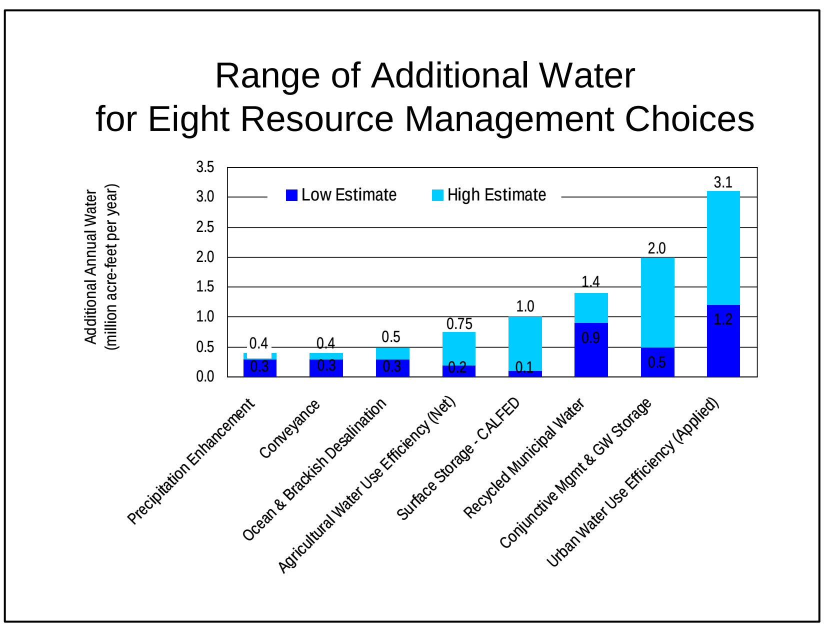
RESOURCE MANAGEMENT STRATEGIES

A resource management strategy is a project, program or policy that helps local agencies and governments manage their water and related resources. For example, urban water use efficiency is a strategy to reduce urban water use. A pricing policy or incentive for customers to reduce water use also is a strategy. New water storage to improve water supply, reliability and quality is another strategy.

Think of these strategies as tools in a tool kit. Just as the mix of tools in the kit will depend on the job, the combination of strategies will vary from region to region depending on climate, projected growth, existing water system, and environmental and social conditions. At the local level, it is important that the proposed strategies complement the operation of the existing water system. Some strategies may have little value in some regions. For example, because of geology, the opportunity for groundwater development in the Sierra Nevada is not nearly as significant as in the Sacramento Valley. Other strategies may have little value at certain times. For example, precipitation enhancement may not be effective during droughts.

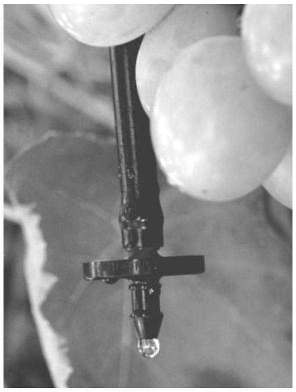
A key objective of the California Water Plan is to present a diverse set of resource management strategies to meet the water related resource management needs of each region and statewide. The basic intent is to prepare good plans that are diversified, satisfy regional and state needs, meet multiple objectives, include public input, address environmental justice, mitigate impacts, protect public trust assets, and are affordable.

This graph shows the potential range of more water demand reduction and supply augmentation for eight resource management strategies by 2030. Low estimates are shown in the lower (dark) section of each bar. Estimates are from different studies described in Volume 2 of *California Water Plan Update 2005.*



The water supply benefits of the resource management strategies are not always additive. As presented here, urban water use efficiency includes reduction in both consumptive and non-consumptive uses (or applied water), whereas agricultural water use efficiency only includes reduction in consumptive uses (or net water). As presented, implementing agricultural water use efficiency measures by 2030 could reduce applied water use by 2.9 million acre-feet / year.

Strategies to Reduce Water Demand



Agricultural Water Use Efficiency

Agricultural water use efficiency involves improvements in technologies and management of agricultural water that result in water supply, water quality, and environmental benefits. These improvements generally include hardware (on-farm irrigation equipment), crop and farm water management practices, and improvements to water supplier distribution systems. Such improvements are intended to reduce the amount of water that goes to excess surface runoff, seepage and excess plant evapotranspiration. Drip water systems and computerized water system controllers are two common examples of this technology.

Urban Water Use Efficiency

Urban water use efficiency involves technological or behavioral improvements in indoor and outdoor residential, commercial, industrial and institutional water use that lower water demand, lower per capita water use, and result in benefits to water supply, water quality, and the environment. The primary benefit of improving water use efficiency is the lowering of demand and the ability to cost-effectively stretch existing water supplies. Once viewed and invoked primarily as a temporary source of water supply in response to drought or emergency water shortage situations, water use efficiency and conservation approaches have become a viable long-term supply option, saving considerable capital and operating costs for utilities and consumers, avoiding environmental degradation, and creating multiple benefits.

Strategies to Improve Operational Efficiency

Conveyance

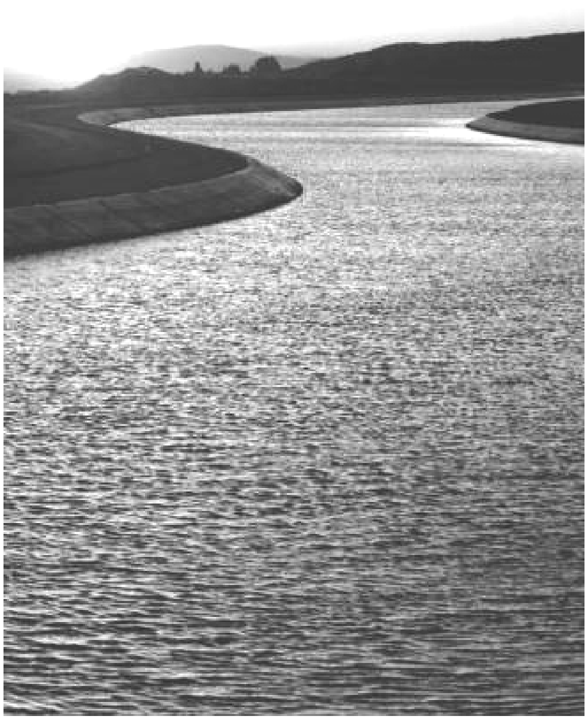
Conveyance provides adequate capacity for the movement of water. Specific objectives of natural and managed water conveyance activities include flood management, consumptive and non-consumptive environmental uses, water quality improvement, recreation, operational flexibility, and urban and agricultural water deliveries. Conveyance infrastructure includes natural watercourses as well as constructed facilities like canals, pipelines and related structures, including pumping plants, diversion structures, distribution systems, and fish screens. Groundwater aquifers are also used to convey water. Common water management objectives are to design water transmission systems with adequate water capacity to efficiently distribute imported or locally produced water to storage or the end users, so that system bottlenecks do not occur.

System Reoperation

System reoperation means changing the existing operation and management procedures for such water facilities as dams and canals to meet multiple beneficial uses. System reoperation may improve the efficiency of existing uses, reduce surplus water outflows from flood events, or it may increase the emphasis of one use over another. In some cases, physical modifications to the facilities may be needed to expand the reoperation capability.

Water Transfers

A water transfer is defined in the Water Code as a temporary or long-term change in the point of diversion, place of use, or purpose of use due to a transfer or exchange of water or water rights. Many transfers, such as those among contractors of the State Water Project or Central Valley Project, do not fit this definition. A more general definition is that water transfers are a voluntary change in the way water is usually distributed among water users in response to water scarcity. Transfers can be from one party with extra water in one year to another who is water-short that year.



Transfers can be between water districts that are neighboring or across the state, provided there is a means to convey and store the water. Water transfers can be a temporary or permanent sale of a water right by the water right holder; a lease of the right to use water from the water right holder; or a sale or lease of a contractual right to water supply. In practice many water transfers become a form of flexible system reoperation linked to many other water management strategies including surface water and groundwater storage, conjunctive management, conveyance efficiency, water use efficiency, water quality improvements, and planned crop shifting or crop idling. These linkages often result in increased beneficial use and reuse of water overall.

STRATEGIES TO INCREASE WATER SUPPLY

Conjunctive Management and Groundwater Storage

Conjunctive management is the coordinated operation of surface water storage and use, groundwater storage and use, and conveyance facilities to meet water management objectives. Although surface water and groundwater are sometimes considered to be separate resources, they are connected by the hydrologic cycle. Conjunctive management allows surface water and groundwater to be managed in an efficient manner by taking advantage of the ability of surface storage to capture and temporarily store storm water and the ability of aquifers to serve as long-term storage.

Desalination

Desalination is a water treatment process for the removal of salt from water for beneficial use. There are two primary types of desalination, one for brackish (low-salinity) surface or groundwater, and the second for ocean water. In California, the principal method for desalination is through reverse osmosis technology. This process can be used to remove salt as well as specific contaminants in water such as trihalomethane precursors, volatile organic carbons, nitrates and pathogens. Desalination usually requires large amounts of energy to run the reverse osmosis equipment, which in turn results in generally results in high production costs.

Precipitation Enhancement

Precipitation enhancement, commonly called “cloud seeding,” artificially stimulates clouds to produce more rainfall or snowfall than they would naturally. Cloud seeding injects special substances into the clouds that enable snowflakes and raindrops to form more easily. Precipitation enhancement in the form of cloud seeding has been practiced continuously in several California river basins since the early 1950s. Most projects are along the central and southern Sierra Nevada

with some in the coast ranges. The projects generally use silver iodide as the active cloud-seeding agent, and it can be applied from either ground generators or from airplanes. The number of operating projects has tended to increase during droughts, up to 20 in 1991, but have leveled off to about 12 or 13 in recent years. Precipitation enhancement projects are intended to increase surface water supplies or hydroelectric power. The amounts of water produced are difficult to determine, but estimates range from a 2 to 15 percent increase in annual precipitation or runoff.

Recycled Municipal Water

Water recycling, also known as reclamation or reuse, is an umbrella term encompassing the process of treating wastewater from previous uses, and then storing, distributing, and using this recycled water to meet demands. Recycled water is defined in the California Water Code to mean “water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.” The treatment and use of municipal wastewater for golf course irrigation is an example of water recycling. Higher levels of treatment can make municipal wastewater reusable for school yards, residential landscape and park irrigation, industrial uses or even uses within office and institutional buildings for toilet flushing. The use of recycled water to meet additional demands results in a direct reduction in the amount of new water supplies needed to serve a community or region.

Surface Storage - CALFED

The CALFED Record of Decision (2000) identified five potential surface storage reservoirs that are being investigated by the California Department of Water Resources, U.S. Bureau of Reclamation, and local water interests. Building one or more of the reservoirs would be part of CALFED's long-term comprehensive plan to restore ecological health and improve water management of the Bay-Delta. The five surface storage investigations are:

- Shasta Lake Water Resources Investigation (reservoir enlargement)
- North-of-the-Delta Offstream Storage (Sites reservoir project)
- In-Delta Storage Project
- Los Vaqueros Reservoir Expansion
- Upper San Joaquin River Basin Storage Investigation

Planning for the five CALFED-directed investigations has made varying levels of progress, with all planning studies to be completed by 2009. Essentially, the planning consists of project formulation, environmental documentation and engineering design, and project cost estimates.

Surface Storage – Regional / Local

Surface storage is the use of reservoirs to collect water for later release and use. Surface storage has played an important role in California where the pattern and timing of water use does not always match the natural runoff pattern. The two categories of surface storage are (1) on-stream storage where a dam and reservoir are located directly in a river system, and (2) off-stream storage, where surface water is moved to a basin or valley that is in a location away from the river course. When justified, local agencies can plan, finance and build surface reservoirs without federal or State partners. Recent examples of surface storage reservoirs completed by local/regional entities include Olivenhain Dam, Los Vaqueros Reservoir, Diamond Valley Reservoir and Seven Oaks Dam. The primary benefits of new reservoirs are related to flood control (Seven Oaks), water quality, system operational flexibility, and system reliability against catastrophic events and droughts.

STRATEGIES TO IMPROVE WATER QUALITY

Drinking Water Treatment and Distribution

Drinking-water treatment includes physical, biological, and chemical processes to make water suitable for potable use. Distribution includes the storage, pumping, and pipe systems to protect and deliver the water to customers. Potable water supplies generally require some of level of water treatment (disinfection and fluoridation) to achieve a safe level of quality, which will then need to be maintained in a distribution system. By producing improved water quality in distribution systems the dangers from water contamination can be reduced, which in turn provides health benefits to customers and reduces waterborne illnesses and associated costs.

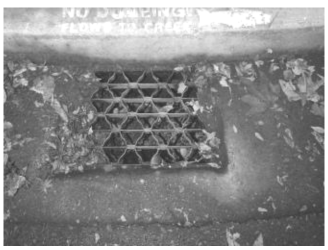
Groundwater Remediation / Aquifer Remediation

Groundwater remediation involves the extraction of contaminated groundwater from the aquifer, treating it through physical and chemical processes, and then discharging it to a water course or using it for approved purposes. It is also possible to inject the treated water back into the aquifer as a form of groundwater recharge. Contaminated groundwater can result from a multitude of sources, both manmade and naturally occurring. Examples of naturally occurring contaminants include heavy metals, high total dissolved solids, and high salinity from specific geologic formations or conditions. There are about 18,500 sites in California where active cleanup of groundwater contaminants is ongoing, which will eventually create usable aquifers to store water for urban and agricultural purposes.

Matching Water Quality to Water Use

Matching water quality to water use is a management strategy that recognizes that not all water uses require the same quality of source water. One common example of inefficient use occurs when source water is treated for urban distribution and use, after which a portion is diverted from the distribution system for agricultural purposes (which did not require treatment). This can occur in areas where only one water distribution system exists to serve both urban and agricultural customers. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water, and lesser quality water can be adequate for other uses, such as riparian streams with plant materials benefiting fish. Further, some new water supplies, such as recycled water, can be treated to a wide range of purities that can be matched to different uses. By properly matching the water source and level of treatment to the intended uses, system efficiency can be improved and treatment costs can be minimized.

Pollution Prevention



Pollution prevention can improve water quality for all beneficial uses by protecting water at its source, reducing the need and cost for other water management and treatment options. By preventing pollution throughout a watershed, water supplies can be used, and re-used, for a broader number and types of downstream water uses. Improving water quality by protecting source water is consistent with a watershed management approach to water resources problems. In addition, the legal doctrine of “public trust” demands that the State protect certain natural resources for the benefit of the public, including uses such as fishing, protection of fish and wildlife, and commerce, all of which are affected by pollution.

Urban Runoff Management

Urban runoff management is a broad series of activities that manage both stormwater and dry-weather runoff. Dry weather runoff occurs when, for example, excess landscape irrigation water flows to the storm drain. Urban runoff management is linked to several other resource strategies including pollution prevention, land use management, watershed management, water use efficiency, recycled water, protecting recharge areas, and conjunctive management. Traditionally, urban runoff management was viewed as a response to flood control concerns resulting from the effects of urbanization. Concerns about the water quality impacts of urban runoff have led water agencies to look at watershed approaches to control runoff and provide other benefits. The watershed approach for urban runoff management tries to emulate and preserve the natural hydrologic cycle that is altered by urbanization. The watershed approach consists of a series of best management practices (BMPs) designed to reduce the pollutant load, volume, and flow rate of urban runoff reaching waterways.

Strategies to Practice Resource Stewardship

Agricultural Lands Stewardship

Agricultural lands stewardship broadly means conserving natural resources and protecting the environment by utilizing farming practices that conserve and improve lands for food, fiber, watershed functions, soil, air, energy, plant and animal and other conservation purposes. Effective use of these practices will help improve watersheds and stream systems, which can lead to improvements to water quality, the environment and water resources. This strategy is focused on agricultural land (cropped and grazed land) as defined by the California Land Conservation (Williamson) Act. A few examples of effective agricultural lands stewardship can include crop rotation practices, wetland restoration, irrigation tailwater recovery, and riparian buffers to help filter runoff.

Economic Incentives (Loans, Grants, and Water Pricing)

Economic incentives are financial assistance and pricing policies intended to influence water management. For example, economic incentives can influence amount of use, time of use, wastewater volume, and source of supply. Economic incentives include low-interest loans, grants, and water pricing rates. Free services, rebates, and the use of tax revenues to partially fund water services also have a direct effect on the prices paid by the water users. In general, higher water rates to water users tends to reduce water use, which can result in water conservation when water supplies are inadequate (such as during drought conditions).

Ecosystem Restoration

Ecosystem restoration generally includes practices that change the flows in streams and rivers, restore fish and wildlife habitat, control waste discharge into streams, rivers, lakes or reservoirs, or remove barriers in streams and rivers so salmon and steelhead can spawn. Ecosystem restoration improves the condition of our modified natural landscapes and biotic communities to provide for the watershed sustainability and improved water quality. Ecosystem restoration focuses on rehabilitating damaged ecosystems so that they can supply important elements of their original structure and function in a sustainable manner.

Forest Management

USDA Forest Service

Forests in California are the sources of the major streams in the state. Forest managers therefore have significant opportunities to improve water quantity, regimen, and quality for downstream users. Resource management on forested lands can prevent excessive runoff and erosion and prolong dry-season baseflows. Although forest management cannot create substantial volumes of new water, management actions can shift the timing of streamflow so that less water flows to the ocean during winters when demand is low and reservoirs are full and more water is available during summers when demand is high and surface storage is depleted. The importance of forest management for water resources will increase as climate changes affect precipitation and snowpack accumulation.

Recharge Areas Protection

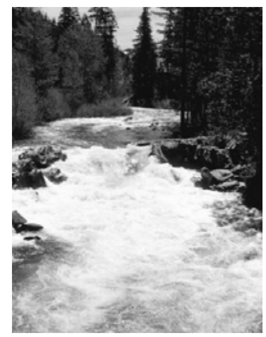
Recharge areas protection involves keeping important groundwater recharge sites from being paved over or otherwise developed, and guarding such recharge areas so they do not become contaminated. Protection of recharge lands, whether natural or man-made, is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. Existing and potential recharge areas must be protected so that they remain functional and they are not contaminated with chemical or microbial constituents. Protecting recharge areas by itself does not provide a supply of groundwater, but instead insures that the capability to percolate surface water into the groundwater aquifer will be available when needed.

Urban Land Use Management

Effective urban land use management consists of planning for the housing and economic development needs of a growing population while providing for the efficient use of water and other resources. The way in which land uses are planned has a direct relationship to water supply and water quality needs of a region. Higher density urban development and the redevelopment of existing urban areas promotes more efficient use of new water supplies, and reduces water transmission and water quality costs.

Water-Dependent Recreation

Water-dependent recreation includes a wide variety of outdoor activities that can be divided into two categories. The first category includes fishing, boating, swimming and rafting, which occur on lakes, reservoirs, and rivers. The second category includes recreation that is enhanced by water features but does not require actual use of the water, such as wildlife viewing, picnicking, camping and hiking. Water-dependent recreation is included among the water management strategies because recreation is an important consideration for water managers. Water management, and water infrastructure, can have significant effects on recreation. By considering recreation during the planning process, water managers can take advantage of opportunities to enhance recreation, and can guard against actions that would limit recreation. Water-dependent recreation influences tourism, business and residential choices. It increases expenditures in the community for travel, food and accommodations.



Watershed Management

Watershed management is the process of evaluating, planning, managing, restoring and organizing land and other resource use within an area of land that has a single common drainage point. Watershed management tries to provide sustainable human benefits, while maintaining a sustainable ecosystem. Watershed management assumes that a prerequisite for any project is the sustained ability for the watershed to maintain the functions and processes that support the native ecology of the watershed. It is recognized that watersheds are dynamic and the precise make up of plants, animals, and other characteristics will change over time. Watershed management seeks to balance changes in community needs with these evolving ecological conditions in ways that generate water quality and water supply benefits.

STRATEGIES TO IMPROVE FLOOD MANAGEMENT

Modify Flooding

Modify Flooding is a strategy that includes projects and programs that detain or divert floodwaters or improve the ability of channels to accommodate floodwaters. This strategy includes dams and reservoirs, dikes, levees and flood embankments, high flow diversions and bypasses, and channel improvements.

Modify Impacts of Flooding

Modify Impacts of Flooding is a strategy that includes projects and programs that assist individuals and communities to prepare for, respond to, and recover from a flood. This strategy includes projects and programs related to information and education, disaster preparedness, post flood recovery, and flood insurance.

Modify Susceptibility to Flooding

Modify Susceptibility to Flooding is a strategy to reduce disruption by avoiding hazardous, uneconomic, or unwise use of floodplains. This strategy includes projects, programs, and policies related to floodplain regulation, development and redevelopment policies, design and location of facilities, housing and building codes, flood-proofing, and flood forecasting and warning.

Preserve and Restore Natural Floodplain Functions

Preserve and Restore Natural Floodplain Functions is a strategy to renew the vitality and functions of floodplains by restoring and/or maintaining floodplains in their natural state. This strategy includes projects, programs, and policies related to floodplain management.

OTHER STRATEGIES

The *California Water Plan Update 2005* highlighted a variety of water management strategies that can potentially generate benefits that meet one or more water management objectives, such as water supply augmentation or water quality enhancements. However, these management strategies are currently limited in their capacity to strategically address long-term regional water planning needs.

- **Crop Idling for Water Transfers:** Crop Idling is removal of lands from irrigation with the aim of returning the lands to irrigation at a later time.
- **Dewvaporation or Atmospheric Pressure Desalination:** Dewvaporation is a specific process of humidification-dehumidification desalination. Brackish water is evaporated by heated air, which deposits fresh water as dew on the opposite side of a heat transfer wall. Energy for evaporation is supplied by the energy released from dew formation.
- **Fog Collection:** Precipitation enhancement also includes other methods, such as physical structures or nets to induce and collect precipitation. Precipitation enhancement in the form of fog collection has not been used in California as a management technique but does occur naturally with coastal vegetation; fog provides an important portion of summer moisture to our coastal redwoods.
- **Irrigated Land Retirement:** Irrigated land retirement is the removal of farmland from irrigated agriculture. The permanent land retirement is perpetual cessation of irrigation of lands from agricultural production, which is done for water transfer or for solving drainage-related problems. Crop idling, with the intent of water transfer, is discussed in the Crop Idling for Water Transfers strategy.
- **Rainfed Agriculture:** Rainfed agriculture is when all crop consumptive water use is provided directly by rainfall on a real time basis. Due to unpredictability of rainfall frequency, duration, and amount, there is significant uncertainty and risk in relying solely on rainfed agriculture.
- **Waterbag Transport/Storage Technology:** The use of waterbag transport/storage technology involves diverting water in areas that have unallocated fresh water supplies, storing the water in large inflatable bladders, and towing to an alternate coastal region.