determined by removing those D-1630 operational constraints that would not be required with a Delta facility, such as reverse flow limitations in the lower San Joaquin River. The removal of these constraints significantly increases SWP supplies. Under Level 3, Metropolitan would receive its full annual entitlement of 2.01 million acre-feet nearly 60 percent of the time, with annual SWP supplies exceeding 1.4 million acre-feet 90 percent of the time.

The IRP assumes that construction of a Delta water transfer facility could begin in 2000, and be completed in ten years. The capital cost for this facility is estimated to be $2.8 billion. This is based on DWR's 1977 cost estimate for the Peripheral Canal, escalated to 2,000 dollars at six percent interest, with a 20 percent contingency added to account for potential changes in design and mitigation requirements. Annual operation and maintenance costs are assumed to be $10 million. This assumption is based upon a Delta water transfer facility which would have similar features to the first reach of the California Aqueduct (e.g. pumping plant, fish screens, and levees). The Delta transfer facility would not eliminate the need for operation of these existing facilities, so these operation and maintenance costs would be in addition to costs for existing facilities.

Level 4

Investment Level 4 consists of additional storage south of the Delta. A number of strategies could be used to provide this south-of-Delta storage, including combinations of reservoir storage and conjunctive use programs. For the IRP process, two previously proposed projects—the 1 million acre-feet

Kern Water Bank (KWB) and the 1.73 million acre-feet Los Banos Grandes Reservoir—currently serve as the basis for supply and cost assumptions.

SWP Level 4 Facts

- *Adds nearly 3 million acre-feet of south-of-Delta storage*
- *Yield reaches Metropolitan's full entitlement 17 out of 20 years*
- *$2.0 billion capital cost (escalated to Year 2005)*
- *$7 million annual O&M cost*

SWP supply reliability with Level 4 increases significantly. Metropolitan would receive its full annual entitlement of 2.01 million acre-feet 85 percent of the time, and would receive at least 1.5 million acre-feet 95 percent of the time.

It is assumed in the IRP that a five-year construction period for the Kern Water Bank would begin in the year 2005, and a ten-year construction period for Los Banos Grandes Reservoir would also begin in the year 2005. Capital costs are assumed to be $122 million for the Kern Water Bank, based on a 1990 DWR staff cost estimate minus expenditures to date, escalated to year 2005 dollars at six percent interest; and $2.3 billion for Los Banos Grandes Reservoir, based on DWR's 1990 Los Banos Grandes Reservoir Feasibility Report cost estimate, escalated to year 2005 at six percent interest. Annual operation and maintenance costs are assumed to be $3 million for the Kern Water Bank, estimated by Metropolitan staff based on 1990 DWR estimates for the first stage of the Kern Fan Element; and $4 million for Los Banos Grandes Reservoir, estimated by Metropolitan staff based DWR's 1990 Los Banos Grandes Reservoir Feasibility Report. Variable unit costs would not change from Level 1.

Figure 5-2 presents the average water supply from the SWP under the levels of resource investment.

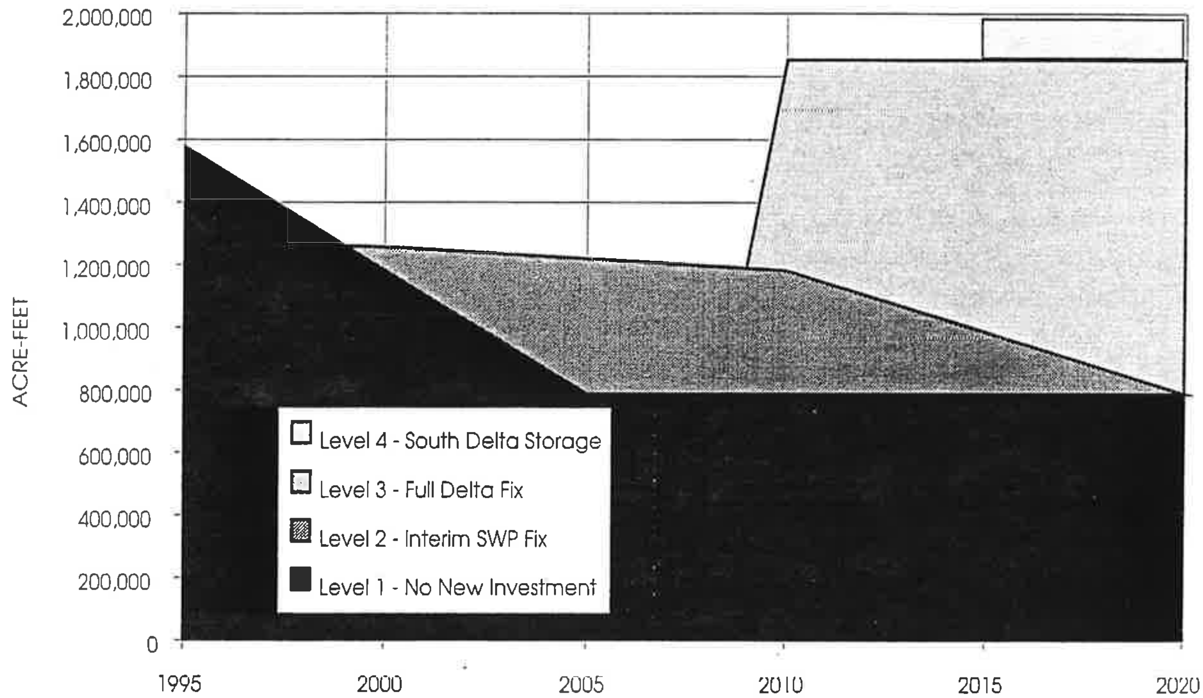
5.2 Water Transfers from the Central Valley

Up to 27 million acre-feet of water, 80 percent of California's developed water supply, is delivered for agricultural use annually. Over half of this water is used in the Central Valley:

- West San Joaquin Valley — 5.7 million acre-feet
- East San Joaquin Valley — 2.8 million acre-feet
- Sacramento Valley — 4.9 million acre-feet
- Within the Delta — 1.0 million acre-feet

Much of this Central Valley water is delivered by, or is adjacent to, State Water Project (SWP) and Central Valley Project (CVP) conveyance facilities, allowing for voluntary transfers to Metropolitan via the California Aqueduct.

Figure 5-2
Average Year State Water Project Supplies



In California, high water use, low value field crops—cotton, alfalfa, irrigated pasture, rice and other grains—account for more than 17 million acre-feet of water each year.

Availability of Supplies

Various water marketing arrangements can yield large quantities of Central Valley water

Recent events indicate that a portion of this Central Valley water supply will be available for transfers through the California Aqueduct:

- The 1991 and 1992 track record of the Governor's Drought Bank. During the record drought year of 1991, the Drought Bank purchased 820,000 acre-feet of such supplies in two months—roughly twice the total annual supply available from the SWP that year.

- The Central Valley Improvement Act was passed by Congress in October 1992. Under this Act, water agencies such as Metropolitan, that are not within the Central Valley Project service area, may for the first time be able to use a portion of the Central Valley Project's 7.8 million acre-feet yield.

- Agricultural interest in water transfers. Many members of the agricultural community are actively pursuing the transfer of a portion of their allocated supplies.

Metropolitan's Water Transfer Policy

Metropolitan's policy is to pursue a variety of voluntary water marketing agreements. Specifically, Metropolitan's policy statement on water transfers lists several considerations that will frame future water transfer actions:

Metropolitan's policy is to pursue voluntary water marketing agreements

- Water transfers, including water marketing, will be developed only on a voluntary basis with willing partners;

- A full-range of water transfer options will be pursued, including arrangements with appropriate state and federal agencies, public and private water entities, and individual water users;

- Water transfers will be designed to protect, and where feasible, enhance environmental resources;

- Efforts will continue to develop water transfers in cooperation with the agricultural community, which seek to avoid unreasonable operational and financial impacts; and

- Strategies will be developed to appropriately address community impacts of water transfers.

Types of Water Transfers

The IRP assumes that, for the right price, sufficient quantities of water used for low value crops can be purchased to supplement other supplies and meet Metropolitan's level of service (reliability) goal. The following four types of water marketing activities are available to supplement Metropolitan's other water supplies:

- *Spot Transfers.* Spot transfers make water available through an annual contract entered into the same year water is delivered. Spot contracts could be either directly with farmers or water agencies, or via participation with others through water brokered acquisitions. The Governor's 1991 and 1992 Drought Bank illustrates the second concept.

- *Option Transfers.* Option transfers through multi-year contracts allow Metropolitan to obtain water when the need exists. Typically these contracts require Metropolitan to "call" this water a minimum number of times during the contract term. Another common feature of option transfers is an upfront payment requirement. This provides a farmer sufficient incentive to commit future water supplies. The proposed Areias Dairy Farms transfer illustrates an option transfer.

Transfers can increase core supplies as well as provide swing supplies for drought management

- *Core Transfers.* Core transfers make water available through multi-year contracts that convey a specific entitlement of water to Metropolitan each year. The purchase or long-term lease of another water agency's Central Valley Project or SWP water supply would be typical of such a transaction.

- *Storage Programs.* These programs allow Metropolitan to store and later recover available Central Valley water not able to be transported immediately to Southern California. Typically, Metropolitan would store this water when available in a groundwater basin or surface water reservoir adjacent to the California Aqueduct. Then the stored water would be returned directly to the California Aqueduct or exchanged for water which otherwise would have been delivered to a water banking partner. The proposed Semitropic/Metropolitan Banking Program illustrates this type of storage program.

5.3 Colorado River Aqueduct (CRA) Supplies

Metropolitan has imported water from the Colorado River since 1941 under water delivery contracts with the U.S. Department of the Interior. These contracts allow diversion of 1.212 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 1.3 million acre-feet per year. The maximum import capability of the CRA is considered to be 1.2 million acre-feet per year assuming an outage factor of approximately 8 percent.

Today, dependable CRA supplies are only about half of Metropolitan's 1.2 million acre-foot entitlement

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 ability to divert water on a dependable basis decreased once the Central Arizona Project began operation in 1985.

Since commencement of operation of the Central Arizona Project in 1985, Metropolitan has been able to continue diverting Colorado River water as needed to meet a portion of its service area's demands and storage objectives. This has been accomplished through the execution of agreements to:

- Deliver Colorado River water in advance to Coachella Valley Water District (Coachella) and Desert Water Agency (Desert)
- Implement a water conservation program with Imperial Irrigation District (Imperial).
- Implement a test land fallowing program with Palo Verde Irrigation District (Palo Verde).

In addition, Metropolitan has delivered available surplus and unused water. Metropolitan's Strategic Plan objective for Colorado River resources is to pursue economic options to maximize Colorado River water supplies and permit the CRA to be operated at capacity as much of the time as is feasible.

Increasing Reliable Supplies

Increasing reliable Colorado River supplies is limited in three ways:

CRA capacity can be used to divert unused and surplus water

- The Secretary of the Interior may elect to hold water in reservoir storage rather than making it available to Metropolitan as unused Arizona and Nevada water and surplus water,
- The higher total dissolved solids content of the water limits water reclamation, and
- The capacity of the CRA is limited.

The Federal government will probably continue to control the salinity of Colorado River water to minimize impacts on consumers as well as on water reclamation. Implementation of a number of programs under consideration by Metropolitan would increase dependable Colorado River supplies. Remaining aqueduct capacity could be used to divert unused agricultural priority water, unused Arizona and Nevada water, and surplus water. Furthermore, yet to be envisioned programs could provide an even greater level of Colorado River water supply reliability. The IRP addresses whether this additional investment would be warranted. To do this, the IRP takes into account hydrologic conditions and projected demands for water in the Colorado River Basin. Determining whether this investment is warranted would consider:

- Whether the Bureau has implemented guidelines for the availability of surplus water,
- The content of Bureau regulations for administering Colorado River entitlements, or a regional water supply solution developed by the Colorado River Basin states to address California, Nevada and Arizona's needs for Colorado River water,
- The disposition of the Bureau's proposal to require a reduction in diversions by higher priority users of Colorado River water in California to offset projected or past overuse, and
- The effects of a U.S. Fish and Wildlife Service rule designating critical habitat for four endangered species of fish, future consultations between the Fish and Wildlife Service and the Bureau regarding reservoir operations, and proposals for multi-species habitat management planning.

Current Programs to Increase CRA Deliveries

Recently, Metropolitan has increased the reliability of its Colorado River supplies by implementing the following programs:

Metropolitan currently increases CRA deliveries through storing water in advance, utilizing unused water, and financing other users' water conservation and land fallowing programs

Coachella Basin Groundwater Storage

Metropolitan holds contracts with Coachella and Desert which require that Metropolitan exchange its Colorado River water for these agencies' SWP entitlement water on an annual basis. In accordance with an advance delivery agreement executed by Metropolitan, Coachella and Desert, Metropolitan delivers Colorado River water in advance to these agencies for storage in the Upper Coachella Valley groundwater basin. In years when supplies are insufficient, Coachella and Desert may use the stored water. In return, Metropolitan may continue to receive Coachella's and Desert's SWP water while maximizing deliveries of Colorado River water to its service area. To determine Metropolitan's dependable supplies of Colorado River water, it is assumed that exchanges will continue from the 394,000 acre-ft of water remaining in storage as of August 1994.

Imperial Irrigation District-Metropolitan Water Conservation Program

Metropolitan and the Imperial Irrigation District (Imperial) executed an agreement for the implementation of a water conservation program and use of conserved water in December 1988. Then Metropolitan, Imperial, the Palo Verde Irrigation District (Palo Verde), and Coachella executed an Approval Agreement and Metropolitan and Coachella executed an Agreement to Supplement Approval Agreement in December 1989. The first two agreements call for Metropolitan to fund a number of conservation projects that Imperial is implementing. The third agreement deals with circumstances under which Metropolitan would reduce its use of conserved water. Thus, Metropolitan can divert a quantity of Colorado River water in most years equal to the amount of water conserved by the conservation projects. Metropolitan projects that 82,750 acre-feet of water will be conserved in 1995, 101,250 acre-feet in 1996, and 106,100 acre-feet per year beginning in 1997 for a 35-year period.

Palo Verde-Metropolitan Test Land Fallowing Program

Under a May 1992 agreement among Metropolitan, Palo Verde, Imperial, Coachella, and the United States, about 20,000 acres of agricultural land were fallowed in the Palo Verde Valley between August 1992 and July 1994. Metropolitan compensated the lessees/landowners for foregoing agricultural production of crops. The 186,000 acre-feet saved has been stored in Lake Mead for subsequent use by Metropolitan. The IRP assumes that this water will be delivered to Metropolitan's service area in 1999.

Surplus and Unused Colorado River Water

Between 1986 and 1994, surplus and unused Colorado River water has been available to supplement Metropolitan's dependable supplies of Colorado River water.

Surplus Water Available via the CRA

Currently, the availability of surplus water is determined on a year-to-year basis by the Secretary of the Interior (Secretary) based on a recommendation by the Commissioner of Reclamation. The Commissioner's recommendation is based on a proposed annual operating plan for the Colorado River system reservoirs prepared by Bureau staff who consult with the Colorado River Management Work Group. The Work Group consists of representatives of federal and state agencies with responsibilities or interests in reservoir system operation. Representatives of water agencies, electrical utilities, and environmental interest groups are invited to participate in Work Group deliberations. Metropolitan holds the highest priority in California to import available surplus water via the CRA.

Metropolitan has the highest priority to divert surplus and unused Colorado River water

Water Apportioned to but Unused by Arizona and Nevada

The availability to California, and thus Metropolitan, of water apportioned to but unused by Arizona and Nevada is also determined on a year-to-year basis by the Secretary. As with surplus water, the Secretary's determination is based on a recommendation by the Commissioner. The Work Group is the forum for discussions on making such water available to California. In certain past years, representatives of Arizona and Nevada have objected to such water being made available, preferring that such water remain in reservoir storage. No guidelines have been issued by Reclamation regarding the circumstances under which unused apportionments would be made available in future years. The 1994 operating plan for the reservoir system permits unused Arizona and Nevada water to be utilized by California in 1994. Based on Reclamation's July 1994 projection of net diversions in the three states, sufficient unused water is available to permit Metropolitan to divert over 1.2 million acre-feet of Colorado River water in 1994. Should the forecast of net diversions approach 7.5 million acre-feet in Arizona, California, and Nevada in 1994, the Secretary would consult with interested parties regarding modifications to the annual operating plan. If the plan is not modified following that consultation and net diversions exceed 7.5 million acre-feet, compensation for overuse of such water would be required by the end of 1999. Compensation for overuse would be in the form of an adjustment to a State's apportionment unless alternate forms of compensation or other time frames are agreed upon by the Governors' representatives of the Colorado River Basin States and the Secretary. As Reclamation's July 1994 forecast of this year's use does not exceed 7.5 million acre-feet, compensation by Metropolitan for overuse has not been projected.

Unused Agricultural Priority Water

Between 1986 and 1993, the amount of unused agricultural priority water available to Metropolitan has varied from zero in 1989 and 1990 to over 500,000 acre-feet in 1992. As net diversions of Colorado River water are accounted on a calendar year basis, the Bureau, Colorado River Board of California and Metropolitan have developed methods to forecast the availability of such water for diversion late in the year. The amount of unused agricultural priority water will continue to vary in the future depending upon agricultural economics, types of crops grown, and acreage irrigated.

Future Colorado River Water Supplies

In 1996, Metropolitan's dependable Colorado River supply is projected to total 621,250 acre-feet. While Metropolitan's dependable Colorado River supply is limited, additional water may at times be available. In addition to unused agricultural priority water, the Secretary may make water unused by Arizona and Nevada available to California. In years in which surplus water is available, California is entitled to divert up to one-half of the surplus, and Metropolitan has the highest priority of any California contractor to divert this surplus water. As a result of favorable power contracts and overall lower energy use, water delivered from the Colorado River is one of the most cost-effective sources of supply available to the region.

Increasing the Reliability of Metropolitan's Colorado River Supplies

As the amount of surplus and unused water which will be available in the future is uncertain, Metropolitan is considering entering into agreements with other water agencies and the United States to increase its dependable supplies of Colorado River water. Additional supplies could be made available through agreements to undertake further conservation improvements and fallow land. Opportunities to store water in central Arizona groundwater basins may also be pursued. Metropolitan projects that if implemented, the currently envisioned programs would allow dependable Colorado River supplies to be increased by 350,000 acre-feet by the year 2005. A description of currently envisioned programs follows.

Today, Metropolitan is seeking to increase reliable supplies through additional conservation improvements and land fallowing

All American Canal Lining Project

The Bureau has completed the final environmental impact statement/environmental impact report (EIS/EIR) for the All American Canal Lining Project, construction of a 23 mile parallel concrete-lined canal. The canal lining would conserve 67,700 acre-feet per year. The water conserved would be used by the California Contractors (Palo Verde, Imperial, Coachella, and Metropolitan). Metropolitan proposes to fund the lining project to either increase its yield from the Colorado River or to be reimbursed, if another California Contractor uses the conserved water. Construction could be completed by 1999.

Coachella Canal Lining Project

In January 1994, the Bureau filed the draft EIS/EIR for the Coachella Canal Lining Project, construction of 33 miles of concrete-lining that would conserve 25,700 acre-feet per year for use by the California Contractors. Construction could be completed by 1998.

Imperial Test Land Fallowing and Modified Alfalfa Irrigation Program

Early in 1993, representatives of Metropolitan and Imperial negotiated the terms and conditions of a two-year test land fallowing and modified alfalfa irrigation program to save 100,000 acre-ft annually. Metropolitan has informed Imperial that it would be appropriate to obtain Palo Verde and Coachella's comments, and to continue working to develop the agreement to a near ready state for implementation in the future should the need arise.

Phase II Water Conservation Program with Imperial

The second phase of the current water conservation program with Imperial could conserve 150,000 acre-feet per year through lining of additional canals and laterals, construction of a regulatory reservoir, and recovery of canal discharges to drains through construction of spill interceptor canals. This project is currently on hold. The Regional Water Quality Control Board staff have suggested that widespread implementation of conservation measures in the Imperial Valley be delayed until selenium control measures for agricultural drainage water are developed.

Underground Storage of Colorado River Water in Central Arizona

Metropolitan and the Central Arizona Water Conservation District (CAWCD) executed an Agreement for a Demonstration Project on Underground Storage of Colorado River Water in October 1992. Under the agreement, 100,000 acre-ft of Colorado River water has been released from Lake Mead, conveyed through the Central Arizona Project's Hayden-Rhodes Aqueduct, and stored underground in Central Arizona. Metropolitan and the Southern Nevada Water Authority (SNWA) paid the costs of storing the water, while CAWCD is responsible for costs of recovery of the water. There are two potential uses of the stored water. CAWCD could use the water to reduce shortages declared by the Secretary. Alternatively, Metropolitan and SNWA could exchange this water for CAWCD's Colorado River water if a surplus occurs or flood releases are made by the Bureau. Metropolitan is considering an amendment to the agreement to permit the storage of an additional 200,000 acre-feet over the next six years.

Other Programs

Additional programs are being considered to increase Metropolitan's dependable Colorado River supplies. These programs include longer-term land fallowing programs in the Palo Verde and Imperial Valleys each saving 100,000 acre-feet per year. A number of lessees and landowners in the Palo Verde Valley who participated in the test land fallowing program have expressed an interest in the implementation of a second program.

Levels of Investment

Metropolitan's preliminary Strategic Plan calls for development of an additional 350,000 acre-feet per year of dependable Colorado River supply by the year 2005. For the IRP, this goal has been translated into three specific levels of investment. Estimates of CRA supply for each level considers the availability of surplus water, based on 70 years of historical hydrologic data.

Level 1

Level 1 represents Metropolitan's basic entitlement plus water provided by the following existing investments:

- Coachella Basin Groundwater Storage
- Imperial/Metropolitan Water Conservation Program
- Metropolitan-Palo Verde Test Land Fallowing Program

CRA Levels of Investment

- *Level 1: Existing dependable Colorado River supply including present programs*
- *Level 2: Planned conservation/fallowing programs*
- *Level 3: Additional land fallowing programs*

Level 2

Level 2 adds the following planned conservation and other programs to further increase the reliability of Metropolitan's Colorado River supplies:

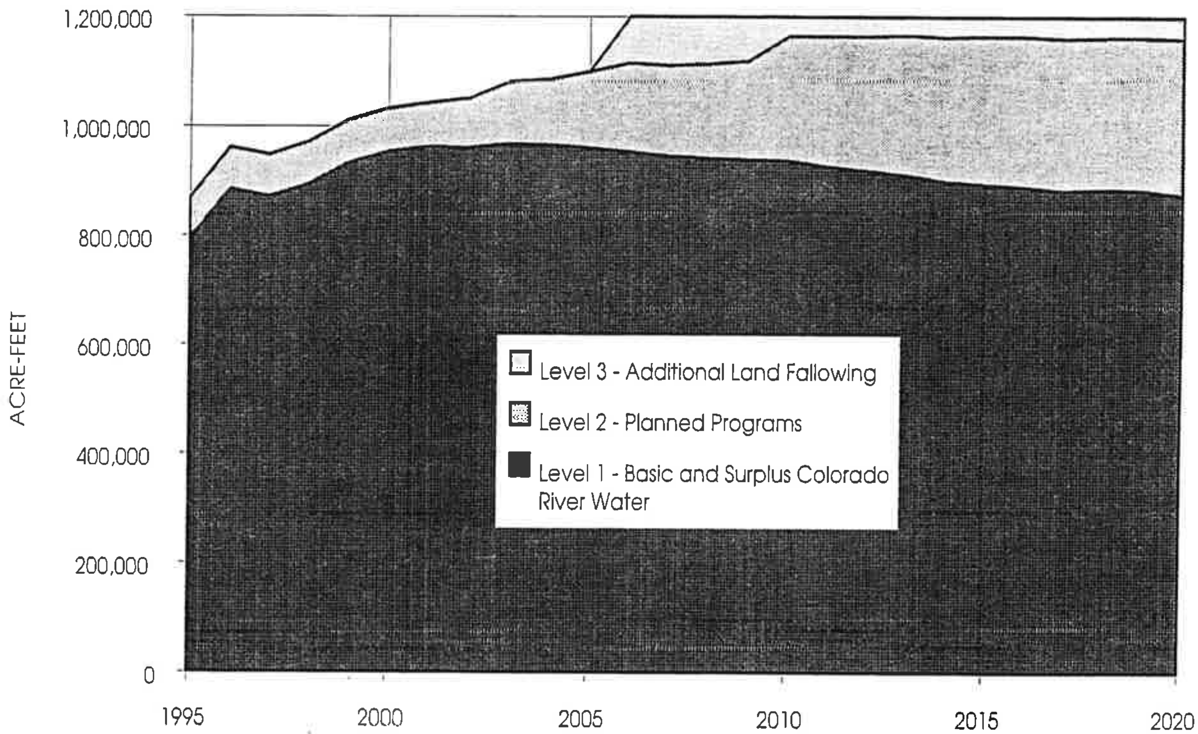
- All-American Canal Lining Project
- Coachella Canal Lining Project
- Imperial and Palo Verde Land Fallowing
- Phase II Water Conservation Program with Imperial

Level 3

Under this level, Metropolitan would be able to deliver 1.2 million acre-feet of Colorado River water every year, taking into consideration the availability of surplus water. This level of investment would be achieved through Metropolitan funding of additional land fallowing within the Imperial and Palo Verde service areas.

Figure 5-3 (on the following page) presents average year supply from the CRA.

Figure 5-3
Average Year Colorado River Aqueduct Supply



Section 6
Development of a Resource Strategy

MWD

Section 6
Development of a Resource Strategy

The data collection and analysis phase of the IRP process concludes with an evaluation of alternative resource strategies. These strategies emphasize various levels of investment in local resources, imported resources, and water management facilities. First, the evaluation assembles the various resource options into "mixes" that generally represent relative differences in emphasis between local and imported supply. Then these resource mixes are evaluated according to three criteria: supply reliability, cost, and uncertainty. This section summarizes these resource mixes and describes how they were evaluated.

6.1 Summary of Resource Options

The previous two sections discussed the various water resources available to Southern California. About one-third of the existing water supply is found locally. The rest of the region's water is imported from three sources —the Colorado River, the Sacramento-San Joaquin River Delta, and the Owens Valley and Mono Basin (through the Los Angeles Aqueducts). Hydrologic variations lead to uncertainty in the reliability of most of these sources.

The region has available a wide range of options, often complementary, for expanding imported supplies and local resources.

As a regional resources plan, the IRP process evaluates all of the possible alternatives to provide the additional supplies needed to meet future demands. The region has available a wide range of options that could expand upon imported supplies and local water resources. These options, which in many cases are complementary, include:

Imported Resources. Increasing Colorado River Aqueduct supplies through investment in cooperative conservation programs, conjunctive use, and land fallowing; and increasing California Aqueduct supplies through capital improvements in the State Water Project System to resolve environmental constraints, Central Valley groundwater storage programs, and market purchases.

Local Resources. Increasing local water resources through expanded reclamation, conservation, groundwater conjunctive use and recovery, and desalination;

The IRP seeks the right balance of resource development and management strategies needed to reliably meet demand in a manner that is both cost-effective and acceptable to the public. However, over the past 10 years, the region's firm supply of water resources has been declining. The data analysis conducted for the IRP indicates that existing dependable supplies will continue to decline dramatically. Figure 6-1 shows how this decline in supply immediately threatens the ability of the region's water providers to meet regional demand. The IRP process is intended to identify the right mix of additional dependable supplies sufficient to meet or exceed projected demands.

6.2 Development of Resource Mixes

Resource Mix Building Blocks

A resource mix is a combination of investments in imported supplies and local resources. In order to identify broadly feasible combinations of local and imported water supplies that meet regional reliability goals, Metropolitan, its Member Agencies, and other water providers have jointly defined an initial set of "building blocks" reflecting increasingly aggressive investments for each major category of water supply. As shown in Table 6-1, the IRP defines up to four levels of potential investment for each water supply option:

Figure 6-1
Water Supply and Demand: Critical Drought Year

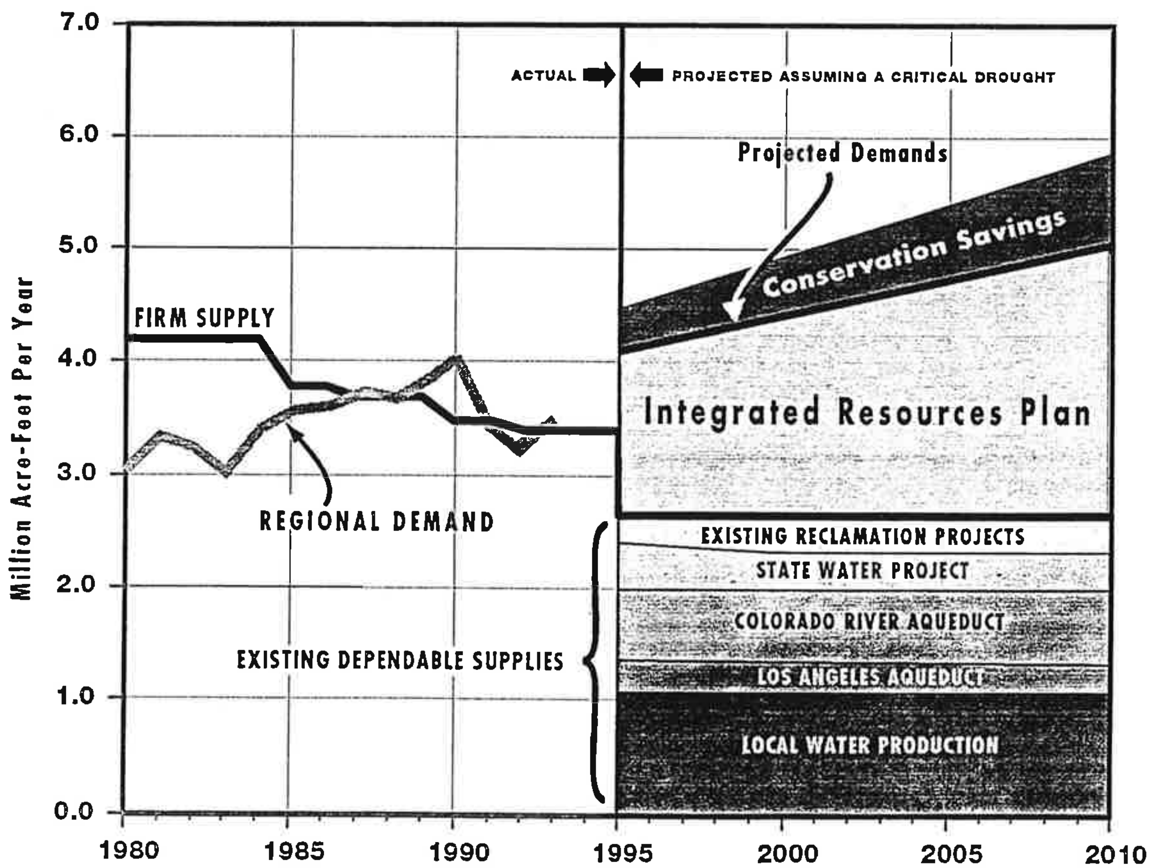


Table 6-1
Overview of Water Resources by Year 2020

Supply Source	Level 1 Investment	Level 2 Investment	Level 3 Investment	Level 4 Investment
Imported				
Colorado River Aqueduct (CRA)	Existing Supplies: 0.6 to 1.2 MAFY	Planned Conservation and Other Programs: 1.0 to 1.2* MAFY	Full Aqueduct and Land Fallowing: 1.2 MAFY	
State Water Project	Existing Facilities. Reduced Deliveries: 0.1 to 1.0 MAFY	Interim Delta Fix: 0.3 to 1.4 MAFY	Delta Transfer Facility: 0.6 to 2.0 MAFY	South of Delta Storage Programs: 1.3 to 2.0 MAFY
Water Transfers from Central Valley	Option and Spot Transfers	Core Transfers		
Local Supplies				
Local Surface and Groundwater	Existing Production: 1.2 to 1.4 MAFY			
Water Reclamation	Existing Projects and Facilities Under Construction: 0.5 MAFY	Existing Projects and Facilities Under Design: 0.7 MAFY	Existing and Planned Facilities: 1.0 MAFY	
Groundwater Recovery	Existing Projects: 0.04 MAFY	Existing and Planned Projects: 0.11 MAFY	All Potential Projects: 0.15 MAFY	
Water Conservation	Existing Programs: 0.3 MAFY	Full BMPs: 0.9 MAFY	Beyond BMPs: 1.1 MAFY	
Ocean Desalination	Small Local Projects: 0.03 MAFY	Small and Mid-sized Projects: 0.1 MAFY	Small, Mid, and Large Regional Projects: 0.3 MAFY	
Los Angeles Aqueduct	Existing Facilities: 0.2 to 0.4 MAFY			

*Depends on availability of surplus Colorado River water.
MAF = million acre-feet; MAFY = million acre-feet per year

- *Level 1* represents water supplies that can be provided by infrastructure and resource programs that currently exist or are already under construction.

- *Level* 2 adds supplies resulting from projects and programs that agencies have taken steps to implement even through they are not currently under construction (i.e., projects either under design or where sufficient planning has occurred to indicate that the project/program is feasible).

- *Levels 3 and 4* represent the potential amount of water than can be provided during the planning horizon based on projects that may only be in the "concept" phase of development.

Each resource mix is defined by selecting a particular level of investment (i.e., Level 1, 2, 3, or 4) for each resource option shown in Table 6-1. For example a potential resource mix might consist of Level 1 State Water Project supply, Level 3 Colorado River Supply, Level 2 Reclamation supply, and so forth.

Resource Levels of Investment:

- *Level 1: Existing/committed resources*
- *Level 2: Partially-implemented resources*
- *Level 3/4: Potential resources*

Categories of Resources

For a resource mix to be feasible, it is generally composed of three categories of resources: (1) core supplies; (2) storage; and (3) swing or flexible supplies. Core supplies represent those supplies that are firmly committed each and every year. In many cases, core supplies cannot be easily "scaled back" even if demands are low. While core supplies greatly improve reliability, the investments also tend to create surplus water (supplies in excess of demands) during normal and wet years. For the IRP, core supplies represent all of the local and imported supplies shown in Table 6-1, except Central Valley water transfers.

Storage, both groundwater and surface, serves two functions: (1) during normal and wet years it allows surplus water to be stored for later use; and (2) during dry and critically dry years it offers an added supply—providing "carryover" water to meet demands. Total annual "carryover" storage requirements are determined in this section, incorporated with projections of seasonal shift and emergency storage needs to define planning level estimates of total storage, treatment and distribution costs under each resource mix.

Swing supplies represent those supplies that are used only when needed, such as during a drought or to replenish storage. Usually, the fixed costs represent a small portion of the total cost of a swing supply. Central Valley water transfers are an example of a swing supply.

IRP Resource Mixes

Four broad resource mixes, or strategies, for the IRP were developed:

- ***No New Investment (base case).*** Represents no new investment in local or imported water resources (i.e., Level 1 investments for all resources).
- ***Emphasis on Local Resources.*** Represents full investment in local resources (i.e., Level 3 investments, where available) and existing investments in imported resources (i.e., Level 1 investments).
- ***Emphasis on Imported Resources.*** Represents full investment in imported resources (i.e., Level 3 or 4 investments, where available) and existing investments in local resources (i.e., Level 1 investments).
- ***Intermediate Investment in Local and Imported Resources.*** Represents moderate investments in both imported and local resources (i.e., Level 2 or 3 investments).

Initial Resource Mixes

	Level of Investment	
Mix	*Local*	*Imported*
No New Investment	*1*	*1*
Local Resource Emphasis	*3*	*1*
Imported Resource Emphasis	*1*	*3/4*
Intermediate Investment	*2/3*	*2/3*

Each resource mix was evaluated to determine its supply reliability for meeting near and long-term water demands during the planning period 1995 to year 2020.

6.3 IRP Evaluation Criteria

There are a significant number of uncertainties involved in long-range water supply planning. Some uncertainties relate to climatic and hydrologic variations. For the IRP, analytical evaluations of supply reliability and cost quantified these types of uncertainties. An IRP work group composed of Metropolitan staff, Member Agency staff, and groundwater basin managers also identified other uncertainties. These uncertainties are interwoven with social, political, and economic considerations that are more difficult to quantify. Therefore, the IRP process qualitatively evaluated the uncertainty presented by each resource option in the following areas:

- Environmental Impacts
- Risk
- Flexibility
- Adaptability
- Timing/Staging
- Equity
- Impact to Local Economy
- Public Acceptance

This section discusses the relative importance assigned to these criteria by the IRP participants and how these criteria were used to evaluate alternative resource options and resource mixes.

Ranking the Evaluation Criteria

Not all criteria may be equally important. Therefore during the October 1993 Strategic Assembly of Metropolitan staff, the Board, and the Member Agency Managers, the IRP evaluation criteria were independently ranked for importance. Table 6-2 lists the relative importance defined for each IRP evaluation criterion by the Strategic Assembly. Assembly members defined long-term reliability, cost, and risk as the most important criteria.

Table 6-2
Relative Importance of IRP Evaluation Criteria

Evaluation Criteria	Relative Importance (Percent of Responses)
Long-Term Reliability	78
Cost	63
Risk (Feasibility/Practicability)	59
Flexibility in Supplies	53
Public Acceptability	52
Equity	49
Adaptability	42
Timing/Staging of Resources	42
Environmental Impact	37
Impact to Local Economy	37
Short-Term Reliability	35

The Computer Tool Option Finder was used by the Strategic Assembly to establish the importance of the evaluation criteria shown in Table 6-2. Option Finder is a survey research tool that allows for the rapid collection and analysis of survey data from small groups in a meeting or workshop setting. The PC-based system allowed every member of the Assembly to respond electronically, using individual keypads, to questions regarding specific choices, opinions, and priorities for planning or other purposes. Once responses were registered, the system provided an immediate display of results on a projection screen for further discussion and evaluation purposes.

Evaluation criteria importance was established by asking each Assembly member to compare criteria in pairs. The number of times each criterion was picked as more important than another criterion represents the relative importance of that criterion.

6.4 Supply Reliability Evaluation

Water supply reliability analysis is used to evaluate how well a resource mix meets future water needs during different hydrologic and climatic conditions. In general, water supply reliability can be defined as: *the degree to which the performance of a supply system results in the delivery of water service to its customers in the amounts desired, and within acceptable quality standards.* Evaluation of supply reliability is important because it provides a signal when additional resources are required. Equally important, reliability planning determines when "enough is enough"—that is, when additional resources would constitute an over-investment in supply.

Water supply reliability is the ability to deliver water in the amounts desired, and within acceptable quality standards.

The supply reliability evaluation starts with the projection of regional retail-level water needs. Local water supplies are estimated and subtracted from the regional water demands in order to obtain the demands for Metropolitan's imported water. Imported water supplies are projected and compared to the demands on Metropolitan. If supplies exceed demand, the surplus water is put into available storage. Storage consists of both surface reservoirs and groundwater basins. If supplies are less than demand, the shortage is alleviated by pulling water from storage (dry year supply), purchasing water through voluntary transfer agreements, and/or rationing.

If future water demands and supplies were known with certainty, no reliability planning would be necessary—because water shortages and/or surpluses would also be certain. In reality, both future water demand and supply are uncertain. Furthermore, there are many types of uncertainty, such as: hydrologic, climatic, institutional, and political. Some types of uncertainty lend themselves easily to technical evaluations, while others are much more difficult to measure quantitatively. Uncertainties that were explicitly handled in the technical IRP evaluation include: (1) hydrologic and climatic conditions; (2) variations in long-term demographic growth; and (3) forecast model error. All other sources of uncertainties, such as institutional or regulatory risk, will be handled in a qualitative manner through a consensus process.

To facilitate the quantitative evaluation of supply reliability and resource cost analysis, an Integrated Resource Planning Simulation model (IRPSIM) was developed by Metropolitan. IRPSIM uses results from other water demand and supply models, and simulates the effects that different hydrologic and climatic conditions have on future supply and demand. IRPSIM also estimates the total costs for different resource mixes, using widely accepted least-cost planning principles.

Simulating Hydrologic and Climatic Uncertainty

Water demands and supplies are not static through time. Demands and supplies can vary significantly from year to year based on hydrology and climate. The fact that water demand and supply are also related to each other further complicates the reliability analysis. The same factors that make supplies go down (hot and dry climate), tend to make water demand go up. These linkages must be included in order to generate a realistic estimate of future supply and demand.

The IRP "mapped" historical hydrology and climate over projected supply and demand to measure supply reliability.

In order to evaluate supply reliability, a statistical simulation of water supply and demand must be performed. In the simulation process, 70 years (1922-1991) of historical hydrology and climate were "mapped" over future estimates of supply and demand to measure the impacts that temperature, rainfall, snowpack, and operational scenarios have on supply reliability. This methodology preserves the contemporaneous relationships between hydrology and climate effects on supply and demand. In other words, when IRPSIM measures the effect that 1933 hydrology has on supplies in Northern California, the 1933 weather impact on demands in Southern California is also used. IRPSIM not only preserves the relationship between supply and demand, but also preserves the time consistency "index" using sequential simulation. Given a long enough trace of hydrology and climate, the sequence of years can be used to simulate the filling and drafting of storage and identify the need for potential water transfers. For example, how would the supply and demand balance out during a sequence of extremely wet years in the beginning of the time sequence, and extremely dry years in the end of the sequence? IRPSIM can "map" any sequence of historic hydrology and weather onto any future level of supply and demand.

An example of how sequential hydrology and climate affect supply and demand is presented in Table 6-3. The projection period is from 1996 to 2020, with a simulation of 1967 to 1991 hydrology and climate. This simulation shows what the supply and demand balance would look like if the projection year 1996 had a 1967 hydrology and climate, and the projection year 2020 had a 1991 hydrology and climate. The example indicates that in some years supply shortages exists (indicated by the negative numbers) and in other years supply surplus exists (indicated by the positive numbers).

A significant benefit of storage is to hold excess water when supplies exceed demand (during wet years) for later use during times when demands exceed

Table 6-3
Hydrologic and Climate Simulation of Supplies and Demand

Forecast Year	Hydrologic/ Climate Trace	Total Regional Demand	Local Supplies	State Water Project	Colorado River Water	Total Supply	Supply Surplus/ Shortage
1996	1967	4.153	2.142	0.891	0.921	3.954	-0.199
1997	1968	4.471	2.282	0.891	0.924	4.097	-0.374
1998	1969	4.211	2.275	0.891	1.200	4.366	0.155
1999	1970	4.678	2.455	0.891	1.200	4.546	-0.132
2000	1971	4.738	2.493	0.891	1.200	4.584	-0.154
2001	1972	4.985	2.555	0.891	1.200	4.646	-0.339
2002	1973	4.652	2.582	0.891	1.200	4.673	0.021
2003	1974	4.802	2.622	0.891	1.200	4.713	-0.089
2004	1975	4.775	2.673	0.891	0.989	4.553	-0.222
2005	1976	5.060	2.730	0.891	1.200	4.821	-0.239
2006	1977	5.066	2.712	0.601	0.973	4.286	-0.780
2007	1978	4.697	2.639	2.012	0.981	5.632	0.935
2008	1979	5.021	2.899	2.012	0.985	5.896	0.875
2009	1980	5.088	2.904	2.012	0.978	5.894	0.806
2010	1981	5.599	3.057	1.875	1.200	6.132	0.533
2011	1982	5.363	2.973	2.012	0.978	5.963	0.600
2012	1983	4.984	3.001	2.012	1.200	6.213	1.229
2013	1984	5.789	3.310	2.012	1.200	6.522	0.733
2014	1985	5.276	3.121	2.012	1.200	6.333	0.607
2015	1986	5.674	3.074	2.012	1.200	6.286	0.612
2016	1987	5.870	3.165	2.012	1.200	6.377	0.507
2017	1988	5.886	3.121	2.012	1.200	6.333	0.447
2018	1989	6.083	3.103	1.903	0.913	5.919	-0.164
2019	1990	6.266	3.111	1.595	0.913	5.619	-0.647
2020	1991	6.046	3.036	1.346	0.913	5.295	-0.751

1967-1975 and 1982-1987 were considered to be normal to wet hydrologic years.
1976-1977, 1981, and 1988-1991 were considered to be dry to critical hydrologic years.

Note: All supplies and demand quantities in million acre-feet per year.

supply (during dry years). IRPSIM keeps track of the total storage capacity year to year, while also constraining how much annual "put" and "take" conveyance can be achieved using operational and system storage rules. If costs were not a limitation, storage would be maximized such that all available surplus water during wet and normal years could be used to alleviate all (or most) of the supply shortages during dry and critical years. Figure 6-2 graphically depicts the total supplies and demands (without storage) during the 1996 to 2020 forecast period using the data from Table 6-3. With adequate storage, the supply shortages during the years 2018 through 2020 could be alleviated by the use of carryover supply.

The top half of the supply reliability curve shows the likelihood of supply shortages, while the bottom half shows the likelihood of surpluses.

Estimating Supply Reliability

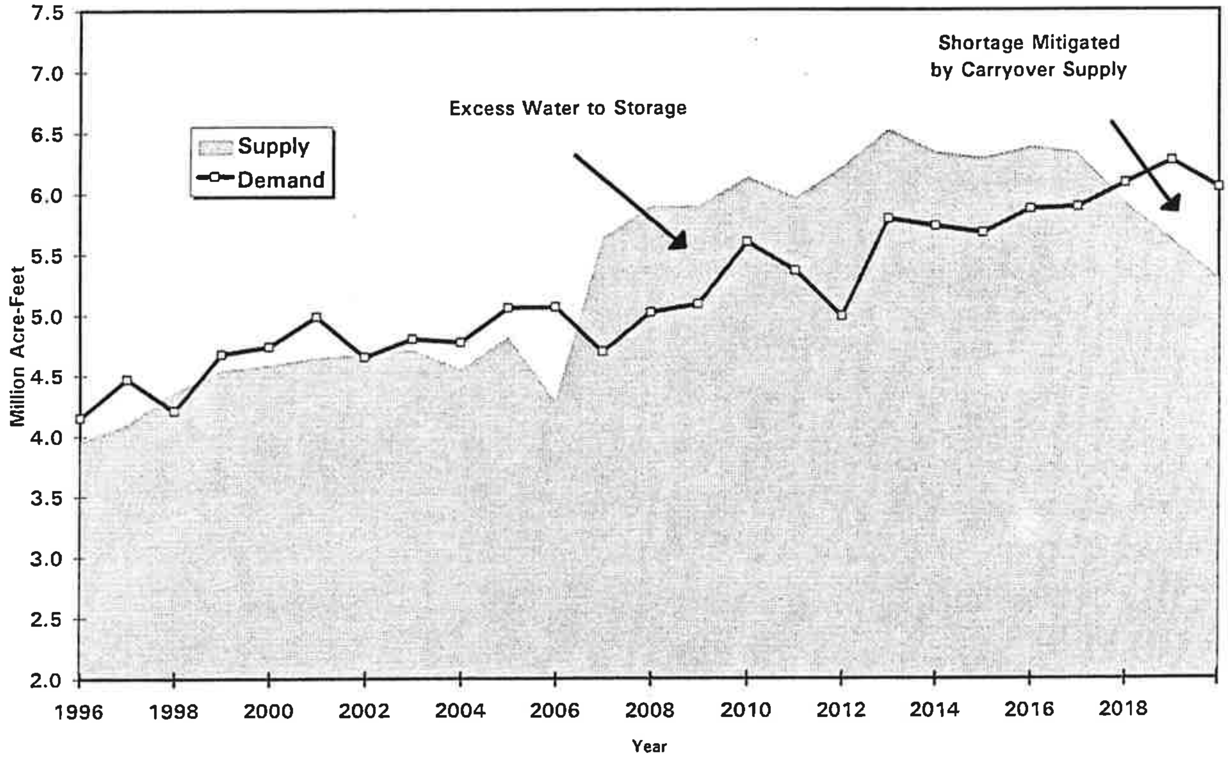
In order to comprehensively evaluate supply reliability, *all* possible future supplies and demands must be examined. The reliability "curve," a cumulative distribution of supply less demand, is generated from the probablistic simulation using different hydrologic and climate traces. The curve represents the relationship between two axes. The vertical axis represents the magnitude of shortage, where shortage is defined as the difference between supply and demand. The horizontal axis represents the cumulative probability (or likelihood) of the shortage occurring, which is bounded from 0 to 100 percent. Typically, reliability analysis has only focused on the likelihood of supply shortages. However, the reliability analysis in the IRP evaluation examines the likelihood of supply surplus as well. The ability to analyze surplus water is critical to the evaluation of the costs and benefits of storage.

Figure 6-3 presents a hypothetical supply reliability curve, presented in two halves. The top half represents supply shortages, and the bottom half represents supply surplus. The vertical axis measures the percent magnitude of supply shortage for the top half of the graph, and percent magnitude of supply surplus for the bottom half. The top horizontal axis measures the likelihood of shortage (reading from left to right), while the bottom horizontal axis measures the likelihood of surplus (reading from right to left). In the hypothetical example, a supply shortage would occur about 30 percent of the time, and a supply surplus would occur about 70 percent of the time. The magnitude of the supply shortage would exceed 10 percent of full service demands, about 10 percent of the time (or 1 in 10 years).

6.5 Evaluation of Supply Reliability

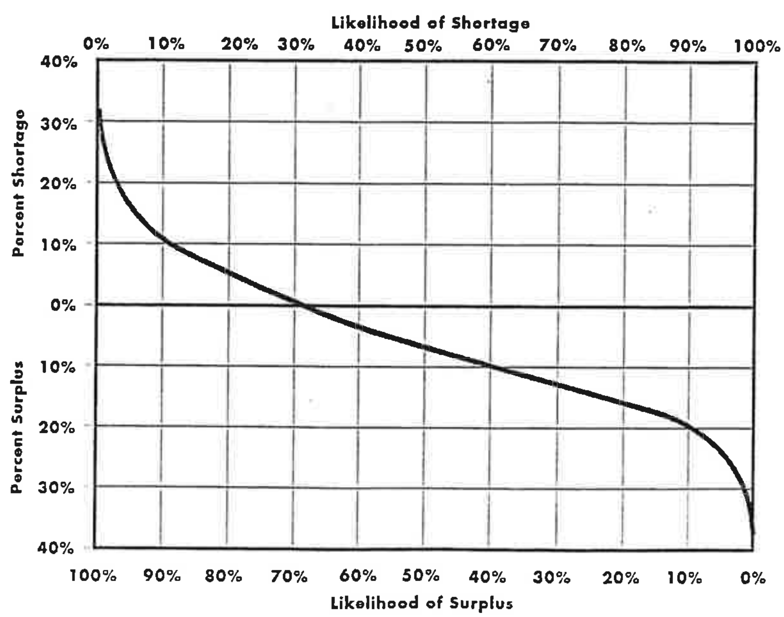
The supply reliability evaluation methodology described in the previous section was applied to the four broad resource mixes in order to:

Figure 6-2
Water Supply and Demand: Hydrology and Climate Simulation



Assuming 1967-1991 hydrology/climate

Figure 6-3
Example Supply Reliability



(1) determine the reliability of core supplies available each year under the various resource mixes,

(2) define the annual amount of available carryover storage needed to improve core supply reliability, and

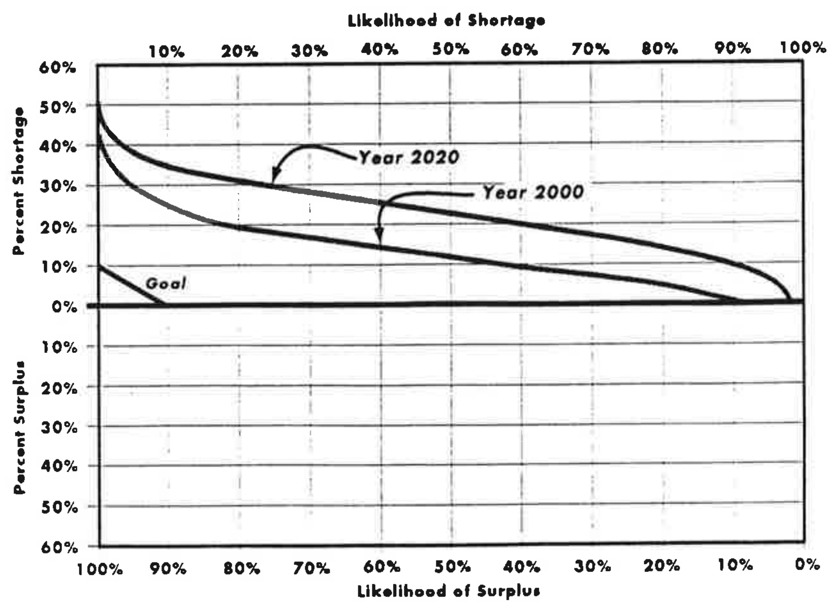
(3) identify water transfers needed for swing supplies during years when available core supplies and storage cannot meet supply reliability goals.

This section discusses the changes in supply reliability in the short-term (i.e., year 2000) and long-term (i.e., year 2020).

No New Investment

The No New Investment mix was a base case to determine the levels and frequency of near and long-term water shortages that would occur without any new investments in local and imported resources. As near and long-term water demands increase due to a continued population growth in the service area of over 220,000 people per year, water shortages for this resource mix increase as well (Figure 6-4). Supply shortages greater than those experienced during the 1991 drought would occur about 60 percent of the time by year 2000, and over 90 percent of the time by year 2020. It is estimated that the economic impacts of water shortages of this magnitude and frequency would be extremely costly and severe.

Figure 6-4
Retail Supply Reliability
No New Investment



Local Resource Emphasis

The original Local Resource Emphasis mix consisted of Level 3 investment in new local resources and no new investment in imported resources. This mix did not meet the reliability goal in the near or long-term planning period. Supply shortages greater than those experienced during the 1991 drought would occur about 30 percent of the time (or 1 in 3 years) by year 2000, and over 20 percent of the time (or 1 in 5 years) by year 2020. In addition, this resource mix would be very costly because it relies heavily on large-scale coastal ocean desalination facilities to meet demands.

For these reasons, a ***Local Resource Emphasis with a Full Colorado River Aqueduct (CRA)*** mix was developed in order to meet the reliability goal. This mix contained Level 3 investments in local resources, where available, and Level 3 investments in CRA. Although the resource mix achieved the desired reliability goal in the near and long-term, the costs remained very high due to its continued heavy reliance on large-scale desalination. In addition, because of total dissolved solids (TDS) water quality standards, this mix assumed use of a desalting facility for the CRA water in order to achieve Metropolitan's water quality objectives at a regional level.

After adding full CRA and limited new SWP resources to the local resource emphasis, supply reliability was achieved with storage and water transfers.

A ***Revised Local Resource Emphasis with Full CRA*** mix substituted additional SWP supplies for the large-scale ocean desalination projects in the original local resource emphasis. The additional SWP supplies are attributed to: (1) an interim SWP fix (that includes acoustic fish barriers in the Delta and south of Delta channel improvements) that would be on-line by year 2000; and (2) reliance on Central Valley water transfers in both the near and long-term. This greatly reduced the overall costs of this resource mix and eliminated the need for a CRA desalination facility due to increased SWP blending. This mix was still able to meet near and long-term reliability goals (Figure 6-5 and 6-6).

Imported Resource Emphasis

The Imported Resource Emphasis mix assumes very aggressive SWP investments in the long-term and heavy reliance on Central Valley water transfers during the early years (Figure 6-7). Water transfers in the early years can be decreased once an interim SWP fix is on-line by year 2000, a full Delta fix is in place by year 2006, and south of Delta storage implemented by year 2015. This mix also includes a full CRA delivery by year 2006, and Level 1 investments for all local supplies except water conservation, which is at Level 2. Figure 6-8 shows that by 2020 the imported resource emphasis mix exceeds reliability goals with a reasonable amount of storage.

Figure 6-5
Retail Supply Reliability in Short Term
Local Resource Emphasis

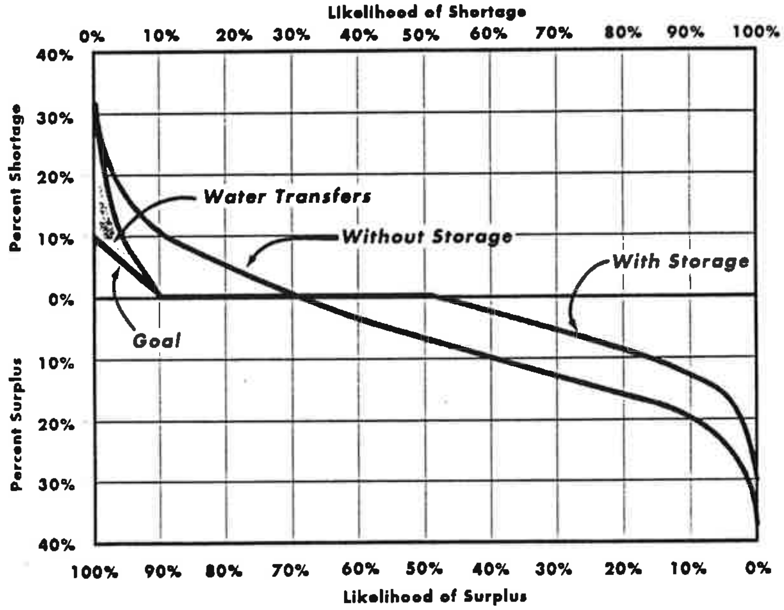


Figure 6-6
Retail Supply Reliability in Long-Term
Local Resource Emphasis

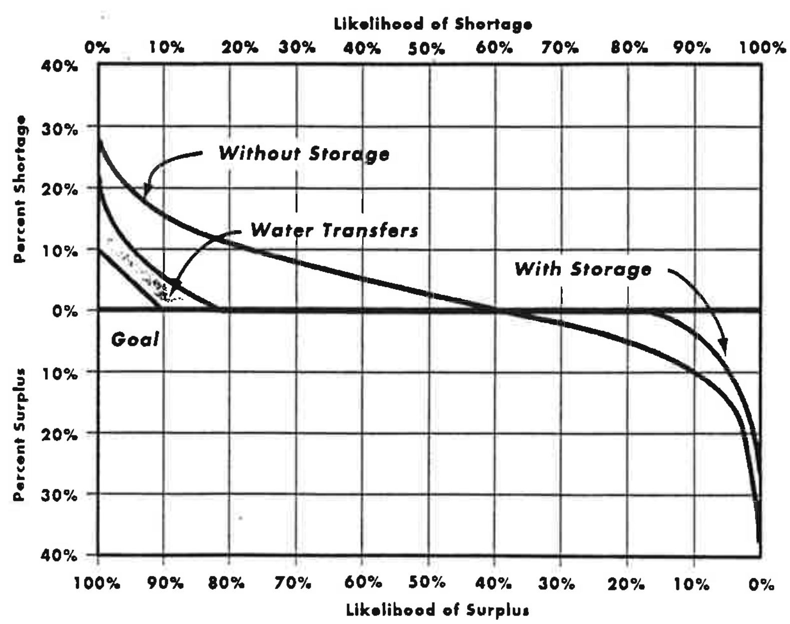


Figure 6-7
Retail Supply Reliability in Short-Term Imported Resource Emphasis

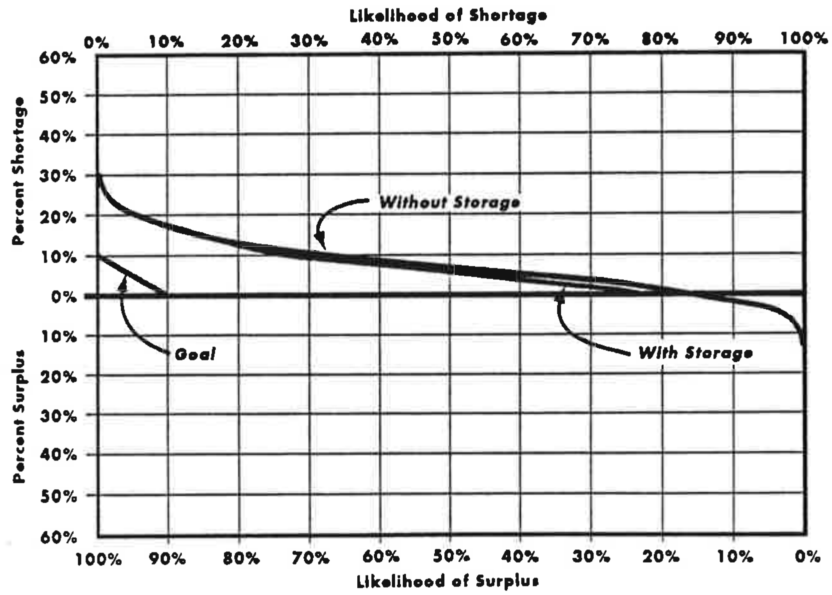
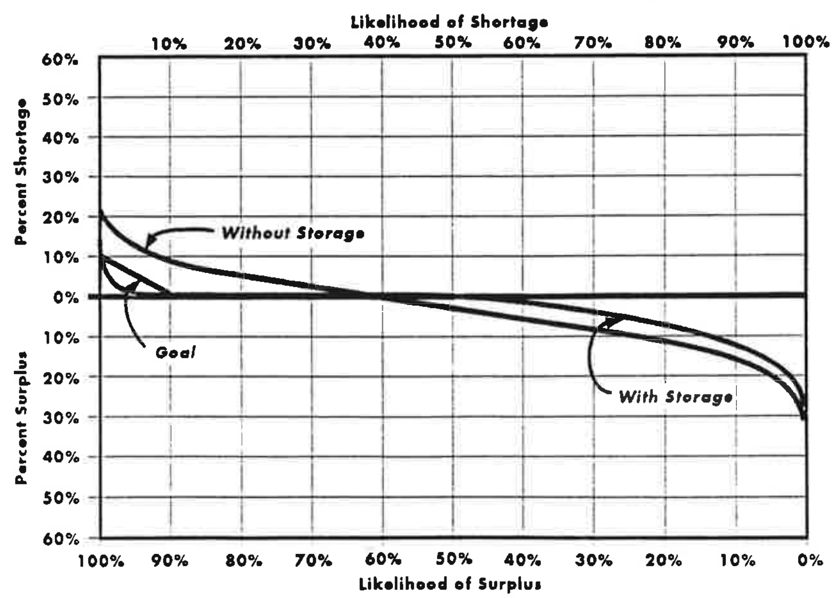


Figure 6-8
Retail Supply Reliability in Long-Term Imported Resource Emphasis



Intermediate Resource Mix

The Intermediate Resource Mix includes an interim SWP fix on-line by year 2000, moderate reliance on Central Valley water transfers, and a full Delta fix by year 2010. This mix also includes a full CRA delivery by year 2006, and Level 2 investments for all local supplies. Figures 6-9 and 6-10 show the importance of transfers in the short-term, followed by long-term reliability without transfers by the end of the planning period.

6.6 Uncertainties and Other Considerations

While the analytical phase of the IRP process presents an assessment of the uncertainties associated with projecting demands and forecasting supplies, there are a number of other factors which influence the desirability of a specific resource mix. In addition to maintaining supply reliability and minimizing regional costs, the preferred resource mix should also provide supply flexibility and adaptability; achieve public acceptance; and satisfy environmental concerns as well as local economic considerations. Assessing the ability of a resource option or resource mix to achieve these goals introduces the need to address additional risks and uncertainties.
What is the likelihood of barriers emerging that could hinder implementation? How could these barriers affect expected yields from resource investments? What are the corrective measures or contingency plans available to overcome possible impediments? These are some of the questions to which the IRP process should provide answers as part of the evaluation of alternative resource mixes.

In order to contribute to the evaluation of these broad areas of concern, the IRP methodology includes a review of the uncertainties related to each resource option. A summary of the potential uncertainties is provided in Table 6-4 through 6-10.

Figure 6-9
Retail Supply Reliability in Short-Term Intermediate Resource Mix

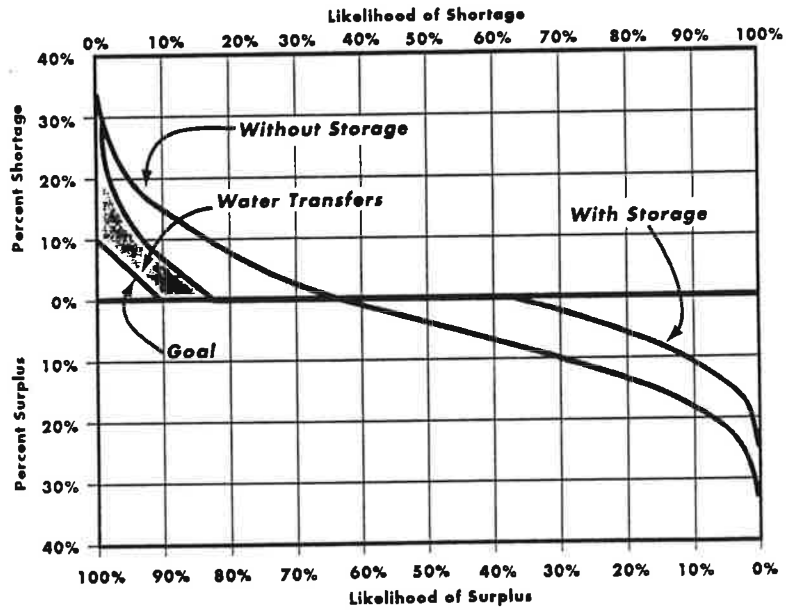


Figure 6-10
Retail Supply Reliability in Long-Term Intermediate Resource Mix

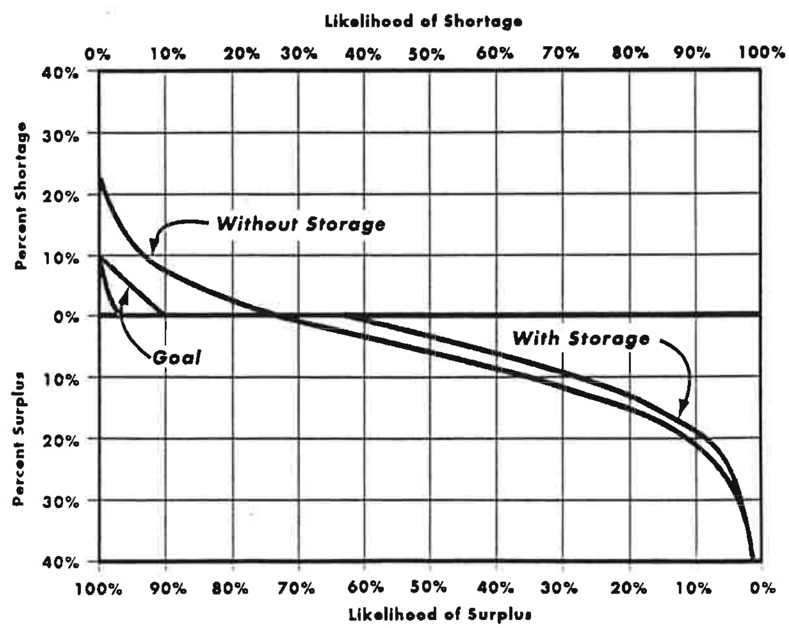


Table 6-4
Central Valley Water Transfers

Uncertainty	Consequences	Means of Overcoming Uncertainty
Emergency Reallocations Potential for reallocation of transfer supplies during a drought.	· Potential loss of transfer supplies if Governor formally declares a drought emergency.	· Include senior south-of-Delta transfers for supply planning. · Seek policies and legislation to preserve benefits of prior planning. · Implement cooperative projects with northern urban agencies.
Water Quality Regulations Affecting Groundwater Potential for new water quality regulations that could affect use of water stored in groundwater basins.	· May not impact use of supplies since potential constituents likely to be more tightly regulated would be reduced through existing conventional water treatment plants.	· Diversify types of transfers; including implementation of entitlement exchange programs for agricultural use that would not be affected by new drinking water quality regulations.
Political Resistance Potential of political resistance to transfer agreements.	· Delay in implementation of needed transfers.	· Develop broad-based programs (e.g. Palo Verde). · Undertake demonstration programs to develop support. · Litigation
Delta Issues Substantial change in Delta regulations interfering with the delivery of transfer supplies.	· Potential loss of use of north -of-Delta transfer supplies.	· Rely on south-of-Delta transfers for supply planning. · Resolve SWP uncertainties (see Table 2).

Table 6-5
State Water Project

Uncertainty	Consequences	Means of Overcoming Uncertainty
Political Resistance Organized political resistance to Delta Improvements from various interest groups.	· No additional yield obtained. · Loss of funds expended for planning and permitting activities.	· Maintain and strengthen North-South urban coalition. · Pursue Bay-Delta Urban Alternative Standard. · Continue to secure agricultural support. · Public and business education. · Initiate Multi-Species Habitat Conservation Plan with "shelf-life."
Unproven Technology Reliance on acoustic fish barriers that are, as yet, unproven technology. (Level 2 only.)	· May require closure of cross channels to protect fish, potentially decreasing supply (already included in the base yield assumption of 50 percent of D-1630).	· Develop alternatives to the use of acoustic fish barriers that reduce fishery problems, while long-term solutions are developed.
Regulatory/ Permitting Reliance on channel improvements within aquatic habitat that require, but may not obtain, Endangered Species Act and Clean Water Act permitting.	· No additional yield obtained. · Loss of funds expended for planning and permitting activities.	· Initiate and support a state-federal EIR/EIS process. · Implement a multi-species protection and recovery program in cooperation with state and federal authorities.

Table 6-6
Colorado River Aqueduct

Uncertainty	Consequences	Means of Overcoming Uncertainty
Commitment of Participating Agencies Unwillingness of participants to enter into agreements.	· Some water conservation and land fallowing programs may not be implemented. · Partial loss of construction funding for participants' lining projects.	· Develop political support and consensus among participants. · Pursue multiple programs.
Environmental Regulations Determination of adverse effects on sensitive species and designation of critical habitat within the Lower Colorado River basin.	· Potential change to current hydrologic operations of the Lower Colorado River and possible reduction in deliveries.	· Develop cooperative work groups with resource agencies. · Develop a Multi-Species Habitat Conservation Plan for the Lower Colorado.
Future Competition for Existing Entitlements The potential for reallocation of entitlements.	· Potential change in firm entitlement water and resulting reduction in deliveries. · Inability to increase entitlements and loss of current excess deliveries.	· Develop modified Colorado River regulations. · Develop political support and consensus among participants. · Consider amending the Colorado River Compact.
High Salinity Levels Impacts to groundwater and water reclamation from use of additional CRA supplies.	· Some agencies could receive unblended Colorado River water affecting up to 90,000 acre-feet per year of groundwater replenishment deliveries and 90,000 acre-feet per year of reclaimed water for replenishment.	· Support the Colorado River Basin Salinity Control Program. · As practicable, blend CRA and SWP supplies. · Provide local desalination facilities for affected replenishment deliveries and recycling plants.

Table 6-7
Water Reclamation

Uncertainty	Consequences	Means of Overcoming Uncertainty
Demand for Reclaimed Water Reduction in demand due to costs or quality.	· Shortfall in projected reclaimed water use.	· Provide price incentives. · Continue public education. · Support ordinances requiring reclaimed water for specific uses. · Foster coordination among water, wastewater, groundwater, and flood control agencies. · Support ordinances to ban self-regenerating water softeners. · Install treatment to provide adequate quality.
High Salinity Levels Limitations on reclaimed water use for groundwater basin recharge and certain irrigation applications as a result of high TDS in product water.	· Shortfall in projected reclaimed water use.	· As practicable, provide blending of CRA and SWP supplies within Metropolitan's system. · Provide desalination treatment at affected reclamation facilities.
Land Use and Facility Siting Difficulty in siting facilities.	· Loss of economic locations resulting in higher costs.	· Increase financial support.
Regulatory and Market Delays Potential that facilities are delayed due to the regulatory process or slow market development.	· Lag in projected reclaimed water use.	· Greater dependence on short-term "swing" supplies.

Table 6-8
Local Groundwater and Surface Water

Uncertainty	Consequences	Means of Overcoming Uncertainty
Groundwater Contamination Potential for further TDS, nitrate, and organic chemical contamination.	· Increased treatment costs associated with groundwater production.	· Provide necessary treatment at wells. · As practicable, blend poor quality well water with high quality water in local distribution systems.
Water Quality Regulations Potential for stringent new water quality regulations for constituents such as arsenic and radon.	· Increased treatment costs associated with groundwater production	· Provide necessary treatment to meet new regulations.
Institutional Barriers Resistance to inter-basin transfers required for increased groundwater development.	· Shortages in areas dependent on inter-basin transfers of groundwater supplies.	· Develop mutually acceptable contractual arrangements and pricing incentives. · Support revisions to basin adjudications and court judgments.

Table 6-9
Desalination

Uncertainty	Consequences	Means of Overcoming Uncertainty
Brine Disposal Permitting Inability to obtain permit for brine disposal.	· Elimination of some potential sites.	· Conduct studies that seek to demonstrate no adverse effects from brine disposal. · Where possible, blend reject water in local wastewater treatment plant ocean outfalls. · Construct deep ocean outfalls.
Power Requirements Potential that sufficient power would not be available.	· Inability to implement desalination facilities.	· Pursue co-generation joint ventures.
Land Use Issues Land use considerations that could prevent siting of facilities.	· Inability to permit brine disposal.	· Avoid sensitive sites and land uses.

Table 6-10
Conservation

Uncertainty	Consequences	Means of Overcoming Uncertainty
Market Penetration Potential that public agencies and/or consumers will not adopt water conserving measures.	· Reduce rate of increase in conservation savings.	· Support aggressive public awareness campaigns. · Provide price incentives.
Code Requirements Potential that plumbing codes and ordinances will not be implemented.	· Reduce rate of increase in conservation savings.	· Foster political and community support for the adoption and enforcement of plumbing codes and ordinances
Demand Hardening Potential that needed cut-backs during drought conditions will not occur as anticipated due to the elimination of non-essential water users.	· Reduced rate of increase in conservation savings.	· Set area specific and realistic rationing limits.

Section 7
Water Supply
Management Strategies

MWD

Section 7
Water Supply Management Strategies

The previous section described regional resource strategies emphasizing different mixes of local and imported water supply. This section describes water supply management strategies, that is, strategies for operating storage, treatment and transmission systems under a wide range of predictable and unpredictable climatic conditions. The IRP considers the following water supply management objectives for these facilities:

- *Drought Management.* Over the years, total annual precipitation and runoff varies. Consecutive years with low precipitation and runoff may result in droughts. One water supply management objective is to save water available during wetter years for use during drier years.

- *Seasonal Shift.* Within each year, it is generally wetter in the winter (when urban water use is lower) and drier in the summer (when water use is higher). Another water supply management strategy is to "seasonally shift" water by storing it in the winter for use in summer.

- *Emergency Operations.* All imported water supply aqueducts cross major faults. If an earthquake disrupted the imported supply system, sufficient water should be available locally to meet at least 75 percent of demand.

- *Water Quality Objectives.* Water delivered to the retail customers must meet increasingly stringent surface water treatment rules and water quality objectives for local water use. The water supply management strategy must recognize that different water supply mixes present different treatment requirements and potentially limit water use by various end users.

The region's water supply management strategy is to provide a flexible system of storage, treatment and distribution facilities able to operate over a wide range of conditions.

- *System Flexibility.* The region's water supply management system should reliably supply water to all end users under a variety of conditions. Examples of system flexibility include redundant and backup systems, interconnected transmission systems, and surface and groundwater storage located at strategic locations.

The rest of this section describes regional storage strategies, water quality management strategies, impacts on Metropolitan's facilities, and costs under each resource mix.

7.1 Regional Storage Strategies

As the recent drought demonstrated, water to meet regional needs is not always available. When precipitation and runoff is abundant, there is more water than needed. When precipitation and runoff diminishes, demands exceed supply. Clearly, these climatic conditions, as well as emergencies and other operational requirements, represent a significant challenge in reliably supplying adequate water.

The solution to this dilemma is storage---saving water when it is available, either in surface reservoirs or groundwater basins, and using it when needed. Storage is vital for meeting all five water supply management objectives outlined in the introduction to this section. Storage facilities are required to balance supplies and emergency, seasonal, and drought-related needs. Furthermore, storage holds water for blending from alternative sources to meet water quality objectives and increase system flexibility. Surface storage can maximize groundwater storage capabilities by providing short-term storage for later delivery to groundwater recharge areas.

This section describes existing regional storage facilities, groundwater conjunctive use opportunities, and regional storage needs under each resource mix.

Regional Surface Storage Facilities

Table 7-1 lists existing regional surface water storage facilities within or adjacent to Metropolitan's service area. The facilities are owned and operated

Table 7-1
Existing Reservoirs in Metropolitan's Service Area

Owner	Reservoir	Total Storage	Dead Storage	Storage Allocated to Others	Storage Available for Regional Use
Metropolitan WD	Lake Mathews	182,000	3,500	0	178,500
	Lake Skinner	44,000	200	0	43,800
Department of Water Resources	Pyramid Lake	171,200	4,800	5,300	161,100
	Castaic Lake	323,700	18,600	11,400	293,700
	Elderberry Forebay	28,200	200	0	28,000
	Silverwood Lake	75,000	4,000	24,900	46,100
	Lake Perris	124,000	4,000	0	120,000
	TOTAL	**948,100**	**35,300**	**41,600**	**871,200**

NOTE: All storage quantities in acre-ft.

either by Metropolitan or the California Department of Water Resources (DWR). All storage in Metropolitan's facilities is available for use within the service area. However, only a portion of the storage in DWR's facilities is available to Metropolitan because of DWR's obligations to other State water contractors.

Metropolitan Reservoirs

Metropolitan owns and operates two large reservoirs---Lake Mathews and Lake Skinner---that provide over 200,000 acre-feet of storage. Lake Mathews is the terminal reservoir of the CRA and distributes water to Riverside, Orange, Los Angeles, and San Bernardino counties. Lake Skinner receives Colorado River and State Project water for distribution to San Diego and Riverside Counties.

Surface Storage Investment Levels

- *Existing Reservoirs: 871,000 acre-ft*
- *New Reservoir: up to 800,000 acre-ft*

Metropolitan is also investigating a new reservoir in Domenigoni Valley in Riverside County. The reservoir would provide up to 800,000 acre-ft of storage for seasonal shift, drought management, and emergency needs.

Department of Water Resources Reservoirs

DWR owns and operates four major reservoirs in or near Metropolitan's service area. Castaic Lake and Pyramid Lake are located on the West Branch of the California Aqueduct. Silverwood Lake and Lake Perris are on the East Branch of the California Aqueduct. DWR's reservoirs currently provide almost 650,000 acre-ft. of storage for regional use.

Groundwater Conjunctive Use Storage

Conjunctive use of groundwater basins means that imported surface water supplies and existing groundwater basins are used in concert to meet consumptive needs. Under a conjunctive use program, the groundwater basin is artificially replenished with surplus imported water during wetter years. During drier years, groundwater production is increased to supplement diminished imported water supplies.

Most groundwater basins within Metropolitan's service area store local and imported water for later use to meet seasonal, dry year, and emergency demands. Since 1980, direct replenishment and in-lieu replenishment of imported supplies have ranged between 125,000 and 450,000 acre-feet per year, with in-lieu replenishment playing an increasingly important role. The groundwater basin managers have identified additional conjunctive use potential for the major groundwater basins in Southern California as shown in

Table 7-2. Low estimates in Table 7-2 represent facilities that are either currently in place or will be in place within the next 5 years. High estimates are the groundwater basin manager's estimates of additional feasible capacity with new facilities. Components of groundwater basin conjunctive use potential are summarized below:

Table 7-2
Conjunctive Use Storage Potential of Major Groundwater Basins in Southern California

Basin	Additional Conjunctive Use Storage (acre-ft)		Additional Production Capacity (acre-ft/yr)		Additional Recharge and Replenishment Capacity (acre-ft/yr)			
					Direct		In-Lieu	
	Low	High	Low	High	Low	High	Low	High
San Fernando	100,000	300,000	50,000	70,000	35,000	75,000	70,000	70,000
Central and West Coast	150,000	180,000	88,000	110,000	20,000	100,000	110,000	110,000
Main San Gabriel	150,000	150,000	45,000	45,000	100,000	240,000	65,600	65,600
Chino	50,000	200,000	20,000	90,000	18,000	80,000	53,000	53,000
Orange County	200,000	400,000	120,000	200,000	90,000	240,000	219,000	219,000
Raymond	100,000	150,000	25,000	31,600	12,000	17,500	20,000	26,200
North Las Posas	350,000	350,000	30,000	100,000	9,800	70,000	30,000	30,000
Elsinore	100,000	100,000	10,000	22,000	10,000	10,000	5,000	37,000
Temecula	100,000	100,000	10,000	22,000	10,000	10,000	5,000	40,000
TOTAL	1,300,000	1,930,000	398,000	690,600	304,800	842,500	577,600	651,200

Note: Groundwater conjunctive use potentials could be constrained by the availability of imported supplies. These constraints could be partially overcome by improving the delivery system of imported supplies and providing short-term surface storage for delayed deliveries to groundwater recharge areas.

- *Additional Conjunctive Use Storage:* The total potential additional volume that the basin could provide for storage of imported water if sufficient supplies are available for replenishment (actual conjunctive use capacity depends on location, overlying demands, and other factors not addressed in this IRP phase).

- *Additional Production Capacity:* The additional annual capacity of groundwater production facilities currently available or potentially available with feasible new production facilities.

- *Additional Recharge and Replenishment Capacity:* Additional annual groundwater recharge and replenishment, either direct (spreading/injection facilities) or in-lieu (reducing groundwater production and replacing it with imported supplies).

Table 7-3
Comparison of Potential Annual Yield from Storage and Annual Regional Storage Requirements

Potential Annual Yield from Storage

Surface Storage	
■ *Existing*	*871,200*
Additional Annual Groundwater Production	
■ Low	398,000
■ High	691,000
Total	1,269,000 to 1,562,200

Annual Regional Storage Requirements

Drought Management	
■ *Emphasize Local:*	*520,000*
■ *Emphasize Imported:*	*680,000*
■ *Intermediate:*	*930,000*
Seasonal Shift	
■ *Emphasize Local:*	*350,000*
■ *Emphasize Imported:*	*380,000*
■ *Intermediate:*	*380,000*
Emergency Management	
■ *Emphasize Local:*	*700,000*
■ *Emphasize Imported:*	*1,030,000*
■ *Intermediate:*	*935,000*
Total Storage Required	
■ *Emphasize Local*	*1,570,000*
■ *Emphasize Import*	*2,110,000*
■ *Intermediate*	*2,245,000*

Note: All Values are in acre-ft/year

Regional Storage Needs Under Resource Mixes

Table 7-3 compares the potential annual yield from storage and the projected regional storage requirements under each resource mix. Potential annual yield from regional surface storage and groundwater conjunctive use programs is summarized from Tables 7-1 and 7-2. These annual yields assume that:

- All available storage in existing surface storage reservoirs can be withdrawn in a single year.
- Yields from groundwater basins are limited by the projected additional annual production capacity.

Total annual regional storage requirements listed on Table 7-3 assume a "worst case"—in a single year, the water system must meet the needs under an extreme drought, with high seasonal shift needs, coupled with a water supply emergency. In a more typical year, a particular storage facility may serve one or more of these functions. Within a larger system of storage facilities, these functions may vary under different system operating conditions.

The rest of this section defines the region's drought management, seasonal shift, and emergency management storage requirements under each resource mix, and compares these requirements with potential annual yields from storage facilities and groundwater conjunctive use. Total storage required would be the sum of drought management, seasonal shift, and emergency management storage.

Drought Management Storage

Drought management storage requirements were determined as a part of the supply reliability evaluation discussed in Section 6.5. As a first cut, the total additional groundwater storage volume was limited to the low range of the available groundwater conjunctive use capacity (an additional 1,300,000 acre-ft). Water transfers were purchased when there was not sufficient carryover storage to meet dry year demands. The following annual drought management storage volumes are based on a statistical analysis of required withdrawals from storage under each resource mix:

- *Local Resource Emphasis.* Under this mix, 880,000 acre-feet of drought management storage is needed for dry year conditions. By 2020, however, imported core supplies will only be sufficient to provide 520,000 acre-feet of drought management storage. Thus, 360,000 acre-feet of water transfers are needed by 2020 to meet Metropolitan's reliability goal.

- *Imported Resource Emphasis.* Drought management storage under the imported resource emphasis mix is approximately 700,000 acre-feet in the years 2010 and 2020. In the year 2010, an additional 150,000 acre-feet of water transfers are needed to meet the reliability goal due to the lack of local core supplies. By the year 2020, water transfers would not be necessary due to additional storage provided by the south of Delta storage facility included in SWP Investment Level 4.

- *Intermediate Resource Mix.* Available imported supplies constrain drought management storage under the intermediate resource mix to 500,000 acre-feet by the year 2010. Therefore, water transfers amounting to 250,000 acre-feet would be needed to meet the reliability goal. By 2020, drought storage needs increase to 930,000 acre-feet which can be met with the increase in SWP supplies after a Delta fix.

Existing surface storage and groundwater conjunctive use capacity does not satisfy storage requirements under the three resource mixes.

Seasonal Shift Storage

Additional storage is needed to "seasonally shift" available winter supplies to meet summer demands. The monthly sales pattern between 1985 to 1989 was used to define seasonal shift storage. This period represents conditions before Metropolitan's seasonal pricing program went into effect. During this period, about 215,000 acre-ft of seasonal shift storage was provided by DWR's terminal reservoirs (Castaic, Silverwood, and Perris). By 2020, a total of about 380,000 acre-feet of seasonal shift storage (including storage provided by DWR's terminal reservoirs) will be required under the Imported Resource Emphasis and Intermediate Resource Mix, while a total of about 350,000 acre-ft will be required under the Local Resource Emphasis Mix.

Emergency Management Storage

During emergencies, imported supplies may be disrupted for up to 6 months. For the IRP analysis, it is assumed that all local resources—groundwater production, water reclamation, desalination—will remain uninterrupted. Emergency storage will be used to supplement local resources to meet 75 percent of the region's water demand. As the Imported Resource Emphasis has the least amount of local resources, it requires the largest emergency storage volume of 1,030,000 acre-feet by the year 2020. Emergency storage needs in 2020 are less under the Intermediate Resource Mix (935,000 acre-feet) and the Local Resource Emphasis (700,000 acre-feet).

A combination of additional surface and groundwater storage provides greatest system flexibility for meeting regional needs.

Comparing Storage Requirements with Available Storage

For this phase of the IRP process, the region's water suppliers first determined if existing and currently envisioned groundwater conjunctive use and surface storage facilities could meet the total regional storage requirement under each resource mix. Table 7-3 shows that future regional storage requirements are about 1.6 million acre-ft/yr under the Local Resource Emphasis and 2.1 to 2.2 million acre-ft/yr under the Imported Resource Emphasis and Intermediate Resource Mix, respectively. The Local Resource Emphasis has a greater percentage of core supplies, resulting in lower storage requirements than under the other two resource mixes. Therefore, storage requirements under all three resource mixes cannot be satisfied with existing surface storage and low level increases in groundwater conjunctive use capacity (i.e., 1.3 million acre-ft/year). Greatest system flexibility can be achieved by providing additional surface and groundwater storage to meet regional needs. The next phase of the IRP process will determine an optimal mix of new surface and groundwater storage.

7.2 Water Quality Management Needs

This section discusses regional water quality objectives and differences in water quality under the three resource mixes. Section 7.3 discusses the impacts these water quality management needs have on existing and planned Metropolitan facilities.

Water Quality Objectives

Metropolitan is committed to meet or exceed all State and Federal water quality requirements and provide its customers with the highest quality water possible at a reasonable price. The two major sources of imported water for Metropolitan have different water quality characteristics. State project water has a higher potential to form chlorinated disinfection byproducts (Trihalomethanes) than does Colorado River water. However, Colorado River water has much higher concentrations of total dissolved solids (TDS) than does State project water. Current TDS concentrations in Colorado River water are approximately 650 mg/L on average and are expected to rise to 700 mg/L by the year 2000 even with implementation of planned salinity control measures along the river. State project water, by comparison, has TDS concentrations around 350 mg/L.

The recommended secondary standard for TDS has been set by the Department of Health Services (DHS) at 500 mg/L, with an upper level maximum contaminant level of 1000 mg/L. As a result of the State Water Resources Control Board's non-degradation policy, many groundwater basins require that replenishment water have TDS concentrations less than 500 mg/L. To meet the replenishment water quality requirement for TDS, Colorado River water is blended with lower salinity State Project water to the extent practicable. The U.S. Bureau of Reclamation reports that high salinity levels can decrease agricultural and industrial productivity, reduce the life of household equipment that uses water, increase soap/detergent consumption, cause corrosion/scaling of metal water pipes/heaters, and, if sulfates are present, possibly cause adverse health effects. In addition, most customer complaints to Metropolitan concern problems caused by high TDS levels (e.g., water spots and objectionable taste). Unacceptably high TDS levels may prevent direct recharge of Metropolitan's imported water. In addition, high TDS levels may impact the development of water reclamation. Typically, household use of water adds 200 to 300 mg/L TDS. A high level of TDS in the original water supply will render the recycled water not suitable for either groundwater recharge or certain industrial and irrigation applications.

The region's major water quality issues are disinfection by-products and high salinity levels.

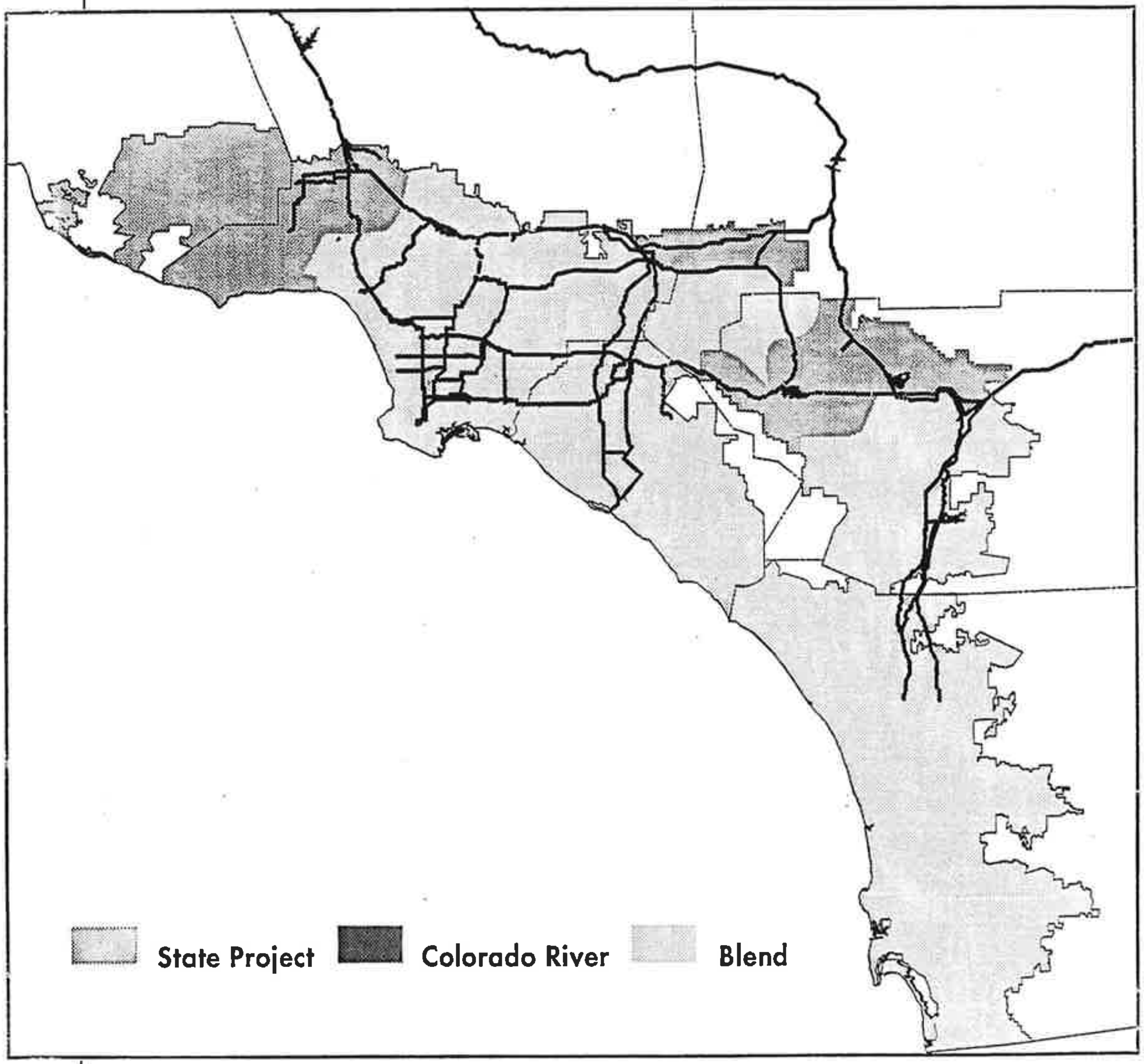
Metropolitan's Policy on Water Quality

Section 136 of the Metropolitan Water District Act codifies Metropolitan's objective of delivering water with acceptable TDS levels. Under this section, Metropolitan is committed to importing SWP supplies to ". . . serve as large an area as is determined by the district to be reasonable and practical . . .". Furthermore, Section 136 commits Metropolitan, where reasonable and practical, to provide at least 50 percent SWP water when blending imported supplies. Metropolitan's ability to meet this policy varies depending on the imported supply mix provided to each customer, impacting some member agencies more than others.

Current Blend of Imported Supplies

Figure 7-1 shows the current distribution of imported State Water Project (SWP) and Colorado River Aqueduct (CRA) supplies within Metropolitan's service area. Currently, all portions of Metropolitan's service area except those

Figure 7-1
Current Distribution of SWP and CRA Supplies Within Metropolitan's Service Area



served from Lake Mathews receive some State Water Project supplies in years of average water supply. Because of the configuration of Metropolitan's distribution system, three areas currently receive only SWP water from Metropolitan:

- Areas supplied exclusively by the West Branch of the SWP system via the Jensen Filtration Plant (Calleguas, Las Virgenes, West San Fernando Valley).
- Areas supplied by the East Branch of the SWP via the Rialto Pipeline (Cities of Rialto and La Verne).
- Areas supplied exclusively by the East Branch of the SWP via the Mills Filtration Plant (Cities of Riverside and Moreno Valley).

In the rest of the service area, Metropolitan provides a blend of imported waters. Historically the blend has varied from 1 to 60 percent depending on the area and availability of SWP water.

Water Supply Blends under Each Resource Mix

The blend of imported water and the portions of Metropolitan's service area supplied by that blend vary under each Resource Mix. However, under all mixes certain areas currently served exclusively by SWP water continue to receive 100 percent SWP water. The following sections discuss how the blend of imported water varies under each resource mix in the Year 2010. Blends are given using average supply conditions and will vary with hydrology and the availability of State Project Water.

Imported Resource Emphasis

By 2010, there will be little change in the portions of Metropolitan's service area served exclusively by SWP water and blended imported water, as shown in Figure 7-2. The amount of SWP supplies delivered to areas served by blended supplies varies between 30 percent and 50 percent, on average.

Intermediate Resource Mix

SWP water in blended supplies will range between 20 percent and 40 percent on average. The portions of the service area supplied with blended water and exclusively with SWP water is shown in Figure 7-3.

Local Resource Emphasis

Under the Local Resource Emphasis, large portions of Metropolitan's service area would only receive imported water from the Colorado River Aqueduct, as shown in Figure 7-4. In these areas, limited SWP supplies are available for blending once demands are met in areas that must be supplied exclusively by SWP water. The only areas where Metropolitan will be able to blend SWP supply under this mix are in the central and southern Los Angeles County, and the Perris and Hemet areas of Riverside County.

Discussion and Conclusions

By 2010, Metropolitan's objective of providing at least 50 percent SWP water throughout its service area cannot be met under any resource mix under average conditions. The Imported Resource Emphasis comes closest to meeting this goal, followed by the Intermediate Resource Mix. Under the Local Resource Emphasis, CRA water will be the only water imported to over one-third of the service area. Metropolitan's imported water blending objective is not met primarily because insufficient SWP water will be delivered to the region as a whole. Also, the delivery

Shortages in SWP supplies are increasing salinity levels in portions of the region.

Figure 7-2
Distribution of SWP and CRA Supplies Under the Imported Resource Emphasis Mixes

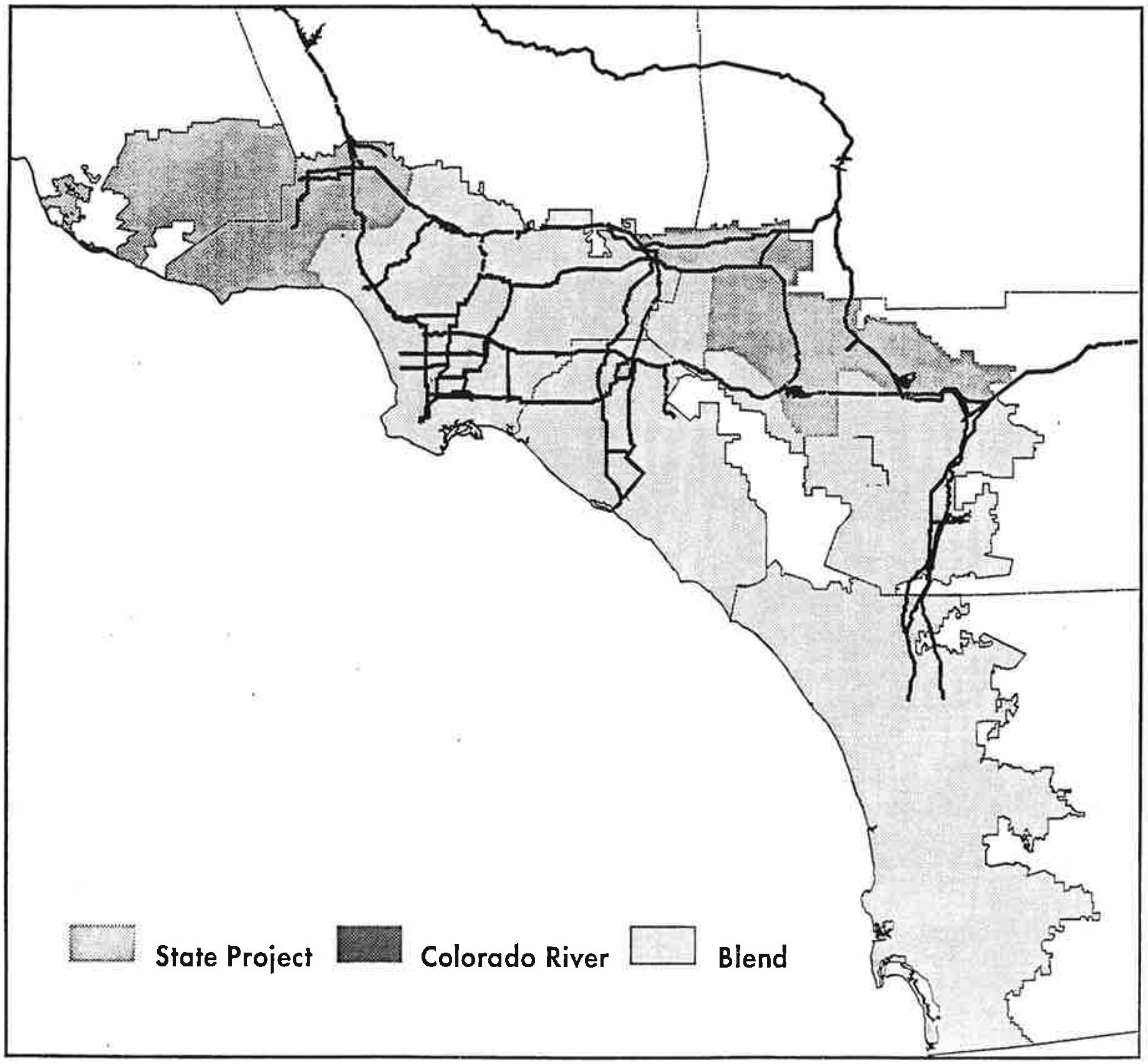


Figure 7-3
Distribution of SWP and CRA Supplies Under the Intermediate Resource Mix

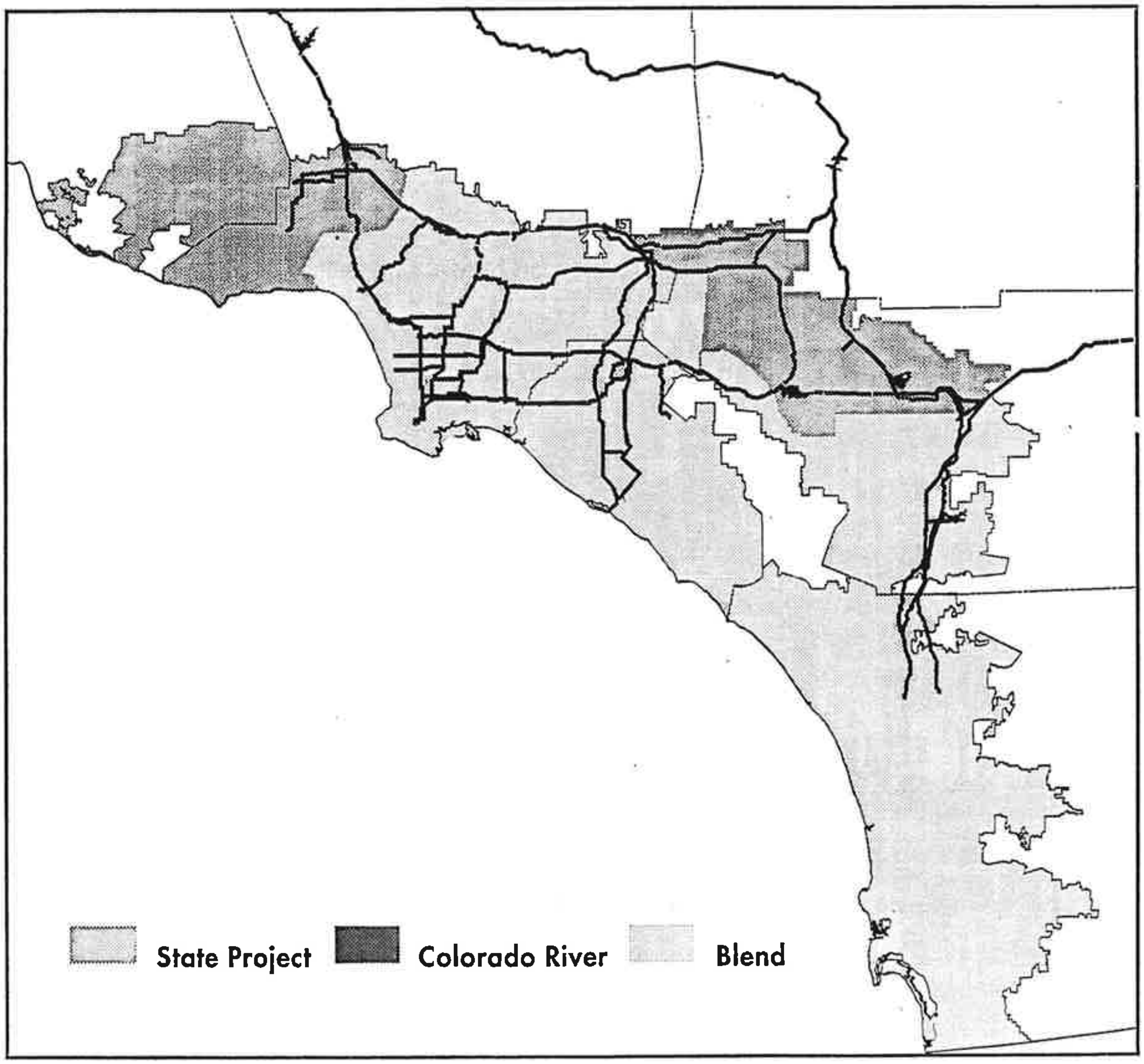
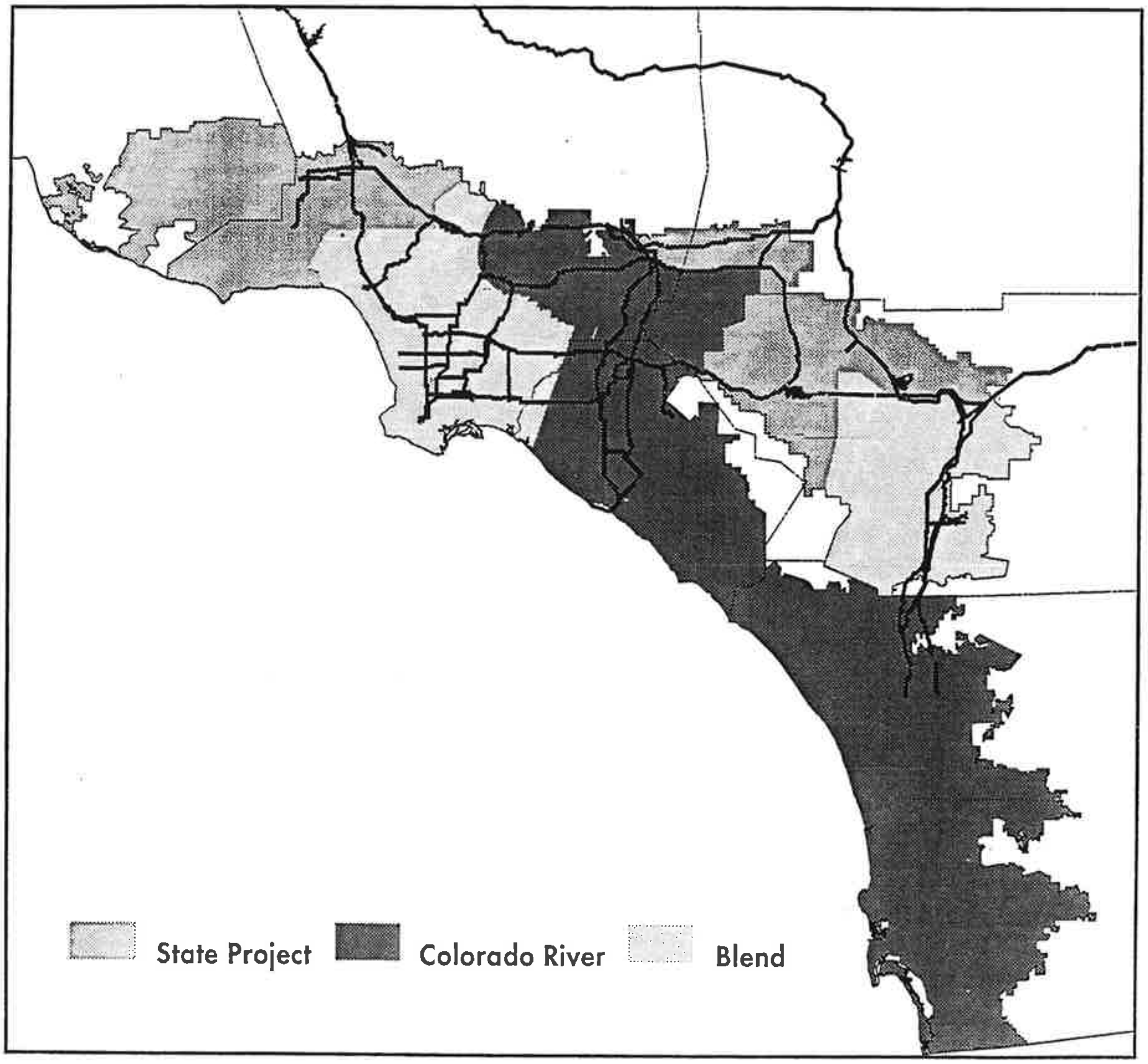


Figure 7-4
Distribution of SWP and CRA Supplies Under the Local Resource Emphasis Mix



points for imported water, coupled with constraints in Metropolitan's distribution system, do not allow some portions of the service area to receive any CRA supplies, further limiting blending opportunities elsewhere in the region.

7.3 Impacts on Metropolitan Facilities

This section presents a brief overview of Metropolitan's system operation objectives for the IRP, and projected impacts on Metropolitan's facilities under each resource mix. After a resource mix is selected, future studies of individual facility improvement needs will be conducted to define a representative capital improvement program. To this end, Metropolitan's Facility Overview Study Update is scheduled to follow the IRP and will provide a more detailed evaluation of Metropolitan's overall facility needs for the preferred resource mix.

IRP Objectives for System Operation

Metropolitan staff defined operational rules and system objectives that represent actual and/or desired system performance. For these IRP analyses, it was assumed Metropolitan operates its transmission and distribution system to achieve the following objectives:

- Maximize total storage.
- Minimize the weighted deviation from each reservoir/groundwater basin.
- Minimize deviation from cyclic storage targets for certain reservoirs.
- Distribute resources equitably throughout the service area to the extent allowable by distribution system constraints.
- Maximize total inflow to the system from all sources, with surplus supply conveyed to storage.

Available storage capacity may not be usable if supplies are inadequate or facility capacities are limited.

Several factors may limit the amount of available storage capacity that can actually be used at any point in time:

- Supplies may not be available, largely due to hydrologic variations.
- The conveyance capacity of Metropolitan and local distribution systems may limit the amount of water that can physically be conveyed to or extracted from a particular reservoir/ groundwater basin.

- The put capacity may limit the amount of water that can be placed into storage within a given period of time (e.g., spreading basin capacity, injection well capacity).
- Unless exported from the basin, conjunctive use storage in a groundwater basin is limited by water demand within the areas overlying the groundwater basin.

Impacts on Metropolitan Facilities

To varying degrees, the three resource mixes impact the ability of Metropolitan's facilities to perform the following functions:

- Meet increased Member Agency demands for water imported by Metropolitan
- Provide imported water for groundwater conjunctive use
- Use Metropolitan's system for "wheeling" (i.e., transmission of non-Metropolitan water)
- Improve blending of SWP and CRA water.
- Increase system flexibility

For this phase of the IRP, Metropolitan determined approximately when demands for imported water exceed capacities of existing Metropolitan facilities under each resource mix, and proposed new facilities required to meet these water needs. Table 7-4 summarizes these findings. This evaluation was performed at a regional level, with sufficient detail to distinguish relative impacts of the three resource mixes. The facility recommendations presented herein do not represent an optimized plan nor final choices of proposed facilities. Metropolitan will conduct a Facility Overview Study as part of the next phase of the IRP. This study will provide a detailed evaluation of Metropolitan's distribution facility needs for the preferred resource mix.

Raw Water Transmission

The major planned new raw water transmission facility is the Inland Feeder. The Inland Feeder would convey additional State Water Project water (when available) into Metropolitan storage facilities to meet member agencies' water demands. This water would also be available for groundwater basin recharge, seasonal demand fluctuations, and supply to treatment plants. The Inland Feeder is required by 1999 under all resource mixes, with a capacity of 600 cfs under the local resource emphasis and 1,000 cfs under the other two mixes.

**Table 7-4
Projected Impacts of Resource Mixes
on Metropolitan Facilities**

Facility	Projected Capacity	Year Required
Local Resource Emphasis		
Domenigoni Valley Reservoir	480,000 AF	2000
Inland Feeder	600 cfs	1999
San Diego Pipeline No. 6	205 cfs	2000
West Valley Conveyance	45 cfs	2016
Perris Filtration Plant	220 cfs	2009
Intermediate Resource Mix		
Domenigoni Valley Reservoir	800,000 AF	2000
Inland Feeder	1,000 cfs	1999
San Diego Pipeline No. 6	465 cfs	2000
West Valley Conveyance	185 cfs	2006
CPA Filtration Plant	600 cfs	2006
CPA Filtration Plant Expansion No. 1	350 cfs	2015
CPA Tunnel and Pipeline	800 cfs	2006
Perris Filtration Plant	190 cfs	2008
Imported Resource Emphasis		
Domenigoni Valley Reservoir	800,000 AF	2000
Inland Feeder	1,000 cfs	1999
San Diego Pipeline No. 6	570 cfs	2000
West Valley Conveyance	175 cfs	2006
CPA Filtration Plant	400 cfs	2001
CPA Filtration Plant Expansion No. 1	400 cfs	2015
CPA Tunnel and Pipeline	800 cfs	2001
Perris Filtration Plant	190 cfs	2007
Perris Filtration Plant Expansion No. 1	220 cfs	2015
Weymouth Plant Expansion	200 cfs	2014
Middle/Lower Feeder Intertie	200 cfs	2015

Water Treatment and Distribution Facilities

New treatment and distribution facilities are ultimately needed to meet increases in demand and system operational needs in the West Valley, Orange County, western Riverside County, and San Diego County areas. The IRP defined the approximate phasing of currently envisioned projects, as summarized in Table 7-4. Such projects include the San Diego Pipeline No. 6, the Perris Filtration Plant, the CPA Project, and the West Valley Project:

- The San Diego Pipeline No. 6 could provide up to 570 cfs of additional raw water from Lake Skinner to San Diego County. Once San Diego Pipeline No. 6 is constructed, San Diego Pipeline No. 3 would be converted from raw to treated water to provide sufficient treated water conveyance to San Diego County. San Diego Pipeline No. 6 is required by the year 2000 under all resource mixes, with a capacity ranging between 205 cfs (local resource emphasis) and 570 cfs (imported resource emphasis).

- The Perris Filtration Plant would provide additional treatment capacity for the Riverside/San Diego area, and allow more operational flexibility in the exclusive areas now served by the Mills and Skinner Filtration plants. The Perris Filtration Plant is required by 2007 under the Imported Resource Emphasis Mix, and no later than 2009 under the Local Resource Emphasis Mix. Also, an expansion of the Perris plant will be required by 2015 under the Imported Resource Mix.

Metropolitan's future facility needs were examined to distinguish relative impacts of the three resource mixes.

- The CPA Project consists of additional conveyance and treatment facilities to supply Orange and western Riverside Counties with additional CRA and east branch SWP water. The CPA Project is not required under the Local Resource Emphasis Mix during the planning horizon, but should be constructed between 2001 and 2006 under the other two mixes. Also, the CPA plant should be expanded by 2015 under both these mixes.

- Finally, the West Valley Project would convey either raw or treated water to Ventura and Los Angeles Counties to meet increasing consumptive needs and enhance system operations. The West Valley Project is required by 2006 under the Imported Resource Emphasis and Intermediate mixes, but not until 2016 under the Local Resource Emphasis mix.

7.4 Evaluating the Cost of Alternative Resource Mixes

In order to assess the affordability of future water resource investments, total costs to end users were estimated for each resource mix alternative. Costs are summarized by dividing the total annual costs by the total annual demand in order to develop an average annual unit use cost index ($/acre-foot). The planning period for the IRP cost evaluation is 25 years. Future costs can be treated and evaluated in several different ways, including:

- *Escalated Costs.* Capital costs are escalated to the point of construction and then financed over the life of the project, O&M costs are escalated throughout the planning period. This shows the effects of inflation on costs over time.

- ***Constant or Real Costs.*** Future costs of capital and O&M are expressed without escalation.

- ***Discounted or Present Worth Costs.*** Costs are first escalated and then discounted, based on an assumed discount rate, which may or may not be the same as the financing rate assumed for capital costs.

The IRP estimated total costs to end users in order to assess the affordability of each resource mix.

Each of these cost evaluations has merit. Escalated dollars give the best measurement of the future costs needed for financial planning and rate-making. Constant dollars show the real increase in costs over and above the effects of inflation. Discounted dollars consider the "time-value" of money and are useful for evaluating the timing and staging of investments.

When discounted costs are used as the basis of comparison between resource alternatives, a salvage value should be applied to all projects that have benefits (i.e., provide water supply) beyond the term of the planning period. For example, a water treatment plant may last 25 years without requiring major capital rehabilitation, but a large reservoir or water canal may have a useful project life of over 50 years. To compare projects in discounted costs, a salvage value for projects that have greater benefits beyond the planning period need to be incorporated into the analysis.

At this phase of the IRP process, resource costs will be provided in (1) escalated dollars to indicate the possible rate impact; and (2) in constant dollars to indicate the real increase in costs over time. Costs for the resource alternatives will not be presented in present worth terms at this time because Metropolitan and its Member Agencies use different salvage values and discount rates.

Region-Wide Costs

Costs for each resource alternative include the following major components: (1) resource development costs, both capital and O&M, for each local and imported resource option (i.e., SWP, water reclamation, groundwater, water conservation, etc.); (2) Metropolitan's capital improvement projects and O&M costs; and (3) Member Agency and local retail agency capital and operating costs.

Capital and O&M costs for imported water development (i.e., SWP and CRA) were developed by Metropolitan staff for each level of development. Metropolitan's capital investment costs were based on the projected demands for Metropolitan water resulting from each resource mix. For cost estimating purposes, Metropolitan capital projects were deferred as long as possible, in order to minimize rate impact. About 80 to 90 percent of Metropolitan's capital improvement costs were assumed to be financed at an average rate of about 6.5 percent over the planning period. Metropolitan's future O&M costs were escalated at about 5.0 percent per year. Remaining costs are expended at the time of construction.

Capital and O&M costs for local resource development (i.e., groundwater, water reclamation, water conservation) were provided by the Member Agencies and retail agencies for each level of development. Most of the cost data received included specific information concerning the capital costs, financing rate, life of project, and projected O&M costs. Many of these local projects were assumed to be completely debt financed at rates between 5 and 8 percent, and had future O&M costs escalated at from 3 to 5 percent per year. If no specific local project cost data was provided, capital costs were assumed to be debt financed at a rate of 6.5 percent for 25 years.

Region-wide costs include resource development costs and capital/O&M costs for Metropolitan, its Member Agencies, and other local retail agencies.

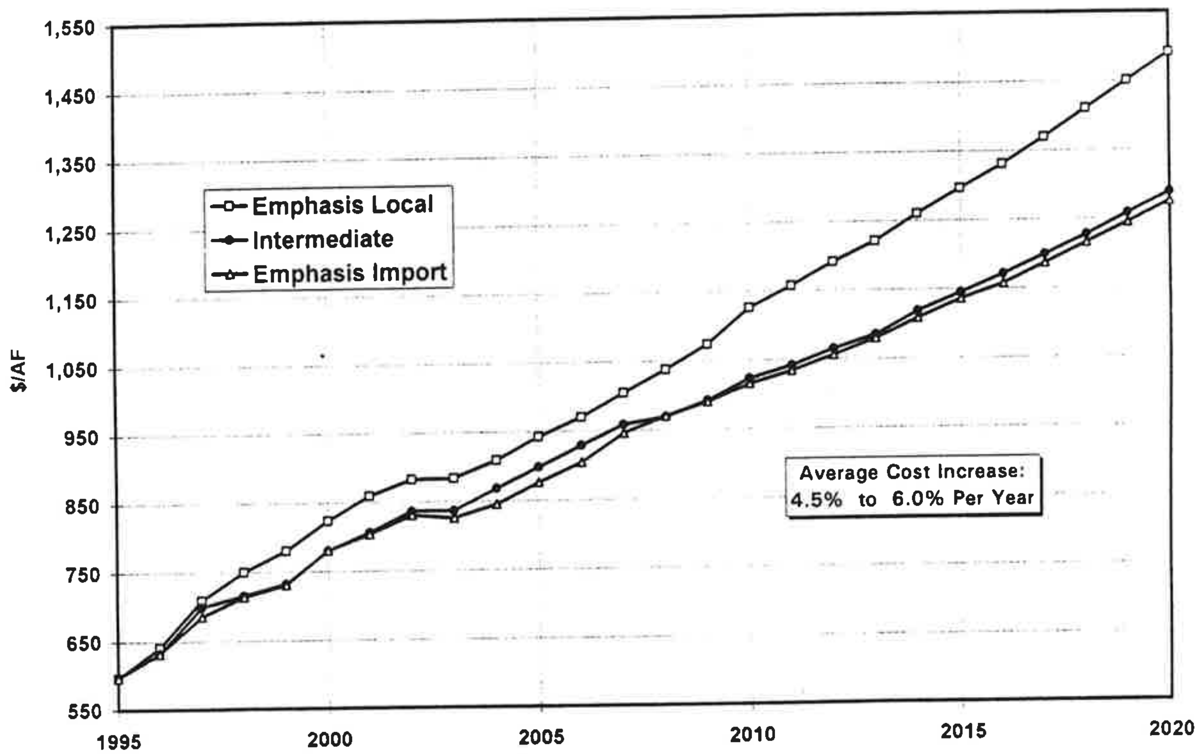
These cost assumptions are consistent with the least-cost planning principles used by the energy industry in its integrated resource planning. It should also be noted that from a historical perspective, the cost of water development and operations has increased at an average rate of about 7 percent per year for the last 10 years. Inflation for all other goods and services, based on CPI indicators, has increased at about 5 percent per year for the last 10 years.

Figure 7-5 presents the region-wide average costs in escalated dollars. There is little difference in costs between the resource alternatives in the near-term, but over time the cost for the Local Resource Emphasis alternative becomes significantly greater than the other two. The Intermediate alternative has a lower cost than the Local Resource Emphasis Mix and greater resource diversity (i.e., it relies on a combination of supply resources to better adapt to uncertainty) than the Imported Resource Emphasis Mix.

As with all forecasts, cost projections are subject to considerable uncertainty. Uncertainties in future imported costs include project cost uncertainty, as well as hydrologic uncertainty. For example, the cost per acre-foot increases when imported supplies decrease due to hydrology. This is due to the large fixed cost portion, which is paid regardless of how much water is supplied. Other potential cost impacts resulting from new water quality regulations, environmental issues, or technology were accounted for in the analysis.

Uncertainties in future local project costs can be estimated by examining the spread between project costs from one type of project and location to another.

Figure 7-5
Region-Wide Average Retail Water Cost
(Escalated Dollars)



The more project costs information, the better the estimate of average cost used in the IRP. For example, reclamation costs were based on over 100 projects. For each resource alternative, resource costs and the cost uncertainties were added together in order to develop total retail-level costs. Figure 7-6 presents the region-wide average retail costs, in current dollars. The average unit cost is shown for the Local Resource Emphasis and Intermediate Mix alternatives, along with the possible range in costs. While the ranges of costs overlap, the average costs for the resource alternatives are statistically different from one another by the year 2020.

Member Agency Costs

In order to examine how future costs could impact Member Agencies, specific retail-level costs were estimated. These estimates were based on: (1) future Metropolitan costs; (2) future local resource development costs; and (3) existing retail-level costs including local operations based on a sample of the largest 60 retail water agencies in the service area. Figure 7-7 presents the average retail-level cost showing the current 1993 value, and the minimum and maximum

Figure 7-6
Region-Wide Average Retail Water Cost With Cost Ranges
(1993 Dollars)

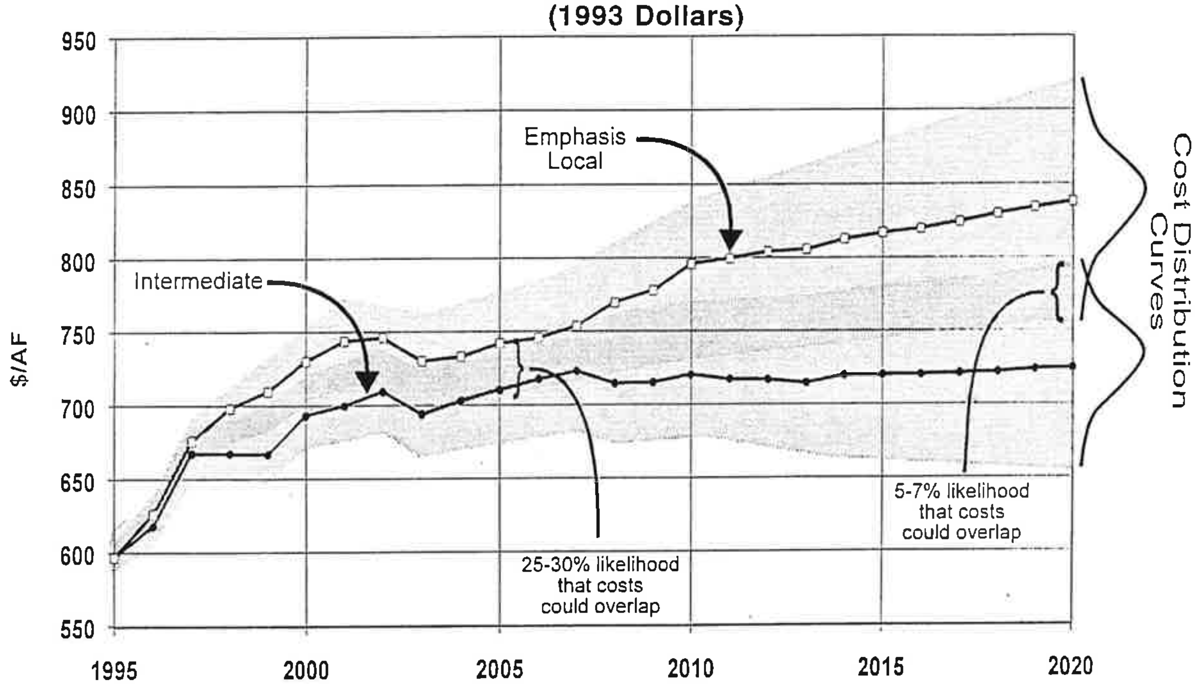
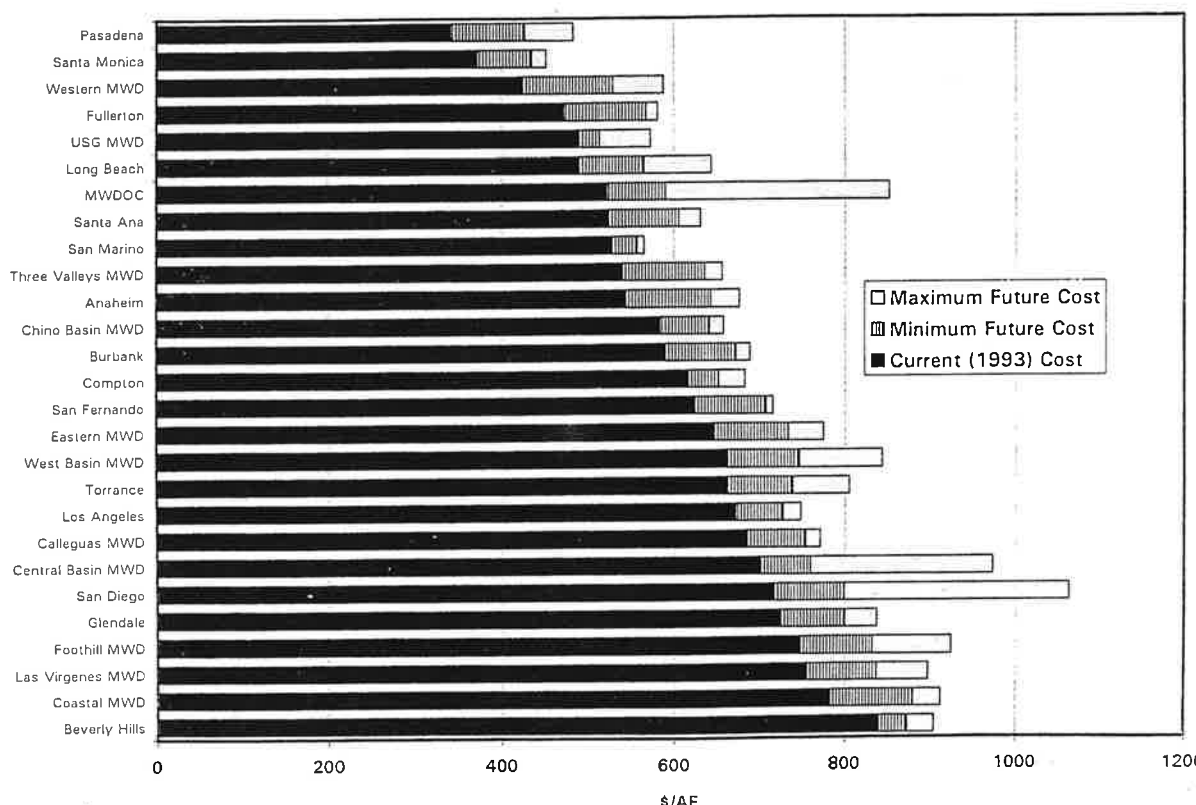


Figure 7-7
Average Retail Cost of Water in Year 2010
(1993 Dollars)



future values under current financing provisions and arrangements for the year 2010. These costs for the Member Agencies can significantly change if financing changes, and should be the basis for reevaluating financing responsibilities. The minimum future value indicates the future costs that could occur regardless of the resource alternative. The maximum future value indicates the sensitivity of cost due to a specific resource alternative.

The maximum future value also includes an estimate of the cost for added water treatment for those Member Agencies required to mitigate the high total dissolved solids (TDS) that would occur under the Local Resource Emphasis alternative. Because the Local Resource Emphasis mix lacks sufficient SWP supply for blending with CRA supply, the TDS for imported supplies being used for reclamation and groundwater replenishment would be much greater for certain areas within Metropolitan's system.

The cost differential between resource alternatives is expected to be significant if a Member Agency: (1) purchases mostly seasonal and/or replenishment water from Metropolitan; (2) has large investments in Level 3 reclamation projects; and/or (3) is projected to have brackish and ocean water desalination on-line during the next 10 years. For many Member Agencies, costs do not change significantly among resource alternatives.

This cost analysis assumed current Metropolitan incentives. If the incentives were increased significantly, it is expected that the total costs would decrease for those agencies with heavy reliance on groundwater, water reclamation, and desalination. At the same time, the total costs would likely increase for those agencies that are more reliant on Metropolitan deliveries and do not have substantial local resources.

Affordability of Supply Reliability

There are several ways to assess affordability. One is to project the costs for resource development over time and calculate the rate increases required to fund planned investments. From this standpoint, it is estimated that the total regional costs to the end-use customer will increase at an average rate of 1.5 to 3 percent per year over the next 25 years in constant dollars, and 4.5 to 6 percent per year in escalated dollars.

Another way to look at affordability is to compare the average monthly cost of water with the monthly cost of other utilities. While varying from agency to agency, the average monthly cost of water in Southern California is approximately $22 per month. The average electric bill is about $60 a month, the average gas bill is about $35 a month, and the average telephone bill is over $65 per month.

Affordability can also be assessed by asking customers how much they would be willing to pay to avoid water shortages (or having low supply reliability). Using a method called contingent valuation, surveys can be used to statistically determine customers' willingness to pay for improved service reliability. Realistic scenarios of water shortages and possible consequences are posed to survey respondents who are then asked how much they would be willing to pay to avoid those shortages.

Today in Southern California, water cost less on average than electricity, gas, and telephone.

In 1993, the California Urban Water Agencies (CUWA), together with representatives of the environmental community, conducted a statewide comprehensive study on the willingness to pay for reliability. Over 1,200 residential customers participated in the survey within Metropolitan's service area. Another 1,000 customers in Northern California participated. The results of the survey were remarkably similar from one study area to the next. On average, residential customers indicated that they would be willing to pay about $11 to $12 more per month to avoid water supply shortages similar to the 1991 drought event, occurring once in 10 years.

The results of this study were used to develop the costs and benefits of achieving different levels of supply reliability. Currently, the region-wide retail level reliability used in the IRP states that supply shortages will never exceed 10 percent of total regional needs. About 1 in 20 years, supply shortages will average about 5 percent of the total regional needs. A lower reliability goal was tested in order to evaluate the potential cost savings and trade-offs due to increased water shortages.

On average, the region's water consumers are willing to pay to avoid supply shortages identified by the IRP.

The lower reliability goal would result in retail level supply shortages of up to 20 percent of total regional needs. Supply shortages of about 10 percent will occur once in ten years. The cost savings resulting from lowering the current reliability goal to this alternative goal are based on deferring water resource investments. For the purposes of this analysis, it was assumed that the most costly resource investments would be deferred—giving the "upper bound" of what could actually be saved in terms of cost.

The results indicate that on average, $108 million per year of costs could be saved by adopting the lower reliability goal. Using the results of the CUWA willingness to pay survey, residential customers indicated they would be willing to pay an average of about $2 to $3 per month to avoid moving from the current reliability goal to the lower alternative.

Multiplying this average value by the number of households in Metropolitan's service area yields an average of about $200 million per year. The amount extrapolated from the amount consumers are willing to pay to avoid the lower reliability is almost twice the costs savings. It should also be noted that supply shortages would likely affect other sectors of the economy as well. Water supply reliability studies of commercial and industrial users indicate a much higher willingness to pay for increased reliability.

Section 8
Recommended Regional Resource Strategy

MWD

Section 8
Recommended Regional Resource Strategy

The previous sections of this report described the Integrated Resources Planning process and how this process was used to define alternative regional water resource strategies during the data collection and analysis phase of the IRP process. This section describes the refinement and decision-making phase of the IRP process, and the recommended regional resource strategy that emerged. The refinement and decision-making phase consisted of three steps:

1. Definition of ***common water management objectives*** among the three broad resource mixes representing the spectrum of alternative resource strategies. This step was completed jointly by senior Metropolitan staff, Member Agency representatives, and groundwater basin managers.

2. A series of ***six open public forums and local agency public workshops*** oriented toward gaining a broad perspective on common issues and significant differences between major groups interested in Southern California's water future.

3. An ***Integrated Resource Planning Assembly***, where the leaders of the region's water purveyors evaluated the findings of the IRP process and selected a regional water resource strategy to guide future planning efforts throughout the region.

The recommended regional resource strategy consists of common water management objectives, an affordable reliability goal, business and water management principles, and preliminary resource targets.

This section concludes with a description of the regional resource strategy recommended by the Assembly, consisting of four elements: (1) an affordable reliability goal, (2) regional business principles, (3) a set of governing water management principles, and (4) preliminary regional resource targets.

8.1 Common Water Management Objectives

The IRP process used "resource mixes" to represent three alternative emphases in future resource development: a local resource emphasis, an imported resource emphasis, or an equal emphasis in new local and imported resources. Figures 8-1, 8-2, and 8-3 show dry year supply in the near-term (year 2000), mid-term (year 2010), and long-term (year 2020) under

Figure 8-1
Dry Year Supplies
Year 2000

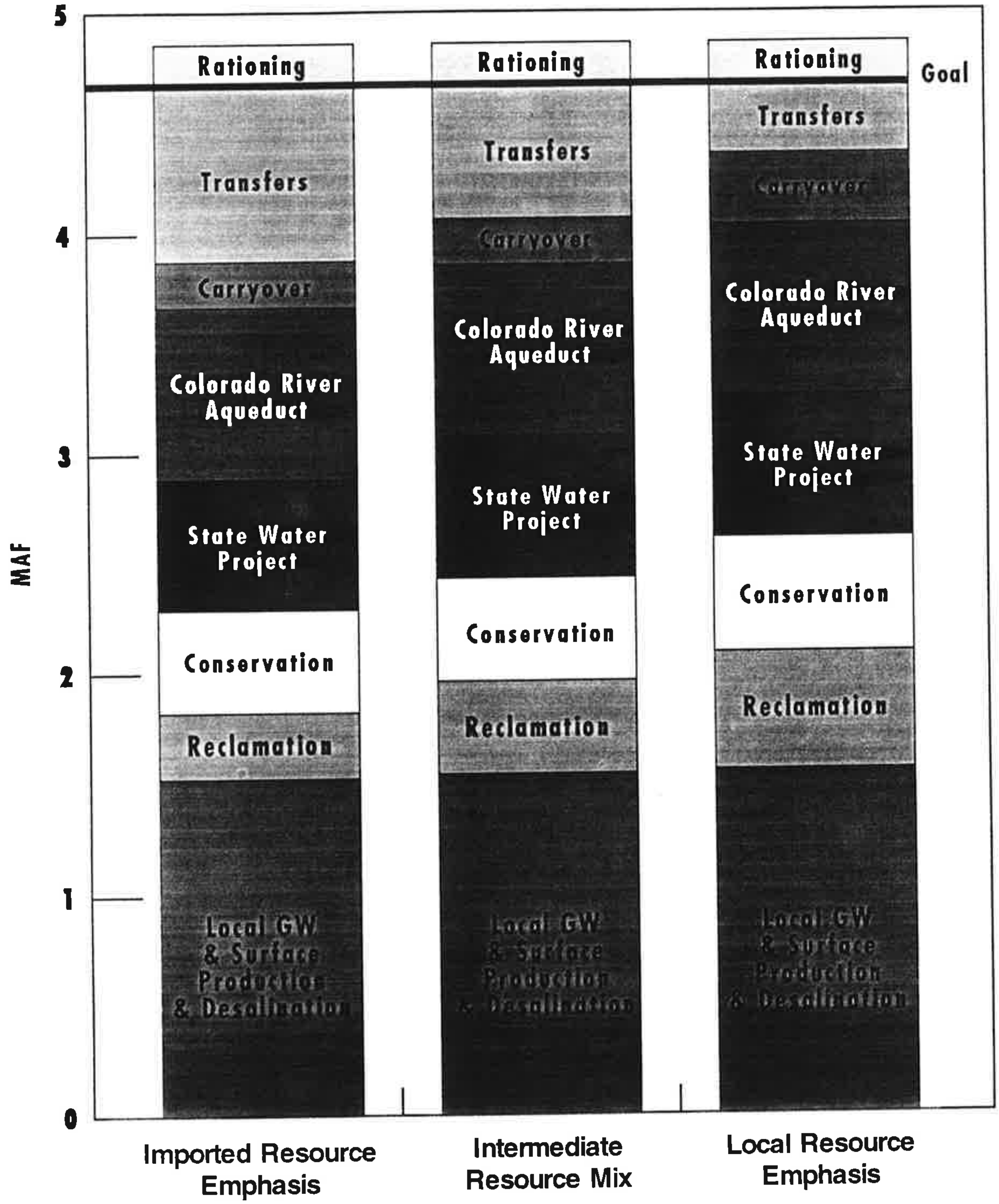


Figure 8-2
Dry Year Supplies
Year 2010

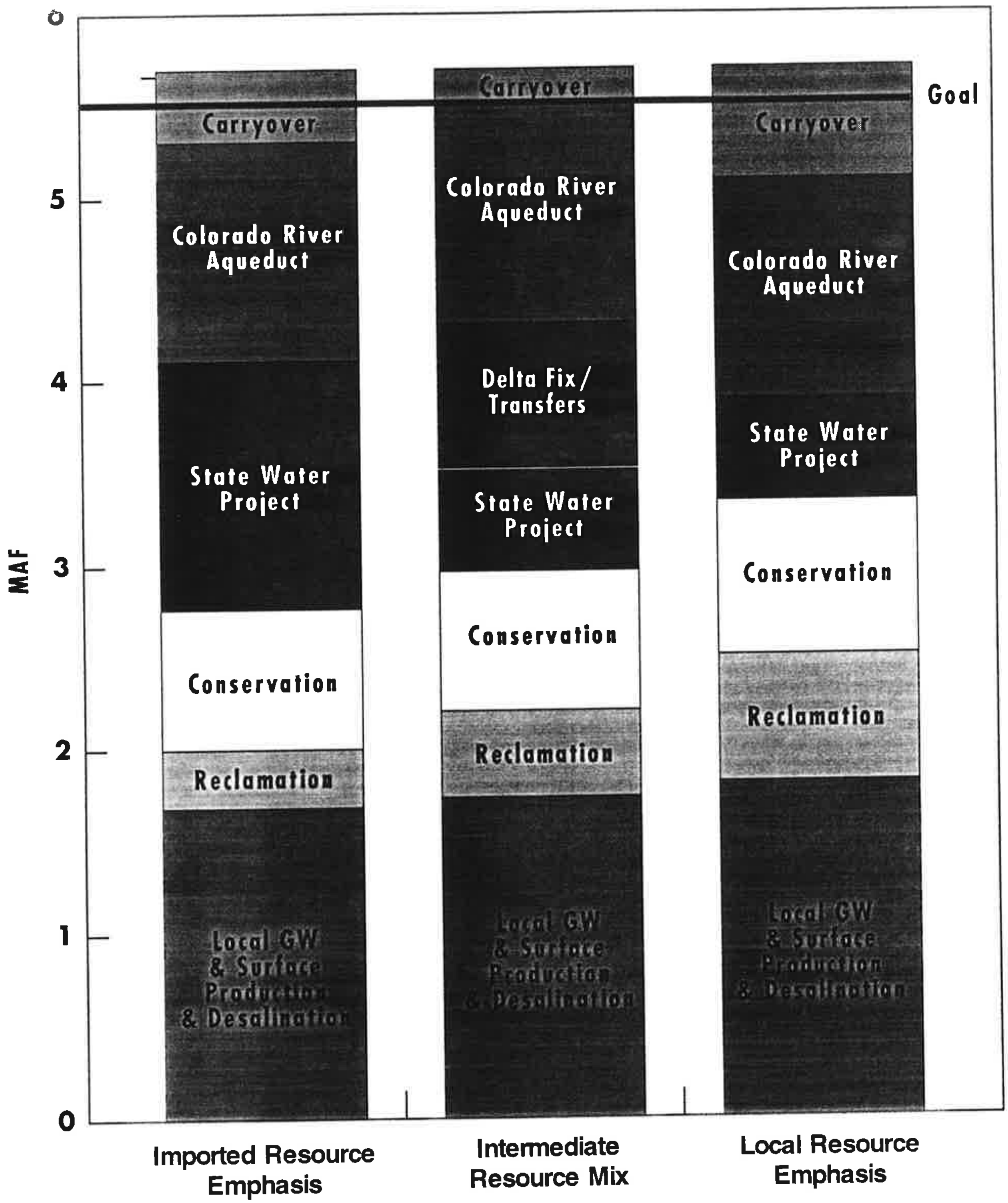
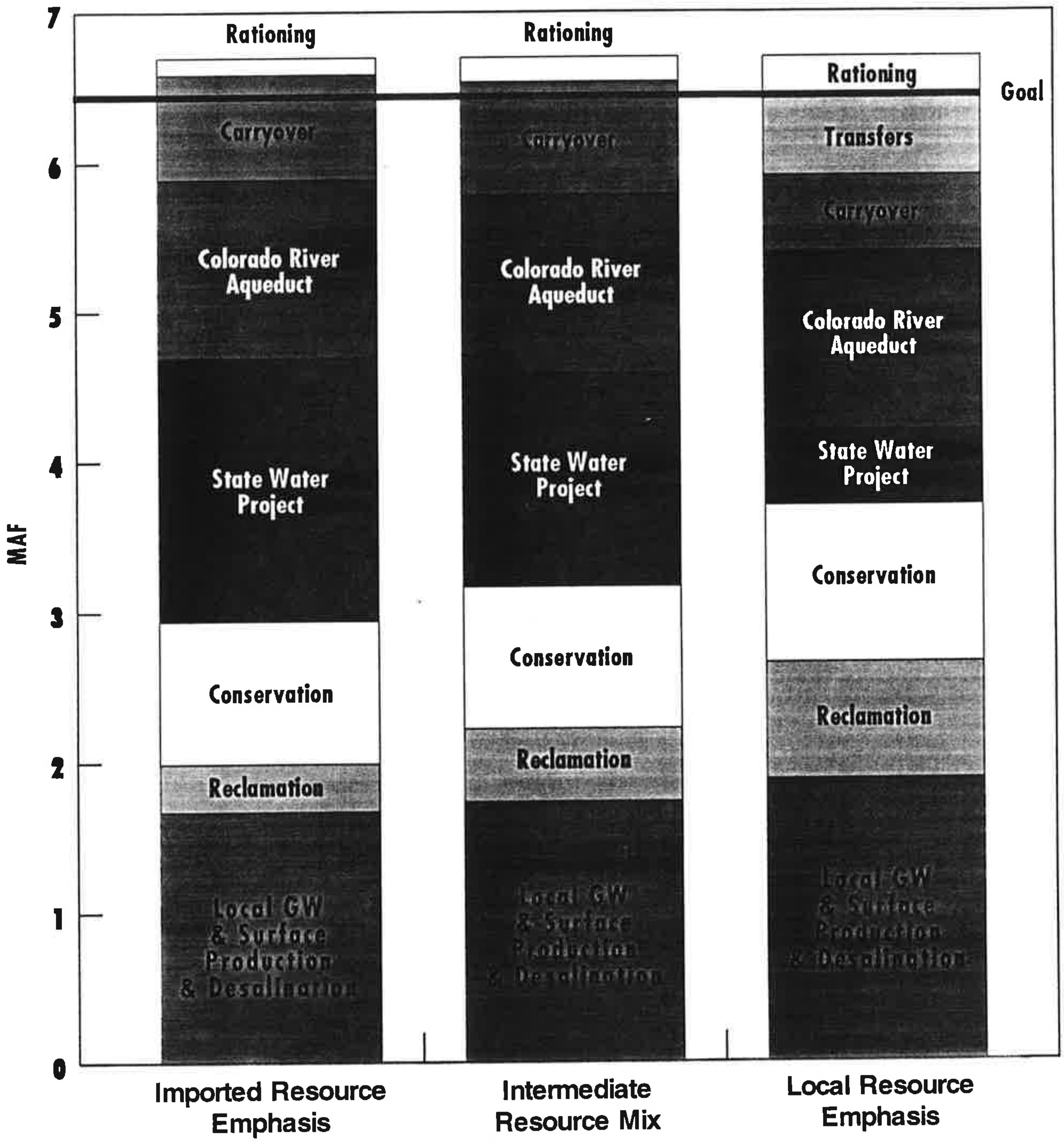


Figure 8-3
Dry Year Supplies
Year 2020



the three resource mixes. These figures show when resource investment levels diverge under each resource mix, helping to identify critical decision points for selecting a specific level of investment and providing insight to appropriate phasing of resource decisions. Sections 6 and 7 described each resource mix in detail and the reliability, cost, and uncertainty evaluations performed with respect to each.

In assembling and evaluating the resource mixes, six broad water management objectives emerged as common elements of all feasible options.

Common water management objectives shared by all resource mixes include:

1. *Aggressive water conservation*
2. *New, economically-feasible local supplies*
3. *Full CRA deliveries*
4. *Dependable SWP base flows*
5. *Optional water transfers*
6. *Maximized storage*

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 and should be maximized in any resource mix.

4. ***Maintain and fully utilize base dependable flows in the State Water Project.*** Despite the challenge of resolving the complex issues in the Sacramento/San Joaquin Delta (Delta), there are significant advantages associated with realizing the benefits that can result from these fixed investments.

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 helps in three ways:

   - Often, it is wetter in the winter (when water demand is lower) and is drier in the summer (when demand increases). Storage is needed to "seasonally shift" this water from when it is available (i.e. winter) to when it is needed (i.e. summer).

   - Over a series of years, total annual precipitation and runoff varies. Consecutive years with low precipitation and runoff may result in droughts. Storage helps retain water from wetter years for use during drier periods or droughts.

   - Imported water supplies are all carried to Southern California by aqueducts that cross major fault lines. When a severe earthquake occurs, one or more of these aqueducts may be damaged, disrupting the supply of water. Current policy is to provide emergency storage of 6 months of water in Southern California to provide enough water to meet 75 percent of normal demand.

8.2 Public Forums and Public Workshops

Metropolitan and the Member Agencies hosted a series of public forums and public workshops to present the issues that emerged from the IRP process and to solicit comments and recommendations for the IRP Assembly participants' consideration. Six public forums and workshops were held throughout Metropolitan's service area. The forums were located in Agoura Hills, Temecula, Pasadena, San Diego, Carson, and Orange County. Participants in the forums included representatives of business, environmental, community, and agricultural interests. The following information is a condensed summary of common comments and recommendations addressed by forum participants. More detailed summaries of each forum are available.

The six IRP public forums/workshops were attended by over 400 representatives of business, environmental, community, and agricultural interests.

Reliable Water Supplies

Most forum participants expressed a need for a 100 percent reliable water supply to meet essential uses and support economic well-being. It was recommended that a hierarchy be established to separate different levels of need for reliability. Reliability would be highest for health, safety, or emergency needs, next highest for agriculture, industry, and commercial uses, and lowest for lifestyle and recreational use. This hierarchy would have to recognize that some levels are less flexible than others in their reliability needs.

Participants at both the Agoura Hills and Temecula forums emphasized the need to integrate land use planning with water supply availability.

Many suggestions were made on how to achieve reliability. One way to achieve reliability would be to start with using local supplies and maximizing conjunctive use. Another option would be to manage growth together with supply. Several groups suggested encouraging the development of technological improvements such as desalination. Yet, all groups emphasized that cost is a major factor for most circumstances. Costs that are too high have economic consequences.

Guiding Principles for Resource Strategy Development

Several principles for developing a resource strategy were suggested:

- Maximizing local resources first (i.e., reclamation, groundwater, conservation);
- Recognizing resource limits to water use;
- Protecting the environment;
- Developing responsible cooperation among agencies and stakeholders;
- Providing water resource stewardship;
- Providing equity among users and geographic areas in terms of price, water quality, and level of reliability;
- Considering storm water as a supply source;
- Protecting public health by adhering to water quality standards; and
- Being fiscally conservative.

The public forums generally endorsed IRP common water management objectives....

IRP Management Objectives

The management objectives suggested in the forums include: implementing economically feasible, market-driven BMPs; optimizing Colorado River Aqueduct supplies in the short term due to cost, but complementing with local resources and storage due to risk; continuing to invest in an environmentally acceptable fix to the SWP in the long term by developing a 3-year Environmental Impact Statement/Report; encouraging local and state water transfers in the short term; and providing financial incentives in order to encourage community based conservation.

IRP Implementation Barriers and Strategies

The following is a list of common implementation barriers and possible implementation strategies that were discussed in the forums:

1) Barrier: Cost of capital improvements:
   - environmental costs
   - quality of life

   Solution: Analyze costs, mitigate costs, augment supplies, adjust expectations, conserve water

2) Barrier: Lack of leadership and political will

   Solution: Public involvement and education

3) Barrier: Environmental regulations (i.e., Endangered Species Act)

   Solution: Support multi-species habitat studies for Colorado River Basin and SWP

4) Barrier: Current anti-degradation policy can prevent discharge of reclaimed water into a watershed

   Solution: Change regulations to provide flexibility as long as beneficial uses in receiving water are not impaired.

5) Barrier: Historic water culture and mistrust among parties (Northern vs. Southern California, Agriculture vs. Urban, Urban vs. Environmental, Water Community conflicts)

   Solution: Education, Outreach, Forums, Stakeholder involvement. On-going timely feedback and two-way discussions.

.... and emphasized education to help resolve barriers to IRP implementation.

6) Barrier: Lack of funding

   Solution: Member agency support and buy-in to MWD finance program. Public credibility of IRP and need for investment. Educate community and political leaders. Cost sharing with MWD.

Education

In all public forum discussions, the need for education was mentioned. All groups seemed to emphasize that community leaders, political leaders, and the public all are lacking in a basic understanding of water problems in California, and would benefit by an education program. In order to increase the public's level of confidence, the fragmented, locally self-serving and conflicting messages must be eliminated, and replaced by a comprehensive, tailored media campaign.

Other Issues

As in any general discussion, the forums did produce conflicting suggestions. For example, participants emphasized both the need to invest in new technology and the need to be fiscally conservative. Also, the participants suggested developing a reliability hierarchy of need and emphasizing equity among users of resources.

8.3 The IRP Assembly

An American Assembly on the Integrated Resources Plan for Southern California was convened on June 9-11, 1994. Over one hundred people attended, excluding Assembly staff and observers. Participants included members of the Board of Directors of the Metropolitan Water District of Southern California (Metropolitan), Metropolitan's Member Agency managers, Metropolitan senior staff, groundwater agency managers, and representatives of retail subagencies that purchase water from Member Agencies. (A list of Assembly participants is provided in the Appendix).

The IRP Assembly of the region's water providers weighed technical and qualitative evaluations of resource mixes....

The format for the Integrated Resources Plan Assembly was based on the American Assembly process, which is a procedure designed to reach consensus on controversial and complex issues of interest to diverse parties. The Integrated Resources Plan Assembly was a follow-up to an October 1993 Assembly on Metropolitan's Strategic Plan. The 1993 Assembly dealt with such fundamental issues as regional water policies, financing structures, and governance, and provided direction for a number of Metropolitan's actions, including adoption of a foundation for a new revenue structure, selection of criteria for resource evaluation, and formulation of initial business practices and water management principles.

Central to the success of the Integrated Resources Plan Assembly was the Steering Committee composed of representatives of constituency groups participating in the Assembly (see the Appendix for Steering Committee members). The Steering Committee was responsible for planning and coordinating the Assembly. The key issue questions considered by the Assembly participants were developed by the Steering Committee. Metropolitan staff and a private consultant developed background papers that were reviewed, modified, and approved by the Steering Committee. The background papers provided Assembly participants with information essential to understanding the key issues and alternative strategies for addressing the key issues.

The June 1994 Assembly focused on strategies for meeting the water needs of Metropolitan's service area through the year 2020. Alternative strategies were delineated through the data collection and analysis phase of the Integrated Resources Planning (IRP) process described in the preceding sections of this report. The main questions the Assembly addressed were which resource mix to emphasize, and how to implement it.

During the evening of first day of the Assembly, Metropolitan staff provided a background session on its IRP process. In addition, presentations were made by the reporters from the three open public forums and three local agency public workshops which were held throughout Southern California to review options and obtain input to the IRP process. On the second day of the Assembly, the Assembly participants, divided into six working groups, considered the key issue questions and developed positions and recommendations. Each working group had a preassigned facilitator and recorder.

.... and agreed that the best resource combination for the region is an intermediate resource mix.

At the end of the second day, the facilitators and recorders met to construct the draft Assembly Statement which was based on the positions and recommendations of the working groups. On the third day of the Assembly, the draft Assembly Statement was reviewed by all participants, and the full Assembly worked through the document. Revisions and/or changes to specific wording in the document were made by the full Assembly, and agreement was reached at that time on specific language that was adopted in the Assembly Statement (Appendix G). The statement represents general agreement. However, no one was asked to sign it. Furthermore, it should not be assumed that every participant subscribes to every recommendation.

8.4 The Region's Preferred Resource Emphasis

The question posed by the IRP was where to put the emphasis along a continuum that covers three basic resource-mix alternatives. At one end of the continuum is the strategy of enhancing local supplies, through very aggressive water reclamation, groundwater development, ocean desalination, and conservation beyond the current Best Management Practices (BMPs). At the other end is securing existing entitlements and additional imported water supplies through Delta improvements and south-of-Delta storage. Between these extremes is the strategy of balancing local and imported supplies, and storing seasonally available imported water in surface reservoirs and groundwater basins for use later during droughts and periods of high demand (a method referred to as "conjunctive use").

Selection of the Intermediate Resource Mix

The Assembly participants agreed that the best resource combination for the region is an intermediate resource mix. Some stated that this mix should lean toward cost-effective local water development. All three of the alternative resource mixes have similar costs over the next ten years (the cost estimates diverge substantially beyond that), and all three mixes meet the reliability goal. But an intermediate resource mix provides the greatest diversity, adaptability, and flexibility.

However, in endorsing an intermediate resource mix, the participants are supporting a general direction, not all of the specific items and goals included in the IRP analysis. Maintaining an appropriate mix which meets the reliability goal is a dynamic process requiring regular evaluation. The following list is a set of suggested parameters:

The intermediate resource mix represents a general framework for a dynamic resource decision making process.

- Water conservation should be implemented aggressively in the region through BMPs.
- Local supplies should be pursued to the point of technical and economic feasibility. The region should make full use of economically and environmentally feasible local water supplies (such as groundwater, reclamation, and desalination) as long as these are coupled with maintaining and enhancing a dependable supply from the State Water Project (SWP).
- Dependable supplies from the SWP have the potential to be highly economical and because of water quality considerations, are essential for successful implementation of local reclamation and groundwater storage programs.
- The Domenigoni Valley Reservoir Project, the Inland Feeder, and groundwater and other local storage all work together to meet overall water supply, emergency storage, and water quality needs.

- Supplies from the Colorado River Aqueduct should be maximized, but steps should be taken to address water quality impacts on local water resources development.

In developing the IRP, the real questions facing the region are "What to do?" and "How to do it?" The advantages of an intermediate resource mix and the need to move forward on the common regional resource requirements are rather obvious. The problem, though, is doing so in a way that shares costs equitably, protects the viability of both Metropolitan and the Member Agencies, takes into account past investments by Member Agencies, and provides for both predictability and flexibility. Metropolitan is addressing many of these issues with its new rate structure, but there are underlying and differing concerns that this rate structure is not achieving necessary equity, and this may become more troublesome as the IRP and its associated capital program are implemented. The issues need to be addressed before closure is reached on the financial program required to implement the IRP.

Disadvantages of Local and Imported Resource Emphasis

Primary emphasis on either local resources or imported supplies has a number of disadvantages. While heavy reliance on local resources might demonstrate that Southern California is trying to solve its own problems in a responsible way, a resource mix exclusively emphasizing local resources would:

The intermediate resource mix was endorsed primarily because it is less risky than the local and imported resource emphasis.

- Pose potential water quality problems. Without substantial imported water to replenish local groundwater basins, high total dissolved solids (TDS) in the Colorado River supplies used for replenishment will cause degradation of groundwater. In addition, high TDS limits the development of water reclamation. These problems could be addressed with desalination, but desalination is costly and creates environmental impacts.

- Create problems of parochialism, particularly during droughts. To the extent that local resources are unavailable to meet regional needs, conflicts will occur during shortages between those that have direct access to local resources and those that do not.

The main problem associated with heavy reliance on imported water is political and environmental risk. It is uncertain whether a resource mix exclusively emphasizing imported supplies would allow Metropolitan to meet its reliability goal. Due to the political and environmental risk, it is unlikely that progress in the Delta can be made without substantial commitment to local resource development and environmental protection.

8.5 Affordable Reliability Goal

Section 7.7 concluded that the region's retail water customers are willing to pay about 50 percent more for water to avoid shortages similar to those that occurred during the 1991 drought. Avoiding such drought conditions would raise retail costs about 25 percent on average under the intermediate resource mix. While some participants in the IRP Assembly felt that the reliability goal might be low, the Assembly participants endorsed the reliability goal set by Metropolitan as a reasonable balance between cost and level of service. The participants also agreed that the goal should be periodically reevaluated. In the short-term, several aspects of the goal need to be kept in mind:

1. Metropolitan is setting the goal at the wholesale level, in the sense that the goal reflects Metropolitan providing supplemental water to Member Agencies. However, the actual level of reliability at the retail level could vary substantially, depending on the extent to which local resources are shared regionally. Regional sharing of local resources could reduce differences in local retail reliability.

2. The goal does not address how Metropolitan will deal with the critical issue of resource allocation during droughts. This issue has implications both for public perceptions of the reliability goal and for how the burden will be shared.

8.6 Regional Business Principles

A variety of strategies should be pursued to finance and implement an intermediate resource mix. These strategies should uphold the following business principles.

1. ***Financial Integrity.*** Investments by Metropolitan, Member Agencies, and other water providers that are consistent with the IRP process should be accompanied by a mutual commitment of reliable revenue sources that recover the fixed and nonvariable operational and capital costs of those investments. Ensuring reliable revenue sources is critical to maintaining Metropolitan's currently high bond rating. This does not require that Metropolitan cover 100 percent of fixed costs with fixed revenues. The revenue stream should be diversified and include alternative fixed sources.

2. ***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 system and

investments. This principle is particularly important to drought management. It implies that mutual benefit to the region, rather than local ownership, should have higher consideration when ensuring each of the Member Agencies comparable access to reliable and quality water service.

3. *Equity and 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 to Member Agencies and the value of the benefits that are provided to them by Metropolitan. A clear connection must be established between the financial incentives and the benefit to the region, and Metropolitan must have the ability to assure that the benefit is delivered. In order to maintain a clear connection between the financial incentives and the benefit to the region, Metropolitan should establish performance requirements that are flexible enough to allow Member Agencies to meet their obligations. In addition, these incentives should be market-driven. The consequences of non-performance should be clear. Consistent behavior by Metropolitan is critical for local resource development.

Five regional business principles will serve as strategies for implementing the intermediate resource mix.

4. *Operating Integrity.* The operating integrity of Metropolitan's system should be maintained. The use of Metropolitan's system for the transmission of non-Metropolitan water supplies (wheeling) should be provided as long as there is no reduction in the level of service, including water quality and capacity, to any Member Agency, and wheeling must not negatively impact the rates or charges to any other Member Agencies.

5. *Public Participation.* Ongoing public information and outreach programs are vital to the IRP process, particularly when any rate increases are required, but great care must be taken when spending money for this purpose. Local, State, and Federal officials should all be involved in informing the public. Public information should focus on the need to conserve water resources and the need for increased reliability.

8.7 Regional Water Management Principles

A specific resources program should be developed out of the IRP in accordance with the business principles, and support from the community should be sought. The following regional water management principles should be upheld in a manner consistent with the business principles outlined above.

The IRP Assembly endorsed water management principles consistent with an intermediate resource mix....

1. ***Water Conservation.*** Water conservation is a priority in any resource strategy developed for Southern California. All governmental agencies, private industry, and the public have a stewardship responsibility for the wise and efficient use of water. In that context, all water agencies, private water companies, cities, and other units of local government having water resource management responsibilities in Southern California share a responsibility to implement the Urban Water Conservation BMPs. This principle should be the foundation of an intermediate resource mix. BMPs should be supported with effective incentives and disincentives to encourage implementation by all Member Agencies. Legislative initiatives also should be considered to ensure implementation of BMPs.

2. ***Water Reclamation.*** To fully maximize the benefits of available water supplies, beneficial reuse of imported and local water is a critical priority. Metropolitan and other water agencies in Southern California must take active steps to support and encourage implementing water reclamation projects. These steps should include seeking legislation which facilitates water reclamation activities. The goal is to develop water reclamation supplies throughout the region and thereby increase the efficient use of available water.

3. ***Groundwater Recovery.*** Recovery and management of degraded groundwater is a developing supply strategy and should continue to be encouraged to improve utilization of aquifers. Unified management strategies should be encouraged locally and statewide.

4. ***Groundwater Storage.*** For much of Southern California, groundwater basins are the foundation of the local water delivery system. Historically, groundwater supplies were the only supply for many communities, and today they serve as the transmission "pipeline" and storage reservoir for a significant portion of the imported supplies delivered to the region. The groundwater basins should be managed conjunctively with the available imported water supplies to provide regional storage benefits, including seasonal (or peaking management) regulation, drought and emergency supplies. Given that storage of imported supplies in groundwater basins is critical to providing emergency and drought storage benefits on a regional basis, all communities that overlie a groundwater basin have a responsibility to participate in mutually beneficial programs to achieve coordinated management of groundwater and other sources of supply. By the same token, the economic value of groundwater storage should be recognized.

5. ***Surface Storage Development.*** Metropolitan has a responsibility to provide regional surface storage and conveyance facilities sufficient to meet operational storage, emergency, seasonal regulation, and drought storage requirements, as well as improved use of groundwater basins for storage. Member Agencies and subagencies are responsible for providing the local emergency storage or interconnections with other agencies needed to meet their needs during a seven-day Metropolitan service outage.

6. ***Colorado River.*** Maintaining a full Colorado River Aqueduct and addressing associated water quality issues is of paramount importance, both short-term and long-term. Implementation of innovative water conservation, conjunctive use, and land fallowing programs with Imperial, Coachella, and Palo Verde irrigation districts, any entities which have entitlements to Colorado River water, and the federal government will continue to be a high priority. In addition, developing cooperative arrangements with Nevada and Arizona water agencies will become increasingly important to optimize utilization of the Lower Basin's apportionment.

7. ***State Water Project.*** Realizing that Metropolitan's SWP entitlement is also important, a critical issue facing California is managing the Sacramento-San Joaquin River Delta estuary in a manner that can preserve the environmental resources and balance the multiple uses of its water resources. Southern California should actively support a Federal/State policy framework for protecting the Delta through water quality standards and implementation of a long-term management program that balances all the uses of the Delta's water resources, minimizes harm to fisheries, and allows for water transfers.

8. ***Water Transfers.*** Water marketing and voluntary transfers should continue to be promoted and implemented in a manner that protects the environment, local rural communities, and other interests. Water transfers in California should be accomplished with a commitment to efficient use of existing supplies.

9. ***Desalination and Demineralization.*** Desalination is relatively expensive but may be an important water supply strategy in the 21st century. The region should support forward-looking demonstration projects to evaluate the "true" costs and benefits of emerging ocean desalination technologies. These demonstration projects should be cooperative research and development programs with the State and Federal governments, electric utilities and water agencies.

New governing structures are not needed to implement the IRP. All water agencies, private water companies, cities, and other units of local government having water resource management responsibilities in Southern California should work cooperatively to meet its objectives, and Metropolitan should function as the facilitator and coordinator of this process. Interagency agreements, contracts, and memoranda of understanding are tools that can be used to ensure implementation.

8.8 Preliminary Resource Targets

.... and established preliminary resource targets for each.

Participants agree that all of the common regional resource requirements listed in Section 8.1 should be pursued, including construction of the Domenigoni Valley Reservoir Project and the Inland Feeder. However, a few participants are concerned that the Domenigoni Valley Reservoir Project is not as cost-effective as competing resources and may not benefit all equitably. The preliminary regional resource targets are:

1. ***Urban Water Conservation.*** It is recommended that by 1996, all water agencies, private water companies, cities, and other units of local government having water resource management responsibilities in Southern California become signatories to, and implement, the "Memorandum of Understanding Regarding Urban Water Conservation in California." It is estimated that the region has conserved about 250,000 acre-feet per year (AFY) during 1980 to 1990 as a result of public education, residential and commercial plumbing codes, and plumbing retrofits of shower heads and toilets. The regional objective should be at least 750,000 AFY by the year 2010 as a result of fully implementing the Urban Water Conservation Best Management Practices.

2. ***Water Reclamation.*** Currently, the region is using about 250,000 AFY of reclaimed water for indirect uses such as groundwater replenishment, and direct uses such as landscape irrigation. The regional requirement should be at least 505,000 AFY by the year 2010, a two-fold increase in 15 years.

3. ***Groundwater Recovery and Treatment.*** Currently, at least 10,000 AFY of brackish/contaminated groundwater is being recovered in the region in order to increase annual groundwater production. The regional requirement should be at least 50,000 AFY by the year 2010, a five-fold increase in 15 years.

4. ***Groundwater and Surface Storage.*** The recommended regional requirement for groundwater storage is expansion of current conjunctive management of local and imported water supplies to develop at least

300,000 AFY of additional annual production and 1,000,000 AFY of additional storage by year 2010.

The Domenigoni Valley Reservoir Project and Inland Feeder should be established as critically needed projects for Southern California to provide emergency, seasonal, and drought storage. In addition, periodic reports should be prepared documenting the status of Member Agency and subagency abilities to meet the emergency needs resulting from a seven-day Metropolitan outage.

5. ***Colorado River.*** Water transfers, water conservation, water quality enhancement, groundwater storage programs, in-river storage agreements, and available surplus and unused water should be pursued to increase the reliability of Colorado River supplies and provide full aqueduct delivery. Promote the creation and maintenance of a Lower Basin coalition to actively support a multi-species habitat conservation and protection program.

6. ***State Water Project.*** Southern California water agencies should develop programs to conjunctively manage their supplies from the SWP to increase use of supplies in time of surplus, and reduce the need for direct deliveries from the SWP during droughts or periods when significant impacts on fisheries could result. The first priority is to fully utilize storage of imported supplies in Southern California. Conjunctive use programs should include developing cooperative SWP banking programs outside of the Southern California region as well. Southern California water agencies should commit to creating, maintaining, and strengthening broad-based coalitions and actively support a multi-species habitat conservation and protection program for the Delta.

7. ***Water Transfers.*** Because water transfers play such a critical role in meeting regional reliability, Southern California water agencies should commit to the establishment of a fully functional and efficient water market for the voluntary transfer of water between willing buyers and sellers. The recommended regional requirement for water transfers should be at least 300,000 AFY available by year 2010. Further evaluations are needed to determine the optimal strategies for using water transfers for consumptive and storage replenishment needs.

8. ***Desalination.*** Southern California currently invests in desalination of brackish groundwater. The region should support pilot programs to develop cost-effective ocean desalination technology and its applications.

The resource requirements described above are intended to provide a foundation for further analysis aimed at defining optimal goals and facilities for a comprehensive regional water resources plan. Metropolitan should also make sure that regional expenditures produce regional benefits. Metropolitan should also evaluate its current programs of technical and financial assistance to local agencies to assure that financial burdens and regional benefits are equitably balanced.

Appendices

Appendix A
Glossary

Appendix A
Glossary

Brackish Groundwater - Groundwater with levels of mineral content that exceed drinking water standards.

Business Principles - Principles that will guide Metropolitan and its Member Agencies as the region proceeds with implementing the Integrated Resources Plan. These principles will guide resource development, including conservation programs, storage facilities (both groundwater and surface), and incentive programs in support of local resources.

Capital Improvement Program - Metropolitan's capital improvement program is designed to refurbish existing facilities needed to ensure: a reliable distribution system, expanded treatment facilities to meet current and future water quality regulations, and expanded storage and conveyance facilities to meet current and future storage requirements needed during droughts and emergencies.

Common Regional Resource Requirements - Those regional resource investments for imported and local supplies that are common to all of the resource mixes evaluated in the IRP.

Conjunctive Use - The practice of storing excess imported water in groundwater basins during normal and wet years for use during dry years thereby improving the region's supply reliability during droughts and emergencies.

Drought Management Plan (DMP) - A comprehensive water management plan that will minimize the need for mandatory supply cutbacks of imported water to Metropolitan's Member Agencies. The DMP will implement a series of water management strategies when a drought occurs, such as calling on stored imported water through its cooperative groundwater storage program, purchasing transfer water, and other management strategies designed to meet the water needs of the region. The DMP is a follow-up to the IRP and will provide essential information needed at the Member Agency level to ensure the development of local resources through groundwater, reclamation, and conservation programs.

Firm Supplies - The minimum existing imported and local supplies that would be available during a critical drought period, such as a repeat of 1991.

Groundwater Recovery - The treatment of degraded groundwater so that it could be beneficially used.

Groundwater Replenishment - The practice of recharging local groundwater basins with imported and local surface water supplies.

Integrated Resources Planning (IRP) - An open and participatory planning process which takes a broad view of all water resource options available to the region, and searches for the right combination of investments to achieve water supply objectives in a cost-conscious and environmentally responsible manner.

Lower Basin Coalition - A partnership among State agencies in Arizona, California, and Nevada, Indian tribes, resource users, and environmental interests to consider a multi-species habitat conservation and protection program for the Lower Colorado River.

Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California - A precedent-setting model for encouraging aggressive water conservation programs and for standardizing evaluation of water conservation savings. The MOU commits water suppliers to implement 16 urban water conservation measures. Presently, over 165 water suppliers, public interest groups, consultants, and other interested parties have signed the MOU.

Metropolitan Water District Service Area - A 5,149 square mile service area which includes portions of six counties in Southern California, over 250 communities, and a current population of about 15.7 million.

Multi-Species Habitat Conservation Plan - A coordinated ecosystem approach to resource management which ensures that regulations aimed at resolving one problem do not create new problems.

Peaking Management - Encouraging Member Agencies to reduce their summertime peak demands on Metropolitan's water treatment distribution system by applying charges and/or financial incentives.

Rate Structure - Metropolitan's new water rate structure which provides a stable water rate, secures a firm revenue base, retains system operating flexibility, and encourages management of resources.

Reliability Goal - A wholesale level supply reliability goal, stating that Metropolitan will provide 100 percent of full service wholesale demand to its Member Agencies 90 percent of the time. During critical drought periods, such as a repeat of 1991, Metropolitan will never provide less than 80 percent of full service wholesale demands.

Resource Mixes - Combinations of imported and local supply investments that meet a desired reliability goal and other regional objectives. Each resource mix is designed to include: (1) water conservation; (2) core imported and local supplies -- supplies available each and every year; (3) storage resources -- both groundwater and surface; and (4) swing supplies -- supplies which are available to meet demands during supply shortages, such as water transfers.

Sacramento-San Joaquin River Delta (Delta) - An environmentally sensitive area near Sacramento through which State Water Project water must flow to reach Southern California and other areas. Moving water across the Delta during the high-demand summer months, especially, is becoming more difficult as additional water is required for environmental purposes.

Total Dissolved Solids - A measure of the mineral content of water.

Water Conservation Best Management Practices - Established water conservation technologies and programs that address residential, commercial, industrial, and landscape water uses.

Water Management Principles - Principles which provide guidance in implementing recommended resource developments.

Wheeling - The use of Metropolitan's system for transmission of non-Metropolitan water supplies.

Appendix B
Local Resource Options

B-1 Potential Groundwater Recovery Projects

B-2 Potential Water Reclamation Projects

MWD

Appendix B-1
Potential Groundwater Recovery Projects

MWD

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
GROUNDWATER RECOVERY PROGRAM

10-Jan-94

Project	Contaminant	Total Yield Acre-Foot per year	MWD Replenishment Acre-Foot/Year	Est. Year Start	Estimated Unit Cost (1994 $ per Acre-Foot)
LEVEL 1- IN PROCESS OF IMPLEMENTATION					
1 Santa Monica	VOC	1,800		93	$373
2 Burbank Lake Plant	VOC	2,744	2,744	93	$401
3 West Basin No. 1	TDS	1,524		93	$632
4 Oceanside No. 1	TDS	2,000		94	$700
5 Tustin Desalter	TDS	3,271	909	95	$561
6 Irvine Desalter	TDS	6,700	1,926	95	$820
7 Rowland	TCE/TDS	516		96	$787
8 Menifee	TDS	3,360		96	$864
9 Chino/SAWPA No.1	TDS/Nitrate	12,000		96	$540
10 Beverly Hills	TDS	2,688		96	$668
11 Arlington Desalter	TDS/Nitrate	7,200		97	$561
12 Sweetwater Desalter No. 1	TDS	3,600		97	$609
13 Francis Desalter No.1	Nitrate	11,260	12,300	98	$711
LEVEL 1 - Subtotal		**58,663**	**17,879**	**Average =**	**$633**
LEVEL 2 - PROBABLE					
14 Burbank Valley Plant	VOC	2,300	2,300	97	$406
15 San Juan Desalter No. 1	TDS	4,300	2,000	96	$513
16 Oceanside No. 2	TDS	3,360		97	$413
17 Glendale	VOC	5,400	3,000	97	$525
18 San Pasqual	TDS/Nitrate	5,000		97	$419
19 San Mateo (Camp Pendleton)	TDS	6,000		98	$130
20 Laguna Beach Desalter	Color	2,000		98	$690
21 Capistrano Beach	TDS	1,372		98	$514
22 Winchester/Hemet Desalter	TDS	3,000		99	$586
23 Otay/Sweetwater	TDS	3,000		00	$636
24 San Juan Desalter No. 2	TDS	6,200	3,000	00	$582
25 Corona/Temescal	TDS/Nitrate	10,000		00	$512
26 Perris Basin	TDS	6,000		00	$531
27 West Basin No. 2	TDS	6,000		01	$647
28 Chino/SAWPA No. 2	TDS/Nitrate	8,000	9,200	02	$779
29 Western/Bunker Basin	Nitrate	8,100		03	$576
30 IRWD Colored Water Project	Color	10,000	10,500	03	$674
31 West Basin No. 3	TDS	5,000		03	$672
32 Moorpark	TDS	8,000	9,200	04	$1,003
33 San Dieguito Basin Desalter	TDS	5,000		04	$583
34 Rubidoux/Western	TDS/Nitrate	3,000		05	$636
LEVEL 2 - Subtotal		**111,032**	**39,200**	**Average =**	**$573**
LEVEL 1 + LEVEL 2 TOTAL		**169,695**	**57,079**		

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
GROUNDWATER RECOVERY PROGRAM

10-Jan-94

Project	Contaminant	Total Yield Acre-Foot per year	MWD Replenishment Acre-Foot/Year	Est. Year Start	Estimated Unit Cost (1994 $ per Acre-Foot)
LEVEL 3 - SPECULATIVE					
35 L.A. Pollock	VOC/Nitrate	5,000		99	$119
36 Torrance Ocean Ave Fac.	Chloride	1,500		99	$1,476
37 Camarillo	TDS/H_2S	2,270		99	$713
38 Hollywood Basin	TDS	3,000		99	$323
39 Santee/El Monte Basin	TDS	1,000		99	$948
40 L.A. Headworks	VOC/Nitrate	5,000		00	$74
41 West Covina Phase 1	TDS	5,000		00	$536
42 Riverview GWRAP	TDS/Nitrate	1,000		00	$948
43 Tia Juana River Valley District	TDS	2,500		00	$563
44 Torrance Elm Ave, Fac.	Chloride	2,500		00	$1,561
45 Chino/SAWPA No. 3	TDS/Nitrate	9,050	10,400	01	$779
46 Compton GW Project	TDS	1,000		02	$948
47 Sweetwater Desalter No. 2	TDS	3,500		02	$609
48 Mesa Colored Water Project	Color	13,500	14,175	03	$726
49 Huntington Beach Colored Water	Color	10,000	10,500	03	$840
50 West Covina Phase II	TDS	5,000		03	$536
51 March Air Force Base	TDS/Nitrate	1,500		03	$791
52 Dyer Rd. Color Removal	Color	10,000	10,500	04	$622
LEVEL 3 - Subtotal		82,320	45,575	Average =	$728
GROUNDWATER RECOVERY PROGRAM TOTAL		252,015	102,654		

Appendix B-2
Potential Water Reclamation Projects

MWD

Integrated Resource Plan -- Water Recycling Projects

Project Name	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Ult. O&M $/AF	Oper. Date	NPD!
** IRP Level: 1																	
Bellflower Reclamation Project	L	50	50	50	50	50	0	92	0.0	0	171	198	254	414	0	1978	no
Cal Trans (5 & 134 Fwys)	L	100	100	100	100	100	0	0	0.0	0	60	70	89	145	60	1984	no
Calabasas System	L	825	1000	1000	1000	1000	0	0	0.0	0	311	360	459	748	748	1972	no
Calabasas System Expansion	L	275	400	500	600	700	0	0	0.0	0	311	360	459	748	748	1991	no
California Country Club	L	372	375	375	375	375	0	0	0.0	0	7	8	9	11	0	1978	no
California Institution for Men	A	700	700	700	700	700	0	0	0.0	0	248	420	538	876	0	0	yes
Caltrans	L	21	65	65	65	100	0	83	0.0	0	236	92	108	131	100	1983	no
Camp Pendleton	I,L,R	3974	3900	3900	3900	3900	0	0	0.0	0	0	0	0	0	0	1942	yes
Central and West Basin Replenishment	R	50000	50000	75000	75000	75000	0	0	0.0	0	23	27	34	56	0	1961	no
Century Water Recycling Project	I,L	49	5000	7500	9000	9000	23	93	5.4	25	143	166	212	346	0	1992	no
Cerritos Reclaimed Water Extension Project	I,L	0	260	260	260	260	0	92	0.0	0	0	115	147	240	0	1993	no
Cerritos Reclamation Project	L	1649	2600	4000	4000	4000	6	88	0.0	0	143	121	155	252	0	1978	no
City of Industry Reclaimed System - Phase A	L	994	3360	3360	3360	3360	0	0	0.0	0	0	0	0	0	0	1983	no
El Prado Park and Golf Course	L	1300	1300	1300	1300	1300	0	0	0.0	0	0	0	0	0	0	1977	no
El Toro Existing	L	573	500	500	500	500	1	93	0.0	0	224	260	332	542	0	1965	no
Elsinore Valley/Horse Thief Reclamation	L	49	110	224	560	560	0	0	0.0	0	0	0	0	0	0	1989	
Elsinore Valley/Railroad Canyon Reclamation	L	730	730	730	730	730	0	0	0.0	0	0	0	0	0	0	1984	
Encina - Phase A	A,I,L	655	1800	2000	2100	2100	3	92	3.0	20	300	350	410	550	0	1992	no
Encina Water Pollution Control Facility	I,L	165	165	165	165	165	0	0	0.0	0	300	350	410	560	0	1992	no
Fairbanks Ranch	R	160	200	200	350	350	1	94	0.0	0	300	350	410	550	0	1998	no
Fallbrook Reclaimed Water Distr. - Phase A	I,L	128	800	800	1000	1000	4	93	4.8	20	190	210	230	250	0	1990	no
Forest Lawn Project	L	348	350	350	350	600	2	92	0.0	0	100	116	148	242	242	1992	no
Green Acres Project	I,L	1859	3300	6800	7700	7700	68	93	0.0	0	86	99	127	207	0	0	no
Griffith Park	L	1625	1800	2000	9900	9900	0	0	0.0	0	60	70	89	145	60	1976	no
Hemet/SJ Reg. Rec. - Recharge Phase A	R	1037	1037	1037	1037	1037	0	0	0.0	0	26	30	39	63	0	0	yes
Hemet/SJ Regional Reclamation - Direct	A,E,L	6454	14178	28123	27464	22815	6	91	0.0	0	26	30	39	63	0	1966	yes
Indian Hills Reclamation Project	L	1310	1310	1310	1310	1310	0	0	0.0	0	0	0	0	0	0	1980	
Irvine Ranch Part 1	A,L,M	5826	6474	6474	6474	6474	22	93	0.0	0	162	188	240	392	0	0	no
Irvine Ranch Part 1 Expansion	A,L,M	3185	3887	3887	3887	3887	10	93	0.0	0	162	188	240	392	0	0	no
Irvine Ranch Part 2	A,L,M	0	526	526	3526	3526	11	93	0.0	0	162	188	240	392	0	0	no
Irvine Ranch Part 2 Expansion	A,L,M	0	3813	3813	3813	3813	26	93	0.0	0	167	193	248	403	0	0	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Ult. O&M $/AF	Oper. Date	NPDE
Jamacha - Phase A	I,L	537	1000	1100	1400	1400	6	91	3.0	20	300	350	410	560	0	1980	no
La Canada-Flintridge Country Club	L	135	135	135	135	135	0	0	0.0	0	1357	1466	1871	2388	2388	1962	no
Lakewood Water Reclamation Project	L	412	800	1400	1800	1800	1	88	4.0	0	259	294	376	613	0	1989	no
Las Virgenes Valley System	A,L	300	300	300	300	300	0	0	0.0	0	128	149	190	310	310	1972	yes
Las Virgenes Western System	L	3000	3100	3500	4200	5700	0	0	0.0	0	311	360	459	748	748	1986	no
Long Beach Reclamation Project	L	1044	1500	1500	1500	1500	2	88	4.0	20	321	372	477	777	777	1980	no
Long Beach Reclamation Project	I,L	2029	2500	2500	2500	2500	0	0	0.0	0	321	372	477	777	777	1980	no
Los Alisos WD	A,L	1171	1722	1722	1722	1722	11	93	0.0	0	181	210	269	438	0	1966	no
Los Alisos WD Expansion	A,L	0	128	378	778	778	1	93	0.0	0	181	210	269	438	0	0	no
Los Angeles Greenbelt	L	29	1600	1600	1600	1600	7	92	6.1	30	60	70	89	145	60	1992	no
March Reclamation Project		261	261	261	261	261	0	0	0.0	0	0	0	0	0	0	0	
Media City Center	L	0	25	25	50	50	1	90	7.1	25	0	400	480	280	340	1993	no
Moreno Valley Reclamation	A,E,L,R	8557	10579	10571	10761	10811	7	92	0.0	0	156	181	232	378	0	1987	yes
Moulton Niguel WD Existing	L	470	470	470	470	470	0	0	0.0	0	0	0	0	0	0	1964	no
Moulton Niguel WD Expansion - AWMA	L	570	1130	3530	5530	5530	0	0	0.0	0	0	0	0	0	0	0	no
OCWD WF21 Above 12-yr. Avg.	R	8192	3500	3500	3500	3500	7	93	0.0	0	381	442	566	922	0	0	no
Oak Park/North Ranch Reclaimed Water Line	L	0	1300	1300	1300	1300	5	93	0.0	0	0	66	84	138	0	1995	no
Oceanside - Phase A	I,L	93	300	300	300	300	0	0	0.0	0	300	350	410	560	0	1992	no
Ontario Golf Course and Westwind Park	L	700	1200	1200	1200	1200	0	0	0.0	0	0	0	0	0	0	1968	no
PSD Power Plant	I,L	900	900	900	900	900	0	0	0.0	0	2	3	4	7	11	1967	no
Perris Valley Regional Reclamation	A,E,L,R	2309	2824	9346	11346	11346	0	0	0.0	0	26	30	39	63	0	1989	no
Pomona Reclamation Project	A,E,I,L,M	7507	9000	9400	9600	9600	0	0	0.0	0	116	135	172	281	0	1966	
Power Plant Project	I,L	451	450	450	450	450	0	0	0.0	0	100	116	148	242	242	1980	no
Puente Hills/Rose Hills	I,L	0	2522	2810	3267	4000	5	93	0.0	0	0	120	140	160	200	1995	no
Rancho California Reclamation Expansion	A,L	0	4800	6000	6000	6000	32	89	0.0	0	0	181	232	378	0	1994	yes
Rancho California/Joaquin Ranch Reclamation	L	269	360	360	672	672	0	0	0.0	0	0	0	0	0	0	1984	
Rancho Santa Fe	I,L,R	208	200	200	300	350	2	93	3.0	20	300	350	410	550	0	1994	no
Rio Hondo Water Recycling Project - Phase 1	I,L	0	5000	6000	8000	8000	10	93	6.1	30	0	166	212	346	0	1995	no
San Pasqual - Phase A	A,I,L	0	800	800	1000	1000	2	92	3.0	20	0	500	550	600	0	1994	no
San Vincente	A,I,L	500	600	600	800	1200	0	0	0.0	0	350	450	480	580	0	1975	yes
Santa Ana River Reclamation Project	R	158000	120000	155000	185000	200000	0	0	0.0	0	0	0	0	0	0	0	
Santa Margarita WD - Oso	L	795	1148	1148	1284	1284	17	93	0.0	0	497	577	738	1203	0	1977	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Ult. O&M $/AF	Oper. Date	NPDE
Santa Margarita WD - Oso Expansion	L	1130	1500	1500	1500	1500	20	93	0.0	0	497	577	738	1203	0	0	no
Santa Maria - Phase A	A,I,L,R	617	700	700	700	700	0	0	0.0	0	300	350	410	560	0	0	no
Santa Monica Water Gardens	L,M	0	22	22	22	22	0	0	0.0	0	0	0	0	0	0	1994	no
Santa Rosa Water Reclamation Facility	A,E,L	0	1	2	3	5	0	0	0.0	0	0	0	0	0	0	1990	
Santee - Phase A	I,L	405	400	400	400	400	0	0	0.0	0	300	350	410	550	0	1968	no
Sepulveda Basin - Phase 1	E,L	0	1444	1444	1444	1444	3	93	6.1	30	0	134	161	185	0	1994	no
South Laguna Reclaimed Water	L	860	900	900	900	900	0	0	0.0	0	448	544	667	944	1222	1984	no
South Laguna Reclamation Expansion	L	0	100	300	600	600	2	89	6.0	5	0	400	333	417	417	1990	no
South Lasselle Reclamation	L	0	357	357	357	357	0	93	0.0	0	0	181	232	378	0	1993	yes
Sun City Golf Courses	L	590	652	652	652	652	0	0	0.0	0	272	316	404	658	0	1983	no
Temecula Valley Reclamation - Phase A	A,L	3269	3300	3300	3300	3300	0	0	0.0	0	156	181	232	378	0	1989	yes
Trabuco Canyon WD - Parts 1 & 2	L	450	550	850	850	850	4	92	0.0	0	53	62	79	129	0	0	yes
Upland Hills Country Club	L	224	224	224	224	224	0	0	0.0	0	796	915	1052	1210	0	1983	yes
Valley Center - Phase A	R	275	300	350	500	500	0	0	0.0	0	300	350	410	550	0	0	no
Verdugo-Scholl Project - Phase 1	L	0	674	832	1054	1054	13	93	0.0	16	0	170	218	355	0	1995	no
Vista - Phase A	I,L	49	300	300	300	300	0	0	0.0	0	300	350	410	550	0	0	no
Walnut Valley Reclamation Project	A,L	1293	1500	2000	2000	2000	0	0	0.0	0	170	197	252	411	0	1986	
Water Reclamation Project - Phase A	L	800	800	800	800	800	7	89	0.0	0	407	472	985	1606	0	0	no
West Basin Water Recycling Project - Phase A	I,L,R	0	11200	11200	11200	11200	100	92	5.4	25	0	200	256	417	0	1994	no
West Coast Barrier Project	I,L,R	0	5600	20000	20000	20000	0	0	0.0	0	0	400	512	835	0	0	
Western Hills Country Club	L	17	17	17	17	17	0	0	0.0	0	1765	2059	2635	4296	0	0	yes
Whispering Palms	A,R	118	200	200	350	350	0	0	0.0	0	300	350	410	560	0	1981	yes
Winchester/Temecula Regional Reclamation Sys.	A,E,L	0	2313	3983	3423	3423	20	92	0.0	0	0	181	232	378	0	1993	yes
** Subtotal **		292949	323298	435688	489098	502569	470			306							
** IRP Level: 2																	
Alamitos Barrier Project - Parts 1 & 2	R	0	0	5000	10000	10000	20	96	0.0	0	0	0	315	513	513	1996	no
Brand Park Project	L	0	50	80	100	120	3	93	0.0	16	0	120	154	251	251	1995	no
City of Industry Reclaimed System - Phase B	L	0	0	4000	4000	4600	26	93	0.0	0	0	0	0	0	0	1996	no
City of Long Beach Reclaimed Water MasterPlan	I,L	0	4780	4780	4780	4780	33	92	0.0	0	0	110	141	230	230	1995	no
Clean Water Program - Phase A	I,L	0	0	5000	15000	15000	190	93	0.0	0	0	0	410	550	0	1997	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Ult. O&M $/AF	Oper. Date	NPDE
Elsinore Valley Water Reclamation Project		0	1800	4500	5400	5400	0	0	0.0	0	0	0	0	0	0	0	
Escondido	A,E,L,R	16	30	1500	2800	3500	40	94	2.6	20	300	350	410	560	0	1996	no
Haun Road (Rose Hills Memorial Park)	L	0	410	2876	2876	2876	4	92	0.0	0	0	181	232	378	0	1995	no
OCWD WF21 Expansion 1	R	0	0	8000	8000	8000	16	93	0.0	0	0	0	566	922	0	0	no
Oceanside - Phase B	I,L	0	0	700	1700	1700	5	93	0.0	0	0	0	410	560	0	0	no
Reclaim Expansion Debell/Landfill	L	0	539	539	647	793	5	93	4.2	20	0	241	297	371	378	1995	no
Rio Hondo Water Recycling Project - Phase 2	I,L	0	2000	7000	7000	9500	20	93	0.0	0	0	166	212	346	0	2000	no
San Elijo	A,I,L	0	0	1200	1800	1800	13	94	2.6	20	300	350	410	560	0	1997	no
San Gabriel Valley Water Reclamation Project	A,I,L,R	0	25000	31000	35000	35000	35	93	6.5	30	0	75	96	157	0	1995	no
Santa Maria - Phase B	A,I,L	0	0	100	300	1100	5	94	3.0	20	0	350	410	550	0	1996	no
Santee - Phase B	I,L	0	200	600	700	700	14	93	2.6	20	0	350	410	550	0	1996	no
Sepulveda Basin - Phase 2	E,L	0	0	196	419	2056	3	93	6.1	30	0	0	161	185	0	1996	no
South Laguna Expanded Reclamation Project	L	0	1000	2500	2500	2500	5	93	0.0	0	0	500	760	800	800	1995	no
Temecula Valley Reclamation - Phase B	A,L	0	1978	1803	1803	1803	1	93	0.0	0	0	181	232	378	0	1995	yes
Valley Center - Phase B	I,L	0	0	250	500	1000	6	95	0.0	0	0	0	410	550	0	1997	no
West Basin Water Recycling Project - Phase B	I,L,R	0	13600	37200	38800	38800	50	92	0.0	0	0	200	256	417	0	2000	no
Westside Los Angeles	I,L,R	0	600	1400	5000	10000	40	94	6.1	30	0	50	64	104	50	1995	no
Whittier Narrows Recreation Area	L	0	2383	3138	3138	3138	9	94	0.0	0	0	138	188	298	0	1995	no
** Subtotal **																	
		16	54370	123362	152263	164166	542			206							
** IRP Level: 3																	
Carbon Canyon Core	L	0	0	1050	1500	2000	6	93	0.0	0	0	0	322	368	353	1995	no
Central City/Elysian Park	I,L	0	0	2100	4100	4100	20	93	6.1	30	0	0	100	163	0	1997	no
City of Corona Irrigation I15/I91	L	0	0	730	913	1825	0	0	0.0	0	0	0	0	0	0	0	
City of Industry Reclaimed System - Phase C	L	0	0	0	0	640	0	0	0.0	0	0	0	0	0	0	0	no
City of Pasadena Reclaimed Water System	I,L	0	0	4700	4700	4700	27	93	0.0	0	0	0	275	448	448	1996	no
Clean Water Program - Phase B	I,L	0	0	0	0	15000	200	93	0.0	0	0	0	0	0	0	0	no
East Valley	I,L,R	0	0	10000	35000	35000	55	93	6.1	30	0	0	150	245	150	1997	no
Eastside Los Angeles	I,L	0	0	800	1500	1500	0	0	0.0	0	0	0	0	0	0	2000	no
El Toro Expansion	L	0	0	450	750	750	8	93	0.0	0	286	331	424	691	0	0	no
Encina - Phase B	I,L	0	0	0	1900	2900	28	93	0.0	0	0	0	0	550	0	0	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Ult. O&M $/AF	Oper. Date	NPDES
Fallbrook Reclaimed Water Distr. - Phase B	I,L	0	0	0	200	500	2	93	0.0	0	0	0	0	250	0	0	no
Forest Lawn Reclaimed Water	L	0	160	260	360	360	0	0	0.0	0	0	165	240	310	0	1995	no
Headworks	R	0	0	5000	10000	15000	20	93	6.1	30	0	200	256	417	0	1995	no
Hemet/SJ Reg. Rec. - Recharge Phase B	R	0	2963	3963	4963	4963	1	93	0.0	0	0	30	39	63	0	1995	yes
Hill Canyon Reclaimed Water Project	A,E,L,R	0	5000	5000	5000	5000	3	93	0.0	0	0	110	141	229	0	1995	yes
Irvine Ranch East Orange Expansion	A,L,M	0	0	4100	6000	11000	28	93	0.0	0	195	226	290	472	0	0	no
Irvine Ranch Part 3	A,L,M	0	0	4500	6300	6300	28	93	0.0	0	181	210	269	438	0	0	no
Jamacha - Phase B	I,L	0	0	0	2600	3600	36	91	0.0	0	0	0	0	560	0	0	no
Los Angeles Harbor	I,R	0	0	5500	10500	30000	50	93	6.1	30	0	0	300	489	0	1998	yes
Moorpark Wastewater Treatment Facility	A	0	1600	2200	3200	3200	0	0	0.0	0	0	60	60	60	0	1995	no
Moulton Niguel WD Expansion - SERRA	L	0	1000	2000	2000	2000	0	0	0.0	0	0	0	0	0	0	0	no
Nason Street Reclamation	L	0	800	1350	1350	1350	1	94	0.0	0	0	181	232	378	0	1995	no
OCWD Regional Water Reclamation Project	R	0	0	50000	75000	100000	231	93	0.0	0	0	0	425	692	0	0	no
OCWD WF21 Expansion 2	R	0	0	0	10000	10000	20	93	0.0	0	0	0	0	922	0	0	no
Oceanside - Phase C	I,L	0	0	0	500	3600	19	93	0.0	0	0	0	0	560	0	0	no
Olivenhain	A,I,L	0	0	1200	3000	3000	21	94	0.0	0	300	350	410	550	0	1997	no
Olsen Road/Sunset Hills Wastewater Trmt. Fac.	L	0	249	249	249	249	1	91	0.0	0	0	320	390	576	701	1995	no
Oxnard Reclaimed Water Project	A,I,L,R	0	0	15000	15000	15000	20	93	0.0	0	0	0	84	138	0	2000	yes
Pico-Kenter Drain Low Flow Treatment Plant	L	0	250	250	250	250	2	95	6.8	25	0	0	0	0	0	1995	no
Pomona Reclaimed Water Storage Reservoir	A,E,I,L,M	0	0	2000	2500	2500	0	0	0.0	0	0	0	0	0	0	0	
Poway	I,L	0	0	500	2000	2000	11	95	0.0	0	300	350	410	550	0	1999	no
Regional Plant #1 Core	A,I,L	0	0	4000	5000	7500	24	92	0.0	0	0	0	223	330	0	2000	no
Regional Plant #4 Core	L	0	0	3937	5000	7500	7	92	0.0	0	0	0	223	330	0	1998	no
Rowland Reclamation Project	L	0	1500	2000	2000	2000	8	95	0.0	0	0	16	15	18	0	1995	no
San Marcos	E,I,L	0	0	0	1000	1500	0	0	0.0	0	0	0	0	560	0	0	no
San Pasqual - Phase B	I,L	0	0	0	1000	1000	11	92	0.0	0	0	0	0	600	0	0	no
Santa Margarita WD - Chiquita	L	0	0	2100	3600	3600	33	93	0.0	0	0	0	187	304	0	0	no
Santa Margarita WD - Chiquita Expansion	L	0	0	0	0	11000	0	0	0.0	0	0	0	0	0	0	0	no
Santee - Phase C	I,L	0	0	0	900	900	0	0	0.0	0	0	0	0	550	0	0	no
Simi Valley Reclaimed Water Project	L	0	500	5000	5000	10000	15	93	0.0	0	0	66	84	138	0	1995	no
Trabuco Canyon WD - Part 3	L	0	0	50	500	650	0	92	0.0	0	53	62	79	129	0	0	yes
Verdugo-Scholl Project - Phase 2	L	0	0	0	0	946	7	93	0.0	0	0	0	0	0	0	0	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Ult. O&M $/AF	Oper. Date	NPDE!
Vista - Phase B	I,L	0	0	100	700	1200	14	93	0.0	0	0	0	410	550	0	1996	no
Walnut Valley Reclamation Plant Expansion	A,L	0	0	1000	2000	2600	7	0	0.0	0	0	0	252	411	0	0	no
Water Reclamation Project - Phase B	L	0	0	2750	2750	2750	11	91	0.0	0	0	0	985	1606	0	2000	no
West Basin Water Recycling Project - Phase C	I,L,R	0	0	0	30000	30000	0	0	0.0	0	0	0	0	417	0	0	no
West Valley Greenbelt	I,L	0	0	0	2350	2350	25	93	6.1	30	0	0	0	149	0	2005	no
** Subtotal **																	
		0	14022	143839	273135	373783	1002			175							
*** Total ***																	
		292965	391690	702889	914496	1040518	2014			687							

Appendix C
Groundwater Conjunctive Use Potential

MWD

Appendix C
Groundwater Conjunctive Use Potential

The following subsections summarize the current operations of the nine largest groundwater basins within Metropolitan's service area. Also presented is a range of investement levels in conjunctive use storage. For each investment level, additional storage, production, and recharge capabilities over and above historical levels are presented. The production capabilies discussed in these subsections only include additional production achievable through a conjunctive use program using available imported water from Metropolitan. The numbers presented in these subsection also do not include additional groundwater basin production that may be achieved through groundwater recovery (see Section 4.2) and groundwater replenishment with reclaimed water (see Section 4.3).

For each basin, a table lists historic production/recharge showing:

- *Production:* Range in yearly groundwater produced from each basin since 1980.
- *Direct Recharge of Imported Supplies:* Imported water place in spreading basins or injection well to replenish groundwater.
- *In-Lieu Recharge of Imported Supplies:* Imported water historically provided to Member Agencies overlying a groundwater basin in-lieu of using groundwater.

The tables also lists the capabilities of each groundwater basin to support a conjunctive use storage program:

- *Storage:* Total additional storage volume available for conjunctive use operations if sufficient imported water was available.
- *Production:* Potential additional annual groundwater production facility capacity.
- *Direct Recharge of Imported Supplies:* Potential additional annual groundwater recharge/injection facility capacity.
- *In-Lieu Recharge of Imported Supplies:* The amount of groundwater production that can be replaced by imported supplies.

Upper Los Angeles River Basins

Current Basin Capacity (acre-ft/yr)

Production: 65,000 to 140,000

Recharge of Imported Supplies:
- Direct: 0
- In-Lieu: 0

Additional Conjunctive Use Potential

Storage (acre-feet):
- Low: 100,000
- High: 300,000

Production (acre-ft/yr):
- Low: 50,000
- High: 70,000

Direct Recharge of Imported Supplies (acre-ft/yr)
- Low: 35,000 to 75,000
- High: 35,000 to 75,000

In-Lieu Recharge of Imported Supplies (acre-feet):
- Low: 70,000
- High: 70,000

Upper Los Angeles River Area (ULARA) Basins (San Fernando, Sylmar, Verdugo, and Eagle Rock) are adjudicated basins operated by a single watermaster. Four member agencies (the Cities of Los Angeles, Glendale, Burbank, and San Fernando) use water from these basins. Since 1980, the historic annual production of the ULARA basins average about 100,000 acre-ft, ranging between 65,000 and 140,000 acre-feet per year. The City of Los Angeles has identified a range of 100,000 to 300,000 acre-feet of storage capacity in the San Fernando Basin for conjunctive use of Metropolitan supplies. In addition, the City of Los Angeles plans to annually supplement existing natural groundwater replenishment with 35,000 acre-feet of reclaimed water. The Watermaster estimates that annual dry weather production could be increased by about 50,000 to 70,000 acre-feet over current production. The City of Los Angeles has excess extraction well capacity to effect additional groundwater production beyond this range. Factors limiting further conjunctive use potential in the San Fernando Basin include the City of Los Angeles' distribution capacity and groundwater quality concerns. The watermaster has estimated direct recharge capability of Metropolitan's supplies of 35,000 to 75,000 acre-ft/yr depending on hydrologic conditions. In addition, approximately 70,000 acre-ft/yr of in-lieu capacity is available for storing imported supplies.

Central and West Coast Basins

Current Basin Capacity (acre-ft/yr)

Production: 216,000 to 268,000

Recharge of Imported Supplies:

- Direct 42,000 to 91,000
- In-Lieu 20,000 to 85,000

Additional Conjunctive Use Potential

Storage (acre-feet):

- Low: 150,000
- High: 180,000

Production (acre-ft/yr):

- Low: 88,000
- High: 110,000

Direct Recharge of Imported Supplies (acre-ft/yr)

- Low: 20,000 to 100,000
- High: 20,000 to 100,000

In-Lieu Recharge of Imported Supplies (acre-feet):

- Low: 110,000
- High: 110,000

Central and West Coast Basins are adjudicated basins that provide water to six member agencies (Central Basin MWD, West Basin MWD, and the Cities of Los Angeles, Compton, Torrance, and Long Beach). Since 1980, the total historic annual production of these basins average about 245,000 acre-feet, ranging between 216,000 and 268,000 acre-feet per year. The Water Replenishment District estimates that between 150,000 to 180,000 acre-feet of storage capacity over and above that currently used is available for additional conjunctive use operations. Approximately 1,000 active groundwater production wells currently exist in these basins. The Water Replenishment District also estimates that annual dry weather production could be increased at least 88,000 acre-feet. Increased production would result from new interconnections among local water purveyors with surplus pumping capacity and purveyors with demands in excess of pumping capacity. The Water Replenishment District also projects that if 10 to 15 additional production wells are installed, annual production capacity will increase by 110,000 acre-feet over current production. Natural replenishment to the basins averages 130,000 acre-ft/yr. The current average pumping level of 245,000 acre-ft/yr requires supplemental replenishment, including seawater barrier injection of 30,000 to 40,000 acre-ft/yr, average annual spreading of 10,000 to 50,000 acre-ft/yr of imported water, annual spreading of 50,000 acre-ft/yr of reclaimed water, and continued in-lieu recharge of 30,000 acre-ft/yr by local agencies throughout the basins. The Central and West Coast Basins also have in-lieu capacity of up to 110,000 acre-ft/yr to effect additional storage of imported supplies. Central Basin MWD and West Basin MWD have plans to increase the use of reclaimed water from groundwater replenishment and seawater barrier injection, thus reducing the need for supplemental imported supplies.

Main San Gabriel Basin

Current Basin Capacity (acre-ft/yr)

Production: 200,000 to 250,000

Recharge of Imported Supplies:

- Direct: 0 to 64,000
- In-Lieu: 0

Additional Conjunctive Use Potential

Storage (acre-feet):

- Low: 150,000
- High: 150,000

Production (acre-ft/yr):

- Low: 45,000
- High: 45,000

Direct Recharge of Imported Supplies (acre-ft/yr)

- Low: 100,000 to 240,000
- High: 100,000 to 240,000

In-Lieu Recharge of Imported Supplies (acre-feet):

- Low: 65,600
- High: 65,600

Main San Gabriel Basin (including the Puente Basin) is an adjudicated basin supplying over 90 percent of the water needed by three member agencies (Three Valleys MWD, Upper San Gabriel Valley MWD, and the City of San Marino). Since 1980, the historic annual production by member agencies from these basins averages about 230,000 acre-feet, ranging between 200,000 and 250,000 acre-feet per year. The San Gabriel Valley is highly permeable and has extensive spreading facilities for replenishing local surface waters and imported supplies. The Puente Basin produces very little groundwater because of the high clay content of the soils and existing groundwater quality problems. The current groundwater production level is supported by approximately 40,000 acre-ft/yr of direct replenishment of imported supplies. Approximately 250 groundwater production wells currently exist. Groundwater recovery programs provide the greatest potential for increasing groundwater production in this basin. The groundwater basin manager estimates that annual dry weather production could be increased by about 45,000 acre-feet with existing surplus well capacities. Local needs and water quality concerns limit further increases in production at this time. The basin has surplus well capacities to increase in-lieu replenishment and dry-year production up to 65,600 acre-ft/yr. However, current direct demand on Metropolitan's supply is only 10,000 to 12,000 acre-ft/yr. To increase conjunctive use ability in this basin would involve extracting groundwater (stored imported supplies) and exporting it to other basins via Metropolitan's distribution system.

Chino Basin

Current Basin Capacity (acre-ft/yr)

Production: 122,000 to 156,000

Recharge of Imported Supplies:
- Direct: 3,300 to 26,600
- In-Lieu: 17,000

Additional Conjunctive Use Potential

Storage (acre-feet):
- Low: 50,000
- High: 200,000

Production (acre-ft/yr):
- Low: 20,000
- High: 90,000

Direct Recharge of Imported Supplies (acre-ft/yr)
- Low: 18,000 to 31,700
- High: 31,700 to 80,000

In-Lieu Recharge of Imported Supplies (acre-feet):
- Low: 53,000
- High: 53,000

Chino Basin (including Cucamonga Basin) groundwater supports virtually all agricultural use and almost 90 percent of the M&I uses within the basin. The Chino Basin MWD, Three Valleys MWD, and Western MWD are the Member Agencies within the adjudicated Chino Basin. Since 1980, the historic annual production of the basin averages about 140,000 acre-feet, ranging between 122,000 and 156,000 acre-feet per year. Existing groundwater replenishment is provided by several spreading basins for runoff from the San Gabriel Mountains, and 14,000 acre-ft/yr of imported supplies. Approximately 900 groundwater production wells currently exist. The groundwater basin manager estimates that annual dry weather production could be increased by about 20,000 acre-feet with existing surplus well capacities. The groundwater basin could have an additional annual production capacity of 90,000 acre-feet if improvements to about 120 acres of spreading basins, approximately 15 new extraction wells, and new turnouts from Metropolitan's Rialto and Foothill Feeders are provided. Due to the limited overlying demand for Metropolitan's direct delivery, about 40,000 acre-ft/yr of stored imported supplies when extracted will be exported to other basins via Metropolitan's distribution system. In-lieu capability within Chino Basin could increase to 53,000 acre-ft/yr, limited by its overlying demand for Metropolitan's supplies.

Orange County Basin

Current Basin Capacity (acre-ft/yr)

Production: 230,000 to 290,000

Recharge of Imported Supplies:

- Direct: 5,000 to 52,000
- In-Lieu: 10,000 to 49,000

Additional Conjunctive Use Potential

Storage (acre-feet):

- Low: 200,000
- High: 400,000

Production (acre-ft/yr):

- Low: 120,000
- High: 200,000

Direct Recharge of Imported Supplies (acre-ft/yr)

- Low: 90,000 to 240,000
- High: 90,000 to 240,000

In-Lieu Recharge of Imported Supplies (acre-feet):

- Low: 219,000
- High: 219,000

Orange County Basin is managed by Orange County Water District (OCWD), providing water to five Member Agencies (MWD of Orange County, Coastal MWD, and the Cities of Anaheim, Fullerton, and Santa Ana). Since 1980, the historic annual production of the basin averages about 250,000 acre-feet, ranging between 230,000 and 290,000 acre-feet per year. The current average annual production is supported by an average replenishment of 30,000 acre-ft/yr of imported supplies and 110,000 acre-ft/yr of reclaimed water. OCWD has recently completed $47 million of improvements to groundwater replenishment facilities that percolate Santa Ana River flows and imported supplies. Approximately 800 groundwater production wells currently exist. OCWD has identified between 200,000 and 400,000 acre-ft of storage available for conjunctive use. OCWD estimates that annual dry weather production could be increased by about 120,000 acre-feet using existing surplus pumping capacities. The groundwater basin manager projects that by installing an additional 20 production wells, annual production capacity will increase by about 200,000 acre-feet. OCWD also estimated that 90,000 to 240,000 acre-ft/yr of additional imported supplies can directly recharge the groundwater basin using existing and planned improvements to spreading facilities. By the year 2010, OCWD plans to replenish the groundwater basin with 75,000 acre-ft/yr of reclaimed water, thus partially displacing the capacity for spreading imported supplies. Current in-lieu replenishment is about 40,000 acre-ft/yr. OCWD estimated that local water purveyors have the capacity for 219,000 acre-ft/yr for in-lieu operations.

Raymond Basin

Current Basin Capacity (acre-ft/yr)

Production: 26,000 to 39,000

Recharge of Imported Supplies:

- Direct: 0
- In-Lieu: 13,000

Additional Conjunctive Use Potential

Storage (acre-feet):

- Low: 100,000
- High: 150,000

Production (acre-ft/yr):

- Low: 25,000
- High: 31,600

Direct Recharge of Imported Supplies (acre-ft/yr)

- Low: 12,000
- High: 17,500

In-Lieu Recharge of Imported Supplies (acre-feet):

- Low: 20,000
- High: 26,200

Raymond Basin is an adjudicated basin that supplies much of the annual water demand of two Member Agencies (Foothill MWD and the City of Pasadena). Groundwater from the Raymond Basin also meets a portion of the water needs of the City of San Marino (a Metropolitan Member Agency) and the City of Arcadia (a subagency of Upper San Gabriel Valley MWD). Annual production is about the basin's safe yield of 30,600 acre-ft/yr. Actual basin production since 1980 ranges from 26,000 to 39,000 acre-ft/yr. Existing groundwater replenishment is provided by four spreading basins for runoff from the San Gabriel Mountains. Approximately 50 groundwater production wells currently exist. The groundwater basin manager estimates that annual dry weather production could be increased by about 25,000 acre-feet using existing surplus production capacity. The groundwater basin manager projects that groundwater production could be further increased by installing six aquifer storage and recovery wells for injecting 17,500 acre-ft/yr of imported supplies, and constructing interconnections among local water purveyors. These facilities will increase annual production capacity by about 31,600 acre-feet over current production level. The watermaster (Raymond Basin Management Board) also estimated in-lieu replenishment capacity of between 20,000 and 26,200 acre-ft/yr.

Southern Ventura County Basins

Current Basin Capacity (acre-ft/yr)

Production: 17,000 to 31,000

Recharge of Imported Supplies:
- Direct: 0
- In-Lieu: 0

Additional Conjunctive Use Potential

Storage (acre-feet):
- Low: 350,000
- High: 350,000

Production (acre-ft/yr):
- Low: 30,000
- High: 100,000

Direct Recharge of Imported Supplies (acre-ft/yr)
- Low: 9,800
- High: 70,000

In-Lieu Recharge of Imported Supplies (acre-feet):
- Low: 30,000
- High: 30,000

Southern Ventura County Basins include the Oxnard Plain Forebay, Oxnard Plain Pressure Area, Pleasant Valley Basin, North and South Las Posas Basins, and several small basins underlying Thousand Oaks, Simi Valley, and the Santa Rosa valley. Since 1980, the historic annual production within the Calleguas MWD service area that overlies these basins averages about 22,000 acre-feet, ranging between 17,000 and 31,000 acre-feet per year. Existing groundwater replenishment is provided by two recharge areas for diverted Santa Clara River flows and releases from Santa Felicia Dam. Calleguas MWD has identified conjunctive use storage capacity of 350,000 acre-feet in the North Las Posas Basin. Calleguas MWD currently has one aquifer storage and recovery (ASR) well and has 5 wells in design. Construction of four ASR wells will allow replenishment with 9,800 acre-ft/yr of imported supplies. Together with the in-lieu replenishment capability of 30,000 acre-ft/yr, dry-year production can be increased by 30,000 acre-ft/yr over existing production. If 30 ASR wells planned for injection of up to 70,000 acre-ft/yr of imported supplies are constructed, annual production capacity will increase by 100,000 acre-feet over current production.

Western Riverside County Basins

<u>*Current Basin Capacity (acre-ft/yr)*</u>

Production: 220,000 to 270,000

Recharge of Imported Supplies:
- Direct: 0
- In-Lieu: 2,000

<u>*Additional Conjunctive Use Potential*</u>

Storage (acre-feet):
- Low: 100,000
- High: 100,000

Production (acre-ft/yr):
- Low: 10,000
- High: 22,000

Direct Recharge of Imported Supplies (acre-ft/yr)
- Low: 10,000
- High: 10,000

In-Lieu Recharge of Imported Supplies (acre-feet):
- Low: 5,000
- High: 37,000

Western Riverside County Basins are found along valleys in the Riverside-Arlington, Temescal, and Lake Elsinore areas, and are operated by subagencies of Western MWD. In addition, the City of Riverside, a subagency of Western MWD, imports groundwater from the Bunker Hill Basin in San Bernardino County. Since 1980, the historic annual production of these basins averages about 240,000 acre-feet, ranging between 220,000 and 270,000 acre-feet per year. Existing groundwater replenishment is provided by percolation of local runoff into these valleys. Western MWD has identified about 100,000 acre-feet of conjunctive use opportunities within its service area, primarily in the Elsinore and Temescal areas near the Riverside and San Diego County lines. Additional dry-year production is estimated at between 10,000 and 22,000 acre-ft/yr. Currently, in-lieu replenishment in the area of 2,000 acre-ft/yr could be increased by between 5,000 and 37,000 acre-ft/yr. Five to seven additional wells would probably be needed for the higher levels of additional production.

Eastern Riverside County Basins

Current Basin Capacity (acre-ft/yr)

Production: 85,000 to 110,000

Recharge of Imported Supplies:

- Direct: 0
- In-Lieu: 0

Additional Conjunctive Use Potential

Storage (acre-feet):

- Low: 100,000
- High: 100,000

Production (acre-ft/yr):

- Low: 10,000
- High: 22,000

Direct Recharge of Imported Supplies (acre-ft/yr)

- Low: 10,000
- High: 10,000

In-Lieu Recharge of Imported Supplies (acre-feet):

- Low: 5,000
- High: 40,000

Eastern Riverside County Basins (San Jacinto, Lakeview, Perris, Hemet, Winchester, Menifee, Diamond, Domenigoni, French, Auld, Murreta-Temecula, and Pechanga) are operated by Eastern MWD and its subagencies. Since 1980, the historic annual production from these basin averages about 90,000 acre-ft, ranging between 85,000 and 110,000 acre-feet per year. Existing groundwater replenishment is provided principally by natural percolation of runoff into valleys. Some conjunctive use opportunities have been identified within the Eastern MWD service area, primarily within the San Jacinto and Temecula basins. The IRP estimates that 100,000 acre-ft of storage capacity is available for conjunctive use. Additional production during dry years is estimated at between 10,000 and 22,000 acre-ft if between 3 and 16 new production wells are installed. In addition, improvements to spreading areas and pipelines to convey imported supplies to the spreading grounds will be required.

Appendix D
Strategic Resources Assessment Summary Report

MWD

FINAL DRAFT REPORT

STRATEGIC WATER RESOURCES ASSESSMENT

NOVEMBER 1994

MONTGOMERY WATSON, INC.

In Association With
KEVIN P. HUNT, WATER RESOURCES ENGINEER

TABLE OF CONTENTS

Table of Contents

Title	Page No.

Table of Contents

Title	Page No.

Table of Contents

Title **Page No.**

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The need for reliable water supplies in Southern California has increased significantly in the 1980s and 1990s. Rapid growth in the 1980s combined with the recent six year drought and increased legal and regulatory constraints on imported water sources has heightened the need to develop additional reliable water supplies. Several of the Metropolitan Water District of Southern California (Metropolitan) member agencies were concerned about their ability to meet projected water demands in the next five to ten years before Domenigoni Valley Reservoir becomes operational. They expressed the belief that development of additional local water resources combined with increased water conservation was critical to avoid severe water shortages in the near term.

Recognizing this need for greater supply reliability, the member agencies took steps to determine the ability of local water resources to meet the growing water demands. This resulted in the initiation of the Southern California Strategic Water Resources Assessment in the summer of 1992. The Strategic Assessment is a joint effort funded by Metropolitan and 26 of its 27 member agencies (see Table 1). The boundaries of these agencies within the Metropolitan service area are shown in Figure 1.

The purpose of the Strategic Assessment is to identify the potential for additional near-term water resources development in Southern California. The focus of the investigation is those resources that could be controlled locally and would not be subject to the uncertainties associated with exports from the Sacramento Delta.

TABLE 1

LIST OF MEMBER AGENCY PARTICIPANTS

Calleguas Municipal Water District	City of Santa Ana
Central Basin Municipal Water District	City of Santa Monica
City of Anaheim	City of Torrance
City of Beverly Hills	Coastal Municipal Water District
City of Burbank	Eastern Municipal Water District
City of Compton	Foothill Municipal Water District
City of Fullerton	Las Virgenes Municipal Water District
City of Glendale	Municipal Water District of Orange County
City of Long Beach	San Diego County Water Authority
City of Los Angeles	Three Valleys Municipal Water District
City of Pasadena	Upper San Gabriel Municipal Water District
City of San Fernando	West Basin Municipal Water District
City of San Marino	Western Municipal Water District

During the course of the Strategic Assessment, Metropolitan began the preparation of an Integrated Resources Plan (IRP). Integrated resources planning is an open, participatory process for determining the appropriate mix of demand-side and supply-side resources that are expected

APPENDIX E

DESALINATION ISSUES PAPER

INTRODUCTION

Background

The Southern California Strategic Water Resources Assessment is a joint effort of The Metropolitan Water District of Southern California and its 27 member agencies. The purpose of the Strategic Assessment is to identify the potential for additional near-term water resources development in Southern California. The strategic assessment provides an approach for identifying the critical issues, setting priorities, and developing programs or projects to resolve the issues. A major goal of the study is to develop an approach to meet the needs and objectives of a diverse group of water resources management agencies in Southern California.

The purpose of this issues paper is to present a summary of the status and issues affecting groundwater and seawater desalination in Southern California. Information on projects have been incorporated into Metropolitan's on-going Integrated Resources Plan (IRP).

Summary of Currently Identified Projects

Desalination is a water treatment process used to remove salt and other dissolved minerals from water. Other contaminants in the water, such as dissolved metals, microorganisms and organics, may also be removed by some desalination processes. Desalination is gaining increasing attention as a way to provide additional potable water supply. Historically, desalination has not been extensively utilized in California because it was not economically attractive relative to imported water supplies or more conventional local water supply development.

For the purposes of this paper, water desalination processes are divided into two categories, brackish water desalination and seawater desalination. Waters having a total dissolved solids (TDS) content from 500 milligrams per liter (mg/l) to 10,000 mg/l are generally considered brackish water, and waters with TDS concentrations in the 10,000 mg/l to 50,000 mg/l range are typically categorized as seawater. There is no universally accepted classification for the cut-off between brackish water and seawater. Typical ocean seawater contains approximately 34,000 to 36,000 mg/l TDS. In general, membrane-type desalination costs increase with higher concentrations of dissolved solids.

The draft Situation Assessment for the Strategic Water Resources Assessment presented information on the currently identified desalination projects in Southern California. Table E-1 lists the proposed seawater desalination plants within the Metropolitan service area for which information is currently available. The potential seawater desalination facilities listed in Table E-1 represent 114,000–165,000 acre-ft/yr of new water supply by the year 2000, if all projects are implemented. The primary drawback of seawater desalination is the relatively high cost of treatment. The cost for seawater desalination varies depending on site-specific variables and is typically over $2,000/acre-ft.

Table E-2 lists the brackish water desalination projects that are existing, or for which plans currently exist. The locations of desalination projects are shown on Figure E-1. If the projects listed are implemented, brackish groundwater desalination will represent a supply of over 26,000 acre-ft/yr by 1995, and approximately 119,000 acre-ft/yr by the year 2000. In some cases, brackish groundwater treatment is proposed in groundwater basins that are currently unused

TABLE E-1

EXISTING AND PROPOSED SEAWATER DESALINATION PROJECTS IN THE METROPOLITAN SERVICE AREA

Project/Location	Capacity (mgd)	Annual Yield (acre-ft/yr)	State of Project	On-line Date	Constructing Agency	Funding/Notes
Avalon, Catalina Island	0.13	100	Operating	1992	Southern California Edison Company	
SCE Coastal Generation Feasibility Study	50	50,400	Feasibility Studies	1997	Unknown	Long Beach, CBMWD/WBMWD, Metropolitan, Southern California Edison
South Bay Desalination Project, San Diego Bay	9 18	Year 2000 9,100 2010 18,100	Completed Feasibility Studies	1997	San Diego County Water Authority and San Diego Gas and Electric	Undetermined probability of implementation.
Huntington Beach Demonstration Project	4.2	4,200	Proposed	1998	MWDSC	MWD Capital Budget
Los Angeles Coastal Desalination	50-100	50,400 to 100,800	Proposed	1999	MWDSC	Not in MWD Capital Budget. Implementation depends on success of H.B. Demonstration Project.
Totals	Year 1995 2000 2010	100 acre-ft/yr 114,200 to 164,600 acre-ft/yr 123,200 to 173,600 acre-ft/yr				

Note: Annual yield assumes 90 percent on-line operation.

TABLE E-2

EXISTING AND PLANNED BRACKISH WATER DESALINATION PROJECTS IN THE METROPOLITAN SERVICE AREA

Project/ Location	Capacity (mgd)	Annual Yield (acre-ft/yr)	Replenishment (acre-ft/yr)	On-line Date	IRP Investment Level	Project Status	Constructing Agency	Expected Funding Sources
Arlington Desalter	6.4	7,200		1990	1	Operating	Santa Ana Watershed Project Authority	State Agricultural Drainage Loan, MWD LPP, MWD GRP (future)
West Basin Demonstration Desalter	1.5	1,700		1993	1	Operating	West Basin MWD	WBMWD Revenue Bonds, Bureau of Reclamation, MWD GRP
Oceanside Desalter No. 1	1.8	2,000		1994	1	Construction contract awarded	City of Oceanside	Water Conservation Bond Loan, MWD GRP
Irvine Desalter	6	6,700	1,900	1995	1	Final Design	Orange County Water District	OCWD, MWD GRP
Tustin Desalter No. 1	2.9	3,200	900	1995	1	Final Design	Orange County Water District	OCWD, MWD GRP
Yorba Linda Desalter	4.6	5,200		1995	—	Conceptual	Orange County Water District	OCWD, MWD GRP
Beverly Hills Desalter	2.4	2,700		1996	1	Design	City of Beverly Hills	MWD GRP
Chino Basin East Desalter	6	6,700		1996	1	Preliminary Design	Santa Ana Watershed Project Authority	Agricultural Drainage Loan Program (SWRCB), Bureau of Reclamation, or Bonds, MWD GRP
Chino Basin West Desalter	6	6,700		1996	1	Preliminary Design	Santa Ana Watershed Project Authority	Agricultural Drainage Loan Program (SWRCB), Bureau of Reclamation, or Bonds, MWD GRP

TABLE E-2 (CONTINUED)

EXISTING AND PLANNED BRACKISH WATER DESALINATION PROJECTS IN THE METROPOLITAN SERVICE AREA

Project/ Location	Capacity (mgd)	Annual Yield (acre-ft/yr)	Replenishment (acre-ft/yr)	On-line Date	IRP Investment Level	Project Status	Constructing Agency	Expected Funding Sources
Menifee Desalter	3	3,400		1996	1	Final Design	Eastern Municipal Water District	State Agricultural Drainage Loan, MWD GRP
Rowland GW Treatment	0.5	600		1996	1	Expected Project	Rowland Water District	MWD GRP
San Juan Desalter No. 1	3.8	4,300	2,000	1996	2	Expected Project	San Juan Basin Authority	MWD GRP
Fullerton I Desalter	1.5	1,700		1997	—	Conceptual	Orange County Water District	OCWD, MWD GRP
Oceanside Desalter No. 2	3	3,400		1997	2	Planning	City of Oceanside	MWD GRP
San Pasqual Desalter	4.5	5,000		1997	2	Planning		MWD GRP
Sweetwater Desalter No. 1	3.2	3,600		1997	1	Planning	Sweetwater Authority	MWD GRP
Capistrano Beach Desalter	1.25	1,400		1998	2	Design	Capistrano Beach	MWD GRP
San Mateo (Camp Pendleton)	5.4	6,000		1998	2	Planning		MWD GRP
Camarillo	2	2,200		1999	3	Conceptual	Calleguas MWD	MWD GRP
Fullerton II Desalter	2	2,200		1999	—	Conceptual	Orange County Water District	OCWD, MWD GRP

TABLE E-2 (CONTINUED)

EXISTING AND PLANNED BRACKISH WATER DESALINATION PROJECTS
IN THE METROPOLITAN SERVICE AREA

Project/ Location	Capacity (mgd)	Annual Yield (acre-ft/yr)	Replenishment (acre-ft/yr)	On-line Date	IRP Investment Level	Project Status	Constructing Agency	Expected Funding Sources
Hollywood Basin	2.7	3,000		1999	3	Conceptual		MWD GRP
Santee/El Monte Basin	0.9	1,000		1999	3	Conceptual		MWD GRP
Winchester/Hemet Desalter	2.7	3,000		1999	2	Planning	Eastern Municipal Water District	State Agricultural Drainage Loan, MWD GRP
Corona/Temescal	8.9	10,000		2000	2	Planning		MWD GRP
Otay/Sweetwater	2.7	3,000		2000	2	Planning	Otay MWD	MWD GRP
Perris Desalter Phase I	5.4	6,000		2000	2	Planning	Eastern Municipal Water District	State Agricultural Drainage Loan, MWD GRP
Riverview GWRAP	0.9	1,000		2000	3	Conceptual		MWD GRP
San Juan Desalter No. 2	5.5	6,200	3,000	2000	2	Planning	San Juan Basin Authority	MWD GRP
Tia Juana River Valley	2.2	2,500		2000	3	Conceptual		MWD GRP
Torrance Elm Avenue Facility	2.2	2,500		2000	3	Conceptual	City of Torrance	MWD GRP
West Covina Phase I	4.5	5,000		2000	3	Conceptual	City of West Covina	MWD GRP

TABLE E-2 (CONTINUED)

EXISTING AND PLANNED BRACKISH WATER DESALINATION PROJECTS IN THE METROPOLITAN SERVICE AREA

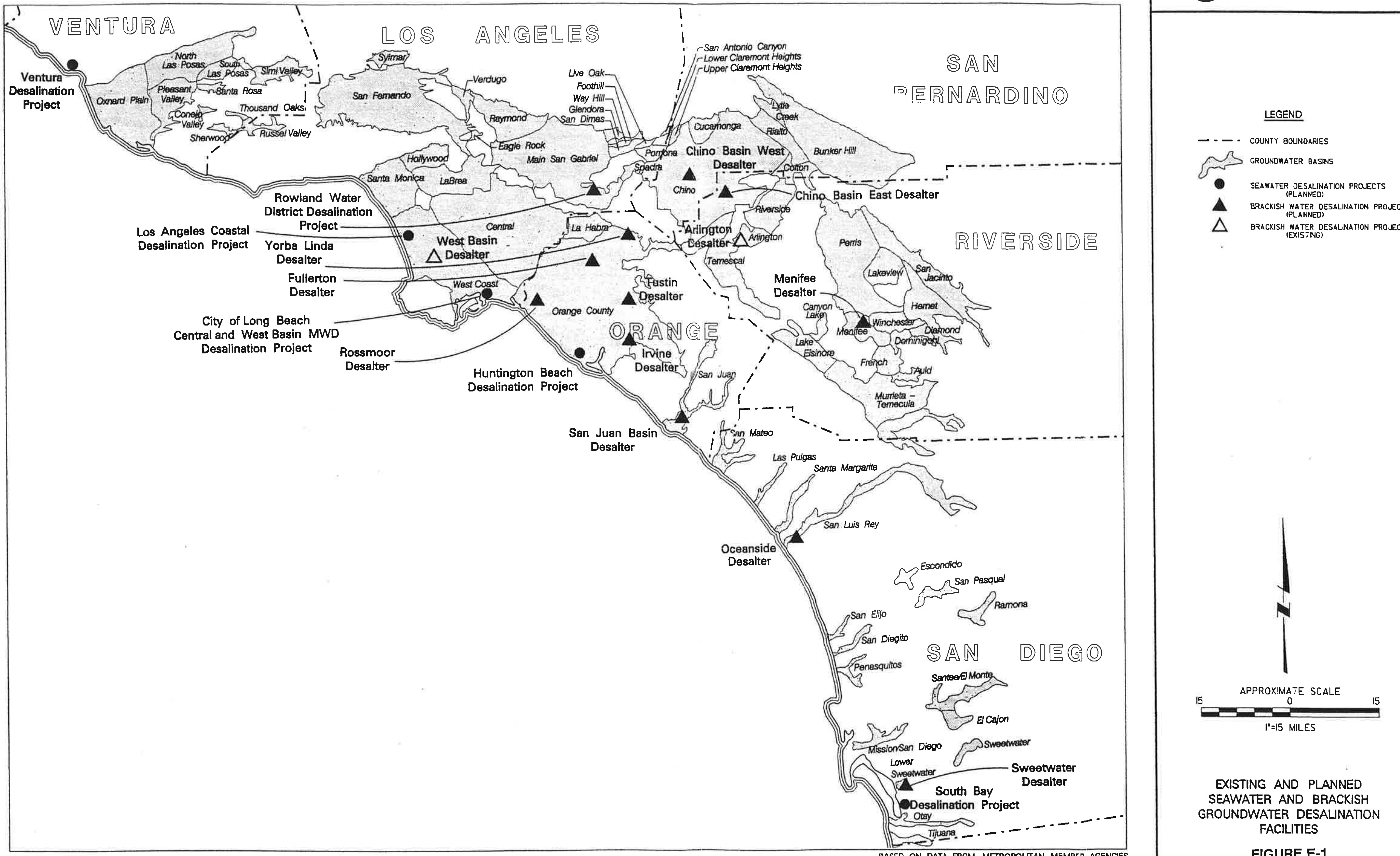
Project/ Location	Capacity (mgd)	Annual Yield (acre-ft/yr)	Replenishment (acre-ft/yr)	On-line Date	IRP Investment Level	Project Status	Constructing Agency	Expected Funding Sources
Chino/SAWPA No. 3	8	9,000	10,400	2001	3	Conceptual	Santa Ana Watershed Project Authority	MWD GRP
West Basin No. 2	5.4	6,000		2001	2	Planning	West Basin MWD Water Replenishment District of So. Calif.	WBMWD, WRDSC, MWD GRP
Chino/SAWPA No. 2	7.1	8,000	9,200	2002	2	Conceptual	Santa Ana Watershed Project Authority	MWD GRP
Compton GW Project	0.9	1,000		2002	3	Conceptual	Compton	MWD GRP
Sweetwater Desalter No. 2	3.1	3,500		2002	3	Conceptual		MWD GRP
March Air Force Base	1.3	1,500		2003	3	Conceptual		MWD GRP
West Basin No. 3	4.5	5,000		2003	2	Planning	West Basin MWD Water Replenishment District of So. Calif.	WBMWD, WRDSC, MWD GRP
West Covina Phase II	4.5	5,000		2003	3	Conceptual	City of West Covina	MWD GRP
Moorpark	7.1	8,000	9,200	2004	2	Planning	Calleguas MWD	MWD GRP
San Dieguito Basin Desalter	4.5	5,000		2004	2	Planning		MWD GRP

TABLE E-2 (CONTINUED)

EXISTING AND PLANNED BRACKISH WATER DESALINATION PROJECTS IN THE METROPOLITAN SERVICE AREA

Project/ Location	Capacity (mgd)	Annual Yield (acre-ft/yr)	Replenishment (acre-ft/yr)	On-line Date	IRP Investment Level	Project Status	Constructing Agency	Expected Funding Sources
Perris Desalter Phase II	5.5	6,200		2005	—	Conceptual	Eastern Municipal Water District	MWD GRP
Rossmoor/Foster Desalter	2	2,200		2005	—	Conceptual	Orange County Water District	OCWD, MWD GRP
Rubidoux/Wester n	2.7	3,000		2005	2	Planning	Western MWD	MWD GRP
Long Beach Desalter	18	20,200		Unknown	—	Conceptual	City of Long Beach	MWD GRP
Tustin Desalter No. 2	3	3,400		Unknown	—	Planning	Orange County Water District	OCWD, MWD GRP
Totals	1990 1995 2000 2010	7,200 26,000 119,100 206,100						

Notes: Projects listed by projected year of operation.
Projects with no specified IRP Investment Level are not currently listed in Metropolitan's IRP.



EXISTING AND PLANNED SEAWATER AND BRACKISH GROUNDWATER DESALINATION FACILITIES

FIGURE E-1

because of poor water quality, and therefore may be considered a "new" water resource. In other cases, brackish groundwater treatment represents maintenance of an existing source that has been historically degraded. In any case, these projects will benefit the region by providing increased reliability, flexibility, and emergency capabilities.

Many of the projects listed are included in Metropolitan's Integrated Resources Plan (IRP). Of the projects listed in Table E-2, seven projects are not currently included in the IRP. These projects represent about 39,000 acre-ft//yr of yield. Approximately on-half of this amount is represented by the Long Beach Desalter, a conceptual project to desalt brackish groundwater near the coast.

Status of Metropolitan Projects

Metropolitan is in the planning and development phase of a seawater desalination demonstration project that includes the construction and operation of a 2,000 gallon per day (gpd) test distillation vertical tube evaporator (VTE) unit. This test unit, which is currently being fabricated and is expected to be operational in early fall 1994, will be used for materials performance testing. The test unit will be located at Southern California Edison's Huntington Beach Generating Station.

Based on successful results from the innovative use of cost-saving materials in the test unit, a 5 million gallon per day (mgd) advanced multi-effect distillation demonstration plant will be built to use steam heat from an electric power generating plant to process seawater. The objectives of the demonstration plant, planned to be on-line in 1998, are to demonstrate the desalination technology in conjunction with existing power generation facilities, supply actual capital and operations and maintenance costs, provide a permanent facility for future development and testing of desalination technology, and provide a proven design for a large-scale 50 to 100 mgd desalination plant. Metropolitan published a preliminary design report in October 1993 for a 75 mgd desalination facility. The large-scale facility would be coupled with the future repowering of an electrical generation station in Southern California. The report presents the application of current desalination technology in Southern California and will serve as the basis for the demonstration project. In addition, Metropolitan is conducting a desalination integration study to investigate the issues involved in integrating a desalination facility into Metropolitan's distribution system.

In a joint study with Central Basin Municipal Water District (MWD), West Basin MWD, the Long Beach Water Department, the Water Replenishment District of Southern California, Southern California Edison Company and Metropolitan, four sites in the Long Beach/South Bay area are being evaluated for a brackish groundwater or seawater desalination facility. The study will include a hydrogeologic investigation, site-specific analysis, design criteria for a recommended project, preliminary design report, and identification of environmental and regulatory requirements.

DESCRIPTION OF DESALINATION ISSUES

The issues affecting desalination of brackish and seawater can be categorized into the following groups:

- Regulatory and Institutional Issues
- Technical Constraints
- Economics of Desalination
- Environmental Issues
- Regional Water Quality Considerations

These issues are discussed in the remainder of this section.

Regulatory and Institutional Issues

The principal regulatory and institutional issues affecting desalination relate to the requirements for disposal of brine and the quality of the product water. These issues are presented below.

Water Quality Control Plans. The Porter-Cologne Act (California Water Code, Section 13170) authorizes the State Water Resources Control Board (SWRCB) to adopt statewide water quality control plans for waters requiring water quality standards under the Federal Clean Water Act. These plans serve as the basis for waste discharge permits issued by the Regional Water Quality Control Boards (RWQCBs). Water quality control plans contain three major sections: protected beneficial uses, water quality objectives and implementation provisions. These statewide plans are more general in scope than the regional water quality control plans.

Four statewide water quality control plans have been adopted:

Water Quality Control Plan for Enclosed Bays and Estuaries of California (1991)

Water Quality Control Plan for Ocean Waters of California (1988)

Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (1975)

Water Quality Control Plan for Inland Surface Waters of California (1991)

The statewide plans present specific numerical water quality objectives for the various waters. These objectives are based on protection of the specified beneficial uses of each water and the prevention of pollution. The objectives focus primarily on chemical constituents that could be toxic. The plans state that the discharge of waste shall not cause violation of these objectives. In addition to the statewide plans, regional plans have been adopted that define specific objectives for surface waters and groundwaters within each region. These objectives include salinity, related mineral constituents, volatile organics, heavy metals and other toxic substances.

The impact of these plans on desalination relates to the levels of the various constituents that can be discharged to the waters of the State. Essentially, no brine discharges are allowed to any inland waterway since the discharges would violate the water quality objectives. Brine discharges to enclosed bays and estuaries would likely be limited since these areas have critical quality requirements to prevent degradation of aquatic resources. Discharges to the ocean may be limited if the concentrations of particular compounds in the brine result in exceeding the Ocean Plan objectives. Discharges from plants employing thermal processes would be required to meet the requirements of the Thermal Plan to control temperature increases. A tentative decision issued by the Superior Court in Sacramento on October 15, 1993 has set aside the Inland Surface Waters and Bays and Estuaries plans on the basis that the SWRCB did not comply with CEQA and other laws when it promulgated these plans. The status of appeals of this decision is uncertain at this writing

Requirements for Seawater Brine Disposal. Discharge of desalination brine to the ocean is a new issue being dealt with by the SWRCB and RWQCBs. Currently, the SWRCB classifies brine discharges as industrial wastes which are subject to the pertinent water quality control plan. There are no separate regulations regarding the initial dilution, distance offshore or the depth of open water required for ocean brine discharge. The primary evaluation criteria involve the anticipated initial dilution of the brine and the potential impact of the discharge on ocean biota. As a part of any evaluation, the salinity dispersion characteristics of the brine discharge plume must be estimated in a modeling study. A secondary concern to be assessed is the potential toxicity of brine discharge especially to benthic (bottom dwelling) organisms.

Wastewater discharge permits for ocean outfalls often require a certain depth of discharge so that the rising plume of the lighter than seawater effluent has adequate time to mix and dilute before reaching the surface. Seawater reverse osmosis (SWRO) concentrate is approximately 65,000 mg/l TDS, almost twice the TDS level of seawater. The resulting higher density causes a directly discharged brine plume to sink to the ocean floor. As such, it is not clear that RWQCB wastewater discharge requirements would be applied to SWRO brine discharge. The influence of local currents may also assist in dispersing the plume concentrations. The current triennial review of the Ocean Plan by the SWRCB is addressing desalination and brine discharge issues.

Drinking Water Regulations. Drinking water quality is regulated by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act and by the California Department of Health Services. Regulations have been established for many constituents in drinking water and future regulations of additional constituents are planned. Any brackish groundwater or seawater desalination project producing water for municipal water supply purposes would be required to meet all drinking water regulations. At this point, no specific requirements have been established for desalination processes. However, the Department of Health Services has issued a protocol statement for applying the Surface Water Treatment Rule (SWTR) to desalination treatment plants (April 3, 1991). This statement requires any new seawater source for desalination to meet the SWTR. These requirements can be met by a combination of pre-treatment, desalination, post-treatment and disinfection. Distillation facilities may require pre- or post-filtration processes to assure compliance with the SWTR. The SWTR requirements do not apply to sources derived from wells that are set back at least 100 feet from surface waters, comply with well construction criteria and are free of turbidity and coliforms.

Other Regulatory Requirements. There are a variety of other federal, state and local agencies that may have regulatory control over desalination projects. These agencies include:

Air Quality Management Districts

California Coastal Commission

California Energy Commission

California Public Utilities Commission

City and County Planning Commissions, City Councils and Boards of Supervisors

County Departments of Environmental Health

National Marine Fisheries Service

Port Authorities

Port Districts

Regional Water Quality Control Boards

State Department of Fish and Game

State Department of Health Services

State Department of Parks and Recreation

State Department of Water Resources

State Lands Commission

State Water Resources Control Board

U.S. Army Corps of Engineers

U.S. Bureau of Reclamation

U.S. Coast Guard

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

The regulatory agencies having specific jurisdiction over a project depend on the location of the specific project. Essentially all desalination projects must comply with the requirements of the California Environmental Quality Act (CEQA) by preparing either an environmental impact report (EIR) or a negative declaration. If a state of emergency due to drought conditions is declared by the Governor, the requirements for preparing an EIR may be waived and other permitting processes significantly streamlined. This was done for the recently constructed Santa Barbara desalination project.

Technical Constraints

The technical considerations relating to brackish and seawater desalination are summarized in the following discussions: state of the art desalination, pre-treatment considerations, methods of brine disposal and interfacing with electric power plants.

Desalination Processes. Desalination is a water treatment process used to remove salt and other dissolved minerals from water. Other contaminants in the water, such as dissolved metals, microorganisms and organics, may also be removed by some desalination processes. Water desalination processes can be generally categorized as thermal and non-thermal processes.

Three major thermal distillation processes are widely used for commercially desalting water are: multi-stage flash (MSF) evaporation, multiple-effect distillation (MED), and vapor compression (VC) evaporation. These processes are typically used to desalinate highly brackish water or seawater since other more cost effective processes are generally used for brackish water desalination. The product water produced from seawater by these thermal processes is of a "distilled" water quality, having a TDS content in the range of 5 to 50 mg/l.

Non-thermal desalination processes include the membrane processes of reverse osmosis (RO) and electrodialysis (ED). The RO process is suitable for both brackish water and seawater desalination applications. The electrodialysis process commonly uses a variation known as electrodialysis reversal or EDR. The ED and EDR processes are generally limited to the desalination of brackish water. Seawater desalination by ED or EDR is typically not cost competitive with other processes.

Another non-thermal desalination process is ion exchange (IX) treatment. This process is suitable for producing "pure" water by removing minerals or salts from feedwater that contains relatively low concentrations of contaminants. Ion exchange demineralization or desalination is only practical for feedwater containing total dissolved solids in the range of 100 to 800 mg/l, and is not feasible for seawater desalination.

The major processes widely used for commercial water desalination are summarized in Table E-3. Energy consumption constitutes a major portion of desalination operation and maintenance (O&M) costs. Energy consumption for each process has been estimated and is listed with the desalination descriptions in Table E-3. These energy consumption values consider the equivalent electrical generation value of oil used in distillation processes.

There are also a number of experimental desalination processes that are being proposed as more cost and energy efficient than current processes. These potential processes have not been constructed and operated at a sufficiently large scale to demonstrate their feasibility. Any new processes should be thoroughly demonstrated at a suitable capacity before major commitments are made to utilize these technologies.

Intake and Pre-treatment Considerations. The level of pre-treatment required for desalination is a function of the source water quality and the desalination process. Most thermal processes require little pre-treatment whereas membrane processes such as reverse osmosis or

TABLE E-3

SUMMARY OF DESALINATION PROCESS CHARACTERISTICS

Desalination Process	Process Type	Typical Source Water	Typical Application	Product Water Recovery (1)	Energy Consumption (kWh/acre-ft) (2)	Pre-treatment Requirements	Typical Cost Range ($/acre-ft) (3)
Multi-Stage Flash Distillation	Thermal	Seawater	Municipal Supply	25 - 50 %	15,000 – 30,000	Screening	$2,100 - 2,400
Multiple Effect Distillation	Thermal	Seawater	Municipal Supply	40 - 65 %	8,000 – 25,000	Screening	$1,300 - 1,500
Vapor Compression	Thermal or Mechanical	Seawater	Small Scale Municipal and Ships	25 - 50 %	10,000 – 15,000	Screening	$1,800 - 2,200
Reverse Osmosis	Non-thermal Membrane (Pressure-driven)	Brackish Water and Seawater	Municipal Supply	50 -80 % (B/W) 25 - 45 % (S/W)	800 - 2,600 (B/W) 6,500 - 8,200 (S/W)	Filtration	$300 - 600 (B/W) $1,100 - 2,200 (S/W)
Electrodialysis Reversal	Non-thermal Membrane with Electric Current	Brackish Water	Municipal Supply	80 - 90 %	1,500 - 2,900	Filtration	$300 - 600
Ion Exchange	Chemical	Slightly Brackish Water	Industrial Supply	95 - 97 %	Minimal	None	$800 - 1,300

Notes:
1. B/W - Brackish Water, S/W - Seawater.
2. Energy consumption for multi-stage flash distillation and multiple effect distillation is based on the equivalent heat value of fuel oil if used to generate electricity at a 35 percent power plant efficiency.
3. Costs are based on actual operating plants and planning study estimates.

electrodialysis require very low turbidity source water.

Raw seawater can be obtained from either an open water intake structure, beach wells, or a subsurface infiltration collector. The capacity of the typical seawater intake is in the range of two to four times the product flow due to the relatively low product recovery. An open ocean intake would normally consist of a submerged pipeline extended into the ocean past the surf zone. This method of supply can be environmentally disruptive to the ocean habitat, susceptible to being clogged with biota, and vulnerable to damage by unusual wave conditions. The unfiltered seawater provided by this method must be extensively pre-treated to reduce its high turbidity content, otherwise the RO membranes will have a reduced efficiency and shortened service life.

Beach wells draw seawater through the shallow sands and gravels found along the coast. Because they extract water from below the ground, they do not directly impact existing habitat and are not susceptible to clogging by marine debris. Using the sand as a natural filter, water acquired from beach wells has low turbidity and requires minimal pre-treatment before desalination. The production capacity of beach wells is a function of the hydraulic characteristics of the sands and gravels along the coastline.

A subsurface infiltration collector, such as a Ranney collector, may be able to provide low turbidity water at an adequate flow rate. The Ranney method of collecting seawater involves sinking a vertical caisson into the saturated alluvium and extending perforated laterals horizontally and radially outward. This type of intake provides water that does not require extensive pre-treatment.

For brackish water sources, groundwater wells are the typical intake facilities. Groundwater usually has a very low turbidity and requires minimal pre-treatment such as cartridge filtration prior to reverse osmosis.

Methods for Brine Disposal. Brine or concentrate from desalination must be disposed of in an environmentally acceptable manner. For brackish water desalination, options include discharge to local wastewater collection systems, dedicated brine disposal systems, injection wells, or evaporation ponds. For seawater desalination, options available include direct discharge through an outfall, combined discharge with municipal wastewater, and combined discharge with power plant cooling water. Chemicals used for membrane cleaning are normally handled as industrial wastes.

The primary consideration for brackish water brine disposal is minimizing impacts on the local ground and surface waters. Due to the potential for degrading local ground and surface waters, it is unlikely that in-stream disposal options would be allowed by the RWQCBs. A potential exception might be in areas where there is an existing dry lake bed or similar area where evaporation ponds could be viable without the potential for percolation or runoff.

For seawater desalination, typical brine disposal methods include: a dedicated submerged ocean outfall or pipeline, mixing of brine with existing treated municipal wastewater effluent before discharge to an ocean outfall, and dilution of brine with power plant cooling water flow before discharge. From the standpoint of time to implement, cost, permit requirements and environmental impacts, it is preferable to use existing outfall facilities when available as opposed to constructing new ones. The RWQCB would need to review the outfall design in the process of granting an NPDES permit.

If the use of an existing permitted wastewater ocean outfall is proposed for brine disposal, the mixing characteristics of the combined discharge may require a NPDES permit modification from the RWQCB. Seawater brine concentrate contains the same constituents as normal seawater, only in a more concentrated form. If, however, it was proposed to add wastewater to a brine-only discharge outfall to reduce the TDS concentration, the added effluent would introduce a new set of potential contaminant constituents. The RWQCB may be less likely to approve an NPDES permit if this mixture of effluents was proposed for a new ocean outfall discharge. In any case, the discharge would be required to meet the Ocean Plan and any specific discharge requirements established by the Regional Board.

Interfacing with Electric Power Plants. Because of the proximity to the coast of many power plants in southern California, there has been considerable discussion regarding combining desalination facilities with power plant operations. Such dual purpose plants have been successfully built and operated in other areas of the world where desalination is a major component of the region's water supply. It is unlikely that any new power plants will be sited in the southern California coastal zone; however, use of existing power plant locations can be beneficial from a siting standpoint. Under certain limited conditions, exhaust heat or steam from the power plant can be used to desalinate water.

Existing coastal power plant sites provide an opportunity for a desalination facility to be located in the coastal zone. Such sites are already developed for industrial use, and may have ocean intakes and outfalls which could be shared by the desalination plant. Other facilities and services (shop, maintenance, waste treatment, security, and emergency services) are common to both plants. If operated jointly, cost savings for both power and water utilities can be realized. Cooling water from the power plant may be used to provide feed water to the desalination plant, increasing the efficiency of the desalination plant and reducing thermal discharge from the power plant. Possibilities also exist to share transmission corridors for distribution of product water.

Many areas of southern California have a stated need for additional power. More stringent air quality emission standards are also forcing power utilities to make expensive changes to reduce air emissions. One method being examined by electric utilities to generate additional power and reduce air emissions is to repower existing power plants. Repowering consists of the elimination of less efficient existing boilers and integration of efficient state-of-the-art generating equipment into the power plant system. If recognized in the repower design process, additional steam can be produced by the power utility and made available for use in desalination. This steam supply is the result of differing capacity ratings between new and existing generating equipment. This steam can be used to drive the high pressure pumps required for reverse osmosis, or to provide energy for thermal desalination processes.

Repowering of existing power plants provide the greatest opportunity for water agencies to co-locate and combine desalination with power plant operations. Water agencies and power utilities should work closely together to create mutually beneficial opportunities to meet the power and water needs of their customers. Metropolitan, through the efforts of a team of selected design consultants, recently completed an evaluation of the application of current desalination technology for large-scale water production. This consultant team produced a conceptual design that could produce desalinated seawater using exhaust steam from a repowered coastal power generation station. The facility would utilize vertical tube multiple effect evaporation. The process will be evaluated in a pilot project located at Southern California Edison's Huntington Beach Generation Station. Metropolitan's studies indicate a significant cost advantage to the proposed technology.

Economics of Desalination

The economics of desalination are dependent on a variety of factors including: water source, source water quality, treatment process, treatment capacity, plant site, brine disposal methods and product water conveyance requirements. Since many of these factors are site-specific, simple cost generalizations are difficult. The factor most affecting economics is the water source and its quality. There are some economies of scale associated with desalination. However, unit cost reductions are realized only for significantly larger facilities., especially those desalting seawater. Discussion of the cost factors associated with desalination of brackish and seawater are discussed below.

Brackish Water Desalination. The cost of brackish water desalination is a function of the source water quality, the desired product water quality, the treatment process(es), the installed capacity and the method of brine disposal. Typical brackish water sources are less than 10,000 mg/l and usually in the range of 1,000–3,000 mg/l. Recent studies by Montgomery Watson developed costs for groundwater desalination using reverse osmosis. Construction cost for reverse osmosis are typically about $1.40/gpd of permeate (desalinated water) capacity. Permeate capacity is the amount of water passing through the reverse osmosis membrane; this water is typically blended with untreated water to achieve the desired water quality.

Operations and maintenance (O&M) costs depend on the source water quality, the amount of water treated and the blended product water quality. Table E-4 indicates the potential range of O&M costs for various source water qualities and capacities to produce a 500 mg/l blended product water.

TABLE E-4

OPERATIONS AND MAINTENANCE COST RANGES FOR GROUNDWATER DESALINATION

Source Water Quality (mg/l)	Unit O&M Cost to Produce 500 mg/l Product Water ($/acre-ft)	
	Total Flow: 4,000 acre-ft/yr	Total Flow: 24,000 acre-ft/yr
1,100	$270	$190
2,100	$370	$300

Reference: Montgomery Watson, 1993.

Brine disposal costs vary significantly with the type of disposal. As mentioned previously, brine disposal methods include: direct ocean disposal, disposal to a regional brine export system, discharge to the local wastewater collection system, evaporation and deep well injection. An analysis of potential brine disposal costs was prepared for Metropolitan (Boyle, 1991). This analysis indicated average brine disposal costs as a function of treatment plant product water flow as shown in Table E-5. A primary constraint is the development and staging of regional brine interceptors. These pipelines are not typically cost-effective unless there is sufficient desalter development to bring their use up to capacity relatively quickly.

The costs associated with the distribution of treated water vary significantly with the particular project. As a result, no generalizations can be made regarding conveyance costs.

The total cost of brackish water desalination can range from less than $300/acre-ft to over

$600/acre-ft. The cost increases as a function of the raw water quality since reverse osmosis systems require higher pressures as TDS levels increase to achieve a given product water quality.

TABLE E-5

ESTIMATED COST OF BRINE DISPOSAL

Disposal Option	Equivalent Unit Cost ($/acre-ft)
Ocean Disposal	50
Regional Interceptor	70
Concentration and Evaporation	170

Reference: Boyle Engineering, 1991

Seawater Desalination. Compared to brackish water, the cost of seawater desalination is more directly related to the process, the installed capacity, and the method of brine disposal. Recent studies indicate the total cost of seawater desalination is in the range of $1,100 - $2,200/acre-ft of water produced. Reverse osmosis has been recently applied in two Southern California projects with costs in the range of $1,700 - $2,200/acre-ft for 5–10 mgd facilities.

Recent studies show the potential for reduced costs if a desalination project is developed in conjunction with an electrical generation plant repowering project. Studies completed for the San Diego County Water Authority indicate potential costs for reverse osmosis as low as $1,100/acre-ft for a 30 mgd facility. Metropolitan's recently completed report, *Seawater Desalination Plant for Southern California,* (Metropolitan, 1993), indicates the cost of seawater desalination could be approximately $600/acre-ft (exclusive of conveyance) for a 75 mgd facility that utilizes exhaust steam from a repowered coastal power generation station. These significantly lower costs are the result of coupling well-proven multiple effect distillation technology with fluted aluminum tubes, a concrete shell and 30 vertical effects in a unique configuration.

As with brackish water desalination, brine disposal can be a significant portion of the total project costs if no existing outfalls exist. Construction of a new outfall may add as much as $100/acre-ft to the total cost of water. Rehabilitation of existing outfalls adds about $60/acre-ft. The ideal situation would involve the use of an existing outfall and obtaining a modified NPDES permit. This approach was taken for the recently constructed Santa Barbara desalination facility where the brine is discharged into the existing wastewater outfall. In this case, brine could represent as much as 60 percent of the total discharge when producing 10,000 acre-ft/yr of desalinated seawater. Construction of desalination facilities in conjunction with electric power plants minimizes brine disposal costs as large capacity outfalls exist to discharge cooling water.

Another aspect of economics that should be considered is the effect of part-time operation on unit costs. Desalination facilities represent expensive capital investments. When these facilities are used less than continuously, the total unit cost increases because the capital costs must be amortized by less water production. This aspect is considered in the Santa Barbara project where the cost of water produced by the plant is approximately $1,900/acre-ft of water produced when operating and $1,300/acre-ft of capacity when on stand-by. ($19M/yr when operating at 10,000 acre-ft/yr and $13M/yr on stand-by.)

Alternative Technologies for Desalination. The recent California drought caused many coastal communities to evaluate seawater desalination as an alternate and reliable water source. This interest has lead many individuals and companies to propose alternative desalination technologies that promise to produce water at significantly lower costs than current technology. However, few of these processes have been proven at a sufficiently large scale and for a sufficient period of time to demonstrate reliability and actual cost savings. A number of corporations are seeking venture capital to finance the development of these technologies. Some have suggested that public agencies provide this capital since the end product would be used by the public agencies (and ultimately, the public). Given the current fiscal problems throughout the state, it does not seem reasonable to expect public agencies to risk limited capital funds on projects that may not produce the desired results.

Environmental Issues

As discussed previously, a desalination plant requires a source of water (groundwater or seawater), a raw water pipeline, pre-treatment, desalination treatment and post-treatment processes, an energy source, brine disposal facilities, and product water distribution facilities. Typical environmental impacts associated with desalination projects include: construction, energy consumption, air quality, and biological resources. Each of these issues is briefly discussed below.

Construction. Project construction activities can result in impacts that are generally localized to the particular construction. Typical construction impacts can include: disturbance of plant and animal communities, air pollution emissions, visual impacts, noise impacts, disturbance of archeological and paleontological resources, erosion, non-point source pollution, and interference with public access and recreation. Impacts associated with construction of seawater intakes and brine disposal lines can be significant if areas of special biological significance are involved. Special permitting may be required in these habitats.

Energy Consumption. Desalination processes are energy intensive compared to other water sources. As a result, the potential for impacts on available energy resources could be significant. Data for the Santa Barbara desalination project indicate an average demand of 0.8 kilowatts (kW) per acre-ft/yr of product water capacity. Significant increases in the amount of seawater desalination in Southern California are expected to result in proportionate increases in energy consumption. Projects developing 50,000 acre-ft/yr of desalinated seawater supply would create a demand of approximately 40 MW of generating capacity while a 200,000 acre-ft/yr of supply would create about 160 MW of demand. The ability of the existing electrical grid to produce and distribute the energy needed for desalination must be considered by power companies. Energy demands for distillation processes are similar in magnitude yet require increased levels of operation for coastal power plants to supply exhaust steam. If new generating capacity is required, the secondary impacts associated with the new power facilities may need to be mitigated as part of the desalination projects.

Air Quality. Desalination facilities do not typically produce air emissions. However, the increased energy production required for the facilities could result in additional air emissions at the point of power generation if fossil-fueled power plants are used. As mentioned under the topic "energy consumption," if the existing power grid can support the increased power demand, then air quality impacts are not likely to be significant. However, the development of new power generation sources or increases operations of existing power plants could result in substantial new air emissions. Evaluation of energy consumption in conjunction with air quality is a critical element of desalination project evaluations.

Biological Resources. The impacts of desalination projects on biological resources tend to be site-specific; therefore, no generalizations can be made. The greatest potential impacts are likely to be associated with the water source and brine disposal. In the case of brackish desalination, little biological impact would be expected unless the project is constructed in an area of special significance. Impacts associated with seawater desalination have the potential to be greater due to the higher volumes of water that must be conveyed to the treatment facility and the higher volumes of brine discharge. The impacts of brine discharges on marine organisms have not been well defined. It has been postulated that some impacts may occur due the higher salinity and density of brine which would sink to the ocean floor. Mixing the brine with wastewater or power plant cooling water may minimize the potential impacts.

Regional Water Quality Considerations

Evaluation of the need for desalination must consider the overall relationship of source water quality to water resources management. The principle consideration includc thc effect of SWP quality and availability on inland wastewater discharges relative to the need for and location of groundwater desalination.

The effect of water supply quality on wastewater discharges has become a significant issue for many member agencies. The TDS of municipal wastewater is typically about 250 mg/l higher than the water supply TDS. Since 1983, the TDS concentration of imported State Water Project (SWP) water has steadily increased from 200–250 mg/l to 300–440 mg/l. As SWP water availability decrease during droughts, agencies must rely more heavily on Colorado River water, which is saltier than SWP water. Colorado River water is currently about 650 mg/l but has exceeded 750 mg/l over the last 20 years. A change in water supply from low TDS SWP water to high TDS Colorado River water can increase municipal wastewater TDS from 450 mg/l to as much as 1,000 mg/l. This increase can adversely impact water reclamation activities.

Many areas of Southern California use water supplies multiple times. In the Santa Ana River Basin, water supply is used several times before ultimate discharge to the ocean. Imported water delivered to the upper portions of the basin are discharged to the river where they recharge downstream basins. Successive use occurs in groundwater basins where return flows from use also become the source of downstream supply. Since each successive use adds salt to the supply, the control of salt becomes a critical concern.

This problem has become acute in the Santa Ana River Basin where the increased water supply TDS has causes wastewater agencies problems meeting their waste discharge requirements and reducing the potential for water reuse. The Santa Ana Regional Water Quality Control Board's Basin Plan contains a Recommended Water Quality Management Plan that includes water supply, waste disposal and groundwater management sub-plans. The goal of the water quality management plan is to achieve the water quality objectives contained in the Basin Plan. The water quality sub-plan includes the concept of salt assimilative capacity and the reasonable use of water, with allowable mineral increments. It also has "delivered water supply goals" for municipal and industrial uses that are the most stringent of: the present water supply TDS level, the State Department of Health Services recommended TDS limit of 500 mg/l, the level of TDS that minimizes costs to consumers, the level necessary to meet surface and groundwater objectives, or the level that permits reclamation and reuse.

The Basin Plan admits that it is not directly within the jurisdiction of the Regional Board to control water supply. However, the Plan says the *Water Code* requires that a water supply plan must be part of an implementation plan that describes the nature of actions necessary to achieve the water quality objectives, including recommendations for appropriate action by any entity, public or private.

Consequently, the Basin Plan recommends specific water supply and water resource management projects. The water supply sub-plan also plays a significant role in the Regional Board's issuance of water discharge requirements and NPDES permits. Limits on TDS and specific mineral constituents may necessitate efforts to improve source water quality. Discharge permits may contain language that requires dischargers who violate TDS objectives due to source water quality to propose mitigation or offset programs. The Regional Board's attitude is shifting toward viewing reverse osmosis as a reasonable form of mitigation, despite the costs. This is partly due to the increasing number of desalters being proposed and built.

The concept of salt balance for an entire hydrologic basin or sub-basin is important. The 1975 Santa Ana River Basin Plan initiated a total watershed approach to salt source control. The Plan discourages the use of Colorado River water and encourages the use of higher quality SWP water, for example.

An important issue is where and how desalination projects should be built to fit into the total water quality management picture. The issue is not only how to increase the quantity of water available through desalination, but to increase the quality of water available in those areas where quality is the limiting factor affecting reuse potential, discharge requirements or salt balance. A fundamental question is "Are investments in inland groundwater desalination facilities where multiple water uses are possible more appropriate than coastal desalination where only one use is possible?

The answer to this question must consider the overall water quality impacts of the desalination activities. Inland groundwater desalination exports salts to the ocean and allows successive use of water from degraded groundwater basins. High quality imported water supplies are also important for inland regions by increasing the assimilative capacity for salt and therefore the potential for reuse. Seawater desalination can improve water quality in the coastal areas and allow local water reuse but provides inland benefits only if high quality imported water can be made available to these inland areas. As the SWP water supply decreases and its salinity increases, the benefits of low TDS supplies for inland areas declines and the need for groundwater desalination to export salt increases. Water supply planning must consider all of these factors in determining the most cost-effective method to meet future demands and quality needs.

POTENTIAL IMPACT OF ISSUES ON FUTURE SUPPLY DEVELOPMENT

The purpose of this section of the issues paper is to discuss the potential impacts of the issues identified previously on future supply development. These impacts may affect the volume of water developed, the timing of new water supplies, and economics.

Impacts on Volume Developed

The issues most likely to affect the volume of water supplies that can be developed using desalination include the cost of desalination compared to other water sources, the mix of desalination with other sources, and the relationship between planned desalination projects and the need for future groundwater treatment facilities.

Cost of Seawater Desalination Compared to Other New Supply Sources. Seawater desalination costs are considerably higher than other water resource development options. Costs are specific to each particular application and range between a minimum estimated cost as low as \$600/acre-ft of water produced to over \$2,000/acre-ft of water. Such costs represent a capital component and an annual operation and maintenance component, but do not include product water distribution. For Metropolitan member agencies, other resource development options may include conservation (\$250–\$600/acre-ft), reclamation (\$700–\$1,200/acre-ft), groundwater recovery (\$500–\$1,500/acre-ft), and treated non-interruptible Metropolitan supplies (currently \$412/acre-ft). In recent years, the cost for imported Metropolitan supplies has increased significantly and is expected to continue rising throughout this decade. As this occurs, and as desalination technology improves, the difference between the cost of seawater desalination and other resource options, particularly water reclamation and increased Metropolitan supplies, is likely to decrease.

Seawater desalination can provide other benefits to water agencies or may lead to cost savings in other areas. These cost savings, or avoided costs, can be for both future capital and operational expenditures. For example a desalination plant, located in an area where growth is occurring or existing storage is deficient, may offset fully or partially the need for expanded water treatment plant capacity or the construction of operational storage. To a lesser degree, emergency storage needs can be provided in part by the construction of a desalination facility. A desalination plant will also provide relief from drought water shortages. When these benefits and potential avoided costs are taken into consideration, the difference in unit cost between seawater desalination and other less costly resource options available to agencies is reduced.

Mix of Desalination with Other Supplies. The amount of desalination that is part of the regional water supply mix has been discussed for years. Proponents state that a water short area such as Southern California should rely more heavily on desalination since it is a "local supply" and it more reliable than imported supplies. The high cost of desalination is frequently considered to be a potential growth deterrent since water would be significantly more expensive and would make growth less economically viable. On the other hand, proponents of other supply sources argue that desalination is too expensive compared to other available resources. High cost supplies should only be used after lower cost sources are fully utilized. A mid-point in these arguments might be that some communities should develop desalinated supplies based on their access to seawater or brackish water sources. However, potential equity issues exist between those that develop the more expensive supplies and those that continue to use less expensive supplies.

Coordination with Groundwater Treatment Issues. The groundwater quality and treatment issues paper has identified a number of current and future quality issues that will affect water agencies. These include:

Current Quality Issues	**Future Quality Issues**
Nitrate	Radon
Volatile Organics	Arsenic
Organic Pesticides	Groundwater Disinfection
Color	Disinfection Byproducts
Total Dissolved Solids (TDS)	
Iron, Manganese	

The activities undertaken to resolve these issues may involve the use of desalination technology. This is obvious in the case of TDS removal. For nitrate removal without the need for TDS reduction, ion exchange has proven to be a cost-effective approach. Membrane processes may be used for arsenic removal in the future. These issues need to be coordinated with other proposed desalination facilities.

Impacts on Timing of Supply Development

The timing of developing new desalination supplies is a function of the required permits and the technology applied to the particular project as well as financial considerations. Application of proven technologies tends to minimize the time of implementation.

Typical Time for Implementation. Because of the lack of experience by regulators in dealing with seawater desalination plants in California and the fact that plants will be located in the coastal zone, siting of desalination projects can be expected to experience close scrutiny by permitting agencies during the environmental review process. Key environmental issues for such projects are land use, noise, concentrate disposal impacts, marine biology, air quality, and construction impacts.

Table E-6 summarizes the potential permits that may be required. Should a desalination plant be co-located with a power plant or be incorporated into a power utility's plans for repowering an existing power generation facility, then portions of the project may be subject to the California Energy Commission's environmental review processes (Notice of Intention and Application for Certification). In this case, review of cost allocations for common facilities and equipment would be subject to review of the California Public Utilities Commission.

Design and construction of a desalination plant will take two to five years, depending plant size, availability of intake and outfall facilities, and complexity of environmental permitting. This length of time is slightly longer than other water supply options such as groundwater development but is less than reclamation and, in some cases, long term conservation.

Need to Use Proven Technology. Nearly every study completed in California over the last three years suggests that reverse osmosis (RO) is currently the most economical desalination technology available for small-scale facilities. While thermal desalination processes such as multi-effect distillation and multi-stage flash have historically had more world-wide applications for large-scale facilities, RO has consistently been chosen as the current state of the art and proven technology. Metropolitan's application of VTE technology that focuses on construction and operation in conjunction with repowered coastal power plants has yet to be proven in a pilot demonstration. The many variations of other thermal processes which are currently being marketed by entrepreneurs are also unproven. Technologies, such as reverse osmosis, need to be used in full scale desalination plants, until other technologies such as Metropolitan's VTE process or emerging technologies can be tested and proven in pilot operations and small scale operations.

Economic and Financial Constraints

There are several economic and financial constraints that affect the level of desalination. These include the marginal cost of supply development, existing rebates and incentives, the need for additional incentives, the potential federal energy tax, regional equity, and impacts on water rates. Each of these topics are discussed below.

Marginal Cost of Supply Development. Seawater desalination costs greatly exceed the cost of other local supply development options for Metropolitan member agencies, even when avoided costs and other local benefits are accounted for. If desalination is to become a part of Southern California's future water supply, then a commitment is needed from beyond just an individual Metropolitan agency. Even those agencies having minimal or even no local supplies frequently have a lower cost resource option to meet future water needs than seawater desalination. Metropolitan's water rate reflects the melded cost of inexpensive Colorado River supplies, and moderately priced State Water Project supplies. It would be difficult for a local agency, even with access to the ocean and a viable site for a desalination plant, to economically justify the cost

TABLE E-6

PERMITS AND CONSULTATIONS POTENTIALLY REQUIRED FOR DESALINATION PROJECTS

Agency	Permit	Requirements	Time Frame
Federal			
U.S. Army Corps of Engineers, Regulatory Branch, Los Angeles Division	Section 10 Rivers and Harbors Act Section 404 Clean Water Act Potential Lead Agency for NEPA Compliance	Section 10 required for work in navigable water. Section 404 required if activities are needed that would alter contours of waters of the U.S.	3-6 months
Environmental Protection Agency, Wetlands, Oceans and Estuaries Branch, San Francisco	Review of Corps Permits and NPDES Permits	Environmental Impacts	3-4 months
National Marine Fisheries Service, Los Angeles	Review of Federal Permits Section 7 Endangered Species Act Consultation	Required for potential impacts to endangered species and commercial fisheries	3-4 months
U.S. Coast Guard Marine Safety Detachment, Aids to Navigation Safety Branch, Los Angeles	Approval of Operations	Required for construction of any offshore structures	3-4 months
U.S. Fish and Wildlife Service, Endangered Species Office, Laguna Niguel	Section 7 Endangered Species Act Consultation	Construction impacts to applicable species	3-4 months
State Historic Preservation Office	Section 106 National Historic Preservation Action Consultation	Required for impacts on cultural, historic, archaeological, and paleontological resources	3-4 months

TABLE E-6 (CONTINUED)

PERMITS AND CONSULTATIONS POTENTIALLY REQUIRED FOR DESALINATION PROJECTS

Agency	Permit	Requirements	Time Frame
State			
California Energy Commission, Siting Office	Application for certification if built in conjunction with power plant	Certifies power plant facilities and serves as CEQA equivalent	12 months
California Coastal Commission	Coastal Development Permit Consistency Determination	Required for development within coastal zone; consistency with local coastal plan	3-6 months
Regional Water Quality Control Board	NPDES Permit	Waste discharge limitations; Ocean Plan, Bays and Estuaries Plan, and Inland Surface Water Plan compliance, Health Risk Assessment, Thermal Plan	3-6 months
California Occupational Safety and Health Administration	Trench/Excavation Permit Hazardous material management plan	Excavation greater than 5 feet deep; hazardous materials on-site	Same day
Department of Health Services, Environmental Management Branch	Consultation with RWQCB	Environmental Impacts	2-3 months
Department of Health Services, Office of Drinking Water	Amended Domestic Water Permit	Required to assess quality of delivered water	2-3 months
State Land Commission	Industrial Lease/ROW; CEQA Compliance	Lease/ROW required if activities impact state lands	Undetermined
Department of Fish and Game	CEQA Compliance	Environmental impacts of operation and construction (i.e., entrainment/impingement, brine dischg), Stream Alteration Permit	6 months

TABLE E-6 (CONTINUED)

PERMITS AND CONSULTATIONS POTENTIALLY REQUIRED FOR DESALINATION PROJECTS

Agency	Permit	Requirements	Time Frame
Local			
County Department of Health Services, Environmental Health	Hazardous Materials Management Business Plan	Storage of hazardous materials on-site	2-3 months
Air Quality Management District	Authority to Construct and Operate	Emissions associated with construction and operations	6 months
Fire Department	Hazardous Materials Management Plan	Review of County hazmat plan	1 month
Local Cities	CEQA Compliance and local permitting	Conditional Use Permit	Undetermined

of developing a desalination plant when increased Metropolitan supplies are cheaper.

Future economic evaluations of desalination may need to consider not only the cost of new facilities but the avoided cost of not constructing other water facilities. In addition, these evaluations should consider the higher reliability of desalinated supplies compared to imported supplies.

Existing Rebates and Incentive Programs. Metropolitan's current Local Projects Program (LPP) funding of up to $154 /acre-ft of water produced is designed to help offset the cost of developing more expensive local supplies. This program is designed to provide financial assistance for water reuse projects. Metropolitan's Groundwater Recovery Program allows up to $250 /acre-ft for local groundwater treatment and desalination projects. Since groundwater desalination costs less than seawater desalination, the GRP incentive has a positive effect on the development of new groundwater supplies. Currently, no program exists to encourage the development of seawater desalination.

Need for Additional Incentives. Metropolitan's Groundwater Reconnaissance Study examined potential groundwater development site and quantities throughout its service area. From the study, it was determined that an incentive credit of $250 per acre foot was appropriate to encourage the development of additional brackish groundwater supplies to meet Metropolitan objectives for such development and competitive with the cost of developing new increments of SWP supply.

If a similar objective for the development of seawater desalination facilities were established by Metropolitan, with an appropriate level of participation by Metropolitan, both through capital cost sharing and per acre foot incentive credits, then agencies would be better able to justify on an economic basis the construction and operation of seawater desalination facilities. Metropolitan should examine the current LPP funding level and increase it appropriately to fully reflect its true avoided cost of supply development and conveyance. If fifty percent federal cost sharing of capital facilities could be obtained, and if a $250/acre-ft incentive similar to that for brackish water desalination were applied to seawater desalination, then seawater desalination could become a more viable water supply option for Metropolitan member agencies.

Potential Federal Energy Tax. The Clinton administration proposed implementing a wide-ranging energy (or BTU) tax as part of its deficit reduction package. Although the proposed federal energy tax is not included in the current tax package, such a tax could be implemented in the future. The effect of an energy tax on desalination, or any other water supply, is unknown at this time. Seawater desalination is energy intensive, using about 6,000 - 8,000 kWh of electricity per acre foot of water produced (for reverse osmosis). State water project water is also energy intensive, requiring about 3,000 kWh/acre-ft. Additional power for treatment and pumping water into water distribution systems is also required. If exhaust steam from a power plant can be used, and such an energy source is not subject to an energy tax, then impacts on desalination would be minimal. If however, a tax is imposed on fossil fuels, nuclear, and hydroelectric power, all water supplies would be affected. The effect on desalination would be greater in proportion to its high energy requirement.

Regional Equity. The issue of regional equity was introduced previously in this section. New desalination projects will only be developed in areas of degraded water sources or near the coast. Agencies that develop these sources may develop new supplies but would incur a higher overall cost of water supply compared to agencies that do not utilize these more expensive sources. This leads to a problem of equity: Why should an agency invest in a more expensive water source if a portion of that source benefits another non-participating agency? This situation could occur where the agency uses the desalinated supply to offset imported water sources. The offset imported water would then be available for use by others. The use of regional rebates for desalination is one method for making the development of these sources more equitable to the project participants.

Impact on Water Rates. The impact of new desalination on water rates depends in large part on who pays the cost of the new source. If a desalination project is funded totally on the local level, only the rate payers of the sponsoring agency would experience a rate increase. Such an increase could be significant especially in the case of seawater desalination. If regional rebates are used to fund a portion of the project costs, then the local impacts would be reduced and other non-participating agencies that purchase imported supplies would pay a portion of the costs based on the level of benefit received. Specific detailed evaluations of rate impacts need to be conducted in conjunction with other feasibility and planning studies.

STRATEGIES TO RESOLVE ISSUES

This section presents potential strategies that could be considered to encourage increased use of desalinated water supplies in Southern California. These strategies are presented under the topics of: desired level of local supply development, potential funding and/or incentives for local supply development, desired roles of Metropolitan and member agencies in local supply development, and other strategies.

Desired Level of Seawater Desalination

The desired level of seawater desalination supply development is a function of many variables. The following discussion summarizes some of the potential approaches that may be considered in assessing the desired level of supply. These approaches include: development of centralized versus local seawater desalination; fixed percentage of the total local supply; and a minimum acceptable level of supply. The final decision on the correct approach needs to consider overall project costs in conjunction with the total mix of local and imported water supplies. This could be done as part of the Integrated Resources Planning process being undertaken by Metropolitan.

Centralized (Large-scale) versus Local (Small-scale) Seawater Desalination. Metropolitan's proposed test of VTE technology, dependent upon steam supplies from a power plant, attempts to reduce the current unit cost of seawater desalination by enhancing current evaporative technologies, developing economies of scale, and using less expensive construction techniques and material. Envisioned is a large plant capable of producing 50–100 mgd in conjunction with a single turbine/generating unit. Smaller seawater desalination projects and proposals would use available reverse osmosis technologies, some interfacing with power plant facilities, in sizes ranging from 2 to 30 million gallons per day. Each project must not only consider the economics of producing the water, but also costs associated with product water distribution, brine disposal, siting, and environmental obstacles.

Large-scale facilities may require large diameter pipelines to inland Metropolitan aqueduct systems in order to distribute product water. Water from any proposed large-scale plant may require pumping over longer distances and to greater hydraulic heads than water from smaller plants since supply would exceed local demands. Large-scale plants could incorporate a large diameter pipeline along the coast to distribute product water to several communities at a much lower cost. While smaller plants may be able to dilute brine with other effluent in existing ocean outfalls, large plant could require new ocean outfalls and have little opportunity for dilution prior to ocean discharge if constructed separate from existing power plants. Such discharges will require more expensive outlet works to meet the California Ocean Plan and other regulatory requirements. The added cost of distribution facilities and brine disposal for large scale plants may offset any economies of scale realized.

Fixed Percentage of Total Regional Demand. One possible approach for desalination (especially for seawater) is to target a certain desired percentage of the total water demand. The percentage could initially be set at a relatively low level that is consistent with the current level of technology and to minimize the impacts on total supply costs. The fixed percentage could be increased in the future if technology improves and costs are reduced. The justification for a particular level of investment could consider the increased reliability of seawater desalination and the higher costs in comparison with the current low reliability of SWP supplies.

As an example, the projected total water demand in Southern California is projected to be about 4.5 million acre-ft/yr for the year 2000. If the percentage were initially set at about one percent, then about 45,000 acre-ft/yr of desalination would be the goal. Assuming that improved desalination technologies are developed in the future, the percentage could be increased as demand increases. The level could be determined by evaluating the cost of desalination in conjunction with other water supplies such that the total supply costs are not significantly impacted. One method for determining this desired level might be through the Integrated Resources Plan being developed by Metropolitan's Planning Division.

Minimum Level of Supply. Another approach is to establish a desired level of desalination based on the minimum level that would provide sufficient supply benefits to the region, demonstrate a suitable level of interest to the public, while minimizing impacts on water rates . The level of supply could be determined by economic analysis, considering the needs for additional new water supplies over the long-term.

Drought Supply. A third approach would be to utilize new desalinated supplies (especially seawater desalination) only for drought supplies. In this case, new projects may be constructed to provide supplies only during periods of drought. The projects would be maintained on stand-by until a drought or other supply shortage occur. At that time, the projects could be activated to produce supplemental water supplies and extend the availability of conventional water sources. This approach is likely to be the most expensive approach since capital funds would be tied up in facilities that are used infrequently. Arguably, these capital funds could be applied to water facilities that provide a greater return on the investment.

Any approach to increase the level of desalination could have an adverse impact on water rates. Therefore, it is important that any proposed projects provide not only water supply but also water quality benefits to maximize cost-effectiveness.

Potential Funding and/or Incentives for Local Supply Development

Several potential options exist to provide additional funding for desalination projects at the local level. As discussed previously, the LPP provides a rebate of $154/acre-ft for projects generating new local reclaimed water supplies. The Groundwater Recovery Program (GRP) provides a rebate of up to $250/acre-ft for projects that treat groundwater and reduce imported water needs. Seawater desalination does not come under either program as currently structured.

Some agencies believe that local seawater desalination projects should have a higher incentive than for reclaimed water or groundwater recovery given the higher cost of seawater desalination. Others argue that all incentives should be the same based on the cost to develop new imported supplies. Since seawater projects typically cost in the range of $1,100 to over $2,000/acre-ft depending on the size of project, it is evident that a significant increase in any incentive level would be needed to make new seawater desalination projects competitive with other local and imported supplies.

Potential options that have been proposed include linking the incentive to the total marginal cost of new water supply and linking the incentive to some desired level of supply development.

Each of these options are discussed below.

Tie Incentives to Metropolitan's Marginal Costs of New Potable Supplies. Metropolitan could establish incentives to develop new supplies regardless of source based on the difference between the cost of new local supplies and the marginal cost of new imported supplies . A higher incentive may result in new local supplies being developed more rapidly. The incentive could be based on the actual difference between the marginal cost of supply and the current Metropolitan non-interruptible rate with an established maximum level. The impact of such an incentive would need to be carefully evaluated in light of the current financial condition of Metropolitan. A thorough evaluation of the marginal cost of new imported water supplies would need to be developed to justify the level of incentive. It is recommended that Metropolitan carefully evaluate the marginal costs of all new water supplies as part of its Integrated Resources Plan.

Tie Incentives to Cost of Developing Target Supply Level. Another potential approach might involve linking the incentives to the cost of developing a particular amount of desalination. If, for example, an evaluation of overall supply need and reliability indicates that 50,000 acre-ft of new desalinated seawater supplies are needed by the year 2000, an incentive program could be developed that would ensure that this level of supply is implemented. The incentive program could be similar to the current local projects program except for providing a higher level of incentive. The program could be designed to phase out once the desired level of supply development is achieved. The same concerns that apply to the previous concept apply to this concept. This major difference may be that the program could have a "sunset" provision that could limit the long term financial impact.

Desired Roles of Metropolitan and Member Agencies in Local Supply Development

Implementation of new desalinated supplies may require changes in the roles of both Metropolitan and its member agencies. Potential concepts are discussed in the following paragraphs.

Need for Seawater Demonstration Projects. A seawater demonstration project would serve many useful purposes both from a public relations and a technical standpoint. From the public relations aspect, a demonstration project would provide a showcase for educating the public on how a desalination facility works, would provide the public with confidence in desalination product water safety, would indicate to the public a commitment to securing a reliable water supply, and would provide realistic water costs for comparison to other available water supplies.

From a technical standpoint, a seawater demonstration project would tackle the presently undefined issues of environmental impacts, Department of Heath Services requirements, brine disposal, and other permitting requirements. A demonstration project of sufficient size would also develop the experience on how to interface with the repowering of a generation facility. Most importantly, a demonstration project would provide realistic design, construction, and operations and maintenance costs. The project would supply operational experience for running a desalination plant and the impacts of the facility on the distribution system. Additionally, a seawater demonstration project could be used to test developmental desalination technologies.

Metropolitan as Lead Agency. As a regional agency, Metropolitan may be able to justify the regional benefits of a large desalination facility. As a regional desalination facility, the costs would be shared by all agencies in Metropolitan's service area. Through economies of scale, Metropolitan may be able to provide a more economical desalination facility. Because of the large size of full-scale plants, the desalination industry will be challenged to develop new and improved distillation technologies to reduce the present costs of desalination, and power generating utilities and regulatory agencies will look favorably on linking existing repowering projects with a desalination facility as part of the region's energy resources management plan.

Member Agency as Lead Agency. A Metropolitan member agency, serving as the leading agency for a desalination project, would be able to fast track a project for several reasons. Since the desalination facility would probably be smaller than a Metropolitan plant, the member agency could use an existing technology which does not require extensive pilot or demonstration testing. In addition, a member agency may already own a suitable plant site and the rights-of-way for the distribution system. The member agency, especially if it is a city, would be able to obtain the necessary city permits more readily. A member agency would have the advantage of minimal distribution costs because the plant could be located to more efficiently distribute the product water directly to the customer. A partnership to share capital costs between Metropolitan and local agencies would encourage the development of smaller facilities.

Other Strategies

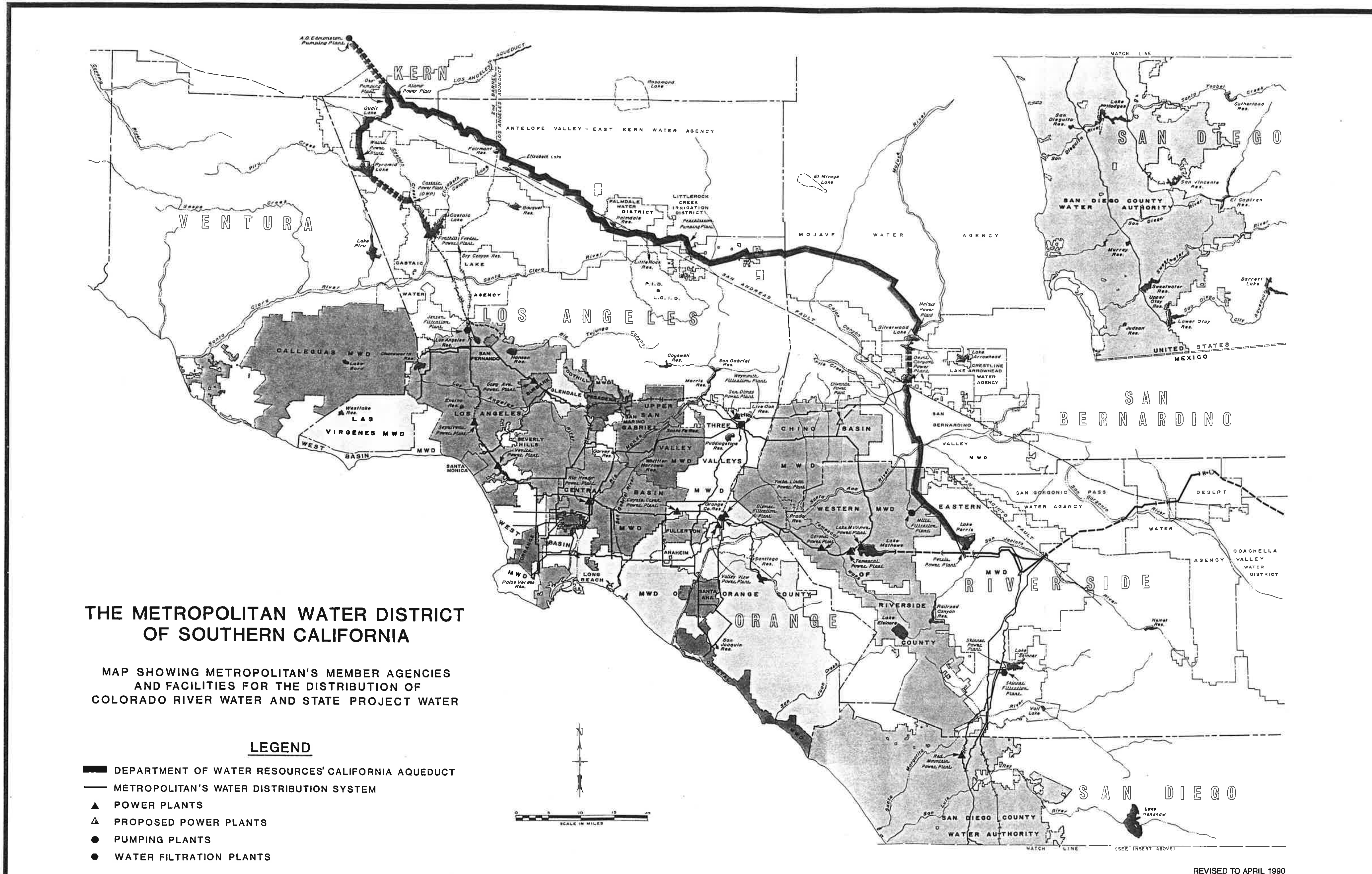
Maximize Use of Available State and Federal Funding. Periodically, State and Federal legislation is adopted that provides funding sources for particular projects. To the extent such funds are available, Metropolitan and its member agencies should maximize the use of the these sources of outside funding where appropriate. In addition, Metropolitan and its member agencies should promote legislation to provide additional funding for desalination research and projects.

The State of California has previously made low interest loans and other incentives available to emerging industries. Low interest loan programs such as the State Revolving Fund and Water Reclamation loans have allowed many projects to proceed by reducing the cost of capital repayment. Although the current financial difficulties of the state have impaired the development of these programs, it is possible that new programs could be developed that can provide funding for desalination projects. Metropolitan and its member agencies should work with the legislature to improve these programs and establish new programs as appropriate.

Recent federal legislation (S-617) has been proposed by Senator Paul Simon (D-Illinois) to provide federal funding for desalination research and development. The bill would authorize appropriations of $95 million over five years. Metropolitan and its member agencies should review this legislation and, if appropriate, support its passage.

Work with Regulators to Develop Guidelines for Brine Disposal. As discussed previously, one of the critical technical issues continuing to face desalination involves the requirements for the discharge of brine into the ocean. Another challenge is to demonstrate the product water quality and plant operating reliability to the regulatory agencies so that drinking water regulations can be revised to better suit public health requirements and desalination technology. Metropolitan and its member agencies should develop a task force of interested agencies that will work with the SWRCB, the RWQCBs, DHS and other state and federal agencies to develop realistic guidelines for brine disposal and to review drinking water regulations relative to desalination processes.

Water Quality Planning. Metropolitan and its member agencies should consider the impacts of delivered water quality on groundwater basin salt balance and water reuse in developing water resources plans under the IRP.



THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

MAP SHOWING METROPOLITAN'S MEMBER AGENCIES AND FACILITIES FOR THE DISTRIBUTION OF COLORADO RIVER WATER AND STATE PROJECT WATER

LEGEND

- DEPARTMENT OF WATER RESOURCES' CALIFORNIA AQUEDUCT
- METROPOLITAN'S WATER DISTRIBUTION SYSTEM
- ▲ POWER PLANTS
- △ PROPOSED POWER PLANTS
- ● PUMPING PLANTS
- ⬣ WATER FILTRATION PLANTS

REVISED TO APRIL 1990

L-1521

to provide long-term reliable water service. The IRP process considers the impacts of various resource mixes on water rates, supply reliability, environmental quality and economic development. The Strategic Assessment established a cooperative forum for the staff of Metropolitan and the member agencies to identify water resources options. In addition, the Strategic Assessment developed a significant amount of information on local water resources in Southern California that is utilized in the development of resource alternatives under the IRP.

The purpose of the study is to develop a *strategic assessment* of near-term water resources development in Southern California. The Strategic Assessment is a means for identifying the critical issues, setting priorities, and developing programs or projects to resolve the issues. A major goal of the study is to develop an approach which meets the increasing water needs of Southern California. The Strategic Assessment consisted of the following key elements:

- **Development of a mission statement** defining the purpose of the water resources assessment.
- **Development of detailed goals and objectives** based on the mission statement.
- **Preparation of a situation assessment** to define the key planning and management issues, assess the current overall water management programs and develop projections of future supply and demand conditions.
- **Identification of the specific programs and activities** which are being currently undertaken, the status of each, who is responsible for which program, and how each program or activity relates to the detailed objectives.
- **Development of additional activities** to meet the objectives.
- **Development of strategies for the near-term implementation** of the goals, objectives and programs.

A specific mission statement and goals and objectives for the Strategic Assessment was developed by the Strategic Assessment Advisory Committee in October 1992 which are described below.

Mission Statement

The Strategic Assessment Advisory Committee adopted the following mission statement to guide the development of the Strategic Assessment:

> *The mission of the Southern California Water Resources Strategic Assessment is to assess opportunities to optimize local water resources development and enhance Metropolitan and local capital improvement planning through education, cooperation and coordination of policy development for Metropolitan and its member agencies.*

Goals And Objectives

The goal of the Southern California Water Resources Strategic Assessment is to assure a reliable water supply now and in the future. The objectives of the assessment are based on minimum supplies available for the various imported water sources to meet demands during a critical drought year similar to 1991. Specific objectives of the assessment are to develop plans, policies and schedules:

- To implement current and potential best management practices to achieve at least 320,000 acre-ft/yr of new water conservation by the year 2000, in addition to the existing conservation of 220,000 acre-ft/yr.

- To ensure adequate imported supplies during wet periods to satisfy replenishment of surface and groundwater basins carryover storage.

- To expand the conjunctive management of local and imported water supplies to develop at least 400,000 acre-ft/yr of dry-year yield, including yield from the groundwater recovery program by the year 2000.

- To expand the use of reclaimed wastewater from current levels of 285,000 acre-ft/yr to at least 530,000 acre-ft/yr by the year 2000.

- To evaluate the effect of implementing the above objectives on water supply reliability of Southern California in terms of yield, quality and facilities. A particular goal in terms of water quality is the recognition of customer satisfaction issues during evaluation of potential projects.

- To evaluate the effect of implementing the above objectives on Metropolitan's capital requirements with emphasis on peaking requirements.

- To evaluate existing economic incentives and to identify new programs and incentives that can be developed on the regional and local level to encourage additional local water supplies.

- To evaluate the financial requirements associated with implementing the above objectives, and to determine whether the objectives are cost-effective.

It should be noted that the numerical objectives developed for the Strategic Assessment were based on planning conditions and information as it existed in late 1992. Subsequent planning studies conducted as part of the IRP have resulted in somewhat different numerical objectives.

Situation Assessment

A situation assessment was prepared to assess the status of local supply development. The situation assessment involved an extensive data collection effort. Metropolitan and its member agencies were active participants in data collection efforts. One of the primary methods of data collection from member agencies involved distribution of water resources and reclaimed water project questionnaires. The member agencies spent many hours completing the questionnaires and participating in follow-up discussions. In addition to collection of data from Metropolitan and member agencies, a large amount of data was compiled from other water management agencies, water management data bases, and governmental and private consultants' reports. This assessment served as the basis for subsequent evaluation of individual local resource options and the issues faced in implementing these resources. The findings of the Situation Assessment are summarized in the section titled "Local Water Resources."

Issues Papers

A series of five issues papers were prepared to identify current programs and activities that encourage local resources development, additional activities needed to meet objectives , and strategies for near-term implementation of the objectives and programs. These issues papers were organized by water resources and cover water conservation, groundwater storage and treatment, water reclamation, groundwater quality and treatment and desalination. These issues papers are presented in the appendices of this report. This summary report reorganizes the content of the issues papers into sections titled: "Technical Issues," "Institutional and Regulatory Issues," "Economic and Financial Issues," and " Recommended Strategies."

LOCAL WATER RESOURCES

Water supply for the Metropolitan service area comes from both imported and local sources. Imported supplies currently account for approximately 60 percent of current supplies, with the remainder supplied by local water resources. The following discussion summarizes the current water supply status and existing plans for these sources.

The local water resources in the Metropolitan service area consist of surface water, groundwater, reclaimed water and seawater desalination. Although the Los Angeles Aqueduct is technically an imported source, Metropolitan considers it to be a local source because it is under the control of the City of Los Angeles. Groundwater extraction includes production of water which meets water quality standards with minimal treatment, and increasingly, production of water that requires treatment such as reverse osmosis to remove soluble salts, or air stripping and GAC treatment to remove organics. Reclaimed water is used in a number of Southern California communities and significant increases are planned. Seawater desalination is currently utilized in only one area of Southern California, Santa Catalina Island. Water conservation is also considered a "local" resource in that it is depend on actions taken by local agencies. These local supplies are discussed below.

Surface Water

Due to the relatively dry climate and low-lying physiographic nature of most of the Metropolitan service area, local surface water resources represent a relatively small percentage of the region's water supply. The primary source of surface water supply originates from the Transverse Ranges that form the northern border the Metropolitan service area in Los Angeles and San Bernardino Counties. The Transverse Ranges include the San Gabriel and San Bernardino Mountains, which have relatively large watershed areas with maximum elevations of 10,000 to 12,000 feet. In western San Diego County, surface water is derived from the Peninsular Ranges, which reach maximum elevations of approximately 7,000 feet. A relatively small amount of surface water is also derived from the Santa Ana Mountains in Orange County, which reach maximum elevations of 4,000 feet.

The primary utilization of surface water in the Metropolitan service area is for groundwater basin recharge. Numerous projects for enhancement of natural recharge in existing drainages and artificial spreading grounds are located on the major drainages of the Los Angeles, San Gabriel, Rio Hondo, Santa Ana, Santa Margarita and San Luis Rey river systems.

Relatively few water supply agencies utilize surface water for treatment and direct supply to users. Other surface water is utilized in local foothill areas by smaller water agencies, however, these supplies are relatively minimal. Data provided by member agencies indicate about 111,000 acre-ft/yr of local surface water is used directly to meet demands. This yield varies from 60,000 to 220,000 acre-ft/yr depending on local weather conditions.

Groundwater Resources

In the Metropolitan service area, groundwater resources are abundant and form the cornerstone of Southern California's water supply. Groundwater basins from the Santa Clara River in Ventura County southward to the Tijuana River in San Diego County, and inland to the foot of the San Gabriel and San Bernardino Mountains sustained the beginnings of the dynamic growth in the greater metropolitan area. Groundwater supplies about one fourth of the annual demand of Metropolitan's service area. Groundwater basins are naturally replenished by precipitation and natural runoff from local watersheds. This natural groundwater recharge is supplemented by the percolation of an additional 300,000 acre-ft of imported water and reclaimed water. The groundwater basins are valuable not only for their annual yield, but also because their large storage capacity provides a reliable source of supply during sustained droughts and other emergencies such as seismic damage to the canals and associated facilities of the import systems. Under the conjunctive use concept, groundwater basins can be utilized to store excess supplies of imported water during times of abundance for later use during times of shortage.

The Southern California groundwater basins underlying the service area have a gross storage capacity of more than 200 million acre-ft of groundwater, and together provide a yield of approximately 1.2 million acre-ft/yr. This groundwater supply sustains more than 5 million residents or about one-third of the population of Southern California. As a result, support for the enhancement and protection of these groundwater basins has been a significant priority for Metropolitan and local water agencies.

There are water quality and other problems associated with many groundwater basins. These problems, if not resolved, could reduce groundwater production and increase reliance on imported water supplies. Metropolitan developed its Groundwater Recovery Program to provide an economic incentive to member agencies that construct facilities to treat degraded groundwater supplies. By 2010, about 210,000 acre-ft/yr of treated groundwater is expected to be on-line. After deducting groundwater replenishment needs, the net yield of these projects is about 158,000 acre-ft/yr.

Reclaimed Water

The utilization of treated wastewater is the largest growing source of local water supply in the Metropolitan service area. In many areas of Southern California, municipal wastewater is currently treated to a tertiary level and discharged to local water courses which eventually flow into the ocean. Currently, approximately 135,000 acre-ft/yr of reclaimed water is reused in the Metropolitan service area. An additional 100,000 acre-ft/yr of reclaimed water is indirectly recycled through the downstream groundwater recharge of surface water containing wastewater discharges.

The largest segment of reclaimed water use in the Metropolitan service area is for groundwater replenishment, representing about 52 percent of all reuse. Non-potable uses for industrial, landscape irrigation and recreational uses represent about 34 percent of current usage. Agricultural irrigation represents 14 percent.

Member agencies are planning for significant growth in the amount of reclaimed water use. By the year 2010, reclaimed water usage is projected to increase to about 662,000 acre-ft/yr, an increase of almost five times. Accomplishing this increase will require a significant effort on the part of all water and wastewater agencies as well as regulatory agencies.

Seawater Desalination

The Metropolitan service area generally parallels the Pacific Ocean from the Santa Clara River in Ventura County to the Mexican Border in San Diego County and includes over 200 miles of coastline. The proximity of the service area to the coastline, and the seemingly limitless supply of ocean water have made seawater desalination the focus of increasing attention, particularly from the public and news media. Currently, the only operating seawater desalination facility in Southern California is located on Santa Catalina Island producing about 100 acre-ft/yr.

A number of new seawater desalination facilities have been proposed. If all of these facilities are implemented, 114,000-165,000 acre-ft/yr of supply could be derived from desalinated seawater. The principle drawback to implementing seawater desalination is cost. Seawater desalination is capital and energy intensive with current costs ranging from $2,000/acre-ft to $6,000/acre-ft and bid proposals ranging from $1,400 to $2,800/acre-ft. Opportunities to develop seawater desalination processes at significantly lower costs may be achieved through large-scale thermal desalination implemented in conjunction with electric power plant reconstruction.

Los Angeles Aqueduct

The Los Angeles Aqueduct (LAA) is one of the primary sources of imported water to the Metropolitan service area. The LAA facilities originate from the Mono Basin and Owens Valley approximately 200 miles north of Los Angeles, and convey water to the San Fernando Valley. The LAA is owned by the City of Los Angeles and operated by the Los Angeles Department of Water and Power. The initial facilities of Los Aqueduct (constructed in 1913) had a capacity of 300,000 acre-ft/yr. The primary source of water for this first aqueduct was surface water diverted from the Owens River. In 1940, improvements to the aqueduct were completed which extended the aqueduct into Mono Basin. A second aqueduct with an additional capacity of 200,000 acre-ft/yr was completed in 1970. The second aqueduct derived water from increased surface water diversions from Owens Valley and the Mono Basin, and groundwater extraction from Owens Valley.

In the period of 1970 to 1990, the average imported water supply the City of Los Angeles from the LAA was approximately 450,000 acre-ft/yr, with a maximum supply of over 500,000 acre-ft/yr occurring in 1983 and 1984. Export volumes from the LAA have been the subject of litigation which will ultimately have the effect of reducing the available supply from the LAA. The groundwater management agreement for Owens Valley and the recent Mono Basin judgment regarding diversion from streams feeding Mono Lake are expected to decrease the average yield of the LAA to about 380,000 acre-ft/yr. The nature of these limitations will result in more significant supply variations between wet and dry years. Based on the Draft EIR for the Inyo County/City Agreement (1990), wet year yield (i.e. repeat of 1978, 80,82,83 or 86 hydrologic conditions) from the LAA may be as much as 500,000 acre-ft, or 157 percent of average yield. Dry year yield (repeat of 1972, 76, or 77 conditions) may be as low as 125,000 acre-ft, or 54 percent of average yield.

Water Conservation

Water conservation has become a significant resource in Southern California. Water conservation includes a variety of measures to reduce water demands and use water more efficiently. Metropolitan has estimated that savings of 220,000 acre-ft/yr were achieved between the years 1980-1990. Most of this conservation is due to plumbing code changes occurring in 1980 and customers becoming more efficient due to water rate increases in the 1980s. This amount is about 5 percent of 1990 demand. Metropolitan projects total water conservation of 820,000 acre-ft/yr by the year 2010, doubling the amount projected for 1995.

Summary

Local water resources represent about one half of the total water supply for Southern California. Table 2 summarizes the projected local supplies for the region based on data developed by the member agencies as part of the Situation Assessment in 1993. The total local supplies are projected to increase from 2.1 million acre-ft/yr in 1995 to about 2.7 million acre-ft/yr by 2010. Water conservation projections are based on Metropolitan data. Local water resources and conservation combine to provide the equivalent of 2.5 million acre-ft/yr in 1995 to 3.5 million acre-ft/yr in 2010.

TABLE 2

SUMMARY OF LOCAL WATER RESOURCES

Source	Average Annual Yield (acre-ft/yr)		
	1995	2000	2010
Surface Water	110,000	110,000	110,000
Groundwater (native yield)	1,340,000	1,400,000	1,540,000
Groundwater (imported replenishment)			
Reclaimed Water	280,000	480,000	650,000
Seawater Desalination	0	10,000	20,000
Los Angeles Aqueduct	380,000	380,000	380,000
Total Local Supplies	2,110,000	2,380,000	2,700,000
Water Conservation	430,000	560,000	820,000
Total Local Supply and Conservation	2,540,000	2,940,000	3,520,000

Note: Supplies rounded to nearest 10,000 acre-ft/yr.
Reference: Montgomery Watson, Situation Assessment for the Southern California Strategic Resources Assessment, 1993.

TECHNICAL ISSUES

The issues papers prepared as part of the Strategic Assessment identified a number of technical issues. Some of these technical issues apply to essentially all local resource options. Other issues relate primarily to a specific resource. For example, water quality management is a common issue to not only many local resource options but also imported water options. However, basin storage constraints apply only to groundwater storage and conjunctive use. This chapter summarizes the key technical issues affecting local resource development and summarizes the strategies identified to address these issues. A more detailed discussion of these issues is presented in the appendices to this report.

Water Quality Management

An important concern for water managers is water quality. The expansion of drinking water regulations has led to increased emphasis on the quality of water supplies. An issue raised by several agencies is the need for an integrated water quality management approach in Southern California. The reason for this need is the interrelationship between imported water quality, groundwater supply quality and wastewater quality. Increases in the total dissolved solids (TDS) of imported supplies used for groundwater replenishment will increase the TDS of groundwater supplies. Similarly, increased water supply TDS increases the TDS of wastewater that may be subsequently reused.

In many portions of Southern California, water supplies are used successively. In many areas, water supplies are used for municipal and industrial purposes, the wastewater is treated and then is discharged to inland surface waters. These surface waters are recovered downstream for groundwater replenishment, subsequent extraction and use. A third use may be made if wastewater treated at coastal plants is reused. Each successive use of water adds salt. If the initial source water quality has a high salt content, the opportunities for subsequent reuse can be adversely impacted. To preserve these opportunities, the regional boards have established water quality objectives for receiving waters that serve as the basis for waste discharge permits. In many inland basins, these objectives are based on the presumption that State Water Project water is the primary source of imported water. Some basin plans even discourage the use of Colorado River water due to its higher TDS to protect wastewater quality for subsequent.

The delivery of State Water Project water to Southern California in the early 1970s dramatically increased reuse opportunities through the delivery of low TDS water. However, as a result of the recent drought and operating limitations on the SWP, the TDS of SWP supplies has increased. This has led to discharge permit violations in instances where SWP water is a significant portion of the supply.

Many groundwater basins in Southern California have degraded supplies due to previous agricultural and industrial practices. Proposals to increase the conjunctive use of groundwater and imported water could adversely affect groundwater quality in these degraded basins. Operation of groundwater basins for conjunctive use place additional hydrologic stresses due to the higher recharge in wet periods and extraction in dry periods. These stresses may cause increased gradients that could affect the movement of contaminated groundwater plumes. Sustained extraction during prolonged dry periods could result in degraded water quality as plumes are drawn to extraction wells and require treatment to meet drinking water regulations.

The increased regulation of drinking water quality coupled with the need to improve supply reliability has led water managers to consider groundwater treatment and desalination as an alternative to the use of imported water. Since these processes can be more costly than the purchase of imported water, water managers have important questions to consider including:

- Should they invest limited capital funds in expensive treatment facilities or should they continue to rely on imported supplies that are becoming less reliable and have declining quality?
- What is the impact of increased reliance on Colorado River water on water quality?
- Is it appropriate to delivery better quality imported sources to coastal regions and serve Colorado River water in inland regions where discharge limits are more stringent?

Based on these issues, it is important that water quality be a key consideration in future water supply planning. Some agencies have suggested that Metropolitan reconsider its current methods for delivering imported water to emphasize SWP deliveries to inland regions. This approach could reduce the future dependence on more expensive groundwater desalination processes. It is recommended that a more detailed assessment of water quality impacts be performed in Southern California.

Resource Yield Constraints

There are a variety of constraints that affect member agencies' abilities to increase local resource development. These constraints vary with the particular local resource. Table 3 lists some of the key resource constraints by type of resource. These constraints are discussed in the following paragraphs.

TABLE 3

SUMMARY OF RESOURCE CONSTRAINTS

Local Resource	Constraint
Surface and Groundwater Storage	Supply Availability Inflow and Outflow Limitations Distribution System Limitations Available Storage Capacity Loss of Stored Water Water Quality Impacts
Seawater Desalination	Interfacing with Power plants Distribution Limitations Brine Discharge Plant Siting
Groundwater Treatment	Plant Siting Residuals Disposal Capacity
Water Reuse	Seasonal Storage New Uses for Reclaimed Water
Water Conservation	Quantification of Water Savings Identifying Existing Conservation Levels

Limitations Affecting Storage. A number of limitations affect the ability to store and recover water in Southern California. These limitations include: storage criteria, supply availability, inflow and outflow limitations, distribution system limitations, available storage capacity, loss of stored water, water quality impacts. These constraints are discussed in detail in Appendix B.

These limitations are highly interrelated. Sufficient supplies are needed in periods of surplus to fill or refill depleted storage facilities. Assuming supplies are available, there must be enough facility capacity to get the water into storage. This includes not only for spreading ground capacity at times when water is available but also the distribution system capacity to convey water to the recharge facilities. Basin inflow capacity limitations can be overcome through in-lieu replenishment—substitution of an alternative water source for groundwater or surface water that is then left in storage. However, in-lieu replenishment requires redundant imported and local facilities. Imported water treatment and distribution capacity may effectively limit in-lieu potential.

Outflow capacity needs to be adequate to remove water from storage during periods of need. However, physical outflow capacity must exist to remove the water from storage. In many groundwater basins, the existing production capacity is reserved for local system peaking. Additional capacity is available for conjunctive use in most basins; however, new extraction capacity may be needed to maximize conjunctive use potential. Some wells are affected by poor water quality and are out of service. Construction of groundwater treatment facilities could overcome some of these limitations.

Limitations Affecting Seawater Desalination. Implementation of seawater desalination presents some unique technical challenges. The technical considerations relating to seawater desalination include desalination process selection, pre-treatment considerations, methods of brine disposal and interfacing with electric power plants.

The technology for seawater desalination typically involves either distillation processes or membrane processes. The selection of the most appropriate technology is a function of many considerations. In general, the larger capacity desalination facilities utilize distillation processes while the smaller facilities use membrane processes. However, site limitations and other considerations also impact the selected process. New processes have been proposed that could reduce costs. Brine or concentrated seawater produced by a desalination process must be disposed of in an environmentally acceptable manner. For seawater desalination, options available include direct discharge through an outfall, combined discharge with municipal wastewater, and combined discharge with power plant cooling water.

Because of the proximity to the coast of many power plants in Southern California, there has been considerable discussion regarding combining desalination facilities with power plant operations. Such dual purpose plants have been successfully built and operated in other areas of the world where desalination is a major component of the region's water supply. Repowering of existing power plants provide the greatest opportunity for water agencies to co-locate and combine desalination with power plant operations. Water agencies and power utilities should work closely together to create mutually beneficial opportunities to meet the power and water needs of their customers.

Limitations Affecting Groundwater Treatment. The principal constraints affecting groundwater treatment projects relate to appropriate treatment technology, plant siting, and disposal of residuals. Groundwater supplies may require treatment to meet current or anticipated water quality regulations. Although treatment technologies exist for each contaminant, there will be added costs to construct and operate treatment systems.

Since groundwater is usually produced by a large number of small capacity facilities, well sites are typically scattered, use small amounts of land, and are located in residential, commercial, or industrial areas. Although there is no systematic inventory of space at well sites, most of them are expected to be too small to accommodate treatment equipment. In some cases where wells are already manifolded and pumped to a central facility, treatment at a central location may be more feasible than at individual well sites. Where wells are not manifolded, construction of new centralized treatment could require substantial pipeline construction as well.

Most of the treatment technologies produce residuals, which creates an issue of disposal. The recent trend toward groundwater desalination has increased demand for brine disposal lines. Although there are some regional brine lines, such as the Santa Ana Regional Interceptor (SARI) line from the Inland Empire to the ocean, remaining capacity is limited. Additional regional brine disposal facilities would be necessary as a means of brine disposal, since other methods are typically more expensive. The timing of construction of new brine disposal facilities is important so that flows approach design capacity relatively quickly to ensure capital recovery.

Aeration to remove volatile organic compounds (VOCs) or radon produces an off-gas. Because of the local air quality conditions, it is difficult to obtain an operating permit from the air quality management district without off-gas treatment, usually by granular activated carbon (GAC). The GAC is then contaminated, and has its own set of disposal issues. Groundwater treated by enhanced coagulation for disinfection by-products (DBPs) or arsenic control will have more solids resulting from high coagulant dose; again, residuals management to a sewer or landfill must be considered.

Limitations Affecting Water Reuse. The principal technical constraints affecting water reuse projects are the need for seasonal storage and application of new technologies. Landscape irrigation demand experiences tremendous seasonal variations due to Southern California's predominant "winter only" rainfall pattern. These annual variations in landscape irrigation demand point to the need for seasonal storage if reclaimed water use is to reach its full potential. However, developing seasonal storage reservoirs of adequate capacity to meet reclaimed water development potential in the Southern California area is fraught with both cost and environmental constraints. While groundwater recharge options may provide the most cost-effective opportunities to store reclaimed water, basin adjudications, competing potable development, water quality limitations, capacity limitations, and the fact that many areas in the Metropolitan service area lack groundwater resources limits the groundwater storage development option. Surface storage opportunities are similarly constrained.

Existing reclaimed water technology has focused on non-potable uses such as landscape irrigation and industrial uses. Although groundwater replenishment with reclaimed water has been successful, regulatory agencies have been slow to approve new projects. However, proposals have recently been developed to use reclaimed water for potable surface reservoir replenishment. This represents the cutting edge of reclaimed water technology. Levels of treatment are high to provide public health protection. If testing is successful, this could pave the way for significant increases in the amount of reclaimed water use.

Limitations Affecting Water Conservation. The concept of conservation being considered as a demand reduction tool is rapidly changing to a vital supply component not only in Southern California but throughout most of the state. With the increased regularity of water shortages, most agencies are taking hard looks at their total water picture in terms of long-range water planning. With many conservation programs now being implemented and hard data on water savings becoming available, it makes sense to categorize these savings as dependable sources of supply.

An important aspect of any water conservation program is its water savings effectiveness. In developing new conservation programs a comprehensive method of evaluating the water savings and program effectiveness (i.e., market penetration, ancillary administrative costs, etc.) should be incorporated into its design, thus making it an integral part of the program. Without this evaluation, cost effectiveness calculations cannot be made. These calculations are needed to support the investment of time and dollars in programs.

INSTITUTIONAL AND REGULATORY ISSUES

Institutional and regulatory issues affecting the development of additional local water resources were identified in the issues papers. These issues include regulatory constraints, permitting considerations, institutional authority and legal constraints. These issue areas are summarized in the following paragraphs.

Regulatory

Many issues affecting the development of additional local water resources are driven by the regulatory processes. Specific issues identified in the issues papers include basin plan objectives, best management practices and the Bay-Delta hearings, drinking water regulations, and other issues.

Basin Plan Objectives. With increasing conjunctive use of groundwater basins, there have been issues related to Regional Boards' basin plan objectives for water quality. These water quality objectives are based on the prevailing water quality and beneficial uses. For example, recharging Colorado River water increases groundwater TDS.

As discussed in the desalination issues paper, the basin plans have generally adopted more stringent water quality objectives in inland areas to allow for the successive use of water and to protect the quality of downstream supplies. These plans have placed more emphasis on desalination and other treatment technologies to meet water quality objectives and to maintain the salt balance in the groundwater basins.

Development of additional local water resources must consider the effects of multiple uses of water on receiving water quality. In some cases, basin plans may need to be amended to provide the flexibility needed to accommodate additional reuse. In others, the preservation of downstream quality will necessitate additional treatment.

Best Management Practices and the Bay-Delta Hearings. Prior to 1991, there was substantial differences of opinion regarding the role of water conservation in water supply planning. Environmental groups tended to cite significant levels of potential conservation while water agencies stressed the difficulties in documenting savings. To avoid the adoption of unrealistically high estimates of conservation in Bay-Delta hearings, urban water agencies developed the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU). The MOU defines Best Management Practices (BMPs) for water conservation that are achievable, technically and economically feasible, and environmentally and socially acceptable. When the BMP concept was finalized in 1991, it began the aggressive implementation of water conservation programs by its signatories. While the BMP process provides implementation flexibility, the signatory agencies have set agendas on which measures are to be started, what is required for each BMP, and timetables for completion. The adoption of the MOU essentially removed the issue of water conservation from the Bay-Delta hearings. D-1630, while currently not being actively processed, indicates a strong interest by the State Water Resources Control Board to aggressively implement water conservation programs throughout the state.

Drinking Water Regulations. The U. S. Environmental Protection Agency (EPA) is establishing new drinking water standards and monitoring frameworks for many additional contaminants pursuant to the federal Safe Drinking Water Act Amendments. California has adopted even more stringent standards for a number of inorganic chemicals (IOCs), VOCs and synthetic organic chemicals (SOCs). Also, California is proposing Recommended Public Health Goals (RPHGs) in drinking water for all regulated contaminants. Under these new rules, several of the most common contaminants found in Southern California groundwater basins would be regulated at levels below the existing maximum contaminant levels (MCLs). Failure to comply with RPHGs would require public water systems to prepare Water Quality Improvement Plans and could ultimately result in mandated treatment of groundwater sources even if MCLs are not exceeded.

Permitting

The combination of the National Environmental Protection Act, the Endangered Species Act, the Corps of Engineers 404 permitting process and the California Environmental Quality Act has greatly constrained and increased the cost of construction of new water storage facilities and the efficient operation of existing facilities. The establishment of multi-agency regional environmental mitigation banking programs might facilitate further water facility development.

The environmental and regulatory permitting process is sometimes contradictory, and is always somewhat confusing and costly. Many water storage projects are delayed or fail due to permitting requirements. Streamlining of the process by coordination, regional permits and defined exemptions would accelerate implementation of new water storage projects.

Institutional and Legal

There are a number of institutional and legal issues that affect the ability to increase the utilization of local water resources. These issues include control of stored water, facilities ownership and operation, groundwater judgment limitations and live stream discharge requirements. These issues are summarized below.

Control over Stored Water. There has been substantial discussions regarding the approach for regional coordination of groundwater storage operations. Groundwater producers view their basins as a form of property and strongly resent any attempts for outside control of these basins. In fact, the trend in recent judgments and modifications to existing judgments have involved increased "basin" control through the use of management boards acting as basin watermasters.

There is a concern that increased water management powers for Metropolitan would require regional growth management which is currently controlled on the local level. Potential problems with adjudicated rights could also develop. Many member agencies do not want Metropolitan to act as a "water czar" with direct control over the allocation of all water supplies. In fact, Metropolitan exercised a significant amount of control over water use during the drought through the IICP. This control was accomplished through economic incentives and disincentives. At this time, economic incentives and contracts appear to be the preferable way to achieve maximum use of surface and groundwater storage.

It was concluded at the Strategic Planning Assembly in January 1994 that Metropolitan's powers should not be enhanced legislatively. Instead, Metropolitan should concentrate on improving regional cooperation and coordination.

Facilities Ownership and Operation. An additional area of institutional concern involves the ownership and operation of facilities. Currently, groundwater recharge and production facilities are owned by local water agencies. When water is stored in a basin by outside agencies, a potential for conflicting use of facilities can develop. In the case of recharge facilities, most spreading basins are operated to recover as much local water as is practical. This recharge occurs primarily in the winter and spring months. Imported water is also normally available during these same periods. To maximize recharge of local water, it is important that local water have a higher priority for recharge than imported water. However, opportunities to store imported water may be lost if these conflicts occur. Increased use of in-lieu recharge can minimize these conflicts.

Similar conflicts can occur with the extraction of stored water. Many agencies are maximizing their groundwater extraction during the summer months to take advantage of the Seasonal Storage Program. However, Metropolitan also may want to extract stored water during these same periods when imported water supplies are low. This creates a conflict for the same extraction facilities. Construction of additional groundwater production facilities appears to be a viable approach. The ownership of these facilities and the operations then becomes an important factor so that conflicts in basin operating objectives do not occur.

Judgment Limitations. The operation of groundwater basins are generally controlled on the local level. However, Metropolitan's Seasonal Storage program has significantly changed the pumping patterns in most groundwater basins. Many groundwater basins in Southern California are governed by water rights adjudications which set specific limits on the amount of water that can be extracted and stored by the parties to the judgments. These judgments are typically administered by a watermaster who, in turn, is responsible to the courts. Other basins, such as the Orange County Basin, are not adjudicated but rather are managed by a groundwater management agency (Orange County Water District in this case). No regional agency exists with the authority to require local agencies to take certain actions relative to groundwater storage. Table B-6 summarizes the storage and overdraft provisions in eight of the groundwater basins in the Metropolitan service area. Of these basins, six are adjudicated, all of which have some form of storage provisions. Generally, the most recent judgments have the most flexible storage arrangements.

Live Stream Discharge. The economic viability and therefore the fate of many water reclamation projects is often tied to the use of natural watercourses for the conveyance and downstream reuse of reclaimed water. Discharging reclaimed water into a watercourse provides an economical means of transporting water to a downstream use, and a method for managing surplus reclaimed water available during wet weather when supply exceeds the market demand.

The federal Clean Water Act, which provides the legal basis for both state and federal regulations governing the chemical character of reclaimed water discharges, presumes that all waters of the United States have, or could potentially have, "fishable-swimmable" uses. Unlike streams of the Northwest and Eastern U.S., many streams in a large portion of southwestern U.S., including Southern California, are not suitable for the development of aquatic life due to the climate and intermittent flows. In fact, due to less restrictive regulation in the past, today several existing watercourses in arid or semi-arid climates that receive significant amounts of reclaimed water are supporting a limited aquatic habitat and other beneficial uses which would not otherwise exist without the discharge of reclaimed water.

Although reclaimed water can be treated to levels that would not represent a threat to human health, the same water may not be suitable for the survival of more sensitive aquatic species. Treatment technologies that are available to achieve a level of treatment required by these more sensitive species, including reverse osmosis, are cost-prohibitive.

ECONOMIC AND FINANCIAL ISSUES

Until the early 1980s, Metropolitan's role in water resources was limited to that of a supplemental supplier of imported water. Except for offering discounted service for groundwater replenishment deliveries beginning in 1955, Metropolitan had little involvement in local water resources management. However, with the defeat of the Peripheral Canal in 1982, Metropolitan began to examine other water resource management alternatives. As a result of the 1982 Orange and Los Angeles County Water Reuse Study, Metropolitan initiated the Local Projects Program to financially assist recycled water projects in Southern California. Metropolitan actively began to re-examine its water resource strategies in the late 1980s. This section discusses the economic and financial issues affecting local resource development. Other issues include incentives and equity.

Resource Economics Issues

One of the major factors affecting decisions to implement new local resources is the cost difference between imported water supplies and new local supplies. From the perspective of local water agencies, a new local water supply project is economically viable if the cost of implementation is less that the cost of purchasing imported water. Since many new reclamation and groundwater treatment projects are more expensive than imported water purchases, the local agencies may not implement these projects on strictly economic considerations. Supply reliability and local control also affect implementation viability. Table 4 shows the typical range of costs for various local water resources.

TABLE 4

COMPARISON OF RESOURCE COSTS

Water Source	Resource Cost Range ($/acre-ft)
Groundwater Production	50-150
Water Conservation	250-600
Water Reclamation	300-1,500
Treated Non-Interruptible Water (Current)	412
Brackish Groundwater Desalination	500-1,500
Seawater Desalination (recent bids)	1,400-2,800

Metropolitan's new financial structure changes the allocation of some of the costs of imported water and, hence, may affect decisions to implement new local resources. A portion of the capital costs of new facilities to meet the reliability and water quality needs of existing users will be recovered from a new "readiness-to-serve" charge. That portion of the capital cost of new facilities to meet new demands on Metropolitan will be recovered through a "new demand" charge. The new demand charge is projected initially to be $1,000/acre-ft of new demand payable over a 15 year period. The readiness-to-serve and new demand charges will generate additional fixed revenue for capital recovery. Implementing these new fixed charges will have the effect of reducing the water rate compared to what it would have been without the fixed charges. Although a reduced imported water rate could be an economic disincentive to new local water resource development, the new demand charge would represent an economic incentive to areas where growth is occurring.

Local water supply projects provide benefits to areas outside the service area of the project. These regional benefits include reduced demand for imported water, drought protection, reduced peaking on the imported water system and emergency supplies. These benefits can be translated into reduced regional costs for imported water to all water agencies. Metropolitan's IRP is evaluating the effect of local resource development on the cost of imported water supplies in terms of both resources and distribution.

Financial Issues

A key question in considering project financing is "Who pays?" Most local projects are funded at the local level using local bonding capacity. This approach is appropriate when a project strictly provides local benefits. Sources of funding have included local financed bonds, State low interest loans and in some cases, Federal grants and loans. The Bureau of Reclamation's small projects loan program has funded over $250 million of local reclaimed/groundwater related projects in Southern California in the last five years. However, when a project provides both local and regional benefits, it can be argued that both local and regional financing should be utilized. Metropolitan has recognized the regional benefits of local resources development through its various water management programs. These programs provide economic incentives to participating member agencies who develop new local resources.

Local agencies have not been satisfied with some sources of funding. An example is the State Revolving Fund (SRF) low-interest loans for groundwater and reclaimed water projects. The primary purpose of the SRF loan program is to assist in the financing of publicly owned treatment works necessary to protect and promote the health, safety, and welfare of the inhabitants of the State. In addition to pollution protection, water reclamation projects are eligible for SRF funding. However, any reclamation project funded through the SRF must meet both SRF and Water Reclamation Loan Program funding requirements. The added burden of the Water Reclamation Loan Program funding requirements puts water reclamation projects at a disadvantage when competing with pollution control projects.

Some local resources programs have significant impacts on a local agencies cash flow. For example, water conservation programs have always been a 'double edged sword' because when done effectively they reduce revenue and raise expenses. In general, these changes in revenues and expenses will occur gradually over time enabling the impacts to be factored in future rate increases. Even though the effects on revenue are somewhat inflexible, agencies are looking for creative ways to finance conservation programs to minimize the impacts on water rates.

Incentives

Incentives are economic signals designed to achieve a result by making a desired action less expensive than an undesirable action. Currently, Metropolitan uses both incentives and disincentives to encourage development of additional local water resources. A typical incentive program would be the Local Projects Program (LPP) while a disincentive program would be the penalties for excessive water use in the Incremental Interruption and Conservation Program (IICP).

History of Metropolitan's Incentive Programs. Programs to encourage increased water resources management have taken many forms over the years. These programs have generally been structured to encourage the development of a particular local resource such as groundwater storage or reclaimed water. Table 5 presents a brief summary of these programs.

Many of these programs provide financial benefits to participants based on performance. Metropolitan only pays if the project proponent actually produces the water. All risk is assigned to the local project developer. These programs generally have minimal up-front costs to Metropolitan and thus avoid using Metropolitan's capital debt limit.

Adequacy and Term of Incentives. An issue raised in all of the issues papers is the adequacy and term of the existing incentives. Some agencies argue that the incentives do not consider all of the avoided costs associated with imported water. These avoided costs include not only energy and treatment costs but also avoided or down-sized capital investments in the Metropolitan distribution system, and the avoided costs of obtaining additional imported water such as water transfers. Agencies that propose new local supplies believe the incentives should be based on the marginal cost of the new supplies.

TABLE 5

METROPOLITAN'S HISTORICAL INCENTIVE PROGRAMS

Resource	Program	Period
Conjunctive Use	Groundwater replenishment rates - discounted water rates for groundwater recharge	1955, 1958-1981
	Interruptible water rates - discounted water rates for direct and in-lieu groundwater and reservoir storage and agricultural service	1981–1991
	Seasonal Storage Service - discounted water rates for direct and in-lieu groundwater and reservoir storage and peak reduction	1988–Present
	Cooperative studies - technical and financial assistance for evaluating groundwater development	
	Demonstration Storage Program - one-time program for long-term water storage	1993
	Cyclic Storage Program - pre-delivery of replenishment water	1978–Present
	Cooperative Storage Program - program for long-term	1994–Present
	Drought Storage Agreements	1991–Present
Reclaimed Water	Local Projects Program - capital contribution toward construction, repayment at defined rate	1982–Present
	Local Projects Program - incentive payment for new reclaimed water yield	
Water Conservation	Conservation Credits Program	1988–Present
	Technical assistance	
Groundwater Treatment	Groundwater Recovery Program	1991–Present

A second concern with the existing incentives is the lack of assurance that the programs will continue for a sufficient period to recover investments in new capital facilities. This is not a significant concern for the LPP and GRP programs due to their contract provisions but it is for the seasonal storage rates. Metropolitan has indicated its commitment to the program but recognizes that the current Board of Directors cannot tie the hands of future Boards to make new policies. Development of a separate program to provide guaranteed incentives for new capital investment may be a reasonable approach.

Another concern regarding incentive adequacy is that the incentive tends to be fixed over a period of time. For example, the current LPP incentive of $154/acre-ft was established in 1990 subject to periodic review every three to five years. There is no direct provision for adjustment due to inflation. Inflation at a rate of 4 percent/year would justify an increase in the incentive to about $180/acre-ft today.

A final concern involves the linkage between incentive programs and other water management activities such as the Drought Management Plan (DMP). In the recent drought, Metropolitan adopted the Incremental Interruption and Conservation Program (IICP) to provide an economic disincentive for excessive use of imported water. During the drought, some agencies contended that the IICP did not sufficiently encourage agencies with access to groundwater storage to utilize their stored water. The IICP is being replaced by a new DMP for 1995 that will address some of the concerns with the old IICP. A long-term DMP will be developed in the future. The main consideration for the DMP is that it work with the other incentive programs to encourage the development of new resources or storage and not develop barriers to efficient water usage.

Equity

The equity of providing incentives for local water supply projects is a significant issues to many member agencies. Equity involves the perception that each agency is treated fairly with regard to pricing, availability of incentives, and benefits. Agencies that do not participate in an incentive program question whether the program really generates benefits commensurate with the program costs. Several questions must be addressed in considering whether incentive programs are equitable:

- Do local resources projects provide water supply benefits to "non-participating" agencies and districts?
- Are the regional costs of providing incentives defined in terms of the regional benefits?
- Are potential controls on local water too restrictive to permit effective and efficient multi-purpose water resources management by Member Agencies?
- Who should assume the risk of implementing a local water resources project?

RECOMMENDED STRATEGIES

The issues papers developed as part of the Strategic Assessment pointed out a number of issues that affect the ability to implement additional local water resources. These issues include technical issues, institutional and legal issues, and economic and financial issues. This section presents a set of strategies that are recommended to assist in developing additional local water resources.

General Strategies

Several general strategies for increasing the development of local water resources are proposed:

- Evaluate existing Metropolitan programs as part of the IRP process to determine whether these incentive programs are sufficient to encourage additional local water resource development. This evaluation is on-going.

- As part of the IRP process, Metropolitan should evaluate regional reclaimed water projects and support the Bureau of Reclamation's Southern California regional recycling study.

- Metropolitan should expand its regional leadership role in encouraging wise local water resources management activities by consolidating its member agency technical assistance programs in one division (conservation credits, local projects, groundwater programs, desalination, drinking water quality issues with retail agencies).

- Metropolitan should convene a member agency task force to evaluate what worked and did not work during the 1990-92 drought.

- Resource planning decisions should be made on the basis of least cost planning principles to the extent practical.

- Metropolitan should evaluate the water quality impacts of the water supply plans developed in the IRP on water reclamation potential and ability to meet waste discharge requirements.

- As part of its Integrated Resources Plan, Metropolitan should evaluate the effect of proposed water supply plans on the delivered water quality and the ability of member agencies, subagencies and wastewater management agencies to meet waste discharge requirements.

Resource-Specific Strategies

The issues papers identified a number of strategies that are specific to particular local resources. These strategies are summarized by resource.

Water Conservation. The strategies related to water conservation focus on the need for better coordination, technical assistance and financial incentives include the following:

- Metropolitan should assist member agencies in allocating the new forecasts to member agency service areas and encourage a common forecasting methodology. Use of MWD-MAIN by member agencies could be considered, or the model could provide unit water use factors; i.e., gallons per person per day, appropriate for each member agency service area.

- Replenishment should not be added into regional demand figures since it makes comparison of demand projections more difficult.

- Better coordination of water conservation planning is needed. Metropolitan should provide guidance to member agencies and sub-agencies on how to calculate projected water savings.

- Adequate resources, in terms of money and staff, should be provided to implement the hundreds of individual conservation projects needed to meet conservation goals. Metropolitan should consider allocating additional financial resources to assure the conservation staffing level necessary to meet the currently planned objectives for demand management.

- A regional accounting system should be developed to keep track of water savings and associated costs. Metropolitan and its member agencies should utilize a least cost planning strategy that continually compares investment in conservation to other ways to reduce demand or increase water supply.

- Metropolitan should continue the Conservation Credits Program to sustain the aggressive implementation schedules required by the BMP MOU. Options to consider are:

  1. Develop financial incentives based on avoided costs.
  2. Develop creative payback programs instead of rebates.
  3. Fund demand side management programs from rate payers.
  4. Provide funding based on available funds.
  5. Participate in the Financial Authority for Resource Efficiency of California (FARE Cal).
  6. Capitalize conservation investments.
  7. Use private or third party financing.
  8. Form partnerships with other utilities.
  9. Develop innovative retail rate structures.

Water Reclamation. Strategies for addressing issues associated with developing increased water reclamation include the following:

- Metropolitan and its member agencies should establish a cooperative working relationship with the California Department of Health Services (CDHS) and each of the six County Health Departments in its service area, focusing on water reclamation activities to:

  1. Develop communications and a joint evaluation process for facilitating the regulatory approval of water reclamation projects
  2. Support CDHS's efforts to amend Title 22 to expand the uses of reclaimed water which maximizes beneficial uses while continuing to protect public health
  3. Coordinate information exchange among regulatory and reclamation agencies leading to development of consistent, realistic and safe guidelines and information on the use of reclaimed water
  4. Meet with the public health officials as often as necessary to review or resolve strategies and issues related to reclaimed water

- Metropolitan and its member agencies should participate and support such organizations as WESTCAS (Western Coalition of Arid States) to maximize the use of reclaimed water. This should include support for amendments to the Clean Water Act needed to facilitate the use of reclaimed water in arid and semi-arid regions and to recognize that not all water bodies can be "restored" to the point where they can fully support a wide range of aquatic life.

- Metropolitan should submit comments on future drafts of the Inland Surface Water Plan (ISWP), as well as meet directly with USEPA and State Water Resource Control Board (SWRCB) representatives to stress the importance of an ISWP that supports reuse to the extent environmentally possible.

- Metropolitan should support agencies in their effort to address seasonal storage of reclaimed water by tailoring its Local Projects Program (LPP) to provide financial support for regional storage facilities that would enable several agencies, each with their own reuse program, and support agencies in developing seasonal storage projects by providing technical guidance and leadership.

- Metropolitan should reevaluate the value of the LPP contribution based on the total avoided costs of additional imported water supplies and other associated regional benefits. The LPP should recognize the current changes being proposed in Metropolitan's rate structure.

- Metropolitan and its member agencies should encourage the following modifications to the State Revolving Fund (SRF):

    1. Set aside a specific amount of SRF funds for water reclamation projects consistent with the State Legislature's water reclamation policy (Water Recycling Act of 1991) to develop 700,000 acre-ft/yr of reclamation by 2000 and 1,000,000 acre-ft/yr by 2010.

    2. Remove any unnecessary requirements from the water reclamation loan criteria (i.e., letters of intent should not be required where mandatory use ordinances are in place and eligibility criteria should be based on projections similar to pollution control projects.)

Groundwater Treatment. A number of issues have been raised relative to groundwater quality and treatment. Potential strategies to resolve these issues are presented below:

- Metropolitan and its member agencies should continue their proactive role in commenting on the development of new drinking water regulations including the cost impacts of these regulations.

- Metropolitan and its member agencies should continue with its efforts to evaluate the impact of the new regulations on groundwater production in its service area.

- Metropolitan should provide technical assistance to its member agencies in assessing the cost of new groundwater treatment projects and in the use of the most appropriate treatment technologies.

- Metropolitan should work with its member agencies to identify potential groundwater treatment projects that have both local and regional benefits.

- Metropolitan and its member agencies should jointly evaluate the need for new or enlarged brine disposal facilities to handle the anticipated waste loads from new inland groundwater treatment facilities.

- Metropolitan should proceed with its plans to re-evaluate all of its incentive programs and propose modifications as appropriate to encourage the treatment and use of degraded groundwater.

Ground and Surface Water Storage. Strategies for ground and surface water storage should address technical, institutional, financial and environmental concerns as follows:

- The Association of Groundwater Agencies and Metropolitan should continue to identify and quantify alternative storage opportunities in Southern California, assess the cost and feasibility of alternatives, and develop implementation programs.

- Member agencies and subagencies should develop sufficient local water supply system redundancy to provide maximum in-lieu replenishment in wet period and maximum groundwater pumping in dry periods. Local water agency interconnections should be provided to expand potentials for joint use of storage facilities. Adequate emergency storage should be provided consistent with Metropolitan's recommendations.

- Metropolitan should develop a strategy of increased investment in hydrologic forecasting coupled with close coordination between Metropolitan and local water storage agencies.

- Metropolitan and its member agencies should consider development of a regional environmental mitigation bank to be used by local agencies proposing new water storage facilities and foster greater cooperation among water agencies in joint mitigation activities.

- Metropolitan should reevaluate the seasonal storage differential to ensure that an appropriate incentive is provided to ensure adequate participation in the SSS program. Provisions should be included for a higher incentive if capital investment is made in new storage facilities.

- Metropolitan should consider alternative programs for capital investment by Metropolitan in place of per acre-foot incentives including development of a regional revolving loan fund to facilitate local storage development, a separate rate program for long-term (carryover) storage or other mechanisms to guarantee seasonal pricing for a specified period of time to pay for specified capital projects.

- Member agencies should commit to drafting from storage during periods of imported water shortage in exchange for reduced water rates. This may best be accomplished through an improved DMP.

- Metropolitan water storage programs must be sufficiently flexible to enable them to work within the constraints of individual Member Agencies, or within groundwater basin operating parameters.

- Significant augmentation of groundwater storage in Southern California should be undertaken while the Domenigoni Reservoir is being constructed. Stored waters could later be extracted to offset supplies diverted to fill Domenigoni. Expanded use could be made of Southern California groundwater basins provided:

    1. Additional spreading and injection capacity is developed

    2. Institutionally-derived operating criteria can be modified

    3. Greater cooperation is exhibited by Member Agencies.

- Metropolitan, its member agencies and groundwater managers should identify potential modifications to existing groundwater rights judgments to improve flexibility for drought storage.

Seawater Desalination. Seawater desalination is a potential resource that has not been utilized due to its high cost. Strategies to increase the utilization of seawater desalination include the following:

- The feasibility of seawater desalination should consider overall project costs in conjunction with the total mix of local and imported water supplies. Any proposed projects should provide not only water supply but also water quality benefits to maximize cost-effectiveness.

- If seawater desalination is determined to be a cost-effective and required part of the regional water supply, Metropolitan should consider establishing an incentive program for desalination based on avoided costs and regional benefits. A thorough evaluation of the marginal cost of new imported water supplies would need to be developed to justify the level of incentive.

- Metropolitan should proceed with its development of a seawater demonstration project from a public relations and a technical standpoint. From the public relations aspect, a demonstration project would provide a showcase for educating the public on how desalination works, provide confidence in desalination product water safety, and indicate a commitment to securing a reliable water supply. From a technical standpoint, a seawater desalination demonstration project should address the presently undefined issues of environmental impacts, brine disposal, other permitting requirements, develop the experience on how to interface with the repowering of a generation facility, test developmental desalination technologies. and provide realistic design, construction, and operations and maintenance costs.

- Metropolitan should take a lead role in the evaluation of technologies for regional desalination projects. Member agencies should develop small scale desalination projects where economically justifiable.

- Metropolitan and its member agencies should maximize the use of the these sources of outside funding where appropriate and promote state and federal legislation to provide additional funding for desalination research and projects.

- Metropolitan and its member agencies should develop a task force of interested agencies that will work with the SWRCB, the RWQCBs, CDHS and other state and federal agencies to develop realistic guidelines for brine disposal and to review drinking water regulations relative to desalination processes.

- Metropolitan and its member agencies should consider the impacts of delivered water quality on groundwater basin salt balance and water reuse in developing water resources plans under the IRP.

APPENDIX A

WATER CONSERVATION AND DEMAND PROJECTIONS ISSUES PAPER

The amount of water needed to support future growth in Southern California is critical to planning water management strategies. This paper reviews available water demand projections, one prepared by Metropolitan and the other prepared from a member agency water needs survey, published in the Task 3 report of this project. Expected water needs from both sources will be compared and contrasted and reasons for differences explored. In addition the impact of other factors that could change the projections, such as updated population forecasts by regional planning agencies, drought carryover and the recent economic downturn, are cited.

Water conservation is a resource option that can be used to meet future needs. As such the cost-effectiveness as compared to other options is an important issue. The first, and perhaps most important question, is how much water can be saved cost-effectively. Current estimates for the amount of water that has already been saved by past efforts as well as the range in projected savings from future efforts are given. Prior actions include plumbing code changes, price changes and public education. New initiatives include the Best Management Practices. The impact of the uncertain and ever changing regulatory climate on requirements for conservation programs is described. Barriers to implementation, such as a lack of clear supportive data and funding, are discussed and strategies to remove these barriers are suggested.

INTRODUCTION AND IDENTIFICATION OF ISSUES

Demand Projections

The development and ongoing refinement of accurate forecasts of future water use are probably the most essential component in completing comprehensive water resource planning. They create a critical foundation for making political and financial decisions regarding the feasibility, implementation and timing of both regional capital improvement projects and demand management programs. *Specifically, the overall results of the demand forecasts, combined with the potential for local agency resource development, will ultimately direct the level of investment Metropolitan will need to make in conservation and local supply projects that will determine the demand for imported water.* The Southern California Water Resources Strategic Assessment currently under preparation is a cooperative effort of Metropolitan and its member agencies to identify the level of local resource development and imported supplies necessary to meet demands and associated reliability objectives in the future.

For the study to be successful, an accurate forecasting data base for the entire service area which is sensitive not only to population, but to trends in income, housing, employment, conservation and pricing (such as the MWD-MAIN model) must be available for comparison to aggregated forecasts provided by the member agencies. Forecasts from the MAIN model are critical in providing a point of comparison to member agency data in two key areas: base forecast demands derived from statistical information, and effective levels of demand reduction from existing and future conservation.

The first area where member agency information must be verified against Metropolitan's planning data is in the base forecasts. The MAIN model uses input data primarily from three sources: U.S. Bureau of Census, local/regional/state agencies (e.g. San Diego Association of Governments – SANDAG, Southern California Association of Governments – SCAG, local planning agencies, etc.) and private economic and market data collection firms. To insure that the forecast base demand data provided by the member agencies are compatible with the MAIN model "Base Water Use" output (exclusive of conservation), the processes used in their development and key assumptions need to be reviewed. Identification and reconciliation of any differences in statistical data will be an essential task in finalizing the Strategic Assessment.

The second critical area where verification of member agency data needs to occur is the expected level of conservation. In Task 3 of the Strategic Assessment, member agencies were asked to submit their forecast demands, local supply project yields, and expected level of conservation for 1990, 1995, 2000 and 2010. This data was then compiled to determine the total regional demand for water from Metropolitan.

For the most part, conservation effectiveness has not been well studied by the member agencies, and the values typically submitted for the Strategic Assessment appeared to be either educated guesses, or were totally omitted from the agencies' submittals. In addition, many of the agencies assumed that in 1990 there virtually was no conservation, when in fact most sources agree that through substantial retail price increases in the eighties (averaging 40%), and 1981 plumbing code changes, there was a certain degree of conservation in place. This raises the question of what is the "baseline" year for measuring conservation program effectiveness, and what current and planned conservation programs are being assumed by member agencies.

The MAIN model provides three modes for analyzing and reporting forecast data, two of which are sensitive to varying degrees of conservation. The model output segregates forecast demands into "Base Water Use", assuming no conservation; "Water Use With Conservation", assuming retail pricing increases and effects of the 1981 plumbing code changes; and "Water Use With BMPs", which incorporates the retail pricing increases and many of the BMPs contained in the 1991 "Memorandum of Understanding Regarding Urban Water Conservation in California".

With the output from the MAIN model categorized in this fashion, modeled data can be readily compared to the expected levels of conservation reported by the member agencies. In addition, the model allows for existing levels of conservation to be analyzed to determine what the appropriate base demand year for measuring future conservation program effectiveness should be. Another issue which impacts the level of existing conservation versus that expected in the future is the amount of conservation in place which can be attributed to the public's memory of the drought. Given the extensive amount of public education and media attention devoted to the recent drought, and in many cases mandatory rationing, a certain level of behavioral changes are likely to have occurred. Whether these changes in water use patterns are indeed permanent, or if they will be tempered to some degree by several years of abundant supply is somewhat speculative.

Conservation Issues

Conservation as a Resource Option. The concept of conservation being considered as a demand reduction tool is rapidly changing to a vital supply component not only in Southern California but throughout most of the state. With the increased regularity of water shortages, most agencies are taking hard looks at their total water picture in terms of long-range water planning. With many conservation programs now being implemented and hard data on water savings becoming available, it makes sense to categorize these savings as dependable sources of supply.

Long-Term Conservation versus Rationing. In past decades conservation meant preserving or sustaining a resource during drought conditions. When rainfall and/or snowpack conditions reduces supply below projected demands, emergency rationing programs can be implemented to mandate reduced demand to a desired level. However, because Southern California continues to grow in population and the water resources have become less reliable, conservation is now a long term water supply component as well. The difference is that rationing is only a drought response which ends when plentiful rainfall returns, while long term conservation implements measures that reduce consumption over many years on a much more permanent basis, such as the installation of ultra-low-flush toilets which save water indefinitely. Another important distinction is that rationing often involves harsh measures that result in economic hardships and inconveniences, while long-term measures lead to gradual changes in lifestyle that do not necessarily result in hardships.

Identify Existing Levels. Since there have been many past conservation activities that have resulted in water savings, any discussion of demand forecasting and future conservation efforts must include an identification of the existing levels of conservation. This is especially true with Southern California just concluding six years of drought which required multiple years of rationing in some communities. Many of the programs implemented to reduce the effects of the drought are still producing considerable savings today, as well as a general increased awareness of our environment by Southern California water users. Additionally, plumbing code changes in the early 1980s have caused permanent demand reductions. Metropolitan estimates that the current level of long-term conservation for the region is about 7 percent, using 1980 as a base year.

Evaluation of Water Savings. An important aspect of any water conservation program is its water savings effectiveness. In developing new conservation programs a comprehensive method of evaluating the water savings and program effectiveness (i.e., market penetration, ancillary administrative costs, etc.) should be incorporated into its design, thus making it an integral part of the program. Without this evaluation, cost effectiveness calculations cannot be made. These calculations are needed to support the investment of time and dollars in programs.

BMP/D1630 Process. When the concept of Best Management Practices (BMPs) was finalized in 1991 it began the aggressive implementation of water conservation programs by its signatories. While the BMP process provides implementation flexibility, agencies have set agendas on which measures are to be started, what is required for each BMP, and timetables for completion. D1630, while currently not being actively processed, indicates a strong interest by the State Water Resources Control Board to aggressively implement water conservation programs throughout the state.

Other Regulatory Processes. There are other regulatory processes besides D1630 or BMPs that can dictate how or what conservation programs are implemented. Any new Bay-Delta standards which may supersede D1630 in the future, will undoubtedly contain similar, if not more restrictive, conservation requirements. Once enacted they could have a serious impact on an agency's flexibility of different program implementation. The state's Landscape Ordinance AB 325 (*Water Code* §13551), Federal Clean Water Act, and potential Bureau of Reclamation requirements are examples. A related program is the requirement for conservation plans to be submitted before the State Board will make loans through the State Revolving Wastewater Loan Program. Agencies need to plan for such processes when determining staffing and funding requirements for multi-year programs.

Financing. While water conservation programs are an important component of most agencies' budgets, they must be balanced with other equally important functions such as operations and maintenance or water quality improvements. Therefore, financing of water conservation programs can be an integral part of the decision process of which programs are implemented each year. They should be prioritized along with other water supply and wastewater reclamation projects. With many programs involving cash incentives or 'free' services to the customer, assistance from Metropolitan (conservation credits program) is currently the primary way to make programs financially feasible. Other financing strategies are identified later in this issues paper.

Impact on Rates and Revenues. Water conservation programs have always been a 'double edged sword' because when done effectively they reduce revenue and raise expenses. In general, these changes in revenues and expenses will occur gradually over time enabling the impacts to be factored in future rate increases. Even though the effects on revenue are somewhat inflexible, agencies are looking for creative ways to finance conservation programs to minimize the impacts on water rates.

Cost of Water Saved. As mentioned above, the cost effectiveness of conservation programs is vital to promoting these programs to upper management as well as to the customers. Using common economic principles, including present value analysis, the dollars spent on a program can be used along with the water saved to estimate a dollars per acre-foot number for the program. Comparing this calculated number with the agency's cost of water generates the feasibility of the program. Conservation programs should compete with local water supply projects such as reclamation and desalination of brackish groundwater for funding.

New Technology. As conservation becomes a way of life for Southern California, the state and even the country, new technology will play an increasingly active role. Agencies should not concentrate only on conservation using existing products or processes. Manufacturers, if shown the marketability of new, environmentally designed products, will continue to develop new technology for residential and commercial/industrial sector including but not limited to items such as revised industrial processes, ultra-low-flush toilets, water-conserving washing machines, dishwashers, etc.

Even the BMP process has incorporated the concept of potential BMPs to be added to the list as new technology is incorporated into the marketplace. Another driving force behind this new technology is emerging regulations governing efficiency standards of water and energy products. These new standards can play an active role in the development of 'new and improved' water conserving products.

Implementation Barriers. With all the current efforts to promote long-term conservation, some barriers still exist to wide scale implementation. Already mentioned are the difficulties in financing expensive programs and the effects these programs have on rates and revenue. Adequate staffing presents an equally challenging task for most managers. Very few organizations can devote more than one employee to water conservation; and many do conservation as one of many tasks given to an employee. Also important are the diverse skills required in administering these programs. Few in the field, for instance, have the industrial engineering background necessary to properly design and implement industrial/commercial programs. Therefore, the staffing levels and skills of the conservation group can hinder adequate program implementation.

Other barriers include:

- Institutional acceptance of demand management
- Customer acceptance of new technology to support program feasibility
- Knowledge of available technology

SUMMARY OF CURRENT DEMAND PROJECTIONS

A comparison of regional water demands was made, forecasted independently by member agencies and Metropolitan. The comparison is displayed on Figure A-1 on a regional basis and in Table A-1 on a county by county basis. Explanation of the differences are provided in the following paragraphs.

TABLE A-1

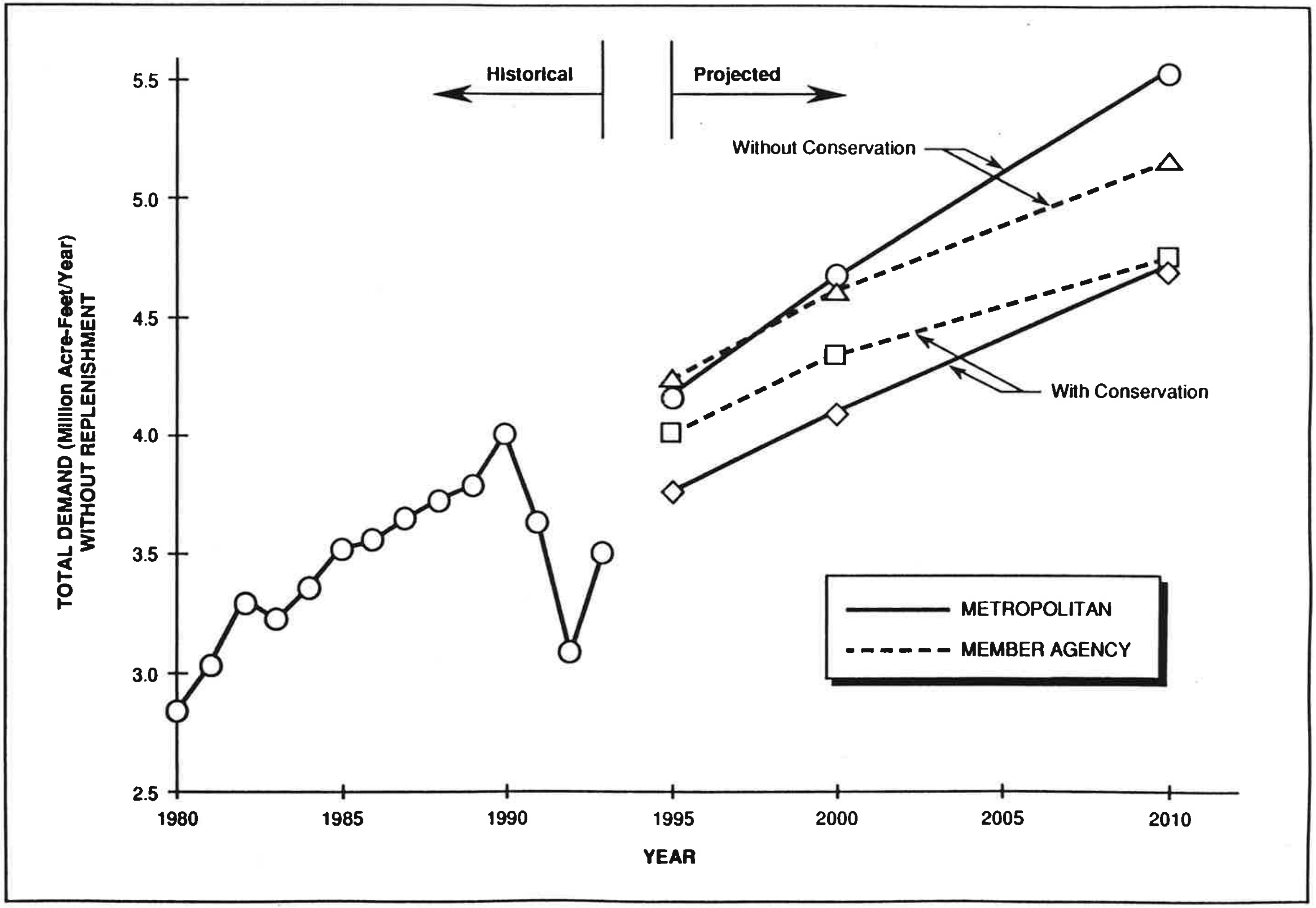
COMPARISON OF METROPOLITAN AND MEMBER AGENCY PROJECTED WATER DEMANDS

Year	County	Member Agency[1]		Metropolitan[2]		Difference[3]		Difference[3]	
		Without Conservation[4]	With Conservation	Without Conservation	With Conservation	Without Conservation		With Conservation	
		Acre-feet/yr	Acre-feet/yr	Acre-feet/yr	Acre-feet/yr	Acre-feet/yr	Percent	Acre-feet/yr	Percent
1995	Los Angeles	1,892,236	1,768,703	1,893,759	1,681,229	-1,523	-0.1%	87,474	4.6%
	Orange	725,900	654,000	716,573	636,703	9,327	1.3%	17,297	2.4%
	Riverside	499,804	499,804	449,893	416,583	49,911	10.0%	83,221	18.5%
	San Bernardino	250,100	250,100	255,033	235,470	-4,933	-2.0%	14,630	5.7%
	San Diego	706,090	691,500	725,671	656,178	-19,581	-2.8%	35,322	4.9%
	Ventura	148,650	136,300	147,636	132,983	1,014	0.7%	3,317	2.2%
	Total	4,222,780	4,000,407	4,188,565	3,759,146	34,215	0.8%	241,261	5.8%
2000	Los Angeles	1,992,339	1,851,578	2,054,247	1,800,037	-61,908	-3.1%	51,541	2.5%
	Orange	809,193	707,000	797,966	697,873	11,227	1.4%	9,127	1.1%
	Riverside	561,560	561,560	502,474	455,538	59,086	10.5%	106,022	21.1%
	San Bernardino	288,000	288,000	303,766	277,234	-15,766	-5.5%	10,766	3.5%
	San Diego	789,000	752,000	825,965	730,867	-36,965	-4.7%	21,133	2.6%
	Ventura	162,350	144,950	165,032	145,902	-2,682	-1.7%	-952	-0.6%
	Total	4,602,442	4,305,088	4,649,450	4,107,451	-47,008	-1.0%	197,637	4.3%
2010	Los Angeles	2,141,188	1,962,651	2,333,042	1,976,158	-191,854	-9.0%	-13,507	-0.6%
	Orange	882,668	747,000	947,331	796,310	-64,663	-7.3%	-49,310	-5.2%
	Riverside	663,250	663,250	640,526	553,704	22,724	3.4%	109,546	17.1%
	San Bernardino	337,200	337,200	412,835	365,398	-75,635	-22.4%	-28,198	-6.8%
	San Diego	902,000	832,000	1,019,743	859,910	-117,743	-13.1%	-27,910	-2.7%
	Ventura	190,934	164,200	200,125	170,563	-9,191	-4.8%	-6,363	-3.2%
	Total	5,117,240	4,706,301	5,553,602	4,722,043	-436,362	-8.5%	-15,742	-0.3%

<u>Notes:</u>

Demands include municipal/industrial and agricultural demands but exclude replenishment.

1. Member Agency demands are based on information provided by agencies in late 1992.
2. Metropolitan demands are based on CCSCE forecasts of May 1992.
3. Difference is measured relative to Member Agency demands (Member Agency-Metropolitan/Member Agency).
4. Demands without conservation assume no additional conservation programs beyond existing programs.



MEMBER AGENCY AND METROPOLITAN DEMANDS

FIGURE A-1

MONTGOMERY WATSON

In all likelihood, Metropolitan's projections and those of the member agencies will be closer when both groups are using the same demographic forecasts. The discrepancies in the assumed level of conservation also needs to be addressed and an agreement on a common methodology developed. In addition, the handling of replenishment should be made consistent so that the projections are comparable.

Basis of Member Agency Projections

Member agencies provided water demand projections for the years 1995, 2000, and 2010, using 1990 as a base year. The projections were obtained from a survey that asked for estimates in the categories of:

- Municipal/industrial
- Agricultural
- Non-potable
- Replenishment (of groundwater basins)

The results of the survey are contained in Appendix C of the Situation Assessment. Member agencies were not asked what demographic projections they were using. Most likely, they used the growth forecasts prepared in 1986-87 by the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG). These forecasts used the 1980 census and growth estimates after that time.

Projections from individual member agencies were totaled by county for use in Table A-1. Replenishment is shown separately and not included in the totals with and without conservation. The member agencies provided an estimate of the amount of conservation expected to occur in each future year. This estimate and the demand projections in the Task 3 Report were called the "with conservation" projection. The "without conservation" projection was developed by adding the amount of conservation assumed by each agency to the municipal/industrial category. For example, if an agency estimated conservation in year 2000 to be 5 percent, then 5 percent of the year 2000 municipal/industrial demands were added to their total demands. It should be noted that only 13 out of 23 agencies provided conservation percentages. For the 10 agencies that did not provide percentages, zero percent conservation was assumed. For those agencies that provided a conservation estimate, it was unclear whether savings include all conservation measures, including plumbing code changes, or only conservation resulting from planned programs. The percent conservation listed in Appendix C of the Situation Assessment was assumed not to apply to agricultural, non-potable or replenishment.

Non-potable demand is expected to rise from 26,500 acre-foot in 1990 to 296,400 acre-foot in 2010. These projections are included in the demands shown in Table A-1. It was not clear whether member agencies reduced municipal/industrial demands to reflect non-potable use replacing fresh water.

Member agencies forecast the need for nearly 5 million acre-foot of water demand by year 2010 without conservation, plus another 650,000 acre-foot to replenish groundwater basins. Conservation could reduce demands about 4 percent. Most of the demand will come from Los Angeles County; however, the demand is growing at a faster rate in other counties with the largest increase in demand (241,000 acre-foot) expected to occur in San Diego County.

Basis of Metropolitan Projections

Metropolitan normally uses SCAG and SANDAG adopted population and demographics in its water demand projections. Post-1990 census projections from SCAG and SANDAG will not be adopted until December 1993. Because the currently adopted growth management plans were based on 1986 data and are outdated, Metropolitan asked the Center for Continuing Study of the California Economy (CCSCE) to provide demographic and economic projections in light of the 1990 census and the recession. Until SCAG and SANDAG release their post-1990 census growth plans, Metropolitan is using the revised CCSCE projections to forecast water needs for its service area.

Metropolitan's Population and Demographic Trends in the Metropolitan Water District of Southern California Service Area, and Current and Projected Water Needs in the Metropolitan Water District of Southern California Service Area, Exhibits 3a and 3b of the Bay-Delta Hearings, describe Metropolitan's methodology and basis for its water demand projections. Projections include municipal/industrial, agricultural, non-potable demand, and long-term replenishment of groundwater.

Metropolitan MWD-MAIN model is used to forecast water demands. Originally developed and calibrated in the 1980s, the model forecasts demand on a city and county basis with and without conservation. Conservation programs undertaken since 1980 are reflected in the projections. Metropolitan forecasts a gradual pull out of the current recession, which has slowed the growth in demand. By the year 2000 and 2010, the report projects that there will be no residual effect on the projections.

Comparison of Projections

Figure A-1 shows actual water use since 1980 through 1993 and projected use through 2010, using the data from Table A-1. The figure illustrates the differences in demands forecasted by Metropolitan and the member agencies. The "without conservation" scenario shows Metropolitan's projection to be nearly 400,000 acre-foot higher than that projected by member agencies for year 2010. Apparently, Metropolitan is using demographic projections which forecast higher growth than the member agencies are generally using or member agencies did not eliminate all conservation from base line consumption determinations. The "with conservation scenario" determined by Metropolitan has substantially lower demands with a water savings of about 16 percent indicated by 2010 (using 1980 as a base). The amount of conservation forecasted by the member agencies is much less, only about 8 percent by 2010 (using 1990 as a base).

Table A-1 shows the difference between Metropolitan and the member agency demands on a county by county basis. Metropolitan's 2010 without conservation projection is higher in every county except Riverside. Metropolitan's with conservation projection is lower in most counties until 2010 when it is lower in Riverside and San Diego. The with conservation projections are converging but this is coincidental since the conservation assumptions are different.

Table A-2 compares the amount of replenishment projected by member agencies and Metropolitan. Although replenishment represents a demand on Metropolitan, it is usually considered a water supply, not a demand. If the amount of replenishment were added to member agency demands, the without conservation scenarios would be closer but the with conservation scenarios would be far apart. Since the MWD-MAIN model forecasts consumptive demands, it only includes annual put and take replenishment (about 100,000 to 140,000 acre-foot per year) and excludes long-term (drought carry-over) replenishment. It is not clear whether replenishment indicated by member agencies are short-term or long-term replenishment and it is therefore not included in the comparison.

As indicated, the 2010 conservation levels are considerably different except in Ventura County. Differences in projections, county by county are listed in Table A-3.

TABLE A-2

COMPARISON OF REPLENISHMENT PROJECTIONS

Year	County	Member Agency Acre-ft/yr	Metropolitan Acre-ft/yr
1990	Los Angeles	186,865	137,145
	Orange	66,000	31,027
	Riverside	7,663	0
	San Bernardino	19,300	26,617
	San Diego	0	0
	Ventura	1,717	1,717
	Total	281,545	196,506
2000	Los Angeles	241,600	131,000
	Orange	65,000	35,000
	Riverside	18,320	0
	San Bernardino	42,800	15,000
	San Diego	0	0
	Ventura	0	0
	Total	367,720	181,000
2010	Los Angeles	269,300	136,000
	Orange	75,000	30,000
	Riverside	18,000	0
	San Bernardino	96,900	18,000
	San Diego	0	0
	Ventura	0	0
	Total	459,200	184,000

Table A-4 shows the differences in projections of agricultural use for 1990 and 2010. The total difference of 117,502 acre-foot in 2010 is mostly explained by the difference in Riverside County. Apparently, agricultural use in Western MWD service area, not served by Metropolitan, was not accounted for.

Table A-5 shows the assumed level of conservation by Metropolitan. Table A-6 compares differences in conservation effectiveness. Metropolitan's level of conservation in 2010, 15.8 percent, is twice as high as assumed by member agencies. Metropolitan references some of the savings to 1980. A possible explanation is that member agencies do not recognize existing conservation and have not yet become proficient at calculating future conservation savings. Another explanation might be that member agencies do not believe conservation will save much water. Member agencies also used 1990 as a base year, which had some conservation already in the base, and was during a well-publicized drought, so demand levels may have been depressed. If Metropolitan uses a 1990 base, then their conservation percent is only 50 percent higher than

TABLE A-3

EXPLANATIONS FOR WATER DEMAND PROJECTION DIFFERENCES

County	Possible Explanation
Los Angeles	Metropolitan higher when replenishment deleted, even with a higher level of conservation. Gap widens over time. Different base years account for some of the difference.
Orange	Same as above
Riverside	Western MWD only included agricultural demand that uses Metropolitan water and not that using local supplies. M&I demand in Eastern and Western are much higher than Metropolitan.
San Bernardino	Same explanation as for Los Angeles County.
San Diego	San Diego County Water Authority is using preliminary SANDAG Series 8 projections which are lower than those used by Metropolitan. Metropolitan projects higher conservation savings.
Ventura	Demand projections are comparable as are conservation savings.
Overall	Difference in water requirements is substantial, and probably due to use of different demographic projections, assumed conservation effectiveness, and the manner in which replenishment is handled.

TABLE A-4

COMPARISON OF AGRICULTURAL USE PROJECTIONS

County	Member Agency		Metropolitan	
	1990 Acre-ft/yr	2010 Acre-ft/yr	1990 Acre-ft/yr	2010 Acre-ft/yr
Los Angeles	600	2,500	3,900	3,500
Orange	23,000	13,000	35,200	21,400
Riverside	30,100	23,198	208,400	114,500
San Bernardino	33,200	18,200	33,500	35,000
San Diego	122,300	108,000	121,200	108,000
Ventura	28,200	16,200	25,600	16,200
Total	237,400	181,098	427,800	298,600

TABLE A-5

CONSERVATION EFFECTIVENESS

Year	Item	Amount Acre-Feet/Year
1995	Existing[a]	220,000
	Drought Carryover	32,000
	Best Management Practices	178,000
	Subtotal	430,000
	Percent of Normal Municipal/Industrial Demand	10.3
2010	Existing[a]	220,000
	Drought Carryover	0
	Best Management Practices	612,000
	Subtotal	832,000
	Percent of Normal Municipal/Industrial Demand	15.8

a. Relative to 1980 base year, includes primarily effect of 1980 plumbing code and price-induced conservation

TABLE A-6

DIFFERENCES IN MUNICIPAL/INDUSTRIAL CONSERVATION EFFECTIVENESS

County	2010 Conservation Level, %		
	Member Agency	Metropolitan	
		1980 Base	1990 Base
Los Angeles	8.3	15.3	10.2
Orange	15.4	16.3	12.1
Riverside	*	16.5	13.9
San Bernardino	*	12.6	10.4
San Diego	6.7	17.5	14.2
Ventura	14.0	16.1	12.0
Overall	7.8	15.8	11.7

* Member agencies did not provide information on conservation savings, does not necessarily mean zero conservation

member agencies. This would narrow the gap in the "with conservation" scenario by 220,000 acre-foot that Metropolitan assumed occurred by 1990.

CONSERVATION EFFECTIVENESS

Table A-5 showed that Metropolitan projects 820,000 acre-foot of conservation by the year 2010, doubling the amount projected for 1995. This section describes where those savings are expected to come from, what has been accomplished to date, and how much money will be needed to achieve this level of water savings. As stated above, member agencies are forecasting lower conservation savings.

Prior Conservation Efforts

Metropolitan has estimated that savings of 220,000 acre-foot were achieved between the years 1980-1990. Most of this was due to plumbing code changes occurring in 1980 and customers becoming more efficient due to water rate increases in the 1980s. This amount is about 5 percent of 1990 demand. In general, projections made by member agencies do not recognize these savings, because they used 1990 as a base year.

Current Conservation Credits Program

Metropolitan has initiated a water conservation credits program to help member agencies initiate and fund water conservation projects. Metropolitan pays member agencies $154 per acre-foot of water saved or one-half the project costs, whichever is less. Only projects which have quantifiable savings are eligible. Since September 1991, when the Memorandum of Understanding Regarding Urban Water Conservation (MOU) was signed, the conservation's credits program has emphasized Best Management Practices (BMPs). Sixteen water conservation programs are called BMPs, about half of which are quantifiable and eligible for the conservation credits program.

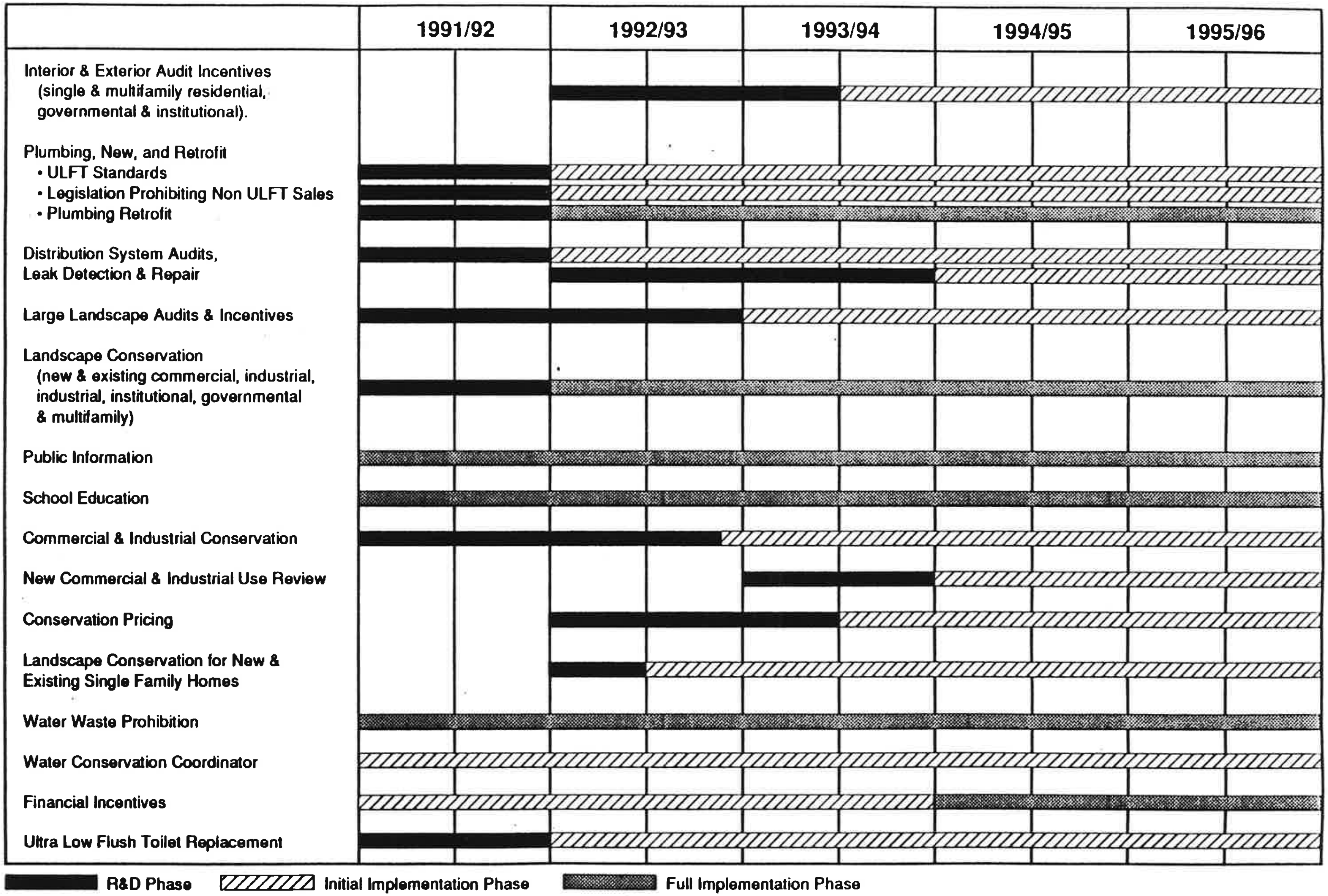
Since the program was started in 1990 over 100 projects have been funded. The main types of programs funded through the credits program have been ultra-low-flush toilet rebate programs and retrofit kit programs and a few pilot programs have dealt with home water surveys, large turf audits and leak detection.

Shown in Table A-7 is a summary of the projects completed or currently underway. Nineteen member agencies are participating, involving eleven sub agencies. This includes 70 programs through conservation credits and 30 through Water Wise (which was a drought program mostly involving retrofit kits). Annual savings from the credit program projects are projected to be 32,500 acre-foot. This represents about 20 percent of the 1995 projected savings due to BMPs. Efforts will need to be accelerated to meet the 1995 goal of saving 178,000 acre-foot per year from BMPs.

Figure A-2 shows Metropolitan's implementation schedule for Best Management Practices. All programs will be operational by 1995. Implementation should be completed within 10 years of start-up.

Cost of Water Saved

Through the conservation credits program, a total of $60 million has been committed to fund water conservation, about half being funded by Metropolitan and the remainder by member agencies. Table A-7 shows the cost of the program to date and the cost of water saved in dollars per acre-foot. The value is calculated by using a discount rate of 8 percent over a period of eight



METROPOLITAN'S IMPLEMENTATION SCHEDULE FOR BMPs

FIGURE A-2

years (which is the average period used by Metropolitan to credit water saved by their program). The cost of water saved ranges from a low of $149 per acre-foot in Orange County to $533 per acre-foot in Riverside County. The average cost for the entire program is $327 per acre-foot.

TABLE A-7

SUMMARY OF METROPOLITAN CONSERVATION CREDITS PROGRAM

County	Number of Participating Agencies	Number of Projects	Estimated Annual Savings (Acre-foot/yr)	Project Cost[1] ($ thousands)	Unit Cost ($/Acre-ft)
Los Angeles	12	38	19,857	43,809	386
Orange	4	14	2,820	2,394	149
Riverside	1	1	46	141	533
San Bernardino	1	2	366	643	306
San Diego	13	13	9,518	13,564	248
Ventura	1	2	451	1,271	490
Total	32	70	33,058	61,822	327

1. Total member agency and Metropolitan costs.

Planned Investment In Conservation

Metropolitan funding of conservation projects is projected to increase about 10 percent per year. Listed below are planned future budgets:

Fiscal Year	Metropolitan Budget
1994-95	$ 28,000,000
1995-96	31,000,000
1996-97	34,000,000
1997-98	37,000,000
1998-99	41,000,000
1999-2000	45,000,000

Most of the money will go to Metropolitan's share of the conservation credits program.

The cost of water saved to date can be used to estimate the cost of achieving the water savings projected in Table A-7. Table A-5 shows that BMP savings will be 612,000 acre-foot by 2010. The annual cost of achieving these annual water savings, using $327 per acre-foot, would be $200,000,000. Using the discount rate and amortization period listed above, this annual cost translates to an equivalent present worth cost of $1.1 billion dollars. If, however, water savings can be achieved at a less expensive unit cost of, say $150 per acre-foot, then the cost of saving 612,000 acre-foot would be about $500 million dollars. Thus, to achieve these savings by the year 2010 (starting in 1990), would require an average expenditure of $25 - 50 million per year. Assuming Metropolitan pays one-half the cost and member agencies the remainder, then the annual budgets listed above for Metropolitan are adequate to achieve these savings. Member agencies would have to also come up with $25 - $50 million per year to fund their share of the program. The lower range corresponds to $150 per acre-foot and the upper range is based on $327 per acre-foot.

RECOMMENDED STRATEGIES

Described in the following paragraphs are recommendations (italicized) that address the issues raised in this paper.

Reconciliation of Demand Database

Demand projections by Metropolitan and member agencies should be closer. A difference of nearly 400,000 acre-foot by the year 2010 is high. Suggested reasons for the discrepancy are:

1. Use of different demographic forecasts.
2. Difference in opinion on long-term conservation effectiveness.
3. Inconsistent handling of replenishment.
4. Use of different base years for estimating the amount of current conservation.
5. Member agency's projections were prepared in 1992 when water use was depressed due to the drought.
6. Differences in agricultural use projected in Riverside County.
7. Possible tendency of member agencies to request perhaps more than enough water to meet future needs so as not to be short or a tendency for Metropolitan to overestimate conservation effectiveness to assist them in securing new water supplies.

When SCAG and SANDAG forecasts are adopted later this year, the difference in demand forecasts should be smaller. *Metropolitan should assist member agencies in allocating the new forecasts to member agency service areas and encourage a common forecasting methodology. Use of MWD-MAIN by member agencies could be considered, or the model could provide unit water use factors; i.e., gallons per person per day, appropriate for each member agency service area.*

This issue paper has identified a large difference in opinion on how much conservation has already been achieved and how much more will occur. Apparently, the staff persons responsible for demand forecasting in member agencies are not aware of Metropolitan's high level conservation programs planned for the region. *Better coordination of conservation planning is needed. Metropolitan should provide guidance on how to calculate projected water savings.* This might reduce the apparent skepticism on how much water can be saved.

The consistent handling of replenishment is a matter of definition and should be possible to resolve fairly easily. Although the sale of Metropolitan water to member agencies represents a demand on Metropolitan, this category of water use should be called a water supply, just as the use of treated water is for municipal/industrial purposes. Replenishment represents a regional demand for imported water but its timing is not driven by instantaneous demands.

Replenishment should not be added into regional demand figures since it makes comparison of demand projections more difficult.

Identifying the Resources Needed to Achieve Goals

Clearly Metropolitan's goal of saving an additional 612,000 acre-foot of water by 2010 is an ambitious goal. It will take a concerted effort by Metropolitan, member agencies, sub-agencies and customers to achieve this. *Adequate resources, in terms of money and staff, should be provided to implement the hundreds of individual conservation projects that are necessary.* It may be helpful to the member agencies if Metropolitan engaged in more coordination of conservation planning with its member agencies, especially sharing their expertise and reference sources as noted previously. However, Metropolitan's staffing may not be adequate to provide this assistance. *It may be appropriate for Metropolitan to consider allocating additional resources to assure the conservation staffing level necessary to meet the currently planned objectives for demand management.*

Achieving this level of savings will be easier if the cost of water saved is below the average cost of $327 per acre-foot experienced to date. Most of the projects funded in the conservation credits program have been ultra-low-flush toilet rebate programs. While these programs reliably save a considerable amount of water, they are relatively expensive. Some of the future savings will come from use of these fixtures in new construction and also the natural replacement of fixtures, neither of which requires a rebate. Other BMPs are expected to cost much less. Some, such as customer water savings due to the inevitable increases in the price of water, will not cost agencies any money. These savings are probably already occurring, adding to the 33,000 acre-foot that is associated with identified projects. Research into new BMPs is expected to produce more cost-effective ways to save water. In other words, the $1.1 billion figure quoted in Section 3 for achieving 612,000 acre-foot of water may be overstated. Nevertheless, a considerable amount of expenditure will be needed to save this much water.

The region should develop an overall accounting system to keep track of how much water has been saved and at what cost. This includes standardization of water savings estimates, identification of presently non-quantifiable savings from other programs underway, such as public education and pricing impacts. These tools will enable mid-course corrections to be made and added resources provided. *Metropolitan and member agencies should develop a least cost planning strategy that continually compares investment in conservation to other ways to reduce demand or increase water supply.*

Financing Strategies

Financing water conservation programs is probably the biggest uncertainty facing water agencies trying to implement BMPs; uncertainty about where the funds will come from as well as uncertainty in the magnitude of customer participation, both of which affect the total cost for administration.

Metropolitan should continue the conservation credits program critical to sustaining the aggressive implementation schedules required by the BMP MOU. The goal is to find a way to fund water conservation programs that cost less than the marginal cost of new supplies. Options to consider are:

1. *Develop financial incentives based on avoided costs.*
   Any agency that purchases water from Metropolitan should already have some mechanism for funding such purchases. $400 per acre-foot for purchased water is equivalent to $1.25 per 1000 gallons. Therefore, financial incentives based on this

amount of water saved, say for industrial or commercial incentives, would have little impact on the agency since the incentive would equal the avoided cost.

2. *Develop creative payback programs instead of rebates.*
   Although a cash outlay may initiate a customer's inclusion in a program, any paybacks during the course of implementing the conservation measure helps continue the funding for others. Agencies can create a pool to start a program and customers that save water and money on reduced bills can pay back funds into the pool, thus providing funding for future participants.

3. *Fund demand side management programs from rate payers.*
   Certain extra costs are sometimes passed through directly to the customers. Purchased water is an example. Demand side management programs, those which consist of 'hard fixes' such as installing ULF toilets, can be added to these charges and thereby reduce the financial burden of the agency.

4. *Provide funding based on available funds.*
   Once a set of programs have been developed each can have a set amount of money budgeted for that program. If the incentives are then based on available funds and temporarily suspended when those expenditures are reached, then over-expenditures can be avoided.

5. *Participate in FARE Cal.*
   FARE Cal stands for Financial Authority for Resource Efficiency of California and is sponsored by California Municipal Utility Association. This is a financing authority that pools resources of member utilities to borrow money and fund groups of projects. Using economies of scale, lower costs of conservation programs can be achieved.

6. *Capitalize conservation investments.*
   The expense of running conservation programs can be capitalized using life cycle costing (present value). By moving the costs out of the operating and maintenance category and into the capital category bond financing can be used possibly lowering overall costs.

7. *Use private financing.*
   Private or third party financing can be used when the program is packaged as an attractive financial opportunity to investors. This can be arranged through an energy service company or water service company. Investors receive payments based upon shared savings with customers who employ conservation measures.

8. *Form partnerships with other utilities.*
   Conservation programs can benefit energy and wastewater utilities by reducing energy use and wastewater flow. These agencies may be attracted to assist with financing if the pay back analysis shows that they benefit. Partnerships can also be formed with federal agencies who may desire to save water at federal facilities.

9. *Develop innovative retail rate structures.*
   Agencies can implement rate structures that include surcharges on excessive use or temporary fees that are lifted when a customer implements a certain program. An example is the temporary fee that the City of Santa Monica levies on rate payers who have not retrofitted their home or building with low flow fixtures. The fee is lifted after the retrofit is completed.

Scheduling

Once sound financial strategies have been developed, the programs with the greatest impact on demands should be scheduled first where practical. It is also recommended that agencies take advantage of the BMP scheduling flexibility, where possible, and spread out the process by spending more time on important programs using local staff.

Effective Staffing Levels

The planned increased level of conservation will require additional staff. Adequate pay will be needed to attract qualified people. Training will be needed. Many of the programs can be supported by consultants. Besides external support, each agency can look internally for strategies that minimize the financial impact of conservation programs.

Local Agencies. Local agencies must be concerned with providing good customer service. *Provide adequate qualified staff means having qualified people in sufficient numbers.* Local agencies need to be able to deal with individual problems or situations that surface daily even if a consultant is administering the program. Also, understaffing causes delays which negatively impacts customer relations.

It is recommended that guidelines be established to quantify the staffing requirements for proper program management. An example would be one employee for every major program such as toilet rebates or home water surveys, one employee for every two minor programs such as public information programs or new commercial/industrial water use plan check review, and one employee for all consultant administered programs.

Regional Agencies. *Regional agencies should provide support to their local agencies.* The goal is to provide customers with good service whether it is from a local agency or regional agency. Regional agencies should provide staff or hired consultants to enhance local programs wherever resources can be shared.

This regional cooperation works best with programs such as large scale retrofits, commercial/industrial audits, landscape ordinance follow-up and ultra-low-flush toilet promotion programs.

The specific roles of local and regional agencies in implementing BMPs should be explored as discussed above. *Metropolitan should consider expanding its role as a regional agency and operate some programs for its member agencies and subagencies as some of the member agencies do for their subagencies.*

APPENDIX B

GROUND AND SURFACE WATER STORAGE ISSUES PAPER

INTRODUCTION

The Southern California Strategic Water Resources Assessment is a joint effort of The Metropolitan Water District of Southern California and its 27 member agencies. The purpose of the Strategic Assessment is to identify the potential for additional near-term water resources development in Southern California. The strategic assessment provides an approach for identifying the critical issues, setting priorities, and developing programs or projects to resolve the issues. A major goal of the study is to develop an approach to meet the needs and objectives of a diverse group of water resources management agencies in Southern California.

The mission of the Southern California Water Resources Strategic Assessment is to assess opportunities to optimize local water resources development and enhance Metropolitan and local capital improvement planning through education, cooperation and coordination of policy development for Metropolitan, its member agencies and other local water agencies.

A Situation Assessment was prepared in February 1993 that summarized the status of water supply planning of the major water agencies in Southern California. The data collection process for the Situation Assessment identified a number of issues potentially affecting the development of new local water supplies. These issues related to development of new supplies through water conservation, water reclamation, desalination, groundwater treatment, and groundwater and surface water storage. The Strategic Assessment Work Group decided that a more detailed assessment of the issues affecting these potential local supplies was needed. This issues assessments would define potential strategies needed to resolve the identified issues. These issues relating to these five categories were addressed by "issues committees" composed of participants from Metropolitan, member agencies, sub-agencies and Montgomery Watson.

This paper summarizes the general conclusions of the Ground and Surface Water Storage Committee. The ground and surface water storage committee has developed and adopted the following goal statement: "To promote cost effective programs and policies to increase storage of water and water production capabilities for the benefit of the entire region of Southern California". The ground and surface storage issue paper, designed to identify appropriate programs and policies, includes:

- Regional Storage Needs
- Summary of Current Metropolitan Storage Programs
- Issue Identification
- Alternative Strategies to Address Issues
- General Conclusions

REGIONAL STORAGE NEEDS

In October, 1991, Metropolitan prepared an analysis of regional storage needs in the document, Eastside Reservoir Project-Final Environmental Impact Report. Storage requirements were evaluated in a two-step process designed to establish the combined groundwater and surface storage needed to provide reliable water service, and determine the minimum required capacity of new surface reservoir storage. This new storage, if operated in a coordinated fashion with groundwater storage, would meet the regional storage needs.

The combined storage need was calculated by Metropolitan by determining the volume of emergency, carryover (drought-year), and seasonal reserve requirements, and then deducting existing available storage capacity. Emergency storage is based on a six-month outage of all imported water aqueducts, a 25 percent mandatory reduction in retail water demands, suspension of all interruptible deliveries and full local groundwater production. Carryover (drought) storage is imported water stored to meet year to year differences in supply and demand. Seasonal storage is the seasonal difference between supply availability and demand, estimated to be 12 percent of average annual demand. Total storage requirements for the year 2030 equaled an estimated 2,189,900 acre-feet, including 977,200 acre-feet for emergency reserves, 835,800 for carryover storage, and 376,900 for seasonal requirements as shown in Table B-1.

TABLE B-1

REGIONAL STORAGE REQUIREMENTS
(Acre-Feet)

Storage Component	2000	2010	2020	2030
Storage Requirements				
Emergency	646,300	715,600	853,200	977,200
Carryover	650,200	715,400	775,700	835,800
Seasonal	285,600	316,100	338,800	376,900
Total Requirements	1,582,100	1,747,100	1,967,700	2,189,900

Source: MWDSC; Eastside Reservoir Project Final Environmental Impact Report, October, 1991.

Total usable surface storage capacity assumed to be available to meet storage needs in the Metropolitan service area equals 871,200 acre-feet, including facilities operated by Metropolitan and the California Department of Water Resources (DWR) as shown in Table B-2. Based on this level of available storage and the combined storage needs estimate, Metropolitan would need an additional 1,218,700 acre-feet of combined surface and groundwater storage by the year 2030 to meet seasonal, carryover, emergency, recharge, and operating needs.

Metropolitan evaluated the surface reservoir storage needed to meet projected storage needs using the Storage Integration Model. This model considered the combined operation of the imported water sources, distribution system and groundwater basins to determine the minimum storage capacity required. The Storage Integration Model evaluated the available groundwater recharge capacity, the delivery capacity of the distribution system and the groundwater extraction capacity to determine revised estimates of seasonal and carryover storage. Usable groundwater basin storage volume was based on available capacity to recharge and extract imported water beyond local supply needs. Water quality problems were assumed to be controllable through treatment or other means. Institutional constraints were assumed to be modifiable.

TABLE B-2

EXISTING METROPOLITAN AND DEPARTMENT OF WATER RESOURCES SURFACE STORAGE FACILITIES
(Acre-Feet)

Reservoir (Owner)	Total	Dead Storage	Allocated to Others	Available for Metropolitan Use
Pyramid Lake (DWR)	171,200	4,800	5,300	161,100
Castaic Lake (DWR)	323,700	18,600	11,400	293,700
Elderberry Forebay (DWR)	28,200	200	—	28,000*
Silverwood Lake (DWR)	75,000	4,000	24,900	46,100
Lake Perris (DWR)	124,000	4,000	—	120,000
Lake Matthews (Metropolitan)	182,000	3,500	—	178,500
Lake Skinner (Metropolitan)	44,000	200	—	43,800
Total:	948,100	35,300	41,600	871,200

* Conditions for use of storage is described in the Contract Between the Department of Water Resources, State of California, and the Department of Water and Power, City of Los Angeles, for Cooperative Development, West Branch, California Aqueduct; Amendment No. 1, July 3, 1969; and Amendment No. 4, June 27, 1985.

Source: MWDSC; Eastside Reservoir Project Final Environmental Impact Report, October, 1991.

Based on this analysis, the available groundwater storage capacity for direct replenishment, seasonal in-lieu and carryover ranged from 630,000 acre-feet in 2000 to 414,300 acre-feet in 2030. This decrease in storage capacity was based on limitations in the Metropolitan distribution system to convey water to the basins for recharge. As demand for firm deliveries increase, the distribution system's ability to make non-firm deliveries to groundwater storage decreases. The analysis also evaluated alternative imported water delivery schedules ranging from a summer peak pattern to a winter peak pattern. A generally uniform imported water delivery schedule resulted in the lowest storage requirement. The results of the analysis indicated a need of 804,400 acre-feet of regional storage by 2030 as shown in Table B-3. This value served as the basis for the design of Domenigoni Reservoir.

As indicated previously, the evaluation of storage indicated that distribution system capacity limited the ability to move water to and from groundwater storage. Thus, both increasing distribution capacity to maintain a high level of groundwater storage and constructing new surface storage capacity are necessary. Subsequent evaluations of storage needs in conjunction with the June 1994

Strategic Assembly resulted in a recommendation for expansion of current conjunctive management of local and imported water to develop at least 300,000 acre-ft/yr of production and 1 million acre-ft of storage by 2010. These evaluations of storage needs are on-going.

SUMMARY OF METROPOLITAN'S CURRENT STORAGE PROGRAMS

Metropolitan has adopted a number of storage and exchange programs to improve the reliability of water supplies in Southern California. Some of these programs are based on economic incentives through reduced rates, while others are based on water exchanges. The major storage and exchange programs are discussed below.

TABLE B-3

TOTAL STORAGE REQUIREMENT COMPARED TO AVAILABLE STORAGE (Acre-Feet)

Storage Component	2000	2010	2020	2030
Total Storage Requirement (From Table B-1)	1,582,100	1,747,100	1,967,700	2,189,900
Available Storage:				
Existing Surface Storage	871,200	871,200	871,200	871,200
SDCWA Planned Storage	100,000	100,000	100,000	100,000
Available Groundwater Storage*	630,000	545,000	510,800	414,300
Total Available Storage	1,601,200	1,516,200	1,482,000	1,385,500
Net Storage Needs	(19,100)	230,900	485,700	804,400

* Available groundwater storage reflects amount of groundwater storage that can be recharged based on spreading ground capacity and distribution system constraints.

Source: MWDSC, Eastside Reservoir Project Final EIR, October 1991. Draft Coordinated Operations, Inland Feeder and Eastside Reservoir, prepared by MWDSC Planning Division, 10/92.

Seasonal Storage Service

Seasonal Storage Service (SSS) was instituted in fiscal year (FY) 1989-90 in response to a request by the Board of Directors to develop a permanent version of Metropolitan's temporary in-lieu program. Temporary in-lieu was first implemented in 1978 as a drought-related pilot storage program. Seasonal storage is consistent with Metropolitan's historical practice of pricing groundwater replenishment service low enough to encourage more effective management of groundwater storage.

The three principal goals of Seasonal Storage Service are to achieve greater conjunctive use of imported and local supplies, to encourage construction of additional local production facilities, and to reduce member agencies dependence on Metropolitan's supplies during the summer months. Regional benefits include enhancing Metropolitan's ability to capture excess surface supplies from both the State Water Project and the Colorado River and improving the capability of the region both to produce more groundwater and to draft local surface reservoirs during sustained droughts and emergencies.

Seasonal Storage Service is available between October 1 and April 30 whenever and so long as the Metropolitan General Manager determines that water and system capacity are available. Additionally, Metropolitan may make this service available at other times of water availability, as in the summer of 1993. For reservoir storage or groundwater replenishment, SSS may be activated or terminated immediately upon notice to affected agencies. For in-lieu replenishment applications, SSS may be activated upon 5 days notice and terminated upon 15 days notice. The longer notification periods for in-lieu replenishment allow agencies to make the necessary operating changes to accommodate SSS availability.

For FY 1994-95, the rates for non-interruptible (NI) and SSS water are shown below:

Service Class	Treated	Untreated
Non-interruptible	412	335
Seasonal Storage	275	222
Differential	137	113

When SSS was inaugurated in 1989, the differential between NI and SSS rates was $95/acre-ft for treated and $82/acre-ft for untreated deliveries. Although the differential has increased, the increase has not been proportionate to the increase in the non-interruptible rate.

The Seasonal Storage program appears to be meeting its stated goals, however, there are differences of opinion regarding the regional benefits of the program. Metropolitan has been able to reduce summer demands for imported water by encouraging groundwater production during the summer months, thereby reducing the need for some new distribution facilities. Metropolitan has achieved greater conjunctive use of imported and local supplies by making the Seasonal Storage deliveries when adequate supplies are available. This has allowed additional diversions of Colorado River and State Water Project supplies during the winter months which are stored for summer or carryover use.

However, the construction of additional local recharge and production facilities may not have been sufficiently stimulated. Local agencies must be able to recover their costs for new supply facilities in a reasonable period of time to justify such an investment. As currently constituted, the SSS differential of $137/acre-ft may not be sufficient to recover the capital cost of new wells or reservoirs. Metropolitan, in conjunction with Member Agencies, will be analyzing the Seasonal Storage Service program this year to determine what adjustments are necessary to improve the program.

Demonstration Storage Program

Abundant precipitation in 1993 improved water supplies making about 600,000 acre-feet of imported water in excess of demand available to Metropolitan. To take advantage of this opportunity, a program was initiated whereby Metropolitan would demonstrate the effectiveness of entering into agreements with member agencies to encourage additional use of available capacity in Southern California's groundwater basins and surface water reservoirs to store and recover imported water in order to meet firm demands.

Under the program, Metropolitan sold imported water to be placed into storage in 1993 by direct or in-lieu means at rates which were less than Metropolitan's prevailing Seasonal Storage Service rates. Rates were $138 and $163 for untreated and treated water, respectively. These discounted rates were designed to increase 1993 water sales and achieve greater water supply reliability than would be accomplished under Seasonal Storage Service.

Participating agencies agreed to store equivalent, usable amounts of water for up to ten years, and also to produce their stored water at Metropolitan's call in four equal increments, each lasting three months. That production would normally be requested during the April through September periods. Agency performance would be determined by measuring its reduction in non-interruptible service from Metropolitan during the period of Metropolitan's call. That requirement would be based on reductions below 1992 baseline conditions (non-interruptible deliveries from Metropolitan) with allowances for future growth and deductions for increased participation in the Local Projects and Groundwater Recovery Programs. Agencies failing to meet their obligation to reduce demand on Metropolitan, as required under the demonstration program, would pay a penalty for a like amount of service delivered by Metropolitan during a call period. The penalty would equal Metropolitan's untreated non-interruptible rate and would be in addition to the normal water service charge. Permanent implementation of this program could result in a change of water rates and could create a new class of service.

As noted, this program is currently a "one-time project". During 1993, two agencies, Calleguas MWD and the City of Anaheim participated in the program and have 5,917.7 acre-ft and 6,000 acre-ft of storage under contract, respectively. The limited participation in this program appears to be the result of the stringent call provisions which require production of stored water at the same time local water is produced under the seasonal storage program.

Cooperative Storage Program

The Cooperative Storage Program (CSP) is a program that provides a means for coordinating storage capacity available to the member agencies with Metropolitan's annual carryover storage needs. The primary objective of the program is to increase water importation and storage and therefore improve the region's drought and emergency water supply reliability.

Under the CSP, Metropolitan sells excessive water to participating member agencies upon deliver in to storage and would defer payment until Metropolitan subsequently releases the water from storage. The participating member agency would pay for the stored water at the Seasonal Storage Service rate in effect at the time the imported water was placed into storage free of interest.

The program allows agencies with limited funds on hand an opportunity to obtain increased deliveries of imported water for storage when it is available and pay for the water later when it is released under prescribed rules for the benefit of the region and the participant.

The detailed rules and regulations of the program are specified in Section 4517 of Metropolitan's Administrative code. Generally, Metropolitan would release water under the following conditions:

a. In a fiscal year when SSS deliveries are available, Metropolitan may release up to half of the program water stored by the respective member agency in place of the agency's request for SSS delivery through Metropolitan's distribution system.

b. In a fiscal year in which SSS or Non-Interruptible Service deliveries have been suspended, Metropolitan shall release up to one-half of the program water stored by the respective member agency to the extent the agency requests that release.

c. During an emergency such as an earthquake, when Metropolitan's water service is interrupted, Metropolitan shall release up to all the program water stored by the respective member agency to the extent of the interruption in water service and the agency requested that release of water.

The CSP was authorized by the Board in July 1993. Subsequently, the program has gone through several revisions. The most recent revisions of the program was adopted by the Board in April 1994. Cooperative Storage agreements have been negotiated with four agencies as shown below which have accrued 69,916.7 acre-ft of storage as on June 30, 1994:

Agency	Storage Amount (acre-ft)
Calleguas MWD	147.8
Foothill MWD	1,207.6
City of Pasadena	23,497.3
City of Los Angeles	45,064.0
Total	69,916.7

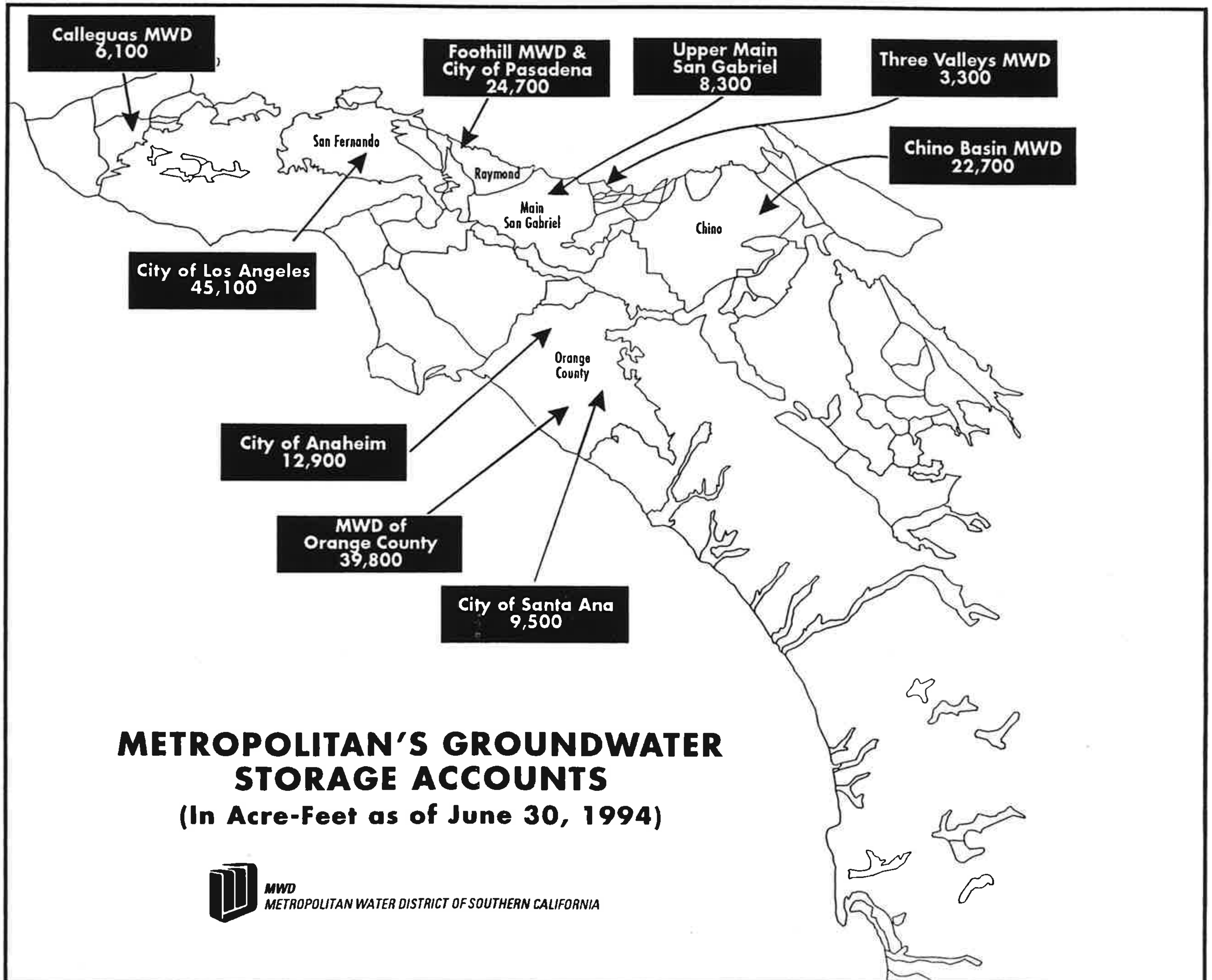
Groundwater Recovery Program

Metropolitan's Groundwater Recovery Program (GRP) subsidizes increased extraction and treatment of degraded groundwater for domestic and municipal purposes. About one-half of the expected GRP projects will recover naturally replenished groundwater. The other half will need imported replenishment water to avoid basin overdraft. These replenishment projects must comply with conjunctive use criteria to be eligible for GRP financial assistance. GRP terms require that each project be able to sustain up to three years of continuous production during droughts while replenishment service is suspended by Metropolitan. There are fifteen potential GRP projects in the replenishment category, which are expected to collectively yield about 130,000 acre-ft/yr and develop about 390,000 acre-ft of conjunctive use storage. Three such projects, now approved for GRP assistance by Metropolitan's Board of Directors, will provide about 11,500 acre-ft/yr of production and 34,500 acre-ft of effective conjunctive use storage. Another project, currently being considered for the Main San Gabriel Basin, would provide 30,000 acre-ft/yr of production and 90,000 acre-ft of conjunctive use storage.

Other Storage Programs

Metropolitan has several other special water storage programs presently in effect with both member and non-member agencies. These programs have been instituted to increase Metropolitan's water supply reliability, to better utilize Southern California's surface and groundwater storage facilities, and to respond to emergency situations as needed. Figure B-1 illustrates Southern California's groundwater basins and the amount of special storage water in each basin as of October 1993. Figure B-2 shows the location and amounts of storage in the programs outside Metropolitan's service area at the same date. A summary of storage programs is presented in Table B-4.

Metropolitan has also undertaken cyclic and drought storage programs. Currently, Metropolitan has cyclic storage agreements with three Member Agencies: Chino Basin Municipal Water District, Three Valleys Municipal Water District, and Upper San Gabriel Valley Municipal Water District. Under the cyclic storage program, Metropolitan delivers water to the Member Agency for storage in a groundwater basin. This water is owned by Metropolitan until such time as the Member Agency requests and purchases the water. This water is pre-delivered for groundwater replenishment and is



METROPOLITAN'S GROUNDWATER STORAGE ACCOUNTS
(In Acre-Feet as of June 30, 1994)

Figure B-1

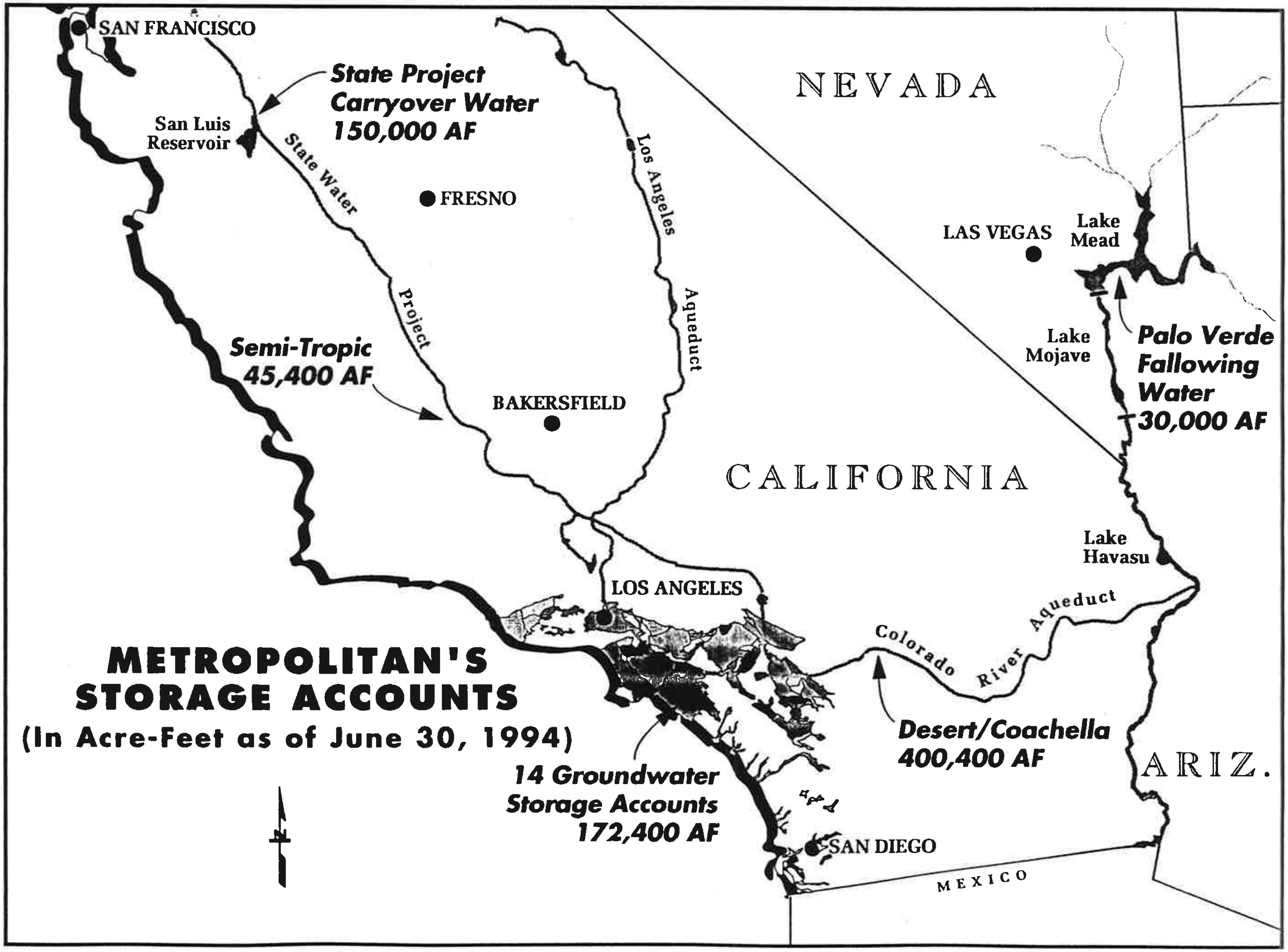

SAN FRANCISCO
State Project Carryover Water 150,000 AF
San Luis Reservoir
State Water Project
FRESNO
Los Angeles Aqueduct
NEVADA
LAS VEGAS
Lake Mead
Semi-Tropic 45,400 AF
BAKERSFIELD
Lake Mojave
Palo Verde Fallowing Water 30,000 AF
CALIFORNIA
Lake Havasu
LOS ANGELES
Colorado River Aqueduct
METROPOLITAN'S STORAGE ACCOUNTS
(In Acre-Feet as of June 30, 1994)
Desert/Coachella 400,400 AF
ARIZ.
14 Groundwater Storage Accounts 172,400 AF
SAN DIEGO
MEXICO

Figure B-2

TABLE B-4

SUMMARY OF METROPOLITAN'S SPECIAL WATER STORAGE PROGRAMS

	Cyclic Storage Accounts			Emergency L.A. Interchange & Storage	Drought Storage Programs (Max. 170,000 acre-ft)			Conjunctive Use Chino Basin MWD Three Valleys MWD
Agency	**Chino Basin MWD**	**Three Valleys MWD**	**Upper San Gabriel MWD**		**Los Angeles**	**Orange County Water District**	**Pasadena**	
Agreement No.	1229		1637	LADWP 10604		3388	3478	3734
Agreement Term:								
Start	5-Jan-79	18-Jun-89	1-Jul-85	11-Sep-86		1-Oct-91	1-Oct-91	4-Aug-92
Expires	5-Jan-96	18-Jun-99	30-Jun-95	1-May-97		30-Sep-94	30-Sep-94	30-Sep-94
Renewable	5 Year Term	5 Year Term	5 Year Term					Yes
Water Ownership	MWDSC	MWDSC	MWDSC	MWDSC	MWDSC	MWDSC	MWDSC	MWDSC
Storage:								
Location	Chino Basin	San Gabriel Basin	San Gabriel Basin	L.A. Aqueduct Reservoirs	San Fernando Basin	Orange County Basin	Raymond Basin	Chino Basin
Current (Acre-ft): [1]								
In MWDSC area	17,940.6	3,300.0	8,345.2	0.0	10,235.0	56,106.9	0.0	4,752.3
Outside MWDSC								
Max. (acre-ft):	100,000.0	25,000.0	142,000.0	None				5,000
Sales Rate:	Prevailing Seasonal Storage	Prevailing Seasonal Storage	Seasonal	Prevailing Exchange	Prevailing	SS-Prepaid	Prevailing Seasonal Storage	N/A
Delivery Method:	Spreading/In-Lieu	Spreading	Spreading	Direct Delivery/ In-lieu	Spreading/ Reservoir	Spreading/ In-Lieu	Spreading/ In-Lieu	In: In-Lieu Out: Upper Feeder via Cucamonga CWD wells
Payments By:								
MWDSC	$0	$0	$0	$0	$0	Actual Admin Costs up to $5/acre-ft	Actual Admin Costs up to $5/acre-ft	$0
Others	$0	$0	$0	$0	$0	$0	$0	$0
Comments:	Agreement to be renegotiated.		Replaces Agreement 992.	Can be positive or negative balance.	IICP Offset water. MWDSC can access reservoir storage	IICP Offset water. Current Storage: Anaheim 6,850.5 OCWD 39,790.3 Santa Ana 9,466.1 Total 56,106.9	IICP Offset water. $10.00/acre-ft to Pasadena if MWDSC releases water to another party over Raymond Basin. Stored water transferred to Cooperative Storage Program in May 1994.	MWDSC pays costs of extraction facilities. Extracted water is sold at basic rate.

TABLE B-4 (CONTINUED)

SUMMARY OF METROPOLITAN'S SPECIAL WATER STORAGE PROGRAMS

	Exchange Programs [2]		Other Programs [2]				
Agency	DWCV Exchange	San Gabriel Valley MWD	Eastern MWD	SWP	Dudley Ridge	CAWCD	PVID
Agreement No.	1568	3760	1878	State Contract	3849		
Agreement Term:							
Start	13-Oct-67	15-Oct-91	15-Nov-87		In negotiation	15-Oct-92	1-Aug-92
Expires	31-Dec-35	See below	15-Nov-92	31-Dec-93	30-Sep-94	[3]	31-Dec-99
Renewable							
Water Ownership	Exchange	Exchange	MWDSC	MWDSC	MWDSC	Exchange [4]	MWDSC
Storage:							
Location	Whitewater River Sub-Basin	San Gabriel Basin	San Jacinto Basin	San Luis Reservoir		Central Arizona	Lake Mead
Current (Acre-ft): [1]							
In MWDSC area							
Outside MWDSC	400,443.0	4,062.6	0.0	170,000.0	0.0	100,000.0	28,301.0: 12/31/92
Max. (acre-ft):	600,000.0	5,000.0	2,000.0	170,000.0	0.0	100,000.0	200,000.0
Sales Rate:	Exchange	Exchange	Seasonal	N/A	Prevailing	Exchange	Prevailing
Delivery Method:	CRA Service Conn to CVWD/DWA/SWP Conn to MWDSC	Spreading/SWP Conn	Spreading	SWP Conn.	SWP Conn.	Indirect storage in 1992/CRA upon recovery by MWDSC	CRA
Payments By:							
MWDSC	$0	$2,000 Admin. costs	$0	$2,000 Admin. costs	$125/acre-ft	(See below)	(See below)
Others	$0	$0	$0	$0	$0	$0	$0
Comments:	MWDSC paid $4,000,000 for enlarging spreading facilities. MWDSC delivers CRA water in exchange for equal SWP water. MWDSC can also deliver CRA water in advance [5].	Expiration upon delivery of equal SGVMWD SWP water to MWDSC in FY 1993-94.	Demonstration project; MWDSC paid 1/2 of energy costs.	Scheduled for delivery Jan - Mar.	MWDSC buys all water not purchased by Dudley Ridge users if MWDSC's entitlement is 50% or less than MWDSC's requests.	MWDSC pays $68/acre-ft for storage of water in AZ in 1992. Cost of storing water in 1993-96 subject to redetermination.	Land Fallowing $620/acre/yr with 4.6 acre-ft/ac/yr saved pluse admin costs. Land fallowed 2 yrs. Agreement ends at earlier date when MWDSC uses all saved water or when U.S. uses all CR reservoir storage space.

Notes:

[1] Current storage levels are as of June 30, 1994.

[2] Other programs exist with Semitropic, Alhambra Exchange, San Gorgonio Pass, San Bernardino Valley MWD and Needles.

[3] Expires upon recovery of water by CAWCD or MWDSC.

[4] Exchange once the Secretary of Interior declares a surplus or flood releases are made from Lake Mead.

[5] A $1 million appropriation was also made for a new delivery facility.

Source: Modified from MWDSC, W.S. Hutton, 1/93.

sold at Seasonal Storage Service rates. At any time, Metropolitan may substitute cyclic storage water for service connection deliveries of replenishment water, an action which expands regional water supplies and helps to stabilize Metropolitan's revenue during shortages and emergencies.

A drought storage program was implemented in October 1991 in response to the availability of an additional State Water Project (SWP) allocation of 170,000 acre-feet. This additional allocation was given to Metropolitan on condition that the delivered water be placed in storage. Agreements were made with the City of Pasadena, the City of Los Angeles, the Municipal Water District of Orange County, City of Santa Ana, and the City of Anaheim. Metropolitan delivered water to the accounts either through direct deliveries, or by in-lieu means, wherein an agency accepts Metropolitan water in lieu of producing water from local groundwater storage. Metropolitan retains the right to offset future delivery requests by "calling" on the water held in the account. Such water will be counted as part of the agency's Incremental Interruption and Conservation Plan allocation at the time it is "called".

In July 1992, Metropolitan entered into an agreement to store and subsequently extract up to 5,000 acre-ft of water from the Chino Groundwater Basin. Metropolitan has completed the storage element through delivery of imported State project water (SWP) to local entities in exchange for equal amounts of Chino Basin groundwater which have been placed into Metropolitan's Trust Storage account. Under the agreement, Metropolitan can pump that quantity of water at specified rates into its pipelines within a two-year period. Metropolitan has executed an additional agreement with the Cucamonga County Water District for the use of their groundwater extraction and storage facilities to deliver Metropolitan's groundwater into the Upper Feeder. Extraction facilities became operational in October, 1993.

Under a pilot demonstration project with Eastern Municipal Water District of Riverside County, Metropolitan stored about 2,000 acre-ft of imported water by spreading its SWP water for the first time in 1990 in the San Jacinto Basin. Eastern MWD recently purchased that water to supplement its drought supply and is planning to store additional imported water in the basin following this successful demonstration of the physical, regulatory, and institutional aspects of conjunctive use. Additionally, a local pumper's association has been formed to develop plans to maximize the use of the local San Jacinto and Hemet basins.

Another special storage agreement was executed with the San Gabriel Valley Municipal Water District (San Gabriel) which is a SWP contractor. Metropolitan has made available to San Gabriel 5,000 acre-ft of its 1992 SWP to augment San Gabriel's 1992 water supplies. In turn, San Gabriel will make available to Metropolitan the amount of SWP entitlement water delivered to San Gabriel by Metropolitan in 1992.

On February 1, 1993, Metropolitan entered a temporary water banking agreement with Semitropic Water Storage District in the San Joaquin Valley. This agreement allowed Metropolitan to store its 1992 SWP carryover water in the groundwater basin underlying Semitropic's service area. During shortage years, Semitropic would pump Metropolitan's stored water back to the California Aqueduct through facilities owned and operated by Semitropic. A minimum pumpback of 40,000-60,000 acre-ft/year would be guaranteed. Semitropic also has a contract water for 158,000 acre-ft/yr of Kern County Water Agency's SWP entitlement. Semitropic could exchange a portion of this entitlement water for Metropolitan's stored supplies increasing the annual yield of the program. Negotiation of a long term agreement and preparation of environmental documentation are in progress.

DISCUSSION OF STORAGE ISSUES

Issues, opportunities and constraints relative to the storage of water in groundwater basins and surface reservoirs in Southern California are discussed in the following section. Each issue is described and the impacts on storage defined and potential mitigation measures assessed. The issues are categorized into technical, environmental and regulatory, financial and institutional issues.

Technical Issues

A variety of technical issues exist which affect the ability to develop new or expanded use of existing storage facilities in Southern California. These issues include:

- Storage Criteria
- Supply Availability
- Inflow and Outflow Capability
- Opportunities for Storage
- Available Storage Capacity
- Losses of Stored Water
- Water Quality Impacts

Storage Criteria. Criteria for determining required storage capacity can be divided into local and regional categories. Local storage is designed to meet the operating needs of local water purveyors while regional storage is designed to meet longer term storage needs. Hourly variations in demand, fire protection storage and short-term emergency storage are provided by local retail water agencies. The storage criteria varies by local agency. Daily operating storage typically ranges from 15 to 30 percent of maximum day demand. Fire protection storage is a function the fire flow requirements established for the type of development in each area and can range from about 0.25 to 3 million gallons per pressure zone. Short-term emergency storage depends on the availability of alternate water sources and expected outages. Metropolitan recommends sufficient emergency storage or supply capability at the local level to sustain a seven day outage of imported supplies. With current imported water demands of about 1.9 million acre-ft, seven days of local storage would amount to about 36,000 acre-ft of local storage. However, most agencies meet this requirement through alternative supplies such as groundwater. In general, the amount of storage required to meet local M&I needs (excluding fire storage) is relatively low, about one percent of annual M&I demands or about 40,000 acre-ft at current demand levels.

The criteria for seasonal storage, annual carryover storage and long-term emergency storage have been defined by Metropolitan in its Eastside Reservoir EIR. As discussed previously, Metropolitan estimates seasonal storage requirements to be about 12 percent of normal annual imported water demand. Carryover storage to meet drought needs is estimated to be the difference between normal and above-normal demands over a two year period or about 16 percent of total annual demands. Emergency storage is based on a six month outage of imported water, a 25 percent reduction in retail water demands and full local groundwater production. The total amount of regional storage required is about 2.2 million acre-ft in the year 2030.

As discussed in the Eastside Reservoir EIR, the actual amount of regional storage needed is dependent on the amount of groundwater storage being operated conjunctively with imported supplies and the operation of the imported water supplies. The amount of additional storage required is lowest if imported water is supplied on a uniform basis. This may not be realistic given recent environmental constraints established on SWP supplies. The criteria for carryover storage may be too simplistic given the annual variability of both supplies and demands. As part of the IRP process, Metropolitan should reassess the criteria for carryover storage.

Metropolitan encourages local purveyors to maintain seasonal storage in surface reservoirs or groundwater basins through its seasonal water pricing. It also encourages maintenance of additional storage at the local level through its storage programs. The actual amount of seasonal, carryover and emergency storage developed by the retail and wholesale water agencies is a complex judgment based upon the available sources of supply, available storage options, access to Metropolitan programs and financial considerations.

Supply Availability. Water agencies with ground or surface storage facilities must make decisions each winter on what percentage of available storage capacity will be used to capture surface runoff from winter storms and what percent will be used to take advantage of Metropolitan's seasonal pricing programs. The hydrologic variability of free local runoff, coupled with the probability of availability of Metropolitan water in the summer (if no water is captured), must be balanced against the seasonal and emergency water rates for Metropolitan water. Better information on potential imported water availability could contribute to greater storage of water in Southern California. The potential availability of imported water should be reported as frequently as possible to allow member agencies to make the operating decisions they need regarding purchase of water for storage. Although still in its infancy, improved hydrologic forecasting capabilities could be highly beneficial for scheduling water deliveries.

Inflow/Outflow Capability. The physical ability to put water into storage, or take water out of storage constrains the use of the storage facilities. Whether the limitation is groundwater recharge facilities and extraction wells, or pipelines to and from a reservoir, the impact is the same. Metropolitan's seasonal pricing program has provided a financial incentive for expanded in/out capability. However, a significant limitation relative to storage of water in local groundwater basins is the extent to which imported supplies can be percolated and artificially recharged, and the annual rate at which these supplies can be extracted in times of drought or emergency.

Initial estimates of gross storage capacity, long-term yield, production capacity, and recharge potential have been prepared for ten local basins as shown in Table B-5. It should be noted that Metropolitan has also made an assessment of storage characteristics for five of the major southern California groundwater basins (MWDSC, Oct. 1991). For these basins, the very large potential gross storage values cannot be fully utilized for a variety of reasons. Some of the storage may be inaccessible due to limited recharge capability, limited extraction capabilities, hydrogeologic constraints and water quality constraints. The various basin managers indicate a potential conjunctive use storage capacity of 1,550,000 acre-ft.

Recharge is achieved primarily through percolation of water in spreading basins and, more recently, in-lieu recharge. Limited land availability in a rapidly urbanizing area has reduced the potential for additional recharge by spreading. Additionally, the existing percolation capacity is being used to spread local runoff and reclaimed water supplies to maintain basin yield. Based on the information in Table B-5, total recharge capacity exceeds the existing and planned annual recharge by about 411,000 acre-ft/yr. Potential remedies for expansion of access to gross storage capacity are to construct injection wells to recharge available treated supplies in any location deemed most suitable within the basins, and/or to develop additional spreading grounds where possible.

The limitations on recharge capacity have been resolved historically by expanding programs of in-lieu groundwater replenishment. In-lieu recharge involves the substitution of imported water deliveries for groundwater production. Information developed for the IRP indicates the maximum annual in-lieu capability of the ten listed basins are about 645,000 acre-ft/yr.

The existing groundwater production capacity is about 422,000 acre-ft/yr greater than the annual yield. However, about 233,000 acre-ft/yr of this "excess" capacity is required for summer peaking or seasonal storage operations. This leaves a balance of about 189,000 acre-ft/yr of production capacity that could be used to produce additional groundwater during dry years. Groundwater

TABLE B-5

APPROXIMATE GROUNDWATER BASIN CAPACITIES

Groundwater Basin	Approximate Gross Storage Capacity (Acre-ft)	Estimated Conjunctive Use Storage Capacity (Acre-ft/yr)	Estimated Long-Term Yield (Acre-ft/yr)	Estimated Total Groundwater Production Capacity (Acre-ft/yr)	Existing or Planned Annual Artificial Recharge (Acre-ft/yr)	Estimated Total Artificial Recharge Capability (Acre-ft/yr)
San Fernando	3,200,000	100,000	90,000	140,000	102,900	152,900
Central and West	20,300,000	150,000	245,000	333,000	163,000	215,000
Main San Gabriel	8,600,000	150,000	235,000	280,000	85,000	185,000
Chino	31,000,000	300,000	140,000	160,000	39,000	70,700
Orange County	40,000,000	200,000	275,000	395,000	225,000	360,000
Raymond	1,000,000	100,000	32,000	57,000	11,000	23,000
North Las Posas	1,500,000	350,000	—	30,000	—	9,800
Elsinore		100,000	—	22,000	10,000	20,000
Temecula		100,000	—	22,000	22,000	32,000
Totals	105,600,000	1,550,000	1,017,000	1,439,000	657,900	1,068,400

Note: Information presented is based on data compiled for Metropolitan's IRP, dated March 9, 1994.
Gross storage estimates prepared by Montgomery Watson based on review of pertinent sources.
Production and recharge capacities indicated with a dash are not defined and are assumed to be zero in the totals..

production capacity could be expanded by constructing additional high-capacity wells, and, in some cases, well-head treatment systems.

Further expansion of in-lieu programs should be considered. In the absence of detailed studies, Montgomery Watson estimates that as much as one half the existing annual yield could be operated for in-lieu replenishment purposes under a system of cooperative basin management. The principal constraint on an in-lieu program the available filtration plant and distribution system capacity. Regardless of the actual in-lieu potential in any given basin, significant expansion of in-lieu programs would increase access to basin storage potential without the requirement of large capital expenditures for recharge facilities.

Available Storage Capacity. Another constraint on storage is the available storage capacity. Groundwater storage capacity is required to balance inflows and outflows so that the basin yield can be maintained. Storage capacity in excess of that needed to maintain yield is available for imported water storage. Table B-5 indicates that about 1.7 million acre-ft of storage was available in the eight groundwater basins in FY 1989-90. A portion of this storage was utilized as a result of the direct and in-lieu replenishment operations in 1993.

It is possible that additional storage space could be developed in some groundwater basins by extracting water in excess of safe yield and any stored imported water. This temporary "mining" has previously been considered unacceptable and is not allowed in some basin adjudications. However, several recent adjudications allow additional groundwater to be extracted. If basin management procedures are modified, it may be possible to extract greater amounts of water during droughts and replenish the overextraction through direct and in-lieu means during wet periods. Such an operation could come closer to utilizing a portion of gross storage capacities of these groundwater basins.

Losses of Stored Water. One issue that is sometimes overlooked in the storage of water is losses due to storage. In open reservoirs, losses primarily include evaporation and spills. A typical method for handling losses in surface storage agreements is to consider the stored water to "float on top" of the normal water storage. Under this assumption, the increased evaporation losses due to the presence of additional stored water is allocated to the storage account. Losses due to spills are generally take first from the stored water. In some cases, a "phantom" reservoir simulation is performed to compute the amount of losses due to evaporation and spills if no additional water is stored in the reservoir.

Water losses from groundwater storage accounts have not been as well defined as those for surface storage. Typical losses include evaporation losses during recharge and increased subsurface outflow. Evaporation losses are typically estimated as a percent of the recharged water. Subsurface outflow losses are usually a function of total basin storage. As the volume of storage and associated water levels increase, the basin gradient increases along with subsurface outflow. Detailed groundwater modeling or other hydrogeologic investigations are needed to determine the relationship between storage and outflow. Groundwater basin seepage losses are typically recaptured in downstream basins; however, only some adjudications provide storage credits for these flows. In some basins, an annual loss based on a percent of the water stored is assigned. However, in many basins, no storage losses are considered. It is important that groundwater losses be considered to reflect reality and to discourage the permanent storage of water to the detriment of other uses.

Opportunities for Storage. The rapid urbanization of Southern California has greatly impacted the opportunity for ground and surface storage facilities. However, opportunities for new or increased storage still exist. These opportunities need to be identified and evaluated. Among the opportunities identified are:

- Storage at existing flood control reservoirs by revised operating agreements. For example, Orange County Water District has negotiated a revised operating agreement at Prado Dam that will "produce" 5,000 acre-ft/yr.

- Storage at new surface reservoirs such as Metropolitan's Domenigoni Valley and sites identified by San Diego CWA.

- Improved use of local groundwater basins, for storage of Metropolitan water, particularly those requiring no treatment. Estimates of currently available storage capacity throughout Southern California groundwater basins range from 1.0 to 3.0 million acre-feet. Available storage capacity and potential for artificial recharge are examined for selected basins in Table B-5.

- Storage of Metropolitan water in basins outside of Metropolitan's service area, such as the Desert-Coachella exchange or the Semitropic Storage Program.

- The potential exists for developing several thousand acre-ft of conservation storage at Whittier Narrows that could increase the amount of recharge in downstream basins.

Other opportunities may arise both within and outside the Metropolitan service area. A summary of the potential alternatives for storage should be developed in order to identify and prioritize new programs and policies, and to remove or minimize constraints.

Distribution System Limitations. Evaluations of Metropolitan's distribution system conducted as part of the Eastside Reservoir EIR capacity indicated limitations in the ability to deliver imported water to groundwater storage. As the demand for firm deliveries increase in the future, the ability of the distribution system to convey water to groundwater storage decreases. Table B-3 indicated a loss of groundwater storage capacity of 216,000 acre-ft between 2000 and 2030. This reduction was primarily due to distribution system constraints. Evaluations conducted as part of the IRP indicate similar results. Metropolitan is evaluating these constraints to determine which facilities most impact the ability to maximize the use of storage. If the distribution system constraints can be resolved, the ability to store additional imported water in the groundwater basins will be enhanced.

Water Quality Impacts. Water quality represents a significant potential constraint on groundwater storage. Storage of water in groundwater basins may accelerate the release of contamination from the unsaturated zone as groundwater levels rise into areas of degraded soils. The water may become degraded while it is percolating, or through mixing with degraded water in the aquifer. Increasingly stringent drinking water quality regulations may require additional groundwater treatment for all supplies. The groundwater quality and treatment issues paper addresses specific issues associated with new regulations and the need for groundwater treatment. This paper indicates that Metropolitan's groundwater recovery program has attempted to address the recovery of contaminated groundwater.

Surface water quality is subject to increased salinity due to evaporation; to algae and other sunlight effects; and to degradation from surface runoff, bird droppings or wind blown debris.

Environmental and Regulatory Issues

The combination of the National Environmental Protection Act, the Endangered Species Act, the Corps of Engineers 404 permitting process and the California Environmental Quality Act has greatly constrained and increased the cost of construction of new water storage facilities, and the efficient operation of existing facilities. The establishment of multi-agency regional environmental mitigation banking programs might facilitate further water facility development.

The environmental and regulatory permitting process is sometimes contradictory, and is always somewhat confusing and costly. Many water storage projects are delayed or fail due to permitting requirements. Streamlining of the process by coordination, regional permits and defined exemptions would accelerate implementation of new water storage projects.

Financial Issues

A variety of financial issues affect the ability to store additional water. These issues include availability of capital funding, equity, and the adequacy of incentives.

Capital Requirements. Water storage projects require significant capital to construct facilities and to purchase water for storage. The ability of some member agencies to take advantage of Metropolitan seasonal pricing programs is constrained by availability of capital funding for new facilities. In general, Metropolitan has not provided capital funding for new water facilities but instead has relied on economic incentives or rebates to encourage local resource development. One exception is the Chino Basin conjunctive use program where Metropolitan is investing in new facilities to store and extract water.

Possible mitigation approaches include regional and sub-regional capital funding pools; a Metropolitan revolving loan fund; revision of the Metropolitan seasonal program to provide greater capital contributions; privatization of water facilities; or seasonal storage incentives which are guaranteed for a period of time to pay for specific capital investments.

Equity. A significant issue affecting the use of surface and groundwater storage is equity. Equity involves the perception that each agency is treated fairly with regard to pricing, availability of incentives, and benefits. Several questions must be addressed in considering whether storage programs are equitable:

- **Do storage projects for agencies which overlie groundwater basins provide water supply benefits to "have-not" agencies and districts?** Agencies which do not directly benefit from participation in a storage program must realize regional benefits that commensurate with the cost associated with the program. An example is the seasonal storage program. In this case, agencies that do not have the ability to participate in this program due to a lack of groundwater resources must see the benefits of the program in terms of increased reliability. This could be accomplished through a stronger link between seasonal storage and any future supply allocation program such as the Incremental Interruption and Conservation Program (IICP).

- **Are the regional costs of providing local storage incentives defined in terms of the regional benefits?** Again, this is an issue where non-participating agencies must see a regional benefit that justifies their paying a higher water rate for firm water deliveries. The basis for the increased water rate should be demonstrated in terms of the benefits provided by the program. In the case of Domenigoni Reservoir, agencies that do not derive water from this facility must realize secondary benefits commensurate with the incremental cost of the facility.

- **Are potential controls on stored water too restrictive to permit effective and efficient multipurpose groundwater basin storage management by Member Agencies?** Agencies are concerned that their ability to manage their local resources will be diminished if they participate in storage programs. This was a significant concern with the Demonstration Storage Program. In this case, local agencies were concerned that participation in the program would require them to operate their wells at times when they were also required to operate under the Seasonal Storage program. The recently proposed Cooperative Storage Program appears to resolve some of the concerns.

- **Who should deal with the risk of storing water in surface reservoirs or groundwater basins?** The risk associated with maintaining storage varies with the storage program. Under the SSS program, the local agency is responsible for maintaining its own local supplies in storage until needed for summer use. In most groundwater basins this is not a significant problem. However, when additional SSS water is purchased for replenishment and long-term storage, the local agency is responsible for any losses or quality degradation that occurs. If Metropolitan is the entity maintaining storage (as in the Cyclic Storage programs), it is usually responsible for any storage losses. Currently, only a few basin adjudications recognize any losses in groundwater storage. Such is not the case in reservoir storage where evaporation can be a significant detriment. The question to be answered is "Should the region as a whole pay for storage losses that occur from participation in a regional storage program such as SSS?"

Adequacy of Incentives. Metropolitan has relied heavily upon economic incentives to encourage agencies to develop local storage capabilities over the last twelve years. The development of Seasonal Storage Service is predicated on providing an economic incentive for agencies to shift their use of local production facilities to reduce peaks on Metropolitan during the summer months. The IICP is an example of a disincentive where agencies were penalized for purchasing more imported water than their allocation. Several concerns have been expressed regarding these incentives. These concerns center on level of the incentives and Metropolitan's long-term commitment to these programs.

The principal incentive for encouraging local storage is the Seasonal Storage program. This program provides imported water during the winter months at reduced rates in exchange for reduced imported water purchases during the summer. Although the program has been successful in encouraging local storage and load shifting, member agencies have expressed concerns that they cannot justify investment in new capital facilities to make better use of the program because there is no assurance that the program will be continued in the future. Metropolitan has indicated its commitment to the program but recognizes that the current Board of Directors cannot tie the hands of future Boards to make new policies. Discussions at the recent Strategic Assembly reiterated the importance of this program. The general feeling was that the program would continue in some form in the future. However, the local agencies frequently need greater assurance to justify capital investments. Since much of the Seasonal Storage benefits have been achieved with existing facilities, there appears to be a need for a stronger commitment to justify new capital expenditures for wells or recharge basins. Development of a separate program to provide guaranteed incentives for new capital investment might be a reasonable approach.

Another concern of member agencies is the level of the Seasonal Storage incentive. As previously discussed, the incentive for participating in the SSS program is a rate reduction of $137/acre-ft for treated water and $113/acre-ft for untreated water. Many agencies have expressed concerns that the incentive is not sufficient to justify significant new capital investment. A review of the program indicates that the current incentives may not create sufficient savings to pay back capital investments in a relatively short period of time. The program provides that any imported water purchased in the winter months that exceeds a baseline amount qualifies for SSS rates. A commensurate increase in local production during the summer is also required. An agency that has a high proportion of local supplies is likely to realize a more rapid payback on capital investment than an agency having a low proportion of local supplies. There may be a level of local production at which capital investment in new facilities is never recovered due to the inadequacy of the incentive. This is true if a significant number of new wells are required to fully participate in the SSS program. As a result, there appears to be a need for a thorough evaluation of the SSS incentive to ensure that the program continues to provide the intended benefits. It must be recognized that some local water development may not be cost-effective.

The recent IICP is an example of an economic disincentive designed to penalize excessive use of water during drought conditions. One problem that plagued the IICP was the overlap between the old interruptible service and the new SSS program. This resulted in agencies receiving a water allocation for groundwater recharge during the drought and imposition of shortages on non-interruptible customers. Comments on recent proposed revisions to the IICP have suggested that water service be simply classified as firm and non-firm with all seasonal storage deliveries falling into the firm category. Long-term storage would be classified as non-firm. When a shortage is declared all non-firm deliveries would be discontinued. This would reduce demands by approximately 400,000 acre-ft/yr at current demand levels or about 22 percent. This would immediately trigger production of local water supplies that have been stored. Any remaining shortages on firm water deliveries would be significantly reduced.

Institutional Issues

In the Final EIR for Eastside Reservoir, Metropolitan based the determination of required storage on the assumption of expanded coordinated operation of surface and groundwater storage facilities. Metropolitan's analysis projected a need for about 2.2 million acre-ft of regional surface and groundwater storage. Metropolitan assumed that provisions of existing groundwater adjudications that impede maximum use of groundwater storage would be changed to expand conjunctive use.

The operation of groundwater basins are generally controlled on the local level. However, Metropolitan's Seasonal Storage program has significantly changed the pumping patterns in most groundwater basins. Many groundwater basins in Southern California are governed by water rights adjudications which set specific limits on the amount of water that can be extracted and stored by the parties to the judgments. These judgments are typically administered by a watermaster who, in turn, is responsible to the courts. Other basins, such as the Orange County Basin, are not adjudicated but rather are managed by a groundwater management agency (Orange County Water District in this case). No regional agency exists with the authority to require local agencies to take certain actions relative to groundwater storage. Table B-6 summarizes the storage and overdraft provisions in eight of the groundwater basins in the Metropolitan service area. Of these basins, six are adjudicated, all of which have some form of storage provisions. Generally, the most recent judgments have the most flexible storage arrangements.

The level of regional conjunctive management is predominantly a function of participation in Metropolitan's various storage programs. Certain Metropolitan storage programs include "call provisions" wherein Metropolitan may require a participating member agency to pump stored water as directed. Other programs such as the cyclic storage program involve pre-delivery of replenishment water that is transferred to local control upon payment of the appropriate water rate.

There has been substantial discussions regarding the approach for regional coordination of groundwater storage operations. Groundwater producers view their basins as a form of property and strongly resent any attempts for outside control of these basins. In fact, the trend in recent judgments and modifications to existing judgments have involved increased "basin" control through the use of management boards acting as basin watermasters.

Discussions at the recent Strategic Planning Assembly identified local control of groundwater resources as a potential obstacle that could impede full utilization of this resource. However, most

TABLE B-6

COMPARISON OF GROUNDWATER STORAGE PROVISIONS

Groundwater Basin	Basin Adjudicated	Local Storage Provisions	Overproduction Provisions	Current Metropolitan Storage Programs
Central	Yes	Pumpers may carryover unused rights up to 20 percent of adjudicated rights.	Stored water plus 10 percent of adjudicated rights. Special drought overproduction of 17,000 acre-ft	Seasonal Storage Service
Chino	Yes	Unpumped rights up to share of operating safe yield without storage agreement. No limit on storage accounts. Stored water not subject to losses.	No limitations; production in excess of rights subject to replenishment assessment.	Cyclic Storage Agreement Trust Storage (Exchange) Agreement Proposed Conjunctive Use Demonstration Project Short-term Conjunctive Use Project Seasonal Storage Service
Main San Gabriel	Yes	Watermaster may enter into court-approved storage agreements. No charge for storage. Metropolitan has storage rights.	Production in excess of Operating Safe Yield share is subject to replenishment assessment.	Cyclic Storage Agreements with SGVMWD, USGVMWD and TVMWD Seasonal Storage Service
North Las Posas	No	Fox Canyon Groundwater Management Agency (FCGMA) has provisions for storage credits.	FCGMA has imposed pumping restrictions to reduce overdraft.	Pilot Program
Orange County	No	None. OCWD maintains basin storage based on supply availability and water levels.	Production in excess of basin production percentage subject to basin equity assessment.	Drought Storage Program Seasonal Storage Service
Raymond	Yes	Pumpers may carryover unused rights up to 10 percent of adjudicated rights. 100,000 acre-ft allocated in proportion to adjudicated rights. Annual loss factor is 1 percent of stored water. Administrative cost of $1.50/acre-ft.	Pumpers may produce 10 percent over their decreed rights plus any allowable underpumping	Drought Storage Program Seasonal Storage Service
San Fernando	Yes	Unpumped import return water assigned to storage account. No limit on amount in storage. Storage not subject to losses.	Los Angeles may pump "underlying pueblo waters" subject to replacement in a reasonable time. Burbank, Glendale and San Fernando may pump 10 percent over import return credit and replace in following year. Burbank and Glendale may pump "physical solution water" and pay Los Angeles cost of imported water.	Drought Storage Program Seasonal Storage Service
West Coast	Yes	Pumpers may carryover unused rights up to 20 percent of adjudicated rights.	Stored water plus 10 percent of adjudicated rights. Special drought overproduction of 10,000 acre-ft	Seasonal Storage Service

local groundwater managers believe that local control is the best method to ensure full utilization. Options to expand conjunctive use include:

- Legislative expansion of Metropolitan's governmental powers as a regional water management agency with the discretion over resource allocation.
- New or expanded cooperative programs between Metropolitan and its member agencies.
- Increased economic incentives and disincentives through Metropolitan's water rates.
- Contractual arrangements between Metropolitan and its member agencies.

There is a concern that increased water management powers for Metropolitan would require regional growth management which is currently controlled on the local level. Potential problems with adjudicated rights could also develop. Many member agencies do not want Metropolitan to act as a "water czar" with direct control over the allocation of all water supplies. In fact, Metropolitan exercised a significant amount of control over water use during the drought through the IICP. This control was accomplished through economic incentives and disincentives. At this time, economic incentives and contracts appear to be the preferable way to achieve maximum use of surface and groundwater storage.

It was concluded at the Strategic Planning Assembly that Metropolitan's powers should not be enhanced legislatively. Instead, Metropolitan should concentrate on improving regional cooperation and coordination.

An additional area of institutional concern involves the ownership and operation of facilities. Currently, groundwater recharge and production facilities are owned by local water agencies. When water is stored in a basin by outside agencies, a potential for conflicting use of facilities can develop. In the case of recharge facilities, most spreading basins are operated to recover as much local water as is practical. This recharge occurs primarily in the winter and spring months. Imported water is also normally available during these same period. To maximize recharge of local water, it is important that local water have a higher priority for recharge than imported water. However, opportunities to store imported water may be lost if these conflicts occur. Increased use of in-lieu recharge can minimize these conflicts.

Similar conflicts can occur with the extraction of stored water. Many agencies are maximizing their groundwater extraction during the summer months to take advantage of the Seasonal Storage Program. However, Metropolitan also may want to extract stored water during these same periods when imported water supplies are low. This creates a conflict for the same extraction facilities that cannot be resolved as in-lieu can for recharge. Construction of additional groundwater production facilities appears to be the only viable approach. The ownership of these facilities and the operations then becomes an important factor so that conflicts in basin operating objectives do not occur.

STRATEGIES TO ADDRESS ISSUES

Approaches to address the myriad issues affecting increased storage of water in Southern California may be categorized as:

- Technical Strategies
- Environmental and Regulatory Strategies

- Financial Strategies
- Institutional Strategies

Technical Strategies

Technical strategies will encompass the development of approaches to address concerns in water reliability criteria, recognition of opportunities for storage, expansion of in/out capability, minimization of hydrologic uncertainty and reduction in water quality impacts. These could include the following:

- Initiate a program to develop Southern California water reliability criteria, incorporating the California Urban Water Agencies Reliability Study and Metropolitan Board policy. Metropolitan would provide the leadership in assisting each Member Agency and retail agency to quantify it's reliability and comparing it to required criteria. Necessary actions at the local and regional level to increase reliability can then be identified and implemented. This will be addressed in Metropolitan's Integrated Resources Planning efforts.
- Initiate a program to identify and quantify alternative storage opportunities in Southern California, assess the cost and feasibility of alternatives, and develop implementation programs.
- Develop redundancy in local water supply systems to provide maximum in-lieu replenishment of groundwater pumping.
- Develop a strategy of increased investment in hydrologic forecasting coupled with closer cooperation between Metropolitan and local water storage agencies.

Environmental and Regulatory Strategies

Environmental and regulatory strategies will propose regional approaches for reduction of environmental and permitting impediments to water storage. Alternatives include:

- Development by Metropolitan of a regional environmental mitigation bank to be used by local agencies.
- Greater cooperation among water agencies in joint mitigation activities.
- Assignment of regional permitting authority to Metropolitan for selected water activities.

Financial Strategies

Financial strategies will propose opportunities to financially enhance and facilitate increased production and storage. Metropolitan's financial incentive programs have been successful in increasing both water storage and water production in Southern California. The amount of and criteria for these incentive programs are under continual review. However, special attention should be given to the level of incentive provided by the SSS program to ensure that local agencies can justify expenditures for new facilities. Strategies which may complement these approaches include:

- Reevaluate the seasonal storage differential to ensure that an appropriate incentive is provided to ensure adequate participation in the SSS program.

- Programs for capital investment by Metropolitan in place of per acre-foot incentives.
- Development of a regional revolving loan fund to facilitate local storage development.
- Develop regional approaches to obtaining Federal funds for local storage development.
- Separate rate program for long-term (carryover) storage.
- Development of a program to guarantee seasonal pricing for a specified period of time to pay for specified capital projects.

Institutional Strategies by Member Agencies

Institutional strategies will address means of better working together to address issues and increase storage. These could include:

- Regional studies by the water industry at large on benefits of agency consolidation, or multi-agency cooperation.
- Commitments by Seasonal Storage Service users to draft from groundwater storage during periods of imported water shortage. This may best be accomplished through an improved IICP.
- Local water agency interconnections to expand potentials for joint use of storage facilities.
- Strengthening of formal groups to work with Metropolitan on strategies and programs to increase storage.

GENERAL CONCLUSIONS

General conclusions derived from the issues paper on ground and surface water storage may be summarized as follows:

1. Additional water storage facilities are needed for Southern California.
2. Current Metropolitan water storage incentive programs (Seasonal Storage Service, Demonstration Storage Program, and Cooperative Storage Program) have significantly increased water in storage in Southern California.
3. The issues of pricing for water to be stored, summer call provisions, ownership, and the need and desire to increase the storage of available imported surface supplies are not as yet integrated into a workable plan of approach which is widely accepted by all Member Agencies.
4. Programs to encourage greater storage of imported water must take into account capital expenditures of Member Agencies.
5. A storage program for the sale of available imported supplies by Metropolitan without summer call provisions, payment at the time of storage, and subsequent payment to Metropolitan of a small incremental cost at the time the stored water is

pumped would render future storage operations more advantageous to Member Agencies. However, other member agencies must realize a benefit.

6. Future Metropolitan water storage programs must be sufficiently flexible to enable them to work within the constraints of individual Member Agencies, or within groundwater basin operating parameters.

7. Significant augmentation of groundwater storage in Southern California should be undertaken while the Domenigoni Reservoir is being constructed. Stored waters could later be extracted to offset supplies diverted to fill Domenigoni.

8. New facilities will be difficult to complete. In order to encourage new surface storage facilities:

   - Capital-related issues must be considered
   - Regional environmental mitigation panels need to be established
   - Greater joint Metropolitan-Member Agency participation needs to be encouraged.

9. Expanded use could be made of Southern California groundwater basins provided:

   - Additional spreading and injection capacity is developed
   - Institutionally-derived operating criteria can be modified
   - Greater cooperation is exhibited by Member Agencies.

10. In general terms, water management activities encouraging the efficient storage of water must consider control issues. Increased storage is beneficial to Southern California regardless of the location and type of storage.

APPENDIX C

WATER RECLAMATION ISSUES PAPER

INTRODUCTION

The Southern California Water Resources Strategic Assessment performed by the Metropolitan Water District of Southern California (MWD) and its member agencies has identified water reclamation as the fastest growing source of local water supply in the Metropolitan area. Member agencies have identified a potential reuse market of over 500,000 acre-feet per year (acre-ft/yr) by the year 2000. With the current level of reuse in the service area at roughly 135,000 acre-ft/yr, potential constraints to the rapid growth of this local supply need to be identified and quickly resolved.

The development of new reclaimed water systems and uses is expected to be a cornerstone of future water supplies for Southern California. A survey of member agencies was conducted in 1992 as part of the Strategic Assessment. This survey was further updated and revised as part of Metropolitan's on-going Integrated Resources Planning (IRP) process. The table at the end of this issues paper presents the information collected in this survey. Table C-1 presents a summary of the reclaimed water projections that are used in the IRP. In the IRP, levels of development are used to define resource alternatives. Three levels are used for reclaimed water:

- Level 1 Existing or Under Construction
- Level 2 Detailed Planning or Under Design
- Level 3 Preliminary Planning or Conceptual

TABLE C-1

SUMMARY OF RECLAIMED WATER PROJECTS

Year	IRP Investment Level (acre-ft/yr)[1]			
	Level 1	Level 2	Level 3	Total
1992	135,000	0	0	135,000
1995	210,000	50,000	30,000	290,000
2000	271,000	121,000	114,000	506,000
2010	316,000	156,000	191,000	663,000
2020	316,000	156,000	289,000	744,000

1 Does not include Santa Ana River recharge.

This paper presents a discussion of issues and associated constraints to the development of water reclamation, and potential means of resolving these constraints.

REGULATORY ISSUES

The principal regulatory issues affecting implementation of water reclamation include Title 22 and the authority of the regulatory agencies, and live stream discharge issues

Title 22 and County Health Departments

Discussion of Issue. County Health Departments are the local enforcement authority for activities affecting the health and safety of the people within each of the six counties in the MWD service area. The County Health Departments work closely with the California Department of Health Services (CDHS) and the California Regional Water Quality Control Boards. County Health Departments may make recommendations to these agencies related to the regulations affecting reclaimed water use. At times, these recommendations are not consistent from one county to the next.

Assembly Bill 704 (Sher) would establish uniform statewide Title 22 water reclamation criteria. County Health Departments, as well as CDHS, recognize the need for uniform water reclamation criteria and therefore are not opposing AB 704.

CDHS is in the process of finalizing amendments to the Title 22 criteria. It is anticipated that the new Title 22 criteria will address 28 new uses of reclaimed water in addition to the uses that are authorized under the current Title 22 regulations. The regulations should be released for final public comment in late 1994.

Strategy to Resolve Issue. MWD should establish a cooperative working relationship with CDHS and each of the six County Health Departments in its service area, focusing on the environmental management of water reclamation activities to:

- develop communications and a joint evaluation process for facilitating the regulatory approval of water reclamation projects,
- support CDHS's efforts to amend Title 22 to expand the uses of reclaimed water which maximizes beneficial uses while continuing to protect public health,
- coordinate information exchange among these agencies and jointly present to MWD's member agencies and the public consistent, realistic and safe guidelines and information on the use of reclaimed water, and
- meet with the public health officials as often as necessary to review or resolve strategies and issues related to reclaimed water.

Live Stream Discharge

Discussion of Issue. The economic viability and therefore the fate of many water reclamation projects is often tied to the use of natural watercourses for the conveyance and downstream reuse of reclaimed water.

Discharging reclaimed water into a watercourse provides an economical means of transporting water to a downstream use, and a method for managing surplus reclaimed water available during wet weather when supply exceeds the market demand. Because Southern California generally has an arid or semi-arid climate, many of the watercourses targeted for the discharge of reclaimed water have little or no other flow throughout most of the year. Due to this lack of base flow, there is generally inadequate good quality dilution water in the stream (particularity in the summer months) to blend with or dilute reclaimed water constituents that could be harmful to aquatic life. Therefore, the release of reclaimed water to streams in Southern California requires the producer of the reclaimed water to meet both state and federal discharge requirements at the so called "end of pipe".

The federal Clean Water Act, which provides the legal basis for both state and federal regulations governing the chemical character of reclaimed water discharges, presumes that all waters of the United States have, or could potentially have, "fishable-swimmable" uses. This presumption represents the heart of the problem. Unlike streams of the Northwest and Eastern U.S., many streams in a large portion of southwestern U.S., including Southern California, are not suitable for the development of aquatic life due to the climate. In fact, due to less restrictive regulation in the past, today several existing watercourses in arid or semi-arid climates that receive significant amounts of reclaimed water are supporting a limited aquatic habitat and other beneficial uses which would not otherwise exist without the discharge of reclaimed water.

Although reclaimed water can be treated to levels that would not represent a threat to human health, the same water may not be suitable for the survival of more sensitive aquatic species. Treatment technologies that are available to achieve a level of treatment required by these more sensitive species, including reverse osmosis, are cost-prohibitive.

Strategy to Resolve Issues. Amendments to the Clean Water Act are needed to facilitate the use of reclaimed water in arid and semi-arid regions. Amendments to Section 101 are needed to address both Clean Water Act policy, and standards required by the Act. Amendments to Sections 303(c) are needed to address the water quality standards which would govern the use of reclaimed water resources. The act needs to recognize that not all water bodies can be "restored" to the point where they can fully support a wide range of aquatic life.

An organization of western states, WESTCAS (Western Coalition of Arid States) has recently adopted proposed amendments to the Clean Water Act which address the problems outlined above. MWD's participation and support of such organizations would help to maximize the production of reclaimed water.

Additionally, the USEPA and the State Water Resources Control Board are currently conducting negotiations regarding the California Inland Surface Waters Plan (ISWP) which sets inland surface water quality standards for California. In November 1991, the USEPA took actions on California's ISWP and disapproved some sections of the plan, including provisions for water quality standards and enforcement procedures for "Category (a)" water bodies. The Category (a) water bodies are special category water bodies that occur in the arid and semi-arid portions of the state and do now, or plan to, convey reclaimed water.

MWD should submit comments when the next draft of the ISWP becomes available, as well as meet directly with USEPA and State Board representatives to stress the importance of an ISWP that supports reuse to the extent environmentally possible.

TECIINICAL ISSUES

Seasonal Storage

Discussion of Issue. The importance of seasonal storage to the expanded development of water reuse in Southern California is evident when one notes the extreme annual variations in potential demand. In reclaimed water market demand studies completed for the Orange County area, landscape irrigation was shown to comprise approximately 87% of the potential demand for reclaimed water, while commercial/industrial use accounted for the remaining 13%. The significance of this is that while commercial/industrial use exerts a relatively constant demand on thc reclaimed water source, landscape irrigation demand experiences tremendous seasonal variations due to Southern California's predominant "winter only" rainfall pattern. Irrigation demand studies completed for the Orange County area have shown that over 70% of demand occurs during April through September. Moreover, the study indicated that only 3% of annual irrigation demand occurred in the peak rainfall months of January, February and March. These annual variations in landscape irrigation demand illustrate the need for seasonal storage in regional water reuse programs if reclaimed water use is to reach its full potential.

Unfortunately, developing seasonal storage reservoirs of adequate capacity to meet reclaimed water development potential in the Southern California area is fraught with both cost and environmental constraints. While groundwater storage options may provide the most cost-effective and environmentally sensitive opportunities to store reclaimed water, basin adjudications, competing potable development, water quality limitations, capacity limitations, and the fact that many areas in the MWD service area lack groundwater resources limits the groundwater storage development option.

Surface storage opportunities also are severely constrained by cost and environmental issues. In the highly urbanized portions of MWD's service area where the primary reclaimed water markets exist, land for suitable surface reservoirs typically is unavailable, extremely costly, or has been preserved as open space due to its high habitat value. Areas where land is available are typically remotc from treatment plants and service areas where distribution of the reclaimed water would occur. In addition, development of remote storage sites that may be environmentally feasible typically require extensive transmission infrastructure, limiting cost-effectiveness - particularly for a single agency to undertake.

Strategy to Resolve Issue. Development of viable reclaimed water seasonal storage options will not occur unless a multi-agency/multi-component approach is taken. Such an approach must involve the cooperation of many agencies, including MWD, that would benefit from a common seasonal storage facility.

MWD can support agencies in their effort to address this issue in two ways. First, MWD could tailor its Local Projects Program (LPP) to provide financial support for a regional storage facility that would enable several agencies, each with their own reuse program, to increase their respective project yields. Since agencies within an area typically have varying schedules for implementation of their local water reuse project, the funding of a seasonal storage facility to serve the multiple agencies within an area would be difficult. Participating agencies possibly could form a joint venture to provide the conduit for MWD's financial support.

MWD could also support agencies in developing seasonal storage projects by providing technical guidance and leadership. MWD should share the results of its past and ongoing studies on surface emergency storage for domestic water supply. Some of the domestic reservoirs within MWD's service area may cease to be used due to recent state and federal surface water treatment regulations that are causing some agencies to consider covering their reservoirs. MWD could take this technical assistance one step farther and conduct a service area-wide study investigation of potential locations for seasonal storage of reclaimed water. This study could include applicable groundwater basins.

Domestic Water Quality

Discussion of Issue. As a result of the drought in California, delivery of State Water Project (SWP) water into MWD's service area was significantly reduced during 1991 and 1992. Consequently, the salinity of the imported water supplied to much of MWD's service area increased to that of the Colorado River aqueduct (690 mg/l TDS), adversely impacting irrigators using reclaimed water. By contrast, an imported water supply consisting of a 50/50 blend of SWP and Colorado River water would have about 500 mg/l TDS. Excessive reclaimed water salinity discourages further development and use of reclaimed water.

Section 136 of the Metropolitan Water District Act requires that, "to the extent reasonable and practical, not less than 50% of blended water shall be water from the SWP." Currently, it is not practical due to system hydraulics and SWP deliveries for MWD to consistently supply 50% SWP to all member agencies.

Strategy to Resolve Issues. MWD's completion of its Capital Improvement Program (CIP) is expected to improve this deficiency. In the interim, MWD should prioritize the available SWP supply, to the extent practical, to member agencies with the most beneficial reclaimed water production. If hydraulics and SWP delivery shortfalls continue to prevent MWD from meeting the Section 136 obligation, MWD should consider modification of LPP to provide added funding support to areas receiving higher salinity water.

ECONOMIC ISSUES

Local Projects Program

Discussion of the Issue. As with all new water supplies, the unit cost to develop that supply will be significantly greater than the melded cost of water already being served. Yet these new sources must be developed to meet our future water demands. By initiating the LPP in 1981, MWD attempted to assist agencies in overcoming this discrepancy and, in the process, stimulating greater reclaimed water development. In recent years as the state and local health agencies have become more supportive of water reuse, the industry is poised to proceed at an even more rapid pace than in the past to develop reuse projects. However, with the economic benefits of water reuse projects to be reaped in future years, funding remains the primary limitation to the development of water reuse projects in MWD's service area.

MWD's policy for reclaimed water development is to provide financial incentives to the extent that a project is economically justified. In theory, reclamation projects will pay for themselves over time by allowing the member agency to avoid the cost of purchasing an equivalent amount of water from MWD in the future. However, the capital intensive nature of reclamation projects - including costs for treatment facilities, separate distribution systems and storage - combined with gradual market development, make a member agency's project financially infeasible without the appropriate level of assistance from MWD, particularly in the short term.

The original LPP program was designed to provide direct capital construction funding to the member agency for a given project, with MWD acquiring ownership of a portion of the project yield. MWD revised the program in 1985 to provide contributions based on the amount of water the project actually reclaimed. This allowed the project sponsor to own the project yield, and developed a relationship between the amount of the LPP subsidy and MWD's avoided cost for delivering imported water supplies. The original commodity based payment formula included only the potential energy cost savings from the reduced water imports, and amounted to $75 per acre foot in 1989 In early 1990, the subsidy was adjusted upward to reflect the reduction in MWD's treatment and delivery costs, with consideration given to reliability and service area needs. This current LPP payment of $154 per acre foot, when combined with the non-interruptible rate of $385 per acre foot, provides an incentive of $539 per acre foot.

Limitations with the current LPP that have inhibited greater member agency participation include:

- the sense that the LPP contribution is not high enough to truly reflect MWD's avoided costs of additional imported supplies,
- the fact that the contribution is based on a fixed amount - not recognizing the need for varying levels of contribution required by different but equally viable projects, and
- the fact that the contribution does not have an inflation factor - essentially decreasing MWD's proportional contribution over time even though their benefit is increased.

Strategies to Resolve Issues. Many elements of avoided cost seem to be ignored in the LPP's current $154 per acre foot contribution. Specifically, the contribution should be based upon all avoided pumping, treatment, environmental surcharge, water transfer, storage, incremental distribution and other capital costs that are experienced by MWD in developing and delivering additional supplies. In addition, since these costs vary annually, a formula should be derived based upon MWD's approved annual budget, enabling the fee to be adjusted more frequently than a three to five year cycle.

With respect to the fixed nature of the contribution, the program should be reevaluated to acknowledge that some projects - because of differing physical constraints or other conditions - may be equally beneficial, but require greater funding support. This variable funding level could be established as a range, with the exact level of funding determined on a case-by-case basis. Examples of conditions that would warrant increased funding support are projects that require a greater degree of treatment, due either to a high salinity domestic water supply or the incorporation of indirect potable reuse.

Finally, the LPP should recognize the current changes being proposed in MWD's rate structure. The fiscal master plan submitted with the currently adopted budget shows water rates increasing in the short term, and leveling off with minimal increases in the late 1990's. In addition, the Financial Structure Study currently under preparation by MWD staff is evaluating the option for fixed service charges and other revenue sources that would potentially modulate future significant rate increases. These factors combined could serve to reduce near-term financial incentives and extend the pay back period on many projects. As a result, consideration should be given to implementing an inflation factor to offset the rate flattening, and to recognize the increased benefit MWD receives from the local projects as their variable O&M costs rise over time.

State Revolving Fund

Discussion of Issue. The primary purpose of the SRF loan program is to assist in the financing of publicly owned treatment works necessary to protect and promote the health, safety, and welfare of the inhabitants of the State. In addition to pollution protection, water reclamation projects are eligible for SRF funding.

Although the SWRCB has adopted policies to support water reclamation projects throughout the state, the SRF's priority class system along with the Water Reclamation Loan Program funding requirements make it difficult for reclamation projects to compete with water pollution control projects. Under the SRF program, projects are ranked A through F, with A being the highest priority class. Reclamation projects are placed in class E. Additionally, all projects compete on a first come, first serve basis.

However, any reclamation project funded through the SRF must meet both SRF and Water Reclamation Loan Program funding requirements. The added burden of the Water Reclamation Loan Program funding requirements puts water reclamation projects at a disadvantage when competing with pollution control projects. For example, the capacity of a water reclamation project eligible for loan proceeds is that capacity that can be used within five years of completion of construction or twice the initial year capacity after completion of construction - whichever is less. Interest of potential reclaimed water users must be documented through letters of intent or contracts. In comparison, the capacity of a pollution control project eligible for loan proceeds is that capacity that can be used within 12 years for above ground facilities and 40 years for buried facilities such as pipelines. Determination of eligibility is based on population projections.

At the beginning of FY 1993, $216.4 million was available in the SRF for loan commitments. By the end of July 1993, about $45 million of this will have been allocated to water reclamation projects.

Strategy to Resolve Issue. When the SWRCB reviews its policy for the SRF for FY 1994, MWD should encourage the following modifications:

- The SWRCB should establish a level of funding to be allocated to reclamation projects consistent with the State Legislature's water reclamation policy (Water Recycling Act of 1991). The SWRCB should set aside a specific amount of SRF funds for water reclamation commensurate with the Legislature's water reclamation goals (700,000 acre-ft/yr by 2000 and 1,000,000 acre-ft/yr by 2010).

- The SWRCB should review its water reclamation loan criteria and remove any unnecessary requirements i.e., letters of intent should not be required where mandatory use ordinances are in place and eligibility criteria should be based on projections similar to pollution control projects.

INSTITUTIONAL ISSUES

Interjurisdictional Issues

Discussion of Issue. Interagency coordination is one of the most sensitive implementation issues with recycled water projects. Generally, there are three types of project scenarios;

- single agency projects in which one agency is responsible for both wastewater and water services,

- dual agency projects in which a wastewater agency produces recycled water and a water agency distributes it, and

- multiple agency projects in which wastewater and water agencies cooperate to develop a joint project.

The easiest type of project to implement is the one in which a single agency performs both sewer and retail water functions. Under this scenario, an entity both produces and distributes the recycled water. Institutional coordination is limited to regulatory and funding agencies. Slightly more complex institutional arrangements are required in dual agency projects. Typically, a sanitation district will sell recycled water to a water agency that will then distribute and retail the water. In the past, sanitation agencies sold recycled water for minimal fees because it was viewed as a disposal option and because they were not incurring any additional treatment costs to produce the recycled water. Recently, however, sanitation agencies have come to view recycled water as a valuable commodity which can be sold at elevated prices.

The most complex institutional arrangement is one where multiple agencies cooperate on a joint venture. This requires a commitment on the part of all entities involved to develop the project.

Strategies to Resolve Issues. The success of a multiple agency project involves the concept of "partnering." Each participating agency maintains the individual responsibility and liability for its jurisdiction while contributing to a whole project. The single most important factor in developing multiple agency projects is a commitment on the part of all agencies to put aside traditional parochial interests and work together as a team to develop the project. Issues which can cause a multiple agency project to fall include those related to finance, turf, responsibility/liability, and operations. Most successful multiple agency projects have prevented turf and financial issues from becoming deal breakers by agreeing from the outset that existing institutional arrangements will be maintained. This means that no particular agency loses customers, facilities, or a revenue stream, unless it is by choice. All agencies buy into the project and become proponents rather than opponents.

In cases where multiple water agencies are involved in a reclaimed water project, member agencies may request MWD's input, as appropriate. In the case where the project is proposed for inclusion in the LPP, MWD would be able to provide a regional perspective as to how the project will reduce the regional demand for imported supplies.

WATER RECLAMATION PROJECTS USED IN THE IRP PROCESS

03/08/94
ib

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
** Burbank																	
Caltrans	1	L	21	65	65	65	100	0	83	0.0	0	236	92	108	13[illegible]	1983	no
Media City Center	1	L	0	25	25	50	50	1	90	7.1	25	0	400	480	280	1993	no
PSD Power Plant	1	I,L	900	900	900	900	900	0	0	0.0	0	2	3	4	7	1967	no
Reclaim Expansion Debell/Landfill	2	L	0	539	539	647	793	5	93	4.2	20	0	241	297	37[illegible]	1995	no
** Subtotal **			921	1529	1529	1662	1843	6			45						
** Calleguas MWD																	
Hill Canyon Reclaimed Water Project	3	A,E,L,R	0	5000	5000	5000	5000	3	93	0.0	0	0	110	141	229	1995	yes
Moorpark Wastewater Treatment Facility	3	A	0	1600	2200	3200	3200	0	0	0.0	0	0	60	60	60	1995	no
Oak Park/North Ranch Reclaimed Water Line	1	L	0	1300	1300	1300	1300	5	93	0.0	0	0	66	84	138	1995	no
Olsen Road/Sunset Hills Wastewater Trmt. Fac.	3	L	0	249	249	249	249	1	91	0.0	0	0	320	390	576	1995	no
Oxnard Reclaimed Water Project	3	A,I,L,R	0	0	15000	15000	15000	20	93	0.0	0	0	0	84	138	2000	yes
Simi Valley Reclaimed Water Project	3	L	0	500	5000	5000	10000	15	93	0.0	0	0	66	84	138	1995	no
** Subtotal **			0	8649	28749	29749	34749	44			0						
** Central Basin MWD																	
Bellflower Reclamation Project	1	L	50	50	50	50	50	0	92	0.0	0	171	198	254	414	1978	no
Central and West Basin Replenishment	1	R	50000	50000	75000	75000	75000	0	0	0.0	0	23	27	34	56	1961	no
Century Water Recycling Project	1	I,L	49	5000	7500	9000	9000	23	93	5.4	25	143	166	212	346	1992	no
Cerritos Reclaimed Water Extension Project	1	I,L	0	260	260	260	260	0	92	0.0	0	0	115	147	240	1993	no
Cerritos Reclamation Project	1	L	1649	2600	4000	4000	4000	6	88	0.0	0	143	121	155	252	1978	no
Lakewood Water Reclamation Project	1	L	412	800	1400	1800	1800	1	88	4.0	0	259	294	376	613	1989	no
Rio Hondo Water Recycling Project - Phase 1	1	I,L	0	5000	6000	8000	8000	10	93	6.1	30	0	166	212	346	1995	no
Rio Hondo Water Recycling Project - Phase 2	2	I,L	0	2000	7000	7000	9500	20	93	0.0	0	0	166	212	346	2000	no
Whittier Narrows Recreation Area	2	L	0	2383	3138	3138	3138	9	94	0.0	0	0	138	188	298	1995	no
** Subtotal **			52160	68093	104348	108248	110748	69			55						

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
** Chino Basin MWD																	
California Institution for Men	1	A	700	700	700	700	700	0	0	0.0	0	248	420	538	876	0	yes
Carbon Canyon Core	3	L	0	0	1050	1500	2000	6	93	0.0	0	0	0	322	368	1995	no
El Prado Park and Golf Course	1	L	1300	1300	1300	1300	1300	0	0	0.0	0	0	0	0	0	1977	no
Ontario Golf Course and Westwind Park	1	L	700	1200	1200	1200	1200	0	0	0.0	0	0	0	0	0	1968	no
Regional Plant #1 Core	3	A,I,L	0	0	4000	5000	7500	24	92	0.0	0	0	0	223	330	2000	no
Regional Plant #4 Core	3	L	0	0	3937	5000	7500	7	92	0.0	0	0	0	223	330	1998	no
Upland Hills Country Club	1	L	224	224	224	224	224	0	0	0.0	0	796	915	1052	1210	1983	yes
Western Hills Country Club	1	L	17	17	17	17	17	0	0	0.0	0	1765	2059	2635	4296	0	yes
** Subtotal **			2941	3441	12428	14941	20441	37			0						
** Coastal MWD																	
South Laguna Expanded Reclamation Project	2	L	0	1000	2500	2500	2500	5	93	0.0	0	0	500	760	800	1995	no
South Laguna Reclaimed Water	1	L	860	900	900	900	900	0	0	0.0	0	448	544	667	944	1984	no
South Laguna Reclamation Expansion	1	L	0	100	300	600	600	2	89	6.0	5	0	400	333	417	1990	no
Water Reclamation Project - Phase A	1	L	800	800	800	800	800	7	89	0.0	0	407	472	985	1606	0	no
Water Reclamation Project - Phase B	3	L	0	0	2750	2750	2750	11	91	0.0	0	0	0	985	1606	2000	no
** Subtotal **			1660	2800	7250	7550	7550	25			5						
** Eastern MWD																	
Haun Road (Rose Hills Memorial Park)	2	L	0	410	2876	2876	2876	4	92	0.0	0	0	181	232	378	1995	no
Hemet/SJ Reg. Rec. - Recharge Phase A	1	R	1037	1037	1037	1037	1037	0	0	0.0	0	26	30	39	63	0	yes
Hemet/SJ Reg. Rec. - Recharge Phase B	3	R	0	2963	3963	4963	4963	1	93	0.0	0	0	30	39	63	1995	yes
Hemet/SJ Regional Reclamation - Direct	1	A,E,L	6454	14178	28123	27464	22815	6	91	0.0	0	26	30	39	63	1966	yes
Moreno Valley Reclamation	1	A,E,L,R	8557	10579	10571	10761	10811	7	92	0.0	0	156	181	232	378	1987	yes
Nason Street Reclamation	3	L	0	800	1350	1350	1350	1	94	0.0	0	0	181	232	378	1995	no
Perris Valley Regional Reclamation	1	A,E,L,R	2309	2824	9346	11346	11346	0	0	0.0	0	26	30	39	63	1989	no
Rancho California Reclamation Expansion	1	A,L	0	4800	6000	6000	6000	32	89	0.0	0	0	181	232	378	1994	yes
South Lasselle Reclamation	1	L	0	357	357	357	357	0	93	0.0	0	0	181	232	378	1993	yes
Sun City Golf Courses	1	L	590	652	652	652	652	0	0	0.0	0	272	316	404	658	1983	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
Temecula Valley Reclamation - Phase A	1	A,L	3269	3300	3300	3300	3300	0	0	0.0	0	156	181	232	378	1989	yes
Temecula Valley Reclamation - Phase B	2	A,L	0	1978	1803	1803	1803	1	93	0.0	0	0	181	232	378	1995	yes
Winchester/Temecula Regional Reclamation Sys.	1	A,E,L	0	2313	3983	3423	3423	20	92	0.0	0	0	181	232	378	1993	yes
** Subtotal **																	
			22216	46191	73361	75332	70733	73			0						
** Foothill MWD																	
La Canada-Flintridge Country Club	1	L	135	135	135	135	135	0	0	0.0	0	1357	1466	1871	2388	1962	no
** Subtotal **																	
			135	135	135	135	135	0			0						
** Glendale																	
Brand Park Line	3	L	0	50	80	100	120	3	93	0.0	16	0	120	154	251	1995	no
Forest Lawn Pipeline	1	L	348	350	350	350	600	2	92	0.0	0	100	116	148	242	1992	no
Power Plant Pipeline	1	I,L	451	450	450	450	450	0	0	0.0	0	100	116	148	242	1980	no
Verdugo Scholl Pipeline - Phase 1	1	L	0	674	832	1054	1054	13	93	0.0	16	0	170	218	355	1995	no
Verdugo Scholl Pipeline - Phase 2	3	L	0	0	0	0	946	7	93	0.0	0	0	0	0	0	0	no
** Subtotal **																	
			799	1524	1712	1954	3170	26			32						
** Las Virgenes MWD																	
Calabasas System	1	L	825	1000	1000	1000	1000	0	0	0.0	0	311	360	459	748	1972	no
Calabasas System Expansion	1	L	275	400	500	600	700	0	0	0.0	0	311	360	459	748	1991	no
Las Virgenes Valley System	1	A,L	300	300	300	300	300	0	0	0.0	0	128	149	190	310	1972	yes
Las Virgenes Western System	1	L	3000	3100	3500	4200	5700	0	0	0.0	0	311	360	459	748	1986	no
** Subtotal **																	
			4400	4800	5300	6100	7700	0			0						
** Long Beach																	
Alamitos Barrier Project - Parts 1 & 2	2	R	0	0	5000	10000	10000	20	96	0.0	0	0	0	315	513	1996	no
City of Long Beach Reclaimed Water MasterPlan	2	I,L	0	4780	4780	4780	4780	33	92	0.0	0	0	110	141	230	1995	no
Long Beach Reclamation Project	1	I,L	2029	2500	2500	2500	2500	0	0	0.0	0	321	372	477	777	1980	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
Long Beach Reclamation Project	1	L	1044	1500	1500	1500	1500	2	88	4.0	20	321	372	477	777	1980	no
** Subtotal **																	
			3073	8780	13780	18780	18780	55			20						
** Los Angeles																	
Cal Trans (5 & 134 Fwys)	1	L	100	100	100	100	100	0	0	0.0	0	60	70	89	145	1984	no
Central City/Elysian Park	3	I,L	0	0	2100	4100	4100	15	93	8.0	25	0	0	100	163	1997	no
East Valley	3	I,L,R	0	0	10000	35000	35000	38	93	8.0	25	0	0	150	245	1997	no
Eastside Los Angeles	3	I,L	0	0	800	1500	1500	0	0	0.0	0	0	0	0	0	2000	no
Griffith Park	1	L	1625	1800	2000	9900	9900	0	0	0.0	0	60	70	89	145	1976	no
Headworks	3	R	0	10000	10000	15000	15000	0	93	0.0	0	0	30	38	63	1995	no
Los Angeles Greenbelt	1	L	29	1600	1600	1600	1600	7	92	8.0	25	60	70	89	145	1992	no
Los Angeles Harbor	3	I,R	0	0	5500	10500	30000	35	93	8.0	25	0	0	300	489	1998	yes
Sepulveda Basin - Phase 1	1	E,L	0	1444	1444	1444	1444	3	93	8.0	25	0	134	161	185	1994	no
Sepulveda Basin - Phase 2	2	E,L	0	0	196	419	2056	5	93	8.0	25	0	0	161	185	1996	no
West Valley greenbelt	3	I,L	0	0	0	2350	2350	25	93	8.0	25	0	0	0	149	2005	no
Westside Los Angeles	2	I,L,R	0	600	1400	5000	10000	8	94	8.0	25	0	50	64	104	1995	no
** Subtotal **																	
			1754	15544	35140	86913	113050	136			200						
** MWDOC																	
El Toro Existing	1	L	573	500	500	500	500	1	93	0.0	0	224	260	332	542	1965	no
El Toro Expansion	3	L	0	0	450	750	750	8	93	0.0	0	286	331	424	691	0	no
Green Acres Project	1	I,L	1859	3300	6800	7700	7700	68	93	0.0	0	86	99	127	207	0	no
Irvine Ranch East Orange Expansion	3	A,L,M	0	0	4100	6000	11000	28	93	0.0	0	195	226	290	472	0	no
Irvine Ranch Part 1	1	A,L,M	5826	6474	6474	6474	6474	22	93	0.0	0	162	188	240	392	0	no
Irvine Ranch Part 1 Expansion	1	A,L,M	3185	3887	3887	3887	3887	10	93	0.0	0	162	188	240	392	0	no
Irvine Ranch Part 2	1	A,L,M	0	526	526	3526	3526	11	93	0.0	0	162	188	240	392	0	no
Irvine Ranch Part 2 Expansion	1	A,L,M	0	3813	3813	3813	3813	26	93	0.0	0	167	193	248	403	0	no
Irvine Ranch Part 3	3	A,L,M	0	0	4500	6300	6300	28	93	0.0	0	181	210	269	438	0	no
Los Alisos WD	1	A,L	1171	1722	1722	1722	1722	11	93	0.0	0	181	210	269	438	1966	no
Los Alisos WD Expansion	1	A,L	0	128	378	778	778	1	93	0.0	0	181	210	269	438	0	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
Moulton Niguel WD Existing	1	L	470	470	470	470	470	0	0	0.0	0	0	0	0	0	1964	no
Moulton Niguel WD Expansion - AWMA	1	L	570	1130	3530	5530	5530	0	0	0.0	0	0	0	0	0	0	no
Moulton Niguel WD Expansion - SERRA	3	L	0	1000	2000	2000	2000	0	0	0.0	0	0	0	0	0	0	no
OCWD WF21 Expansion	3	R	0	0	0	10000	10000	0	0	0.0	0	0	0	0	0	0	no
OCWD WF21 Talbert Barrier Injection	1	R	8192	12000	15000	15000	15000	30	93	0.0	0	476	552	707	1152	1972	no
Santa Margarita WD - Chiquita	3	L	0	0	2100	3600	3600	33	93	0.0	0	0	0	187	304	0	no
Santa Margarita WD - Chiquita Expansion	3	L	0	0	0	0	11000	0	0	0.0	0	0	0	0	0	0	no
Santa Margarita WD - Oso	1	L	795	1148	1148	1284	1284	17	93	0.0	0	497	577	738	1203	1977	no
Santa Margarita WD - Oso Expansion	1	L	1130	1500	1500	1500	1500	20	93	0.0	0	497	577	738	1203	0	no
Trabuco Canyon WD - Part 3	3	L	0	0	50	500	650	0	92	0.0	0	53	62	79	129	0	yes
Trabuco Canyon WD - Parts 1 & 2	1	L	450	550	850	850	850	4	92	0.0	0	53	62	79	129	0	yes
** Subtotal **			24221	38148	59798	82184	98334	320			0						
** Pasadena																	
City of Pasadena Reclaimed Water System	3	I,L	0	0	4700	4700	4700	27	93	0.0	0	0	0	275	448	1996	no
** Subtotal **			0	0	4700	4700	4700	27			0						
** SDCWA																	
Camp Pendleton	1	I,L,R	3974	3900	3900	3900	3900	0	0	0.0	0	0	0	0	0	1942	yes
Clean Water Program - Phase A	2	I,L	0	0	5000	15000	15000	190	93	0.0	0	0	0	410	550	1997	no
Clean Water Program - Phase B	3	I,L	0	0	0	0	15000	200	93	0.0	0	0	0	0	0	0	no
Encina - Phase A	1	A,I,L	655	1800	2000	2100	2100	3	92	3.0	20	300	350	410	550	1992	no
Encina - Phase B	3	I,L	0	0	0	1900	2900	28	93	0.0	0	0	0	0	550	0	no
Encina Water Pollution Control Facility	1	I,L	165	165	165	165	165	0	0	0.0	0	300	350	410	560	1992	no
Escondido	2	A,E,L,R	16	30	1500	2800	3500	40	94	2.6	20	300	350	410	560	1996	no
Fairbanks Ranch	1	R	160	200	200	350	350	1	94	0.0	0	300	350	410	550	1998	no
Fallbrook Reclaimed Water Distr. - Phase A	1	I,L	128	800	800	1000	1000	4	93	4.8	20	190	210	230	250	1990	no
Fallbrook Reclaimed Water Distr. - Phase B	3	I,L	0	0	0	200	500	2	93	0.0	0	0	0	0	250	0	no
Jamacha - Phase A	1	I,L	537	1000	1100	1400	1400	6	91	3.0	20	300	350	410	560	1980	no
Jamacha - Phase B	3	I,L	0	0	0	2600	3600	36	91	0.0	0	0	0	0	560	0	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
Oceanside - Phase A	1	I,L	93	300	300	300	300	0	0	0.0	0	300	350	410	560	1992	no
Oceanside - Phase B	2	I,L	0	0	700	1700	1700	5	93	0.0	0	0	0	410	560	0	no
Oceanside - Phase C	3	I,L	0	0	0	500	3600	19	93	0.0	0	0	0	0	560	0	no
Olivenhain	3	A,I,L	0	0	1200	3000	3000	21	94	0.0	0	300	350	410	550	1997	no
Poway	3	I,L	0	0	500	2000	2000	11	95	0.0	0	300	350	410	550	1999	no
Rancho Santa Fe	1	I,L,R	208	200	200	300	350	2	93	3.0	20	300	350	410	550	1994	no
San Elijo	2	A,I,L	0	0	1200	1800	1800	13	94	2.6	20	300	350	410	560	1997	no
San Marcos	3	E,I,L	0	0	0	1000	1500	0	0	0.0	0	0	0	0	560	0	no
San Pasqual - Phase A	1	A,I,L	0	800	800	1000	1000	2	92	3.0	20	0	500	550	600	1994	no
San Pasqual - Phase B	3	I,L	0	0	0	1000	1000	11	92	0.0	0	0	0	0	600	0	no
San Vincente	1	A,I,L	500	600	600	800	1200	0	0	0.0	0	350	450	480	580	1975	yes
Santa Maria - Phase A	1	A,I,L,R	617	700	700	700	700	0	0	0.0	0	300	350	410	560	0	no
Santa Maria - Phase B	2	A,I,L	0	0	100	300	1100	5	94	3.0	20	0	350	410	550	1996	no
Santee - Phase A	1	I,L	405	400	400	400	400	0	0	0.0	0	300	350	410	550	1968	no
Santee - Phase B	2	I,L	0	200	600	700	700	14	93	2.6	20	0	350	410	550	1996	no
Santee - Phase C	3	I,L	0	0	0	900	900	0	0	0.0	0	0	0	0	550	0	no
Valley Center - Phase A	1	R	275	300	350	500	500	0	0	0.0	0	300	350	410	550	0	no
Valley Center - Phase B	2	I,L	0	0	250	500	1000	6	95	0.0	0	0	0	410	550	1997	no
Vista - Phase A	1	I,L	49	300	300	300	300	0	0	0.0	0	300	350	410	550	0	no
Vista - Phase B	3	I,L	0	0	100	700	1200	14	93	0.0	0	0	0	410	550	1996	no
Whispering Palms	1	A,R	118	200	200	350	350	0	0	0.0	0	300	350	410	560	1981	yes
** Subtotal **																	
			7900	11895	23165	50165	74015	631			180						
** Santa Monica																	
Pico-Kenter Drain Low Flow Treatment Plant	3	L	0	250	250	250	250	2	95	6.8	25	0	0	0	0	1995	no
Santa Monica Water Gardens	1	L,M	0	22	22	22	22	0	0	0.0	0	0	0	0	0	1994	no
** Subtotal **																	
			0	272	272	272	272	2			25						
** Three Valleys MWD																	
City of Industry Reclaimed System - Phase A	1	L	994	3360	3360	3360	3360	0	0	0.0	0	0	0	0	0	1983	no

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
City of Industry Reclaimed System - Phase B	2	L	0	0	4000	4000	4600	26	93	0.0	0	0	0	0	0	1996	no
City of Industry Reclaimed System - Phase C	3	L	0	0	0	0	640	0	0	0.0	0	0	0	0	0	0	no
Forest Lawn Reclaimed Water	3	L	0	160	260	360	360	0	0	0.0	0	0	165	240	310	1995	no
Pomona Reclaimed Water Storage Reservoir	3	A,E,I,L,M	0	0	2000	2500	2500	0	0	0.0	0	0	0	0	0	0	
Pomona Reclamation Project	1	A,E,I,L,M	7507	9000	9400	9600	9600	0	0	0.0	0	116	135	172	281	1966	
Rowland Reclamation Project	3	L	0	1500	2000	2000	2000	8	95	0.0	0	0	16	15	18	1995	no
Walnut Valley Reclamation Plant Expansion	3	A,L	0	0	1000	2000	2600	7	0	0.0	0	0	0	252	411	0	no
Walnut Valley Reclamation Project	1	A,L	1293	1500	2000	2000	2000	0	0	0.0	0	170	197	252	411	1986	
** Subtotal **			9794	15520	24020	25820	27660	41			0						
** Upper SGV MWD																	
California Country Club	1	L	372	375	375	375	375	0	0	0.0	0	7	8	9	11	1978	no
Puente Hills/Rose Hills	1	I,L	0	2522	2810	3267	4000	5	93	0.0	0	0	120	140	160	1995	no
San Gabriel Valley Water Reclamation Project	2	A,I,L,R	0	25000	31000	35000	35000	35	93	6.5	30	0	75	96	157	1995	no
** Subtotal **			372	27897	34185	38642	39375	40			30						
** West Basin MWD																	
West Basin Water Recycling Project - Phase A	1	I,L,R	0	11200	11200	11200	11200	100	92	5.4	25	0	200	256	417	1994	no
West Basin Water Recycling Project - Phase B	2	I,L,R	0	13600	37200	38800	38800	50	92	0.0	0	0	200	256	417	2000	no
West Basin Water Recycling Project - Phase C	3	I,L,R	0	0	0	30000	30000	0	0	0.0	0	0	0	0	417	0	no
West Coast Barrier Project	1	I,L,R	0	5600	20000	20000	20000	0	0	0.0	0	0	400	512	835	0	
** Subtotal **			0	30400	68400	100000	100000	150			25						
** Western MWD																	
City of Corona Irrigation I15/191	3	L	0	0	730	913	1825	0	0	0.0	0	0	0	0	0	0	
Elsinore Valley Water Reclamation Project	2		0	1800	4500	5400	5400	0	0	0.0	0	0	0	0	0	0	
Elsinore Valley/Horse Thief Reclamation	1	L	49	110	224	560	560	0	0	0.0	0	0	0	0	0	1989	
Elsinore Valley/Railroad Canyon Reclamation	1	L	730	730	730	730	730	0	0	0.0	0	0	0	0	0	1984	
Indian Hills Reclamation Project	1	L	1310	1310	1310	1310	1310	0	0	0.0	0	0	0	0	0	1980	

Integrated Resource Plan -- Water Recycling Projects

Project Name	Lvl.	Type of Use	1992 Yield AFY	1995 Yield AFY	2000 Yield AFY	2010 Yield AFY	Ult. Yield AFY	Fixed Cost $M	year est.	(%)	Term Year	1992 O&M $/AF	1995 O&M $/AF	2000 O&M $/AF	2010 O&M $/AF	Oper. Date	NDPES
March Reclamation Project	1		261	261	261	261	261	0	0	0.0	0	0	0	0	0	0	
Rancho California/Joaquin Ranch Reclamation	1	L	269	360	360	672	672	0	0	0.0	0	0	0	0	0	1984	
Santa Rosa Water Reclamation Facility	1	A,E,L	0	1	2	3	5	0	0	0.0	0	0	0	0	0	1990	
** Subtotal **			2619	4572	8117	9849	10763	0			0						
*** Total ***			134965	290190	506389	662996	744018	1683			617						

APPENDIX D

GROUNDWATER QUALITY AND TREATMENT ISSUES PAPER

INTRODUCTION

The local water resources in the Metropolitan Water District of Southern California (Metropolitan) service area consist of groundwater, surface water, and reclaimed water. Groundwater resources are abundant and form the cornerstone of Southern California's local water supply. Groundwater accounts for about one-third of the annual demand of Metropolitan's service area. The total production of about 1.2 million acre-feet per year (acre-ft/yr) in 1990 is expected to grow to 1.5 million acre-ft/yr by 2010. The groundwater basins are valuable not only for their annual yield, but also because their large storage capacity provides a reliable source of supply during sustained droughts. Basins underlying the service area have a gross storage capacity of more than 200 million acre-ft of groundwater. Although there is a large quantity of groundwater in storage, a relatively small percentage of this water can be economically withdrawn annually on a long-term basis, while maintaining basin safe yield.

As part of its overall water supply planning activities, Metropolitan is preparing an Integrated Resources Plan (IRP). The purpose of the IRP is to develop the most favorable mix of resources for Southern California considering such factors as yield, economics, reliability, water quality, environmental and regulatory considerations, equity and public acceptance. Whatever the recommended resource mix, heavy emphasis is being placed on the use of available groundwater basin storage to meet seasonal demand variations and to provide supplemental supplies during droughts. As a result, groundwater utilization will be substantially increased.

Another factor that inhibits the effective utilization of these groundwater resources is water quality. For example, the Main San Gabriel Basin has a gross storage of about 8.6 million acre-ft. Unfortunately, concentrations of organic solvents have now been encountered in more than 100 wells, thus restricting the use of stored groundwater. In the lower portion of the Chino Basin, TDS has been found to exceed 500 mg/l with peak TDS exceeding 1,500 mg/l.

There are other groundwater quality concerns facing water suppliers in Southern California that will require local agencies to implement innovative water quality management and treatment programs. Many of these concerns relate to the anticipated regulation of various chemicals at more stringent levels. Increases groundwater treatment will be critical to ensure these resources are not abandoned for imported water.

Support for the enhancement and protection of these groundwater basins has been a significant priority for Metropolitan and local agencies. An initial impetus to the treatment of contaminated local groundwater originated in 1991 when Metropolitan began its Groundwater Recovery Program (GRP). As currently configured, the GRP will provide a member agency up to $250 for each acre-ft of contaminated water produced. Agencies are responsible for funding the initial capital for the project. They must demonstrate to Metropolitan that the unit costs (amortized capital plus operations and maintenance) exceed Metropolitan's applicable non-interruptible water rate. To apply, the agency must submit an application to Metropolitan along with an engineer's report, and to qualify, a project must meet specific criteria including CEQA documentation and obtain approval from Metropolitan's Board.

Water produced by the GRP project must be used within the area served by Metropolitan so that pumping groundwater replaces imported water that would otherwise be served by Metropolitan.

With this proviso, the member agency benefits further by avoiding the cost of imported Metropolitan water. As an example, at the current Metropolitan non-interruptible rate of $412/acre-ft and maximum GRP subsidy of $250/acre-ft, the agency could justify spending as much as $662/acre-ft on developing new groundwater and still break even.

DESCRIPTION OF ISSUES

Groundwater extraction includes production of water that meets water quality standards with minimal treatment, and increasingly, production of groundwater of poor quality. In general, Federal and State regulations coupled with the need for every drop of local water, mandate the efficient protection of water quality and the treatment of degraded water. The major water quality issues include:

- Groundwater Quality and Regulatory Constraints
- Treatment Technology and Technical Constraints
- Groundwater Quality Management
- Economic and Financial Impacts
- Environmental Issues

Groundwater Quality and Regulatory Constraints

Significant improvements in the understanding of the health effects of trace chemicals in water as well as the levels of detection of these chemicals have occurred in recent years. Public awareness has increased significantly due to organic solvent and pesticide contamination of groundwater. As a result, the monitoring and protection of drinking water quality have become more complex and expensive.

The U. S. Environmental Protection Agency (EPA) is establishing new drinking water standards and monitoring frameworks for many additional contaminants pursuant to the federal Safe Drinking Water Act Amendments. California has adopted even more stringent standards for a number of inorganic chemicals (IOCs), volatile organic chemicals (VOCs) and synthetic organic chemicals (SOCs). Also, California is proposing Recommended Public Health Levels (RPHLs) in drinking water for all regulated contaminants. Under these new rules, several of the most common contaminants found in Southern California groundwater basins would be regulated at levels below the existing maximum contaminant levels (MCLs). For instance, the VOCs trichloroethylene (TCE) and tetrachloroethylene (PCE), both with an MCL of 5 micrograms per liter (μg/l), would have RPHLs of 2.5 and 0.7 μg/l, respectively. As an example, ten percent of the active wells in the Central Basin service area would exceed either one or both of these RPHLs. Failure to comply with RPHLs would require public water systems to prepare Water Quality Improvement Plans and could ultimately result in mandated treatment of groundwater sources even if MCLs are not exceeded.

The EPA recently added standards for 60 contaminants in their Phase II and Phase V regulations. Most of these contaminants have been previously regulated in California. No significant impact is foreseen concerning water quality compliance for these contaminants.

Current Groundwater Quality Issues. Current groundwater quality issues in the Metropolitan service area include the following, divided into health-associated concerns and aesthetic concerns:

Health-Associated Concerns	Aesthetic Concerns
Nitrate	Color
Volatile Organics	Total Dissolved Solids
Organic Pesticides	Iron, Manganese
Radionuclides	

There are water quality problems with each of the major groundwater basins in the Metropolitan service area. Groundwater producers in some of these basins must cope with multiple water quality problems locally. Metropolitan recently prepared and report titled *Groundwater Quality, A Regional Survey of Groundwater Quality in the Metropolitan Water District Service Area*, May 1994. This report summarizes the groundwater quality in Southern California and identifies the number of wells currently affected by water quality problems. This data is summarized below.

Health-Associated Concerns. Nitrate in drinking water causes methemoglobinemia, especially in infants. This condition prevents red blood cells from carrying oxygen in the blood, thus resulting in possible anoxia and death. Its presence in levels exceeding the MCL, 10 mg/l as N or 45 mg/l as NO_3, is historically associated with intensive application of fertilizers and dairy wastes in agricultural areas, especially in Ventura, Chino, Upper Santa Ana, Orange County, and Main San Gabriel basins, as well as the use of private wastewater disposal systems. About 14 percent of the wells in the Metropolitan service or 233,000 acre-ft/yr of production exceed the nitrate or nitrite MCLs.

Volatile organic compounds (VOCs) in groundwater are generally derived from commercial or defense-related activities as a leachate from contaminated soil. VOCs were used to clean equipment and train firefighters at military bases and airports, which are near a number of groundwater flow paths. Leaking underground fuel storage and chemical storage tanks have been identified as a major source of VOC contamination. VOCs are regulated based on carcinogenicity. VOCs in the eastern portion of the Upper Los Angeles River Basin have affected wells in Burbank, Glendale, Los Angeles, and San Fernando. Areas of the Main San Gabriel Basin constitute the largest federal Superfund site because of VOCs encountered in more than 100 wells. About 11 percent of the wells or 238,000 acre-ft/yr of production are currently affected by VOC contamination.

Organic pesticides are less frequently detected in groundwater than VOCs. Atrazine and simazine, two herbicides, have been found in wells downgradient of the Montebello Forebay in the Central Basin of Los Angeles County. These herbicides were applied to control weeds in the groundwater recharge basins. This practice was stopped several years ago and no wells have exceeded standards. All uses of dibromochloropropane (DBCP), a pesticide used to control nematodes, were discontinued in 1977 after evidence suggested potential effects on the reproductive systems of humans working with DBCP. Carcinogenicity tests with rats and mice have been positive. DBCP has been detected in a number of wells in Bunker Hill, the Chino and Cucamonga Basins of San Bernardino County and Riverside Basin in Riverside County, where it was used in citrus agriculture. About 1 percent of wells or 35,000 acre-ft/yr of production are affected by pesticides.

Radionuclides. Radionuclides are elements that spontaneously undergo radioactive decay and include man-made and naturally occurring isotopes. The radionuclides that are currently regulated are: Strontium-90, Radium-226, Gross Beta Activity, Gross Alpha Activity, and Uranium. According to Metropolitan's report, less than one percent of wells or 9,000 acre-ft/yr of production are affected by currently regulated radionuclides. Radon, another naturally occurring radionuclide, is proposed to be regulated in the future. This is discussed later in this issues paper.

Aesthetic Concerns. Aesthetic quality of drinking water is regulated through secondary MCLs. Problems, such as excessive total dissolved solids from agriculture, mineralization, and seawater intrusion, cause objectionable tastes, and depending on the specific salts present, may have a laxative effect. High levels of salts also interfere with industrial and commercial operations, often forcing these industries to pre-treat their water. Significant TDS problems in the Metropolitan service area occur in the Chino and San Jacinto basins, numerous small basins in San Diego County. TDS plumes due to seawater intrusion have seriously degraded coastal groundwater supplies from Ventura to San Diego. TDS exceeding 1,000 mg/l currently affects about 17 percent of wells or about 152,000 acre-ft/yr of production. An additional 14 percent of wells or 149,000 acre-ft/yr of production have TDS levels between 500 mg/l and 1,000 mg/l.

Iron and manganese cause fixture and laundry staining, as well as objectionable tastes. These problems are highly localized in the Metropolitan service area. The appearance of water is most perceptible by its color. Sources of color in water can include natural metallic ions and organic matter. According to the Metropolitan report, about 14 percent of wells or 129,000 acre-ft/yr of production have manganese levels exceeding the MCL. About 9 percent of wells or 89,000 acre-ft/yr of production have iron levels exceeding the MCL.

Future Groundwater Quality Issues. Several regulations under development at the federal level could adversely affect Southern California utilities using or planning to use groundwater to augment their supplies. Four pending regulations could be significant for local groundwater: radon, arsenic, groundwater treatment rule and disinfection byproduct rule.

Radon. EPA has proposed a maximum contaminant level (MCL) for radon, a gas that is a naturally occurring radioactive decay product in certain rock formations, of 300 picocuries per liter (pCi/l), based on carcinogenicity from inhalation. Recently Metropolitan analyzed radon data collected from 449 wells from 1986 to 1991 in its service area. The data indicates that about 35 percent of the wells have Radon concentration exceeding 300 pCi/l. There are even some concerns that EPA may lower the Radon MCL to 200 pCi/l, in which case, 66 percent of the sampled wells could exceed the limit.

Arsenic. EPA plans to propose a rule reducing the MCL for arsenic, a naturally occurring inorganic contaminant found in some groundwater and surface water supplies. The proposed regulation is expected to be issued in 1994. After re-evaluating data from epidemiological studies in Taiwan, EPA is expected to treat arsenic as a carcinogen and lower the MCL from 50 μg/l to 0.5 to 2 μg/l. At this point, most laboratories have a detection limit of 5 μg/l, so many utilities do not know whether they will have an arsenic problem. One study of wells in Central Basin has found some wells exceeding the expected limit.

Groundwater Treatment Rule. EPA has also announced plans to develop a groundwater treatment rule, which would require disinfection to inactivate viruses unless the likelihood of microbiological contamination is remote. Since many local groundwater are not routinely disinfected, this rule could require addition of chlorine or chloramines at wells.

Disinfectant/Disinfection Byproduct Rule. EPA conducted a negotiated rule-making procedure to establish disinfectant and limit disinfection byproduct (DBP) limitations, including trihalomethanes (THMs), haloacetic acids (HAAs), and disinfectant residuals for surface waters and groundwaters under the direct influence of a surface water. The latter condition could pertain to some groundwaters. It appears that the MCL for THMs will be dropped from 100 to

80 µg/l and HAAs will have an MCL of 60 µg/l. A second stage of the DBP rule may lower these MCLs to 40 and 30 µg/l, respectively. The effective date of the regulation differs by utility size. Most local groundwater are low in total organic carbon (TOC) and unlikely to be affected by the DBP rule, but there are some colored groundwater along the coast in Long Beach and Orange County with sufficient organic material to form DBPs above the expected limits such that treatment would be required.

The total impact of these proposed regulations have not been determined. Metropolitan has recently commenced a study to estimate the impact of the new regulations on groundwater production in Southern California.

Basin Plan Objectives. With increasing conjunctive use of groundwater basins, there have been issues related to Regional Boards' basin plan objectives for water quality. These water quality objectives are based on the prevailing water quality and beneficial uses. For example, recharging Colorado River water increases total dissolved solids (TDS). Conjunctive use in the Chino Basin was questioned earlier because of predictions it would move existing nitrate plumes to extraction wells, resulting in degradation of basin quality.

As discussed in the desalination issues paper, the basin plans have generally adopted more stringent water quality objectives in inland areas to allow for the successive use of water and to protect the quality of downstream supplies. These plans have place more emphasis on desalination and other treatment technologies to meet water quality objectives and to maintain the salt balance in the groundwater basins.

Technical Constraints Affecting Supply Development

There are a number of technical constraints affecting the continued ability of Southern California utilities to add to their groundwater supplies, all of which add to groundwater costs:

Treatment for Contaminants. Groundwater supplies may require treatment for current or anticipated water quality regulations. Treatment technologies exist for each contaminant, but there will be added costs to construct and operate treatment systems. Some of the technologies for specific contaminants are listed below:

Contaminant	Treatment Technology
Nitrate	ion exchange, reverse osmosis, biological denitrification
Color	conventional treatment with enhanced coagulation, chlorine/chloramines, ozone/ filtration, granular activated carbon (GAC), membranes
VOCs	granular activated carbon, aeration (usually with off-gas treatment in Southern California), advanced oxidation
Total dissolved solids	membranes
Iron and manganese	oxidation and filtration, greensand
Organic pesticides, such as DBCP	granular activated carbon

Contaminant	Treatment Technology
Radon	aeration (effectiveness of off-gas treatment using carbon is problematic)
Arsenic	enhanced coagulation, greensand
DBP rule	where precursors are present, organic precursor removal (enhanced coagulation and/or granular activated carbon) plus chlorine
Groundwater treatment rule	chlorine/chloramines.

Wellhead Treatment Siting. Groundwater, unlike surface water, is usually produced by a large number of small capacity facilities, wells pumping on the order of 500 to 3,000 gallons per minute (gpm). Well sites are typically scattered, use small amounts of land, and are located in residential, commercial, or industrial areas. Although there is no systematic inventory of space at well sites, most of them are expected to be too small to accommodate treatment equipment.

In some cases where wells are already manifolded and pumped to a central facility, as in Pomona and Long Beach, treatment at a central location may be more feasible than at individual well sites. Where wells are not manifolded, construction of new centralized treatment could require substantial pipeline construction as well.

Most wells are pumped directly into the distribution system. Many of the treatment technologies listed above expose the water to air at atmospheric pressure, and would thus require a second pumping stage to meet system pressure requirements. For a technology like GAC where treatment occurs under pressure, there is still a loss in hydraulic pressure through the treatment process. In either case, additional pumping is needed with its associated energy consumption and cost.

Disinfection Compatibility. With increasing requirements for groundwater disinfection, there is a need to consider regional compatibility of disinfection practices. Metropolitan's surface water treatment plants use chloramines whereas groundwater disinfection, where practiced, is typically with chlorine. Mixing two waters with chlorine and chloramines reduces disinfectant residual, which could result in violation of water quality regulations and may also cause taste and odor problems.

Disposal of Residuals. Most of the treatment technologies produce residuals, which creates an issue of disposal. For example, nitrate treatment by ion exchange produces a brine from salt used for resin regeneration. Although there are some regional brine lines, such as the Santa Ana Regional Interceptor (SARI) line from the Inland Empire to the ocean, remaining capacity is limited. Additional regional brine disposal facilities would be necessary as a means of brine disposal, since other methods are typically more expensive. Construction of a brine line to the ocean would not be cost-effective for a single well or group of wells, but could be a viable regional solution. The timing of construction of new brine disposal facilities is important so that flows approach design capacity relatively quickly to ensure capital recovery.

Aeration to remove VOC or radon produces an off-gas. Because of the local air quality conditions, it is difficult to obtain an operating permit from the air quality management district without off-gas treatment, usually by GAC. The GAC is then contaminated, and has its own set of disposal issues. Groundwater treated by enhanced coagulation for DBP or arsenic control will have more solids resulting from high coagulant dose; again, residuals management to a sewer or landfill must be considered.

Economic and Financial Issues

There are several economic and financial issues facing agencies that treat groundwater including overall economics, seasonal use of facilities, equity and incentives.

Overall Economics

Many agencies initially developed groundwater resources because they are nearby and inexpensive. As water quality problems increase the need for treatment, the economics of groundwater development become more tenuous. In the past, when faced with a decision to treat groundwater, many agencies opted to either drill new wells in an uncontaminated area or purchased imported water. However, the recent increases in the cost of imported water coupled with the drought has demonstrated the importance of the groundwater supply to the region. This coupled with Metropolitan's GRP incentive have resulted in more groundwater treatment projects in the past few years.

A wide range of costs can be expected for most groundwater treatment projects due to variations in groundwater quality and plant capacity. It is generally more desirable from a cost point of view to construct regional treatment facilities so that economies of scale reduce the unit cost of treatment. However, the spatial distribution of wells with water quality problems do not always make regional projects viable.

Seasonal Use. Many utilities in Southern California use their groundwater supplies seasonally to avoid higher Metropolitan rates during the peak demand summer months. If groundwater is only pumped in the summer, the treatment facilities will stand idle in the winter, meaning that capital costs must be recovered with only half the production capacity in use. An option is treating groundwater for base flow and peaking from Metropolitan. However, this would negate any regional seasonal storage benefits. Individual economic analyses are needed to determine which strategy is more economical.

Equity. Groundwater contamination is a touchy subject when it comes to the question of who pays. That question has held up implementation of regional treatment for VOCs in the San Gabriel Valley for over a decade as EPA has been operating under the Superfund rules to find the parties responsible for contamination and get them to pay for cleanup before actually installing treatment. New initiatives are underway at the local level to move ahead with treatment first and assign responsibility later.

Another equity issue relates to the appropriateness of using Metropolitan incentive programs as part of a groundwater contamination cleanup project. Should Metropolitan member agencies pay for these groundwater treatment projects through the GRP? Ultimately, it should be the responsibility for the polluter to cleanup his groundwater contamination. However, it may be more expedient to use the GRP incentive initially to get a project underway and avoid the delays in cleanup mentioned previously and recover costs for contamination later.

Incentive Programs. An issue that relates to equity but also has broader implications is the overall structure of an incentive program. Metropolitan's Groundwater Recovery Program provides an incentive of up to $250/acre-ft of treated groundwater for projects whose costs exceed the treated non-interruptible rate. As the non-interruptible rate increases, more expensive projects could qualify for the rebate. However, the rebate decreases for existing projects such that the cost of treatment is equal to the non-interruptible rate. This incentive has stimulated the development of groundwater treatment programs but the question is "Is this the appropriate level of incentive?"

The GRP incentive was originally based on the difference between the average cost of proposed groundwater treatment projects and the then current non-interruptible rate. Using this approach, some projects would benefit from the program and others whose costs exceeded the non-interruptible rate by more than $250/acre-ft would not. Perhaps a better approach would set the incentive at a level that would generate a certain percentage of the degraded water projects' yield. This could be done by ranking the projects in order of cost and determining what incentive would generate 50 or some higher percent of the yield.

Another issue related to incentive level is whether an incentive that reduces the cost to just the non-interruptible rate is enough to encourage new treatment projects. Since groundwater treatment projects are more difficult to operate, it could be argued a higher incentive that reduces the net cost to less than the non-interruptible rate is more appropriate.

Groundwater Quality Management

The development of groundwater treatment projects should consider a total quality management approach. Water quality decisions in one basin can have an affect on downstream basins of surface water supplies.

Cleanup vs. Treatment. Where groundwater has been contaminated by VOCs and the EPA has declared an area to be a Superfund site, there are debates on whether groundwater treatment is being used to supplement the water supply or for cleanup. Well use can be affected by these decisions at a regional level. For example, EPA considers cleanup objectives to be achieved best by pumping from the contaminated plume at the expense of clean wells, in an effort to halt spread of contamination. Groundwater pumpers, on the other hand, are more likely to want to use clean wells to maximize production and minimize treatment costs. In some cases, like the San Gabriel Valley, a new regional treatment facility is being planned. Where feasible, the objectives of water supply and cleanup should be integrated.

Blending. Historically, water utilities have blended groundwater and surface water in their distribution systems to achieve water quality objectives. Where groundwater is contaminated, this strategy has allowed compliance with MCLs without the need to treat groundwater. Blending has been used for high nitrate groundwater in the Chino San Bernardino and San Fernando Basins.

Changing Location of Contaminants. Contaminants move in aquifers, subject to recharge, withdrawal, and basin hydrogeology. As a result, a well may be contaminated one year and clean the next. A response may be regional treatment facilities, where several wells are piped to a central location, which continues to provide treatment regardless of individual well water quality. Another option, used by the Los Angeles Department of Water and Power in the San Fernando Valley, could be transportable treatment units that can be moved from one well to another to follow the plume movement. Some treatment technologies, including GAC and aeration, are available in skid mounted units so they can be moved. Similar units involving reverse osmosis are being considered to control the saline water plume in the West Coast Basin.

Environmental Issues

Groundwater treatment facilities must also address environmental issues. Some of the more significant environmental issues include air quality, GAC regeneration or disposal, disinfectant handling and safety, noise and aesthetics.

Air Quality. The aeration process transfers contaminants from water to air. Air quality is an issue when health-related impacts to those people residing in a plume area can be questioned. Air quality management districts in Southern California are increasingly requiring off-gas treatment for aeration to remove VOCs prior to granting an operating permit. Off-gases containing Radon have yet to be regulated, but if VOCs can be used as a precedent, Radon may be similarly regulated in the future.

GAC Regeneration or Hazardous Waste Disposal. Utilities using GAC for VOC removal have been concerned about whether the used GAC will be considered a hazardous waste. There are limits to adsorbed concentrations of some organics, such as trichloroethylene, beyond which the GAC is classified as hazardous and subject to more stringent transport and disposal requirements. To date, utilities have relied on the carbon suppliers to handle this issue. An alternative for a large regional GAC facility would be local regeneration. A study by Metropolitan indicated siting a regeneration facility in Southern California would be difficult but not impossible.

Disinfectant Handling and Safety. With recent modifications in the Uniform Fire Code and interpretations of that code by local fire departments, the ability to use chlorine gas for disinfection has been restricted for safety reasons. Chlorine gas installations need retrofits to curtail exposure from leaks, such as containment and scrubbers. Another option, particularly in residential areas, is to convert from chlorine gas to liquid hypochlorite, which increases the cost of treatment.

Noise. Treating water at wellheads near residences raises concerns about noise, particularly when blowers are used for aeration. Noise can be mitigated by sound enclosures, such as the building constructed around the blowers of an aeration unit for La Habra.

Aesthetics. Another issue with adding treatment to wells in residential or commercial areas is aesthetics. For example, aeration units are tall (typically 20 to 30 feet) in comparison to homes. Carbon units are not as high, but they look industrial. Attention to aesthetics is important for both process selection and site development (screening, color selection, building and landscaping).

Public Acceptance. Some utilities have expressed concerns that consumers will not accept drinking water originating from a contaminated source, such as a Superfund site, even after treatment. To date, especially in the San Fernando and San Gabriel Valleys, this has not been an problem. Nevertheless, it may surface in the future.

POTENTIAL IMPACT OF ISSUES ON FUTURE SUPPLY DEVELOPMENT

Because of the groundwater quality issues described earlier, there may be additional treatment for both existing and "new" groundwater. Since some of the standards affecting groundwater are not yet finalized, information on quality and treatment is still being developed, and estimates are uncertain.

Estimates Of Contamination And Treatment Needs

According to data presented in the Situation Assessment, groundwater production in the Metropolitan service area will increase from an estimated 1.20 M acre-ft/yr in 1990 to 1.51 M acre-ft/yr in 2010, an increase of 316,000 acre-ft/yr. There are 10 member agencies projecting groundwater supplies to increase by more than 10,000 acre-ft/yr, as shown below. Together, they represent the major portion (86 percent) of the additional supply estimate. Table D-1 summarizes the agencies expecting to add substantial amounts of groundwater by 2010.

In order to estimate the percentage of this "new" groundwater which will require treatment, we contacted the larger agencies and/or estimated the treatment requirements from existing information. Most of the agencies had trouble estimating the treatment requirements because, in many cases, future wells are not yet sited. For constituents not yet regulated, such as Radon and arsenic, agencies are unsure of their present groundwater quality characteristics and the need for treatment. Therefore, the estimates are rough at this time.

TABLE D-1

EXPECTED GROWTH IN GROUNDWATER PRODUCTION IN METROPOLITAN'S SERVICE AREA

Member Agency	Groundwater Production (1000 acre-ft/yr)		
	1990	2010	Increase
Burbank	0	12	12
Central/West Basin MWD	186	214	28
Chino Basin MWD	147	168	21
Eastern MWD	12	26	14
Los Angeles DWP	110	130	20
MWDOC	230	335	105
San Diego CWA	12	27	15
Three Valleys MWD	44	65	21
Upper San Gabriel MWD	157	180	23
Western MWD	198	213	15
Total	1,096	1,370	274

Information available from member agencies to date is summarized below.

Burbank. The City of Burbank has estimated that their groundwater production from San Fernando Basin will increase from 0 in 1990 to 11,600 in the year 2010. This increase in groundwater production is due to construction of a planned VOC groundwater treatment system. Nitrates may also need to be treated, but to an unknown extent.

Central and West Basin MWDs. Production in the Central Basin is expected to increase from 147,218 acre-ft/yr in 1990 to 167,100 acre-ft/yr in 2010--an increase of almost 20,000 acre-ft/yr. Production in the West Basin is expected to increase from 38,862 acre-ft/yr in 1990 to 46,500 acre-ft/yr in 2010, an increase of about 7,600 acre-ft/yr. Nitrates are not an issue in either basin, nor are pesticides. A wellhead treatment project is planned for an existing well owned by Southern California Water Co. A reasonable estimate of this amount is probably 1,000 acre-ft/yr. If the radon limit is 300 pCi/l, 10 to 15 percent of the existing wells are estimated to need treatment. If the limit for arsenic is 2 μg/l, 50 percent of the existing wells are estimated to be out of compliance. If the latter is the case, sub-regional treatment facilities would probably be needed. TOC and disinfection byproducts do not appear to be an issue.

The major treatment facilities planned in the West Basin are associated with desalting water degraded by saltwater intrusion. The recently-constructed West Basin desalter treats 1,700 acre-ft/yr. Other desalters have been recommended in the recent Plume Mitigation Study amounting to 10,000 acre-ft/yr of desalting (RO) capacity, although the timing of these facilities depends on the rate of intrusion. In the West Basin, the City of Inglewood is upgrading and expanding their iron and manganese treatment capacity from 6,000 acre-ft/yr to 12,000 acre-ft/yr, although there is apparently no plans to drill additional wells at this time.

Chino Basin MWD. Within the Chino Basin MWD service area, a large increment of new groundwater production is projected. An on-going water resources management study in the Chino Basin being undertaken for SAWPA has developed estimates of future demands and supplies as shown below:

	1990	1995	2000	2010	Ultimate
Total Groundwater Production	138,200	157,000	152,900	191,800	200,300
New Groundwater Production	0	18,800	14,700	53,600	62,100

The data listed above includes production from Chino and adjacent basins that are within Chino Basin MWD. Much of the increased production is expected to meet growing demands and urbanization of agricultural areas. A total Chino Basin production identified in the SAWPA studies is as follows:

	1990	1995	2000	2010	Ultimate
Chino Basin Groundwater	151,500	184,400	192,700	246,100	249,400
New Groundwater	0	32,900	41,200	94,600	97,900

The predominant water quality problems in the Chino Basin are TDS, nitrate, and pesticides (especially DBCP). The TDS in the southern one-third of the basin generally exceeds 500 mg/l with peak TDS exceeding 1,500 mg/l in some wells. Nitrate is a more general problem in the basin. There are no documented iron and manganese problems in the basin. VOCs exceeding MCL or action levels have been detected in several wells, primarily near Ontario Airport. DBCP has also been detected in some wells located in the northern portions of the basin where citrus was historically grown. Radon is likely to be a problem in the future depending on the final MCL. Radon concentrations average about 1,000 pCi/l and range from under 100 pCi/l to over 2,000 pCi/l. There is no groundwater under the influence of surface water in the basin.

There are several plans for new groundwater treatment in the Chino Basin. These include the recently completed Pomona Nitrate Treatment Plant, and the proposed Chino East and West desalters. The Pomona plant produces about 10,000 acre-ft of groundwater of which 4,000 acre-ft/yr is "new" groundwater. The two Chino desalters are expected to produce about 6,000 acre-ft/yr each. These desalters could be expanded to produce 9,000 to 12,000 acre-ft/yr each depending on demand (up to 24,000 acre-ft/yr, total desalination).

No other treatment plants have been identified at this time. However, several cities are considering nitrate treatment. Future demands will likely require construction of at least one additional desalter to meet future potable water demands as the agricultural area develops. Depending on the future mix of sources, as much as 30,000 acre-ft/yr of additional desalination may be required. Facilities to remove nitrates may be required in the northern portion of the basin if blending with imported water is not adequate. No plans exist to treat for VOCs, radon or DBCP at this time.

Based on this rough estimate, as much as 58,000 acre-ft/yr of new groundwater treatment capacity may be constructed over the next twenty years. It should be noted that the increased groundwater production exceeds the safe yield of the basin. All groundwater production in excess of 140,000 acre-ft/yr must be replenished. Under ultimate conditions, replenishment needs could amount to about 110,000 acre-ft/yr. Additional treatment may be needed if significant amounts of reclaimed water are used for recharge. This treatment could be performed on the wastewater prior to recharge or on the groundwater following extraction.

MWD of Orange County. Production from the Orange County basin is projected to have the largest increase in the Metropolitan service area, with an increase of 100,000 acre-ft. The OCWD indicates that most of the production could be realized without major treatment because there are large areas of the basin which have good water quality. However, several wellhead treatment facilities are planned, spurred largely by Metropolitan's Groundwater Recovery Program. Several treatment projects are now in operation, such as the Tustin I and Garden Grove I projects (nitrate and salt removal). OCWD estimates that the projects shown in Table D-2 will come on line by 2010.

TABLE D-2

PROPOSED GROUNDWATER TREATMENT IN ORANGE COUNTY

New Project	Capacity (acre-ft/yr)	Treatment Required				
		Nitrate	TDS	VOC	Color	Selenium
Fullerton I	1,500	yes	yes			
Fullerton II	1,500	yes				yes
Garden Grove II	3,000	yes				
Irvine	6,700	yes	yes	yes		yes
Tustin II	3,300	yes	yes			
Yorba Linda I	1,000		yes			
Orange I	1,000			yes		
Forebay II	2,000			yes		
Dyer Road	30,000				yes	
Costa Mesa	13,500				yes	
Huntington Beach	10,000				yes	
San Juan I	4,300		yes			
Other	12,000				yes	
Total	89,800	16,000	15,300	9,700	65,500	8,200

In addition to the Orange County groundwater basin, production in the San Juan Basin (associated with a desalter project) is expected to increase from the present 6,000 acre-ft/yr to 11,000 acre-ft/yr. In total, an additional 90,000 acre-ft/yr will be treated in Orange County.

San Diego County Water Authority. San Diego indicates an increase in groundwater production from 12,216 acre-ft/yr to 27,216 acre-ft/yr--an increase of 15,000 acre-ft/yr. The Oceanside desalter accounts for 5,360 acre-ft/yr of the new groundwater, while the remainder would come from the San Pasqual Valley. Treatment requirements for San Pasqual Valley groundwater are probably minimal.

Upper San Gabriel Valley MWD. USGVMWD has estimated that their groundwater production will increase from 157,119 acre-ft/yr in 1990 to 180,000 acre-ft/yr in the year 2010, an increase of 22,881 acre-ft/yr. VOCs are expected to continue to be a problem in the basin. EPA has recently announced a plan to construct $50 million treatment facilities. Perhaps a reasonable estimate would be that 50 percent of the "new groundwater" would be treated for VOC removal. Nitrates are also a problem, but are typically dealt with by blending with deeper groundwater or imported sources. No major nitrate treatment facilities are planned. Because of the nearby San Gabriel Mountains, Radon would be a suspected problem. Pesticides are not a problem in the basin. Iron and manganese problems are not common.

Western MWD. Western has indicated an increase in groundwater production from 198,472 acre-ft/yr to 213,395 acre-ft/yr, an increase of about 14,700 acre-ft/yr. No major treatment requirements are expected with the possible exception of radon. Radon concentration range as high as 1,000 pCi/l, meaning that most wells will require treatment if the new maximum is 300 pCi/l. Organics may be an issue in isolated areas such as Norton AFB, but potential treatment projects do not appear to be planned yet.

The Arlington desalter was constructed in 1990 and produces 6,100 acre-ft/yr. However, this is not included in the "new" groundwater total above.

Eastern MWD. Eastern MWD expects to increase groundwater production from 11,600 acre-ft/yr in 1990 to 26,400 acre-ft/yr in 2010, with an increase of 14,800 acre-ft/yr. The increase in production mainly comes from San Jacinto Basin. About 12,000 acre-ft/yr will require desalination. Beyond 2010, Eastern expects to develop five smaller basins in its area to produce an additional 6,000 acre-ft/yr, which will expand to 16,000 acre-ft/yr later.

Los Angeles Department of Water and Power. Groundwater production of 110,000 acre-ft/yr in 1990 is expected to increase to 130,400 acre-ft/yr by 2010, with an increase of 20,000 acre-ft/yr. Since most of the new groundwater comes from San Fernando Basin, it is expected to require treatment of VOC and possibly for nitrate. Most of the increased production is expected to be replenished with reclaimed water.

Three Valley MWD. Groundwater production in the TVMWD service area is expected to grow from 44,400 acre-ft/yr in 1990 to 64,800 acre-ft/yr in 2010, with an increase of 20,400 acre-ft/yr. Groundwater with high TDS concentrations can be blended with import or deeper water, however, if the blending is not possible, up to 10,000 acre-ft/yr of water could require treatment for TDS.

Summary. Table D-3 summarizes member agency estimates of groundwater contamination issues in their basin. Where available, estimates of production expected to need treatment are provided. There are many uncertainties in the estimates.

Many of the member agencies expect to need treatment for existing groundwater as well as new supplies. However, for the sake of consistency with other incremental water supply costs, the

TABLE D-3

MEMBER AGENCY ESTIMATES OF NEW GROUNDWATER REQUIRING TREATMENT

Member Agency	Total New Production Acre-ft/yr	Water Quality Issue and Estimated Annual Treatment (acre-ft/yr)									
		Nitrate	TDS	Color	Selenium	VOC	Pesticides (DBCP)	Iron and Manganese	Radon	Arsenic	TOC/ DBP
Burbank	12,000	Maybe	No	No	No	Yes 12,000	No	No	Unknown	Unknown	No
Central/West Basin MWDs	27,600	No	Yes 13,000	No	No	No	No	Yes 6,000	Maybe 3,000	Maybe 10,000	No
Chino Basin MWD	62,000	Yes 4,000	Yes 12-54,000	No	No	Yes ?	Yes ?	No	Yes ?	Unknown	No
Eastern MWD	14,000		Yes 12,000	No	No	Unknown	Maybe	No	Unknown	Unknown	No
Los Angeles DWP	20,000	Maybe	No	No	No	Yes	No	No	Unknown	Unknown	No
MWDOC	105,000	Yes 16,000	Yes 15,000	Yes 65,500	Yes 8,200	Yes 9,700	No	No	Unknown	Unknown	No
San Diego CWA	15,000	No	Yes 5,000	No	No	No	No	No	Unknown	Unknown	No
Three Valleys MWD	21,000	No	No 10,000	No	No	No	No	No	Unknown	Unknown	No
Upper San Gabriel Valley MWD	23,000	Yes blend	No	No	No	Yes 11,000	No	No	Maybe	Unknown	No
Western MWD	14,700	Yes	Yes	No	No	Maybe	No	No	Maybe	Unknown	No
Total	261,000	20,000	67-109,000	66,000	8,000	33,000	—	6,000	3,000	10,000	—

discussion herein has been limit to "new" groundwater sources requiring treatment. It should be made clear that member agencies planning to treat existing supplies may be anticipating Metropolitan incentives under the groundwater recovery program (see, for example, the discussion of colored groundwater for MWDOC).

Estimated Costs For Treatment

Treatment of contaminated groundwater, whether existing or "new" supplies, will add costs, regardless of funding source. There are a number of projects in Southern California that provide experience on costs of groundwater treatment. Table D-4 includes estimated costs from conceptual projects from the Metropolitan Brackish Groundwater Reclamation Study (Boyle Engineering, 1991). The 21 projects total 130,000 acre-ft/yr in production.

For the predominant groundwater quality issues, the contaminant, technology, and cost can be summarized as follows :

Water Quality Issue	Number of Projects	Treatment Technologies	Cost Range ($/acre-ft)
TDS	11	Reverse osmosis	$330-1,240
TDS	0	Electrodialysis	—
Nitrate	4	Ion exchange	$370-567

A summary from Metropolitan of projects approved for participation in the Groundwater Recovery Program (GRP) is shown in Table D-5. Project costs, which include capital and operation and maintenance, were obtained from the engineer's final estimated cost, submitted by agency.

In this table, the cost for contaminants ranges as follows:

Contaminant	Treatment Technologies	Cost Range ($/acre-ft)
TDS	Reverse osmosis	$561–700
TDS	Electrodialysis Reversal	$908
VOC	Aeration + off-gas control	$365
VOC	Granular activated carbon	$401
TDS and VOC	Reverse osmosis	$820
TDS and VOC	Reverse osmosis + GAC	$787

Table D-6 shows data from Metropolitan on the most recent costs of existing groundwater treatment projects. These facilities have been treating groundwater from basins contaminated with organic and non-organic constituents for a number of years. Most of the treatment plants were constructed and operating prior to the initiation of the GRP. Some of the agencies did not apply for financial assistance because the project costs did not exceed Metropolitan's water rate. For these projects, the costs ranged from $60–300/acre-ft for VOC removal and $150–280/acre-ft for nitrate removal.

TABLE D-4

COST SUMMARY OF CASE STUDIES

Case Number	Study Area	Dominant Water Quality Problem: Constituent	Dominant Water Quality Problem: Concentration (mg/L)	Treatment Process	Project Capacity (MGD)	Project Production (AFY)(12)	Brine Disposal Option	Capital Cost ($ million): Brine	Capital Cost ($ million): Facility	Capital Cost ($ million): Replenish-ment (9)	Capital Cost ($ million): Total	Capital Recovery ($ million)	O&M Cost ($ million): Brine	O&M Cost ($ million): Facility	O&M Cost ($ million): Replenish-ment (10)	O&M Cost ($ million): Pumping (11)	O&M Cost ($ million): Total	Project Annual Cost ($ million)	Total Unit Cost ($/AF)(12)
1	Western Simi Valley	TDS	1,824	EDR	5	5,000	CRI (1)	3.08	12.35	--	15.4	1.5	.01	1.86	--	.35	2.2	3.8	754
2	Moorpark	TDS	1,350	EDR	8	8,100	CRI	4.08	16.58	4.45	25.1	2.4	.01	2.23	1.15	.57	4.0	6.4	812
3	Monk Hill	Nitrate	60	IX	7	7,100	LARI (2)	.64	8.70	3.51	12.9	1.2	.02	.43	.81	.50	1.8	3.0	440
4	Beverly Hills	Hardness	189	MS	4	3,500	LARI	.96	7.47	--	8.4	.8	.05	.69	--	.25	1.0	1.8	521
5	Vernon	Manganese	0.1	OF	3	3,000	--	--	4.97	--	5.0	.5	--	.27	--	.21	.5	1.0	327
6	Torrance	TDS	1,596	RO	6	6,000	WI (7)	--	13.49	--	13.5	1.3	--	1.34	--	.42	1.8	3.1	518
7	City of Pomona	Nitrate	66	IX	9	9,100	MWD LINE(5)	.69	9.51	--	10.2	1.0	.04	.53	1.14	.64	2.4	3.4	370
8	Alamitos Barrier	TDS	14,700	SWRO	1	1,000	OC (6)	2.25	11.25	--	13.5	1.4	--	1.06	--	.07	1.1	2.5	2390
9	San Bernardino	Nitrate	115	IX	8	8,100	SARI (4)	3.75	10.78	--	14.5	1.5	.08	.86	1.64	.57	3.2	4.6	567
10	Chino	Nitrate	83	IX/SOFT	12	12,100	SARI	9.20	27.75	--	37.0	3.7	.20	.21	1.72	.85	3.0	6.7	560
11	Corona	TDS/Nitrate	737/70	RO	10	10,100	SARI	8.33	16.52	2.11	27.0	2.7	.18	1.81	.51	.71	3.2	5.9	589
12	Santa Ana Canyon	TDS	1,343	EDR	5	5,000	SARI	5.55	10.38	--	15.9	1.6	.10	1.67	--	.35	2.1	3.7	742
13	Huntington Beach	TDS	2,920	RO	4	3,500	OC	1.95	16.15	--	18.1	1.8	.10	1.41	--	.25	1.8	3.6	1019
14	Talbert Gap	TDS	3,202	RO	4	3,500	OC	1.95	9.65	--	11.6	1.2	.10	1.41	--	.25	1.8	2.9	833
15	San Juan	TDS	1,005	EDR	6	6,000	OC	1.05	13.16	--	14.2	1.4	--	2.01	--	.42	2.4	3.9	642
16	Hemet/Valle Vista	TDS/Nitrate	748/67	RO	8	8,100	SMRI (3)	5.34	16.36	3.65	25.4	2.5	.01	1.17	.84	.57	2.6	5.1	643
17	Winchester/ West Hemet	TDS	3,403	RO	4	4,000	SMRI	11.45	12.05	2.56	26.1	2.6	.01	1.35	.6[illegible]	.28	2.3	4.9	1240
18	Pauba Valley/ Wolf Valley	Fluoride	3.6	AA	4	4,000	SMRI	.76	5.76	3.22	9.7	.9	.01	.54	.67	.28	1.5	2.4	639
19	Camp Pendleton	TDS	704	RO	13	13,400	SMRI	4.47	18.86	--	23.3	2.3	.02	1.13	--	.94	2.1	4.4	330
20	Oceanside	TDS	1,403	EDR	5	5,000	OC	.90	11.47	--	12.4	1.2	--	1.63	--	.35	2.0	3.2	643
21	Western San Pasqual	TDS	853	EDR	5	5,000	EV (8)	3.90	8.04	--	11.9	1.2	.05	1.31	--	.35	1.7	2.9	581
	TOTAL				130	130,600		70.30	261	19.50	351	35.1	.99	24.9	9.15	9.18	44.2	79.3	611(13)

Notes:
(1) CRI = Proposed Calleguas Creek Regional Interceptor, brine capacity cost $4.53m/MG.
(2) LARI = Proposed Los Angeles Regional Interceptor, brine capacity cost $3.21m/MG.
(3) SMRI = Proposed Santa Margarita Regional Interceptor, brine capacity cost $7.64m/MG.
(4) SARI = Santa Ana Regional Interceptor, brine capacity cost $9.25/GPD, treatment $517/MG.
(5) MWD = MWDSC Wastewater Line (LACSD), brine capacity cost $2.30/GPD, treatment $382/MG.
(6) Ocean Outfall capacity cost at $1.5m/MG.
(7) Oil field well injection.
(8) Concentration/Evaporation.
(9) Includes recharge basin, pipeline and turnout.
(10) Includes recharge basin, pipeline and purchase of MWD replenishment water @142/AF.
(11) Includes well operation, maintenance and energy costs.
(12) Per production rate at 90% plant utilization.
(13) Weighted average per production rate.

SOURCE: MWD (BOYLE ENGINEERING), 1991

TABLE D-5

COST OF GROUNDWATER TREATMENT PROJECTS
METROPOLITAN'S GROUNDWATER RECOVERY PROGRAM

No.	Project Name	Contaminant	Type of Treatment	Annual Production (Acre-ft/yr)	Start Date	1994 Unit Cost ($/Acre-ft)
1	Santa Monica GW Treatment Project	VOC	Airstripping w/ Off-gas GAC	1,800	1993	365
2	Oceanside Desalter	TDS	RO	2,000	1994	700
3	Burbank Lake St. Plant	VOC	GAC	2,750	1993	401*
4	West Basin Desalter	TDS	RO	1,500	1993	632*
5	Rowland GW Treatment Project	TDS, VOC	RO/GAC	600	1996	787
6	Irvine Desalter Project	TDS, VOC	RO	6,700	1996	820*
7	Tustin Desalter Project	TDS	RO	3,200	1995	561*
8	Menifee Basin Desalter Project	TDS	EDR	3,360	1996	908
9	Arlington Desalter	TDS	RO	6,100	1990	610

* – Unit cost includes replenishment assessment.
All unit prices include pumping costs.

TABLE D-6

COST OF EXISTING GROUNDWATER TREATMENT PROJECTS

No.	Project Name	Contaminant	Type of Treatment	Annual Production (Acre-ft/yr)	Start Date	Unit Cost ($/Acre-ft)
1	Glenwood Nitrate Removal Plant	Nitrate	IX	1,600	1989	280
2	El Toro TCE Pump-out Project	VOC	Rotary Air Stripping	1,100	1990	270*
3	Orange TCE Removal Project	VOC	Rotary Air Stripping	1,100	1993	150*
4	South Gate Wellhead Treatment Unit	VOC	GAC	1,279	1991	255*
5	LADWP Advanced Oxidation Process Plant	VOC	AOP	5,800	1991	250
6	DWP/North Hollywood Operational Unit	VOC	Air Stripping, GAC	3,000	1989	300
7	Devil's Gate VOC GW Treatment Plant	VOC	Air Stripping, GAC	10,200	1990	135
8	Newmark/San Bernardino	VOC	Air Stripping, Off-Gas	6,000	1986	125
9	Waterman/San Bernardino	VOC	Air Stripping, Off-Gas	7,200	1988	125
10	Pomona Nitrate Plant	NO_3	IX	16,800	1993	150

* – Unit cost includes replenishment assessment.
All unit costs include pumping costs.
Reference: MWDSC, *A Regional Survey of Groundwater Quality in the MWDSC Service Area, Report* 991, May 1994

Overall, it can be shown that the costs of groundwater treatment are highly specific, depending on contaminant, production capacity, treatment technology, and other factors. Existing information suggests a range of costs for treatment of the contaminants as follows:

Contaminant	Unit Cost ($/acre-ft)
VOC	$125–400
TDS	$500–900
Nitrate	$150–300

Costs for treating some other contaminants are estimated as follows.

Enhanced Coagulation and Conventional Filtration. Enhanced coagulation and filtration can be used to remove color, iron/manganese, arsenic and TOC/DBP. The cost of this process varies with the capacity of the process from $250 to $130/acre-ft for 1 million gallons per day (MGD) to 10 MGD, respectively.

Granular Activated Carbon. The costs for granular activated carbon treatment for the removal THM and DBP precursors will generally range from $300 to $170/acre-ft for 1 and 10 MGD facilities, respectively.

Chlorination. Unit costs for groundwater disinfection depends largely on plant capacity and to lesser degree on the contaminant level, however, it varies from $38 to $15/acre-ft for 1 to 10 MGD, respectively. The treatment costs would be about 50 percent higher if chloramines are used.

Regional Cost Estimates

Based on Table D-3, which illustrates the amount of new groundwater that will require treatment plus the mid-range of treatment costs presented above, the overall impact of using this supply can be estimated to be in the range of $124 to $154 million/year as shown in Table D-7. Note there are major uncertainties in some of the estimates, in contamination level, areal extent of contamination, regulations, and treatment costs. These costs do not include the potential costs of treatment to meet the new drinking water regulations, especially for arsenic and radon.

The above costs do not include additional costs which may be incurred, such as:

- Post treatment costs - pH or alkalinity adjustment to control lead and copper corrosion following lime treatment
- Land acquisition cost
- Well development, installation, and pump costs
- Replenishment costs
- Piping and pumping to a central treatment location.

TABLE D-7

TREATMENT COST ESTIMATES

Treatment Process	Treatment Capacity (1000 acre-ft/yr)	Unit Cost ($/acre-ft)	Annual Cost ($ Million)
Reverse Osmosis	136—178	$700	$95–$125
Ion Exchange	23	$225	$5
Coagulation	66	$190	$13
Granular Activated Carbon	46	$235	$11
Total	**271—313**		**$124–154**

STRATEGIES TO RESOLVE ISSUES

A number of issues have been raised relative to groundwater quality and treatment. Potential strategies to resolve these issues are presented below for each general issue area.

Groundwater Quality and Regulatory Constraints

- Metropolitan and its member agencies should continue their proactive role in commenting on the development of new drinking water regulations including the cost impacts of these regulations.
- Metropolitan and its member agencies should continue with its efforts to evaluate the impact of the new regulations on groundwater production in its service area.
- Metropolitan should continue to provide technical assistance to its member agencies in the areas of treatment processes.
- Metropolitan should evaluate the effect of water supply plans on the delivered water quality and the ability of its member agencies, their subagencies and wastewater management agencies to meet waste discharge requirements as part of its Integrated Resources Plan.

Technical Constraints Affecting Supplies

- Metropolitan and its member agencies should jointly evaluate the need for new or enlarged brine disposal facilities to handle the anticipated waste loads from new inland groundwater treatment facilities.

Economic and Financial Issues

- Metropolitan should proceed with its plans to re-evaluate all of its incentive programs and propose modifications as appropriate to encourage the treatment and use of degraded groundwater.

- Metropolitan should consider providing GRP incentives for clean-up projects where essential for preserving groundwater production. GRP funds provided should be subject to repayment after responsible parties are identified.

Future Supply Development

- Metropolitan should work with its member agencies to identify potential groundwater treatment projects that have both local and regional benefits.

Cost of Groundwater Treatment

- Metropolitan should provide technical assistance to its member agencies in assessing the cost of new groundwater treatment projects and in the use of the most appropriate treatment technologies.

Appendix E
IRP Assembly Participants

MWD

Appendix E
IRP Assembly Participants

Name of Participant	Affiliated Agency
Alario, Edward	City of Anaheim
Arakawa, Steve N.	MWDSC
Arant, Gary	Valley Center MWD
Atwater, Richard W.	Central/West Basin MWD
Bangham, Bill	Raymond Basin Management Board
Bannister, Wesley M.	MWDSC Director, MWDOC
Barker, Charles D.	MWDSC Director, West Basin MWD
Becker, Bert H.	MWDSC
Beuhler, Mark D.	MWDSC
Blake, James H.,	MWDSC Director, City of Fullerton
Blevins, Melvin L.	LADWP
Boen, Doyle F.	MWDSC Director, Eastern MWD
Brick, Timothy F.	MWDSC Director, City of Pasadena
Colbaugh, Jim	Las Virgenes MWD
Cook, Hunter T.	Coastal MWD
Corley, Ray E.	MWDSC
Deaton, Ron	City of Los Angeles
Dorff, Karen E.	MWDSC
Drake, Michael S.	City of San Fernando
Ferguson, David	City of Long Beach
Foley, John V.	MWDSC Director, MWDOC
Frahm, Christine M.	MWDSC Director, SDCWA
Frei, Jim	La Habra Heights County Water Agency
French, Dwight F.	MWDSC Director, Chino Basin MWD
Froelich, Donald	City of Glendale
Georgeson, Duane L.	MWDSC
Gewe, Gerald	LADWP
Glancy, Jim	City of Lakewood
Grandsen, Ted	MWDSC Director, Calleguas MWD
Griffen, Harry,	MWDSC Director, SDCWA
Gutierrez, Mike	Southern California Water Company
Harriger, Donald L.	Western MWD of Riverside County
Harry, Lee J.	MWDSC Director, City of Santa Ana
Hazel, Gary J.	MWDSC
Hennigar, John F.	Rancho California Water District (EMWD)
Hill, Bill M.	MWDSC Director, Chino Basin MWD
Hoagland, John E.	Elsinore Valley MWD
Hogan, Steve	City of San Diego

Name of Participant	Affiliated Agency
Horne, Wiley F.	MWDSC
Ibbetson, E. Thornton	MWDSC Director, Central Basin MWD
Ivey, Gilbert F.	MWDSC
Kazarian, Bob	MWDSC Director, City of Anaheim
Kemp, Karl	Mesa Consolidated Water District
Kendall, Donald R.	Calleguas MWD
Kennedy, Ronald	El Toro Water District
King, Jerry A.	MWDSC Director, MWDOC
Krauel, Francesca M.	MWDSC Director, SDCWA
Krieger, Lois B.	MWDSC Director, West. MWD of Riverside Co.
Lewinger, Keith	Otay Water District
Lindhout, Linzey	MWDSC
Little, Edward C.	MWDSC Director, West Basin MWD
Magoffin, Linn	Main San Gabriel Basin Watermaster
Malburg, Leonis C.	MWDSC Director, Central Basin MWD
Malinowski, Jay W.	MWDSC
Man, Debra C.	MWDSC
Marott, Janet E.	MWDSC
Mason, Dale	MWDSC Director, SDCWA
McMurray, Wayne T.	MWDSC Director, Coastal MWD
Means, Edward G.	MWDSC
Meyer, Henry J.	MWDSC Director, City of Long Beach
Miller, Patrick H.	MWDSC Director, Calleguas MWD
Mills Jr., Milon	City of San Diego
Mills, William R. Jr.	Orange County Water District
Milne, Bruce J.	MWDSC Director, Three Valleys MWD
Moret, Katherine W.	MWDSC Director, LADWP
Morris, John T.	MWDSC Director, Calif-American Water Co., San Marino
Morse, Gary A.	MWDSC Director, Central Basin MWD
Mundy, John	City of Santa Monica
Mylne, John M., III	MWDSC Director, West. MWD of Riverside Co.
Norman, John W.	Water Replenishment District of So. Calif.
O'Neil, William T.	MWDSC Director, Foothill MWD
Osborne, Wayne S.	City of Fountain Valley
Palmer, Ronald C.	Foothill MWD
Parker, Joseph	MWDSC Director, SDCWA
Peterson, Glen D.	MWDSC Director, Las Virgenes MWD
Quinn, Timothy	MWDSC
Reed, Christine E.	MWDSC Director, City of Santa Monica
Schaich, Chuck	City of Torrance
Schempp, Robert	MWDSC
Shollenberger, Thomas E.	Cucamonga County Water District
Snow, Lester	SDCWA
Snyder, Gary M.	MWDSC

Name of Participant	Affiliated Agency
Soltz, Roberta M.	MWDSC
Sprague, Stanley E.	MWDOC
Stamper, Larry L.	MWDSC Director, City of Burbank
Stassi, Ronald V.	City of Burbank
Stuart, Charles L.	MWDSC Director, West Basin MWD
Tamble, Terry	California Water Service Company
Taylor, Greg	MWDSC
Thomas, Brian G.	MWDSC
Underbrink, Tom	City of Pasadena
Watton, Mark W.	MWDSC Director, SDCWA
Wein, George	MWDSC Director, LADWP
Westdyke, Robert G.	Chino Basin MWD
Wickser, Jim	LADWP
Witt, Kenneth H.	MWDSC Director, MWDOC
Wodraska, John R.	MWDSC General Manager
Wong, Benjamin	City of Oxnard
Worley, Tim	Three Valleys MWD
Wright, Bill	MWDSC Director, City of Torrance
Wysbeek, Doude	MWDSC Director, City of San Fernando
Young, Michael B.	MWDSC
Young, Ronald E.	Irvine Ranch Water District

Appendix F
IRP Assembly
Steering Committee

MWD

Appendix F
IRP Assembly Steering Committee

Richard W. Atwater	General Manager, Central/West Basin MWD
Charles D. Barker	MWDSC Director, West Basin MWD
James H. Blake	MWDSC Director, City of Fullerton
Alf W. Brandt	MWDSC Director, LADWP
Timothy F. Brick	MWDSC Director, City of Pasadena
Christine M. Frahm	MWDSC Director, San Diego Co. Water Authority
Gerald A. Gewe	Engineer of Water Resources Planning, LADWP
Duane L. Georgeson	Assistant General Manager, MWDSC
Ted Grandsen	MWDSC Director, Calleguas MWD
Donald L. Harriger	General Manager, Western MWD of Riverside Co.
Bill Hill	MWDSC Director, Chino Basin MWD
F. Wiley Horne	Assistant General Manager, MWDSC
Donald R. Kendall	General Manager, Calleguas MWD
Lois B. Krieger	MWDSC Director, Western MWD
Debra C. Man	Director, Planning Division, MWDSC
Edward G. Means	Director, Resources Division, MWDSC
Timothy H. Quinn	Director, SWP and Conservation Div, MWDSC
Lester A. Snow	General Manager, San Diego Co. Water Authority
Stanley E. Sprague	General Manager, MWD of Orange County
John R. Wodraska	General Manager, MWDSC

Facilitators and Recorders

Assembly Facilitator

Lance deHaven-Smith	Director, Inst. of Gov't., Florida Atlantic Univ.

Assembly Recorder

Patty Metzger	Research Assoc., Florida Atlantic Univ. Inst. of Gov't.

Subgroup Facilitators

Paul Brown	Sr. Vice President, Camp Dresser & McKee Inc.
Byron Buck	Assistant to the General Manager, SDCWA
Virginia Grebbien	Ass't General Manager, Central/West Basin MWDs
Dale Hunter	Principal Gov. Affairs Representative, MWDSC
Paul Jones	Assistant General Manager, MWD of Orange Co.
Karen Tachiki	Assistant General Counsel, MWDSC

Subgroup Recorders

Jeanne-Marie Bruno	Principal Engineer, MWDSC
Marti Farley	Supervisor, Special Projects, MWDSC
George Martin	Director of Water Conservation, LADWP
Karl Seckel	Ass't Mgr/District Engineer, MWD of Orange County
Lynda Smith	Associate Environmental Specialist, MWDSC
Kevin Wattier	Regional Operations Manager, MWDSC

Project Manager

Anne E. Baker	Executive Assistant for Strategic Policy Development, MWDSC

Support Staff

Carrie Blade	Office Services Assistant II, MWDSC
Randall Collins	Camera Technician, MWDSC
Lorrie Dove	Administrative Analyst, MWDSC
Bob Gomperz	Principal Public Affairs Representative, MWDSC
Steve Hirsch	Resource Specialist, MWDSC
Alice Maupin	Assistant Civil Engineer, MWDSC
Ken McSpadden	Video Technician, MWDSC
Jay Parks	Office Services Assistant II, MWDSC
Christel Strelecky	Senior Public Affairs Representative, MWDSC
Meng Ti	Telecommunications Technician, MWDSC

Appendix G
Integrated Resources Plan Assembly
Assembly Statement

MWD

CONSERVATION

RECLAMATION

GROUNDWATER

WATER TRANSFERS

COLORADO RIVER

STATE WATER PROJECT

OCEAN DESALINATION

Metropolitan Water District of Southern California

INTEGRATED WATER RESOURCES PLAN ASSEMBLY
ASSEMBLY STATEMENT

San Pedro, California
June 9-11, 1994

METROPOLITAN WATER DISTRICT
OF
SOUTHERN CALIFORNIA

INTEGRATED WATER RESOURCES PLAN
ASSEMBLY

ASSEMBLY STATEMENT

San Pedro, California
June 9-11, 1994

METROPOLITAN WATER DISTRICT
OF
SOUTHERN CALIFORNIA

INTEGRATED WATER RESOURCES PLAN ASSEMBLY

ASSEMBLY STATEMENT

At the close of their discussion, the participants of this Assembly reviewed and adopted as a group the following statement. The statement represents general agreement. However, no one was asked to sign it. Furthermore, it should not be assumed that every participant subscribes to every recommendation.

I. INTRODUCTION

This paper presents the conclusions reached at an American Assembly on the Integrated Water Resources Plan for Southern California. The Assembly was convened on June 9-11, 1994, at the Doubletree Hotel in San Pedro. (An overview of the Assembly procedures is provided in Appendix 1.) Over one hundred people attended, excluding Assembly staff and observers. Participants included members of the Board of Directors of the Metropolitan Water District of Southern California (Metropolitan), Metropolitan's Member Agency managers, Metropolitan senior staff, groundwater agency managers, and representatives of retail subagencies that purchase water from Member Agencies. (A list of Assembly participants is provided in Appendix 2.)

The Integrated Water Resources Plan Assembly was a follow-up to an October 1993 Assembly on Metropolitan's Strategic Plan. The 1993 Assembly dealt with such fundamental issues as regional water policies, financing structures, and governance, and provided direction for a number of Metropolitan's actions, including adoption of a foundation for a new revenue structure, selection of criteria for resource evaluation, and formulation of initial business practices and water management principles.

The June 1994 Assembly focused on strategies for meeting the water needs of Metropolitan's service area through the year 2020. Alternative strategies were delineated through an Integrated Resources Planning (IRP) process. IRP is a technical methodology for forecasting needs, assessing alternative supply options against explicit standards, and choosing among different supply combinations.

The main questions the Assembly addressed were which resource mix to emphasize, and how to implement it.

II. SOUTHERN CALIFORNIA'S WATER SUPPLY CHALLENGE

Southern California's water community is at a critical time in its history as a steward of water resources. The region faces a growing gap between its water requirements and its firm supplies. Increased environmental regulations and the attendant competition for water from outside the region have resulted in reduced supplies of imported water. At the same time, demand is rising within the region because of continued population growth. Shortages during 1991 highlighted the seriousness of the problem.

The water used in Southern California comes from a number of sources. About one-third of it is found locally. The rest of the region's water is imported from three sources -- the Colorado River, the Sacramento-San Joaquin River Delta, and the Owens Valley and Mono Basin (through the Los Angeles Aqueducts). The ability of Southern California to secure the same amount of imported water, much less a greater amount, is in question.

The region's population is forecast to increase from the current 15.7 million to about 19.5 million by year 2010, and to 21.5 million by year 2020. At present, between 195 and 215 gallons of water are consumed daily for municipal and industrial uses for every person living in Southern California. Since the 1970s, the total regional water demand in Metropolitan's 5,139 square mile service area has increased from about 2.8 million acre-feet per year to about 3.5 million acre-feet per year in 1993. Based on normal conditions and full implementation of water conservation measures, it is expected that regional demands will increase to just over 4.5 million acre-feet by year 2010, and to just over 5.0 million acre-feet by year 2020. During very hot and dry years, demands could be as high as 4.9 million acre-feet in 2010, and 5.6 million acre-feet in year 2020.

The delivery of water to Southern California water consumers has been nearly 100 percent reliable in the past. However, as existing firm water supplies continue to decrease, future reliability is uncertain. Even with a 15 percent reduction in demand due to full implementation of conservation measures, the reliability of water deliveries during a drought could fall to 50 percent by year 2000 without any additional water supply investments or improvements. This would mean that there would be some type of shortage, on average, every other year, and rationing in many of these years.

III. THE IRP PROCESS

The agency that has traditionally had the lead role for meeting the region's supplemental imported water needs is Metropolitan, a special district created in 1928 under State enabling legislation. Metropolitan, through its staff, carries out many duties in connection with securing, storing, distributing, treating, and financing water under Board policy for the region. It is a confederation of 27 Member Agencies which purchase wholesale water from Metropolitan, handle sub-regional distribution, and resell the water to other suppliers or directly to consumers. The decisions of Metropolitan are made by a 51 member Board of Directors appointed by their Member Agencies. The Directors are accountable to their appointing authorities, most of whom are elected officials.

During the past two decades, Metropolitan has broadened its role not just to function as a supplier of imported water, but also to play a part in region-wide water management. Metropolitan has used financial incentives and other means to encourage its Member Agencies to develop alternative water supplies and to become less dependent on Metropolitan for water supplies. On their own and in response to Metropolitan's incentives, Member Agencies have developed additional groundwater resources, promoted conservation, developed water reclamation projects, and supported Metropolitan at the State and federal level to improve imported supplies.

The IRP process was initiated to give the region as a whole the opportunity to examine its water supply needs and options. The IRP process identified resource mixes that could meet all of the wholesale water demands of Metropolitan's Member Agencies, except during the most severe droughts. At those times, say one year in 50, Metropolitan would deliver no less than 80 percent of the imported water needed to meet wholesale demands within its service area, with the difference made up by rationing or voluntary conservation measures.

The IRP process was designed to be open and participatory. Member Agencies and groundwater agencies were actively involved in reviewing the methodology and results and in establishing a technical framework. Also, acting on one of the recommendations from the 1993 Assembly, three open forums and three local agency workshops were held throughout Southern California to review options and obtain input. Forum and workshop participants presented recommendations to the IRP Assembly on the evening of June 9, the night preceding the Assembly discussion process.

IV. RESOURCE MIX FROM A REGIONAL PERSPECTIVE

The question posed by the IRP was where to put the emphasis along a continuum that covers three basic resource-mix alternatives. At one end of the continuum is the strategy of enhancing local supplies, through very aggressive water reclamation, groundwater development, ocean desalination, and conservation beyond the current Best Management Practices (BMPs).

At the other end is securing existing entitlements and additional imported water supplies through Delta improvements and south-of-Delta storage. Between these extremes is the strategy of balancing local and imported supplies, and storing seasonally available imported water in surface reservoirs and groundwater basins for use later during droughts and periods of high demand (a method referred to as "conjunctive use").

Each IRP mix assumed that water conservation would be implemented aggressively in the region through BMPs, and that Metropolitan would use, at least to some extent, all available strategies.

A. The Assembly participants agreed that the best resource combination for the region is an intermediate mix. Some stated that this mix should lean toward cost-effective local water development. All three of the alternative resource mixes have similar costs over the next ten years (the cost estimates diverge substantially beyond that), and all three meet the reliability goal. But an intermediate mix provides the greatest diversity, adaptability, and flexibility.

B. However, in endorsing an intermediate mix, the participants are supporting a general direction, not all of the specific items and goals included in the IRP analysis. Maintaining an appropriate mix which meets the reliability goal is a dynamic process requiring regular evaluation. The following list is a set of suggested parameters:

1. Local supplies should be pursued to the point of technical and economic feasibility. The region should make full use of economically and environmentally feasible local water supplies (such as groundwater, reclamation, and desalination) as long as these are coupled with maintaining and enhancing a dependable supply from the State Water Project (SWP).

2. Dependable supplies from the SWP have the potential to be highly economical and because of water quality considerations, are essential for successful implementation of local reclamation and groundwater storage programs.

3. The Domenigoni Valley Reservoir Project, the Inland Feeder, and groundwater and other local storage all work together to meet overall water supply, emergency storage, and water quality needs.

4. Supplies from the Colorado River Aqueduct should be maximized, but steps should be taken to address water quality impacts on local water resources development.

C. Primary emphasis on either local resources or imported supplies has a number of disadvantages. While heavy reliance on local resources might demonstrate that Southern California is trying to solve its own problems in a responsible way, a resource mix exclusively emphasizing local resources would:

1. Pose potential water quality problems. Without substantial imported water to replenish local groundwater basins, high total dissolved solids (TDS) in the Colorado River supplies used for replenishment will cause degradation of groundwater. In addition, high TDS limits the development of water reclamation. These problems could be addressed with desalination, but desalination is costly and creates environmental impacts.

2. Create problems of parochialism, particularly during droughts. To the extent that local resources are unavailable to meet regional needs, conflicts will occur during shortages between those that have direct access to local resources and those that do not.

D. The main problem associated with heavy reliance on imported water is political and environmental risk. It is uncertain whether a resource mix exclusively emphasizing imported supplies would allow Metropolitan to meet its reliability goal. Due to the political and environmental risk, it is unlikely that progress in the Delta can be made without substantial commitment to local resource development and environmental protection.

E. Participants agree that all of the common regional resource requirements should be pursued, including construction of the Domenigoni Valley Reservoir Project and the Inland Feeder. However, a few participants are concerned that the Domenigoni Valley Reservoir Project is not as cost-effective as competing resources and may not benefit all equitably. The common regional resource requirements are:

1. **Urban Water Conservation.** It is recommended that by 1996, all water agencies, private water companies, cities, and other units of local government having water resource management responsibilities in Southern California become signatories to, and implement, the "Memorandum of Understanding Regarding Urban Water Conservation in California." It is estimated that the region has conserved about 250,000 acre-feet per year (AFY) during 1980 to 1990 as a result of public education, residential and commercial plumbing codes, and plumbing retrofits of shower heads and toilets. The regional objective should be at least 750,000 AFY by

the year 2010 as a result of fully implementing the Urban Water Conservation Best Management Practices.

2. **Water Reclamation.** Currently, the region is using about 250,000 AFY of reclaimed water for indirect uses such as groundwater replenishment, and direct uses such as landscape irrigation. The regional requirement should be at least 505,000 AFY by the year 2010, a two-fold increase in 15 years.

3. **Groundwater Recovery and Treatment.** Currently, at least 10,000 AFY of brackish/contaminated groundwater is being recovered in the region in order to increase annual groundwater production. The regional requirement should be at least 50,000 AFY by the year 2010, a five-fold increase in 15 years.

4. **Groundwater and Surface Storage.** The recommended regional requirement for groundwater storage is expansion of current conjunctive management of local and imported water supplies to develop at least 300,000 AFY of additional annual production and 1,000,000 AFY of additional storage by year 2010.

The Domenigoni Valley Reservoir Project and Inland Feeder should be established as critically needed projects for Southern California to provide emergency, seasonal, and drought storage. In addition, periodic reports should be prepared documenting the status of Member Agency and subagency abilities to meet the emergency needs resulting from a seven-day Metropolitan outage.

5. **Colorado River.** Water transfers, water conservation, water quality enhancement, groundwater storage programs, in-river storage agreements, and available surplus and unused water should be pursued to increase the reliability of Colorado River supplies and provide full aqueduct delivery. Promote the creation and maintenance of a Lower Basin coalition to actively support a multi-species habitat conservation and protection program.

6. **State Water Project.** Southern California water agencies should develop programs to conjunctively manage their supplies from the SWP to increase use of supplies in time of surplus, and reduce the need for direct deliveries from the SWP during droughts or periods when significant impacts on fisheries could result. The first priority is to fully utilize storage of imported supplies in Southern California. Conjunctive use

programs should include developing cooperative SWP banking programs outside of the Southern California region as well. Southern California water agencies should commit to creating, maintaining, and strengthening broad-based coalitions and actively support a multi-species habitat conservation and protection program for the Delta.

7. **Water Transfers.** Because water transfers play such a critical role in meeting regional reliability, Southern California water agencies should commit to the establishment of a fully functional and efficient water market for the voluntary transfer of water between willing buyers and sellers. The recommended regional requirement for water transfers should be at least 300,000 AFY available by year 2010. Further evaluations are needed to determine the optimal strategies for using water transfers for consumptive and storage replenishment needs.

8. **Desalination.** Southern California currently invests in desalination of brackish groundwater. The region should support pilot programs to develop cost-effective ocean desalination technology and its applications.

F. The resource requirements described above are intended to provide a foundation for further analysis aimed at defining optimal goals and facilities for a comprehensive regional water resources plan.

G. Metropolitan should make sure that regional expenditures produce regional benefits. Metropolitan should also evaluate its current programs of technical and financial assistance to local agencies to assure that financial burdens and regional benefits are equitably balanced.

V. MEMBER AGENCY EQUITY

The participants generally recognized that an intermediate mix provides the greatest benefits to the largest number of Member Agencies. While an intermediate mix is preferable for the region as a whole, it has the potential, unless its financing and management are carefully structured, to create a number of serious inequities. Metropolitan is addressing many of these issues with its new rate structure, but there are underlying and differing concerns that this rate structure is not achieving necessary equity, and this may become more troublesome as the IRP and its associated capital program are implemented. The issues need to be addressed before closure is reached on the financial program required to implement the IRP.

A. Regional funding of programs to develop local water resources poses a challenge when trying to determine costs and benefits. On the one hand, when funding is coming from a regional source, the expectation is that a commensurate regional benefit should be produced. On the other hand, when local resources are developed solely with local expenditures, there should be no regional obligation.

B. Some Member Agencies have made investments in the past based on existing Metropolitan policies and financial incentive programs, but now these policies and programs are potentially changing. There is concern that these agencies should be able to depend on a consistent policy and that Metropolitan should honor all current contracts.

C. As an intermediate mix is refined and implemented, methods must be developed to assure that all Member Agencies and subagencies implement BMPs. All of the alternative resource mixes assumed that BMPs would be widely used, but the voluntary nature of the BMP program weakens its effectiveness in the region. Clear consequences for nonparticipation, including financial disincentives, should be established.

D. One of the essential ingredients to equity is a strong drought management plan. Metropolitan must have the political will to implement its policies. The drought management plan must assure that conservation is rewarded and not penalized. The equitability of providing regional incentives for local resource development is realized in a drought when the local water is produced for regional benefit.

VI. BALANCING REGIONAL BENEFITS AND MEMBER AGENCY EQUITY

In developing an IRP, the real questions facing the region are "What to do?" and "How to do it?" The advantages of an intermediate mix and the need to move forward on the common regional resource requirements are rather obvious. The problem, though, is doing so in a way that shares costs equitably, protects the viability of both Metropolitan and the Member Agencies, takes into account past investments by Member Agencies, and provides for both predictability and flexibility.

A. While some participants felt that the reliability goal might be low, the Assembly participants endorsed the reliability goal set by Metropolitan as a reasonable balance between cost and level of service. The participants also agreed that the goal should be periodically re-evaluated.

B. However, several aspects of the goal need to be kept in mind:

1. Metropolitan is setting the goal at the wholesale level, in the sense that the goal reflects Metropolitan providing supplemental water to Member Agencies. However, the actual level of reliability at the retail level could vary substantially, depending on the extent to which local resources are shared regionally. Regional sharing of local resources could reduce differences in local retail reliability.

2. The goal does not address how Metropolitan will deal with the critical issue of resource allocation during droughts. This issue has implications both for public perceptions of the reliability goal and for how the burden will be shared.

C. Metropolitan should develop an explicit policy on wheeling. The policy should state the criteria under which wheeling is allowed.

D. The following steps should be taken to promote regional equity:

1. Metropolitan and its Member Agencies must develop a drought management plan. In addition to being consistently enforced, the plan should address:

a. How regional investments in local resources are to be shared;

b. When supplies will be interrupted; and

c. How limited imported supplies will be allocated.

2. Consideration should also be given to developing policies on:

a. Recognizing Member Agencies' past investments to develop their local resources;

b. Resolving the issue of preferential rights in light of current financial policy; and

c. Requiring the adoption and implementation of BMPs throughout the region.

VII. FINANCING AND IMPLEMENTATION

A. A variety of strategies should be pursued to finance and implement an intermediate resource mix. These strategies should uphold the following business principles.

1. **Financial Integrity.** Investments by Metropolitan, Member Agencies, and other water providers that are consistent with the IRP process should be accompanied by a mutual commitment of reliable revenue sources that recover the fixed and nonvariable operational and capital costs of those investments.

Discussion: Ensuring reliable revenue sources is critical to maintaining Metropolitan's currently high bond rating. This does not require that Metropolitan cover 100 percent of fixed costs with fixed revenues. The revenue stream should be diversified and include alternative fixed sources.

2. **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 system and investments.

Discussion: This principle is particularly important to drought management. It implies that mutual benefit to the region, rather than local ownership, should have higher consideration when ensuring each of the Member Agencies comparable access to reliable and quality water service.

3. **Equity and 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 to Member Agencies and the value of the benefits that are provided to them by Metropolitan. A clear connection must be established between the financial incentives and the benefit to the region, and Metropolitan must have the ability to assure that the benefit is delivered.

Discussion: In order to maintain a clear connection between the financial incentives and the benefit to the region, Metropolitan should establish performance requirements that are flexible enough to allow Member Agencies to meet their obligations. In addition, these incentives should be market-driven. The consequences of non-performance should be clear.

Consistent behavior by Metropolitan is critical for local resource development.

4. **Operating Integrity.** The operating integrity of Metropolitan's system should be maintained. The use of Metropolitan's system for the transmission of non-Metropolitan water supplies (wheeling) should be provided as long as there is no reduction in the level of service, including water quality and capacity, to any Member Agency, and wheeling must not negatively impact the rates or charges to any other Member Agencies.

B. The following regional water management principles should be upheld in a manner consistent with the business principles outlined above.

1. **Water Conservation.** Water conservation is a priority in any resource strategy developed for Southern California. All governmental agencies, private industry, and the public have a stewardship responsibility for the wise and efficient use of water. In that context, all water agencies, private water companies, cities, and other units of local government having water resource management responsibilities in Southern California share a responsibility to implement the Urban Water Conservation BMPs.

Discussion: This principle should be the foundation of an intermediate resource mix. BMPs should be supported with effective incentives and disincentives to encourage implementation by all Member Agencies. Legislative initiatives also should be considered to ensure implementation of BMPs.

2. **Water Reclamation.** To fully maximize the benefits of available water supplies, beneficial reuse of imported and local water is a critical priority. Metropolitan and other water agencies in Southern California must take active steps to support and encourage implementing water reclamation projects. These steps should include seeking legislation which facilitates water reclamation activities. The goal is to develop water reclamation supplies throughout the region and thereby increase the efficient use of available water.

3. **Groundwater Recovery.** Recovery and management of degraded groundwater is a developing supply strategy and should

continue to be encouraged to improve utilization of aquifers. Unified management strategies should be encouraged locally and statewide.

4. **Groundwater Storage.** For much of Southern California, groundwater basins are the foundation of the local water delivery system. Historically, groundwater supplies were the only supply for many communities, and today they serve as the transmission "pipeline" and storage reservoir for a significant portion of the imported supplies delivered to the region. The groundwater basins should be managed conjunctively with the available imported water supplies to provide regional storage benefits, including seasonal (or peaking management) regulation, drought and emergency supplies. Given that storage of imported supplies in groundwater basins is critical to providing emergency and drought storage benefits on a regional basis, all communities that overlie a groundwater basin have a responsibility to participate in mutually beneficial programs to achieve coordinated management of groundwater and other sources of supply. By the same token, the economic value of groundwater storage should be recognized.

5. **Surface Storage Development.** Metropolitan has a responsibility to provide regional surface storage and conveyance facilities sufficient to meet operational storage, emergency, seasonal regulation, and drought storage requirements, as well as improved use of groundwater basins for storage. Member Agencies and subagencies are responsible for providing the local emergency storage or interconnections with other agencies needed to meet their needs during a seven-day Metropolitan service outage.

6. **Colorado River.** Maintaining a full Colorado River Aqueduct and addressing associated water quality issues is of paramount importance, both short-term and long-term. Implementation of innovative water conservation, conjunctive use, and land fallowing programs with Imperial, Coachella, and Palo Verde irrigation districts, any entities which have entitlements to Colorado River water, and the federal government will continue to be a high priority. In addition, developing cooperative arrangements with Nevada and Arizona water agencies will become increasingly important to optimize utilization of the Lower Basin's apportionment.

7. **State Water Project.** Realizing that Metropolitan's SWP entitlement is also important, a critical issue facing California is managing the Sacramento-San Joaquin River Delta estuary in a manner that can preserve the environmental resources and balance the multiple uses of its water resources. Southern California should actively support a federal/State policy framework for protecting the Delta through water quality standards and implementation of a long-term management program that balances all the uses of the Delta's water resources, minimizes harm to fisheries, and allows for water transfers.

8. **Water Transfers.** Water marketing and voluntary transfers should continue to be promoted and implemented in a manner that protects the environment, local rural communities, and other interests. Water transfers in California should be accomplished with a commitment to efficient use of existing supplies.

9. **Desalination and Demineralization.** Desalination is relatively expensive but may be an important water supply strategy in the 21st century. The region should support forward-looking demonstration projects to evaluate the "true" costs and benefits of emerging ocean desalination technologies. These demonstration projects should be cooperative research and development programs with the State and federal governments, electric utilities and water agencies.

C. A specific resources program should be developed out of the IRP in accordance with the business principles, and support from the community should be sought. Ongoing public information and outreach programs are vital to the IRP process, particularly when any rate increases are required, but great care must be taken when spending money for this purpose. Local, State, and federal officials should all be involved in informing the public. Public information should focus on the need to conserve water resources and the need for increased reliability.

D. New governing structures are not needed to implement the IRP. All water agencies, private water companies, cities, and other units of local government having water resource management responsibilities in Southern California should work cooperatively to meet its objectives, and Metropolitan should function as the facilitator and coordinator of this process. Interagency agreements, contracts, and memoranda of understanding are tools that can be used to ensure implementation.

OVERVIEW OF THE INTEGRATED WATER RESOURCES PLAN ASSEMBLY

The Integrated Water Resources Plan Assembly brought together 103 water leaders who were members of Metropolitan's Board of Directors, Member Agencies, Metropolitan senior staff, groundwater agency managers, and representatives of retail subagencies that purchase water from Member Agencies to focus on strategies delineated through the IRP process for meeting the water needs of Metropolitan's service area through the year 2020. The main questions addressed were Metropolitan's reliability goal, which resource mix to emphasize in the IRP, and how to implement it.

The format for the Integrated Water Resources Plan Assembly was based on the American Assembly process, which is a procedure designed to reach consensus on controversial and complex issues of interest to diverse parties. The American Assembly started with President Eisenhower at Columbia University in the 1950s.

Central to the success of the Integrated Water Resources Plan Assembly was the Steering Committee composed of representatives of constituency groups participating in the Assembly. The Steering Committee members for the Assembly included the following: Metropolitan Board Members -- Charles D. Barker, James H. Blake, Alf W. Brandt, Timothy F. Brick, Christine M. Frahm, Ted Grandsen, Bill Hill, Lois B. Krieger; Member Agency Managers -- Richard W. Atwater, Gerald A. Gewe, Donald L. Harriger, Donald R. Kendall, Lester A. Snow, Stanley E. Sprague; and Metropolitan Management -- John R. Wodraska, Duane L. Georgeson, F. Wiley Horne, Debra C. Man, Edward C. Means, and Tim Quinn. The Steering Committee was responsible for planning and coordinating the Assembly. The key issue questions considered by the Assembly participants were developed by the Steering Committee. Metropolitan staff and a private consultant developed background papers that were reviewed, modified, and approved by the Steering Committee. The background papers provided Assembly participants with information essential to understanding the key issues and alternative strategies for addressing the key issues.

During the evening of first day of the Assembly, Metropolitan staff provided a background session on its IRP process. In addition, presentations were made by the reporters from the three open forums and three local agency workshops which were held throughout Southern California to review options and obtain input on the IRP process. On the second day of the Assembly, the Assembly participants, divided into six working groups, considered the key issue questions and developed positions and recommendations. Each working group had a preassigned facilitator and recorder. At the end of the second day, the facilitators and recorders met to construct the draft Assembly Statement which was based on the positions and recommendations of the working groups. On third day of the Assembly, the draft Assembly Statement was reviewed by all participants, and the full Assembly, led by the Assembly facilitator, Dr. Lance deHaven-Smith, worked through the document. Revisions and/or changes to specific wording in the document were made by the full Assembly, and agreement was reached at that time on specific language that was adopted in the Assembly Statement.

ASSEMBLY PARTICIPANTS

Name of Participant	Affiliated Agency
Alario, Edward	City of Anaheim
Arakawa, Steve N.	MWDSC
Arant, Gary	Valley Center MWD
Atwater, Richard W.	Central/West Basin MWD
Bangham, Bill	Raymond Basin Management Board
Bannister, Wesley M.	MWDSC Director, MWDOC
Barker, Charles D.	MWDSC Director, West Basin MWD
Becker, Bert H.	MWDSC
Beuhler, Mark D.	MWDSC
Blake, James H.,	MWDSC Director, City of Fullerton
Blevins, Melvin L.	LADWP
Boen, Doyle F.	MWDSC Director, Eastern MWD
Brick, Timothy F.	MWDSC Director, City of Pasadena
Colbaugh, Jim	Las Virgenes MWD
Cook, Hunter T.	Coastal MWD
Corley, Ray E.	MWDSC
Deaton, Ron	City of Los Angeles
Dorff, Karen E.	MWDSC
Drake, Michael S.	City of San Fernando
Ferguson, David	City of Long Beach
Foley, John V.	MWDSC Director, MWDOC
Frahm, Christine M.	MWDSC Director, SDCWA
Frei, Jim	La Habra Heights County Water Agency
French, Dwight F.	MWDSC Director, Chino Basin MWD
Froelich, Donald	City of Glendale
Georgeson, Duane L.	MWDSC
Gewe, Gerald	LADWP
Glancy, Jim	City of Lakewood
Grandsen, Ted	MWDSC Director, Calleguas MWD
Griffen, Harry,	MWDSC Director, SDCWA
Gutierrez, Mike	Southern California Water Company
Harriger, Donald L.	Western MWD of Riverside County
Harry, Lee J.	MWDSC Director, City of Santa Ana
Hazel, Gary J.	MWDSC
Hennigar, John F.	Rancho California Water District (EMWD)
Hill, Bill M.	MWDSC Director, Chino Basin MWD
Hoagland, John E.	Elsinore Valley MWD
Hogan, Steve	City of San Diego
Horne, Wiley F.	MWDSC
Ibbetson, E. Thornton	MWDSC Director, Central Basin MWD
Ivey, Gilbert F.	MWDSC
Kazarian, Bob	MWDSC Director, City of Anaheim

ASSEMBLY PARTICIPANTS (CON'T)

Name of Participant	Affiliated Agency
Kemp, Karl	Mesa Consolidated Water District
Kendall, Donald R.	Calleguas MWD
Kennedy, Ronald	El Toro Water District
King, Jerry A.	MWDSC Director, MWDOC
Krauel, Francesca M.	MWDSC Director, SDCWA
Krieger, Lois B.	MWDSC Director, West. MWD of Riverside Co.
Lewinger, Keith	Otay Water District
Lindhout, Linzey	MWDSC
Little, Edward C.	MWDSC Director, West Basin MWD
Magoffin, Linn	Main San Gabriel Basin Watermaster
Malburg, Leonis C.	MWDSC Director, Central Basin MWD
Malinowski, Jay W.	MWDSC
Man, Debra C.	MWDSC
Marott, Janet E.	MWDSC
Mason, Dale	MWDSC Director, SDCWA
McMurray, Wayne T.	MWDSC Director, Coastal MWD
Means, Edward G.	MWDSC
Meyer, Henry J.	MWDSC Dirctor, City of Long Beach
Miller, Patrick H.	MWDSC Director, Calleguas MWD
Mills Jr., Milon	City of San Diego
Mills, William R. Jr.	Orange County Water District
Milne, Bruce J.	MWDSC Director, Three Valleys MWD
Moret, Katherine W.	MWDSC Director, LADWP
Morris, John T.	MWDSC Director, Calif-American Water Co., San Marino
Morse, Gary A.	MWDSC Director, Central Basin MWD
Mundy, John	City of Santa Monica
Mylne, John M., III	MWDSC Director, West. MWD of Riverside Co.
Norman, John W.	Water Replenishment District of So. Calif.
O'Neil, William T.	MWDSC Director, Foothill MWD
Osborne, Wayne S.	City of Fountain Valley
Palmer, Ronald C.	Foothill MWD
Parker, Joseph	MWDSC Director, SDCWA
Peterson, Glen D.	MWDSC Director, Las Virgenes MWD
Quinn, Timothy	MWDSC
Reed, Christine E.	MWDSC Director, City of Santa Monica
Schaich, Chuck	City of Torrance
Schempp, Robert	MWDSC
Shollenberger, Thomas E.	Cucamonga County Water District
Snow, Lester	SDCWA
Snyder, Gary M.	MWDSC
Soltz, Roberta M.	MWDSC

ASSEMBLY PARTICIPANTS (CON'T)

Name of Participant	Affiliated Agency
Sprague, Stanley E.	MWDOC
Stamper, Larry L.	MWDSC Director, City of Burbank
Stassi, Ronald V.	City of Burbank
Stuart, Charles L.	MWDSC Director, West Basin MWD
Tamble, Terry	California Water Service Company
Taylor, Greg	MWDSC
Thomas, Brian G.	MWDSC
Underbrink, Tom	City of Pasadena
Watton, Mark W.	MWDSC Director, SDCWA
Wein, George	MWDSC Director, LADWP
Westdyke, Robert G.	Chino Basin MWD
Wickser, Jim	LADWP
Witt, Kenneth H.	MWDSC Director, MWDOC
Wodraska, John R.	MWDSC General Manager
Wong, Benjamin	City of Oxnard
Worley, Tim	Three Valleys MWD
Wright, Bill	MWDSC Director, City of Torrance
Wysbeek, Doude	MWDSC Director, City of San Fernando
Young, Michael B.	MWDSC
Young, Ronald E.	Irvine Ranch Water District

INTEGRATED WATER RESOURCES PLAN ASSEMBLY

STEERING COMMITTEE

Richard W. Atwater	General Manager, Central/West Basin MWD
Charles D. Barker	MWDSC Director, West Basin MWD
James H. Blake	MWDSC Director, City of Fullerton
Alf W. Brandt	MWDSC Director, LADWP
Timothy F. Brick	MWDSC Director, City of Pasadena
Christine M. Frahm	MWDSC Director, San Diego County Water Authority
Gerald A. Gewe	Engineer of Water Resources Planning, LADWP
Duane L. Georgeson	Assistant General Manager, MWDSC
Ted Grandsen	MWDSC Director, Calleguas MWD
Donald L. Harriger	General Manager, Western MWD of Riverside County
Bill Hill	MWDSC Director, Chino Basin MWD
F. Wiley Horne	Assistant General Manager, MWDSC
Donald R. Kendall	General Manager, Calleguas MWD
Lois B. Krieger	MWDSC Director, Western MWD
Debra C. Man	Director, Planning Division, MWDSC
Edward G. Means	Director, Resources Division, MWDSC
Timothy H. Quinn	Director, SWP and Conservation Division, MWDSC
Lester A. Snow	General Manager, San Diego County Water Authority
Stanley E. Sprague	General Manager, MWD of Orange County
John R. Wodraska	General Manager, MWDSC

FACILITATORS AND RECORDERS

Assembly Facilitator	
Lance deHaven-Smith	Director, Inst. of Gov't., Florida Atlantic Univ.
Assembly Recorder	
Patty Metzger	Research Associate, Florida Atlantic Univ. Inst. of Gov't.
Subgroup Facilitators	
Paul Brown	Senior Vice President, Camp Dresser and McKee Inc.
Byron Buck	Assistant to the General Manager, SDCWA
Virginia Grebbien	Assistant General Manager, Central/West Basin MWDs
Dale Hunter	Principal Government Affairs Representative, MWDSC
Paul Jones	Assistant General Manager, MWD of Orange County
Karen Tachiki	Assistant General Counsel, MWDSC
Subgroup Recorders	
Jeanne-Marie Bruno	Principal Engineer, MWDSC
Marti Farley	Supervisor, Special Projects, MWDSC
George Martin	Director of Water Conservation, LADWP
Karl Seckel	Ass't Mgr/District Engineer, MWD of Orange County
Lynda Smith	Associated Resource Specialist, MWDSC
Kevin Wattier	Regional Operations Manager, MWDSC

INTEGRATED WATER RESOURCES PLAN ASSEMBLY

SUPPORT STAFF

Project Manager	
Anne E. Baker	Executive Assistant for Strategic Policy Development, MWDSC
Support Staff	
Carrie Blade	Office Services Assistant II, MWDSC
Randall Collins	Camera Technician, MWDSC
Lorrie Dove	Administrative Analyst, MWDSC
Bob Gomperz	Principal Public Affairs Representative, MWDSC
Steve Hirsch	Resource Specialist, MWDSC
Alice Maupin	Assistant Civil Engineer, MWDSC
Ken McSpadden	Video Technician, MWDSC
Jay Parks	Office Services Assistant II, MWDSC
Christel Strelecky	Senior Public Affairs Representative, MWDSC
Meng Ti	Telecommunications Technician, MWDSC