


Strategic Plan
Volume 1

California WaterPlan Update 2005

A FRAMEWORK FOR ACTION

Department of Water Resources Bulletin 160-05 December 2005

The California Water Plan Update 2005
is organized in five volumes:

Volume 1:	Strategic Plan
Volume 2:	25 Resource Management Strategies
Volume 3:	12 Regional Reports
Volume 4:	Reference Guide (60+ articles)
Volume 5:	Technical Guide (Online documentation)

The final California Water Plan Update 2005 and the Water Plan Highlights briefing book were completed in December 2005. The five volumes of the update, the Highlights document, and the introductory video, "Water for Tomorrow," are contained on the CD and DVD below and also available online at www.waterplan.water.ca.gov.

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Department of Water Resources

California Water Plan Update 2005

A Framework for Action

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Foreword

This is not just another update of the California Water Plan. As the first update of the 21st century, it represents a fundamental shift in how people look at water resources management. It recognizes the need for a comprehensive approach and the need to work cooperatively in order to succeed in managing the state's water resources. It looks at water as a resource whose management involves many responsibilities and raises many issues. It recognizes that there are no silver bullets for managing water.

Past updates assessed California's water needs, evaluated water supplies, and tried to quantify a gap between them. For the first time, the state's water plan includes a strategic plan with goals, recommendations, and actions for meeting the challenges of sustainable water uses and reliable water supplies in the face of uncertainty. This water plan describes short-term and long-term actions that can be implemented at the state and regional level, and it identifies a portfolio of 25 resource management strategies that can be used to sustain California's communities, economy, and environment. It is a roadmap for meeting our water demands of 2030.

Integrated regional water management is the future for California. It ensures that regions prepare for uncertainties by diversifying their water portfolios with multiple strategies. It ensures that we pursue water management that includes a wide range of local objectives and strives to meet all future water demands--urban, agricultural, and environmental. Integrated regional programs are most successful in providing reliable water supplies when they use water efficiently, protect water quality, and restore the environment.

California still depends on vast statewide water management systems that include physical facilities and statewide water management programs. With maintenance, rehabilitation, and improvements, these systems can continue to provide clean and affordable water, protect lives and property from flooding, withstand drought, and sustain our environmental values.

California Water Plan Update 2005 is the product of a collaborative process that brought together the Department of Water Resources, a 65-member advisory committee representing urban, agricultural, and environmental interests, a 350-member extended review forum, and 2,000 interested members of the public. The result is a plan that includes the very best ideas for meeting our water challenges.

The conclusion of this water plan is clear: Californians can meet their water demands through the year 2030 by making the right choices and investments. The Department of Water Resources will work with State policymakers, local and regional entities, and others to take the actions needed to meet the state's water needs now and in the years to come.

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In 2001, the Department of Water Resources sought to make the California Water Plan more useful to its traditional users and of value to a broader audience. The undertaking required an open, fair, and transparent process that embraced ideas from all California's communities: State and federal, regional and local agencies, agriculture and municipalities, industry and business, environmental groups, tribal interests and other traditionally underrepresented groups, and the general public. Names of the many participants appear on the lists before and after this acknowledgement. DWR regrets if any name has been inadvertently left off. This water plan update was truly a team accomplishment.

The success of this water plan update is owed to the countless individuals who generously shared their talents and expertise during this long and sometimes arduous process. Because of the many years that it took to develop this water plan update, many dedicated individuals, through retirement or other circumstances, could not stay involved until completion of the project—including former chief deputy director Steve Macaulay, former deputy directors Jonas Minton and Lucinda Chipponeri, and former division chief Naser Bateni. The contributions of all these participants have been significant to the final document.

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Acronyms and Abbreviations

CalEPA ..... California Environmental Protection Agency
CEQA ..... California Environmental Quality Act
CVPIA ..... Central Valley Project Improvement Act
CWEMF ..... California Water and Environmental Modeling Forum
DFG ..... California Department of Fish and Game
DOF ..... California Department of Finance
DRMS ..... Delta Risk Management Strategy
DWR ..... California Department of Water Resources
EGPR ..... Environmental Goals and Policy Report
IEPR ..... Integrated Energy Policy Reports
EIS/EIR ..... Environmental impact statement/environmental impact report
EWA ..... Environmental Water Account
FERC ..... Federal Energy Regulatory Commission
GATS ..... General Agreement on Trade Services
GHG ..... greenhouse gas
IEUA ..... Inland Empire Utilities Agency
IOU ..... investor-owned utility
IPCC ..... Intergovernmental Panel on Climate Change
IRWM ..... Integrated regional water management
ISI ..... Integrated Storage Investigations Program
LORP ..... Lower Owens River Project
NEPA ..... National Environmental Policy Act
NOAA ..... National Marine Fisheries Service
OCWD ..... Orange County Water District
OPR ..... (Governor's) Office of Planning and Research
PIER ..... Public Interest Energy Research Program
QSA ..... Quantification Settlement Agreement
RD&D ..... research, development, and demonstration
ROD ..... Record of Decision
SAWPA ..... Santa Ana Watershed Project Authority
SBVMWD ..... San Bernardino Valley Municipal Water District
SCADA ..... Supervisory Control and Data Acquisition
SJRMP ..... San Joaquin River Management Program
SVWM ..... Sacramento Valley Water Management Program
SWRCB ..... State Water Resources Control Board
TROA ..... Truckee River Operating Agreement
TRPA ..... Tahoe Regional Planning Agency
UFP ..... Unified Federal Policy
USBR ..... US Bureau of Reclamation
UWMP ..... Urban Water Management Plan
WMWD ..... Western Municipal Water District
WQCP ..... Water Quality Control Plan
WTO ..... World Trade Organization

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Volume 2 – Resource Management Strategies

[1] A more complete contents list precedes each chapter in Volumes 1, 2, and 3.

Volume 3 – Regional Reports

Volume 4 – Reference Guide

(Articles listed alphabetically by subject)

- Limits to the Productivity of Water in Crop Production (by Andrew Keller and David Seckler)
- Model for Estimating Evaporation and Transpiration from Row Crops (by Francesca Ventura, Ben A. Faber, Khaled M. Bali, Richard L. Snyder, Donatella Spano, Pierpaolo Duce, and Kurt F. Schulbach) Originally published in Journal of Irrigation and Drainage Engineering, American Society of Civil Engineers. Nov/Dec 2001. Obtained from http://www.pubs.asce.org/
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- California Reservoir Summary
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The **Technical Guide** includes information previously on the *Assumptions & Estimates Web Site*, such as process maps, data sources, related legal information and details on the ***Update 2005*** project organization and management. The Technical Guide is organized and formatted as a Web page to document the assumptions, data, analytical tools and methods used to prepare this Water Plan.. The Technical Guide is also known as **Volume 5** of the ***California Water Plan Update 2005***.

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Volume 1

Chapter 1 – Introduction

Chapter 1 Introduction

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Water supply and water quality are inseparable in water management. California must protect water quality to safeguard public and environmental health and secure the state's water supplies for their intended use. (DWR photo)

Chapter 1 *Introduction*

About This Chapter

Chapter 1 Introduction outlines the process for preparing the California Water Plan Update 2005 and its new features, which will become the cornerstone of future updates. It also explains the organization of all five volumes of Update 2005 and its Highlights brochure.

- Changing the Water Plan
- New Process
- New Features
- Phased Work Plan and Schedule
- Organization of Water Plan Update 2005

Changing the Water Plan

The California Water Plan and its updates have been important sources of information for water planners since 1957 (see Box 1-1 Updates of the California Water Plan). As a master plan, it guides the orderly and coordinated control, protection, conservation, development, management, and efficient use of the water resources of the state (Water Code, § 10005(a)). Periodically, the California Department of Water Resources (DWR) has updated the water plan with revised estimates of future water demands and the delivery capability of existing and planned facilities. The difference between those estimates of water demand and supply is sometimes called "the gap."

Over the past 30 years, California water management has changed significantly. State and federal projects have not expanded as originally expected; in fact, deliveries have been reduced in recognition of environmental needs. In response, regional water planning has begun to integrate multiple water and resource management activities to meet a wide range of local objectives. Water agencies, local governments, and the Legislature need a water plan that promotes and supports integrated regional water management and helps State government meet its responsibilities for improving statewide water management systems.

California Water Plan Update 2005 addresses our changing water management and better reflects the roles of the State and federal governments and the growing role of regional and local agencies in California water management. It goes beyond trying to forecast and quantify a simple "gap" between statewide supply and demand. It is a roadmap for meeting the state's water demands through the year 2030. Update 2005 charts a Framework for Action that will help us sustain our water resource use and manage our supplies to ensure that water is available where and when it is needed. Its new features include a strategic plan with vision, goals, recommendations and implementation plan, an analytical approach with extended information and tools, use of water portfolios, regional reports, future scenarios, and resource management strategies.

In preparing this update, DWR sought the participation of California's water communities, responded to new State laws, and developed a new framework to planning California's water future. The result of this new and expanded public process is a water plan that includes the very best ideas for meeting our water challenges.

California Water Plan Update 2005 charts a Framework for Action that will help us sustain our water resource use and manage our supplies to ensure that water is available where and when it is needed.

By statute the California Water Plan cannot mandate actions nor authorize spending for its recommendations. California Water Plan Update 2005 makes neither project-specific nor site-specific recommendations; therefore, it does not include environmental review and documentation as required by the California Environmental Quality Act. **Consequently, policy-makers and lawmakers must take further action to adopt the recommendations in this water plan and develop funding methods to help in their implementation.** This underscores the need to have broad public participation and support for the water plan in order to have its recommendations realized.

New Process

This update recognizes the vital importance of working with the water community to define issues, identify potential management responses, and evaluate planning steps. Since January 2001 DWR has worked with a 65-member advisory committee, a 350-member extended review forum, and 2,000 interested

Box 1-1 Updates of the California Water Plan (Bulletin 160 series)

The California Water Plan is the State's strategic plan for managing and developing water resources statewide. Since its first California Water Plan, published as Bulletin No. 3 in 1957, the Department of Water Resources has prepared 7 water plan updates, known as the Bulletin 160 series. The California Water Code now requires the water plan to be updated every five years. For fuller descriptions, see Volume 4 Reference Guide article "A Look Back at Past California Water Plans."

Bulletin No. 3 described a comprehensive master plan for the control, protection, conservation, distribution, and use of the waters of California to meet present and future needs for all beneficial uses in all areas of the state to the maximum feasible extent. The plan was intended to indicate the general manner in which California's water resources should be developed to satisfy its potential ultimate water requirements with emphasis on statewide water projects.

Statewide planning studies to update the California Water Plan have continued since 1961. Each update took a distinct approach to water resources planning, reflecting issues or concerns at the time of its publication.

Implementation of the California Water Plan (1966). The first of the Bulletin 160 series, Bulletin 160-66, proposed a pattern for implementation of specific parts of the California Water Plan as set forth by the California Water Code. Water policy concerns included flood control and floodplain management, power demands, water-related recreation, the relationship of fish and wildlife to water development, and water quality.

Water for California: The California Water Plan; Outlook in 1970. By 1967 the growth rate of California's population had slowed from that of the 1950s; population projections for 1990 and 2020 were reduced. Irrigated acreage estimates were also reduced, and more accurate information on the consumptive use of crops and the extent of water reuse was available. With projects then under construction or authorized, the report concluded that sufficient water supplies would be available to meet most of the 1990 require ments. The trend toward increasing environmental awareness was noted at both the national and state levels.

The California Water Plan: Outlook in 1974. This report concluded that the status of available supplies was favorable based on the premise that the Auburn, New Melones, and Warm Springs reservoirs and the Peripheral Canal would be operational by 1980. The report was less conclusive about the extent to which supplies would satisfy future needs, considering new California legislation for wild and scenic rivers. The update included a detailed section on water quality control (or basin) planning written by staff at the State Water Resources Control Board as well as water demand estimates for alternative futures for California population growth and agricultural acreage. Key water policy issues were cooling water for electric energy production, water deficiencies (risk), water exchanges, public interest in agricultural drainage (San Joaquin Drain), water use efficiency (water conservation), economic efficiency (water transfers), and wastewater reclamation.

continued

members of the public. The advisory committee is composed of representatives of agriculture, urban water districts, businesses, environmentalists, American Indians, environmental justice advocacy, cities, counties, federal and State agencies, the California Bay-Delta Authority, academia, and different regions of California.

DWR sought a broadly informed and consensus-seeking process using facilitated large group meetings held roughly every six weeks for four and one-half years, more frequent smaller work groups and workshops, and many public briefings. Advisory committee members provided the Department with substantial suggestions and recommendations on all aspects of this update. See Volume 4 Reference Guide article, "The Advisory Committee View" by the California Water Plan Update 2005 public advisory committee.

As part of their membership obligations, advisory committee members periodically briefed their constituencies on key developments. Members relayed comments received during these briefings to DWR. The briefing process helped ensure two-way communication between members and their organizations. In addition, briefings formally expanded the dialogue beyond the advisory committee into a wider audience of potential users of California Water Plan Update 2005. Public outreach and involvement during the preparation of the plan are described in Volume 4 Reference Guide articles "Planning Framework for Water Plan Update" and "Customer and Stake Holders Survey."

The Internet provided another principal venue for advisory committee work. DWR used e-government technology to set up Web pages and electronic surveys, and used e-mail correspondence and teleconferencing whenever possible. DWR posted meeting agendas, materials, and highlights, including draft copies of the water plan update, for all to see. DWR also posted data, assumptions, and documentation on the public Web site for use by advisory committee members and other interested parties.

Box 1-1 continued from previous page

The California Water Plan: Projected Use and Available Water Supplies to 2010 (1983). More of a technical report than were previous editions, this water plan included agricultural models applied for the first time. These were used in assessing the general economic effects of increasing water and energy costs. The report quantified the effect of urban and agricultural water conservation measures and the potential for water reclamation as a means of reducing additional water supply needs. Included in the update was a detailed statewide waterflow diagram titled Hydrologic Balance Network for California 1980.

California Water: Looking to the Future (1987). Bulletin 160-87 took a broad view of water events and issues in California. The report also discussed several leading water management concerns including water quality, the Sacramento-San Joaquin Delta, and a wide range of evolving water policies. One of its main conclusions was that in roughly three out of four years, California's water resources, including rights to the Colorado River, were sufficient to meet all of its water needs for the foreseeable future.

California Water Plan Update: Bulletin 160-93 (1994). This report discussed how population growth, land use, and water allocations for the environment were affecting water resource management. It differed from the five previous water plan updates by (1) estimating environmental water needs separately and accounting for these needs along with urban and agricultural water demands, (2) presenting water demand management methods as additional means of meeting water needs, and (3) presenting separate water balance scenarios for average and drought conditions. This was the first Bulletin 160 update to incorporate an advisory committee of representatives of interested parties.

The California Water Plan Update: Bulletin 160-98 (1998). The 1998 update evaluated water management options that could improve California's water supply reliability. Water management options being planned by local agencies were used as the building blocks to evaluate future water conditions for each of the state's 10 hydrologic regions. Potential local options were integrated with options of a statewide scope to create a statewide evaluation.

To create a fair, open, and transparent process, the California State University Sacramento, Center for Collaborative Policy provided impartial third party facilitation and mediation design, implementation, and refinement for the consensus-seeking process. The center ensured advisory committee members' interests, views, and opinions were thoughtfully considered and advisory committee activities were governed by its own operating guidelines.

This new process is one of the significant accomplishments of this water plan. The principles of a fair, open, and transparent process should serve as the cornerstone for future updates because they (1) considerably expand public involvement and access to the State's water planning process; (2) seek collaborative recommendations that are stronger, have greater longevity, and are more likely to be adopted by the Governor's Office, Legislature, State, federal, and local agencies and governments, and resource managers; and (3) produce a strategic plan with a vision, mission, goals, recommendations, and implementation plan.

New Features

Following are some significant accomplishments of California Water Plan Update 2005 that provide California's water leaders with useful tools and can serve as the cornerstone for future updates.

Strategic Planning Document

The water plan has become a strategic planning document that describes the role of State government and the growing role of California's regions in managing the state's water resources. (See Box 1-2 Strategic Plan: Components as Used for the Water Plan.) Considerable public involvement has brought strong recommendations to this strategic plan.

Box 1-2 Strategic Plan: Components As Used for the Water Plan

Internal/External Assessments. Analysis and evaluation of key data and factors that influence the success of achieving the water plan's goals. In developing the water plan, the Department of Water Resources consulted with the Legislature and solicited and considered the views and suggestions of entities, such as water users, suppliers, and other stakeholders, potentially affected by or interested in the water plan.

Vision. A compelling and succinct statement of the desired future for California water resources and management. A vision statement crystallizes what the water plan visualizes California water to be in the future. It is not bound by time, represents global and continuing services, and serves as a foundation for future water planning.

Mission. The water plan's unique purpose and overarching reason for existence is described in statute. The mission statement succinctly identifies what the water plan should do and why and for whom it does it.

Goals. The desired results of the water plan and general ends toward which State government directs its efforts. Goals address the primary water issues facing California within broad groupings of interrelated state concerns. The goals are founded on the statewide vision and may involve coordination among several agencies with similar functions.

Objectives. The specific and measurable targets for accomplishing a goal. The recommendations of this water plan represent objectives. They mark interim steps toward achieving the plan's long-term mission and goals and emphasize the intended results of actions at a specific time.

Action Plan. A description of the key activities to implement each objective and the entities best positioned to play a key role in implementation. Action plans break objectives into manageable parts including near-term, high-priority actions and long-term comprehensive actions, resource assumptions, implementation challenges, and performance measures for tracking progress.

Performance Measures. The methods used to ensure accountability to measure work performed and results achieved. They describe what is to be measured and methods of measurement. The measures may be short term, intermediate, or long term. In contrast, evaluation criteria represent the technical information used by policymakers, water managers, and the public to compare how well proposed scenarios and resource management strategies would meet desired water management objectives. The criteria include parameters like the cost of implementing different resource strategies, environmental benefits, water reliability, and water quality improvements.

Water Portfolios

State and regional water portfolios cover the entire hydrologic cycle and water quality conditions consisting of more than 80 categories of water use, supply, and management. Actual data are used for 3 recent but different water years—1998 (wet); 2000 (average), and 2001 (driest since extended drought when preparing this update). Water portfolios include flow diagrams, flow diagram tables, water balances, water quality reports, and summary table and charts and identify data gaps. Water balances do not include the additional 1 million to 2 million acre-feet per year needed to eliminate statewide groundwater overdraft. (See Volume 3 Regional Reports, Chapter 1 State Summary for more information about the water portfolio concept.)

Regional Reports

In compliance with SB 672 (Stats. 2001, ch. 320), a regional report has been prepared for each of the 10 hydrologic regions, as well as the Sacramento-San Joaquin River Delta, and the Mountain Counties overlay area (Figure 1-1 Hydrologic regions with Mountain Counties and Legal Delta). Each report includes the region's major challenges, current programs and projects, future outlook, and water portfolio.

Future Scenarios

To acknowledge that we don't know with certainty what will happen in the future, this water plan update has three plausible yet very different baseline scenarios for 2030, rather than a single "likely future." Each scenario describes a different baseline for 2030, to which the water community would need to respond by implementing a mix of management strategies. The scenarios are created by varying assumptions about important factors that affect water use and supplies, but the water community has little control regarding population growth, development patterns, crop markets, industrial productivity, and environmental regulations. The three baseline scenarios developed for Update 2005 are Current Trends, Less Resource Intensive, and More Resource Intensive.

Resource Management Strategies

This water plan update describes a broad and diverse set of 25 resource management strategies. They are available to regions for stronger integrated regional water management to meet future demands and sustain the environment, resources, and economy, involve communities in decision-making, and meet various goals. A resource management strategy is a project, program or policy that helps local agencies and governments manage their water and related resources (see Volume 2 Resource Management Strategies). 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. Each region needs to choose an appropriate mix of strategies based on its own water management objectives and goals (See Box 1-3 Water Management Objectives).

To implement these new features, DWR has made, and needs to make, significant analytical changes as summarized in Box 1-4 Analytical Changes and described in Chapter 4 Preparing for an Uncertain Future.

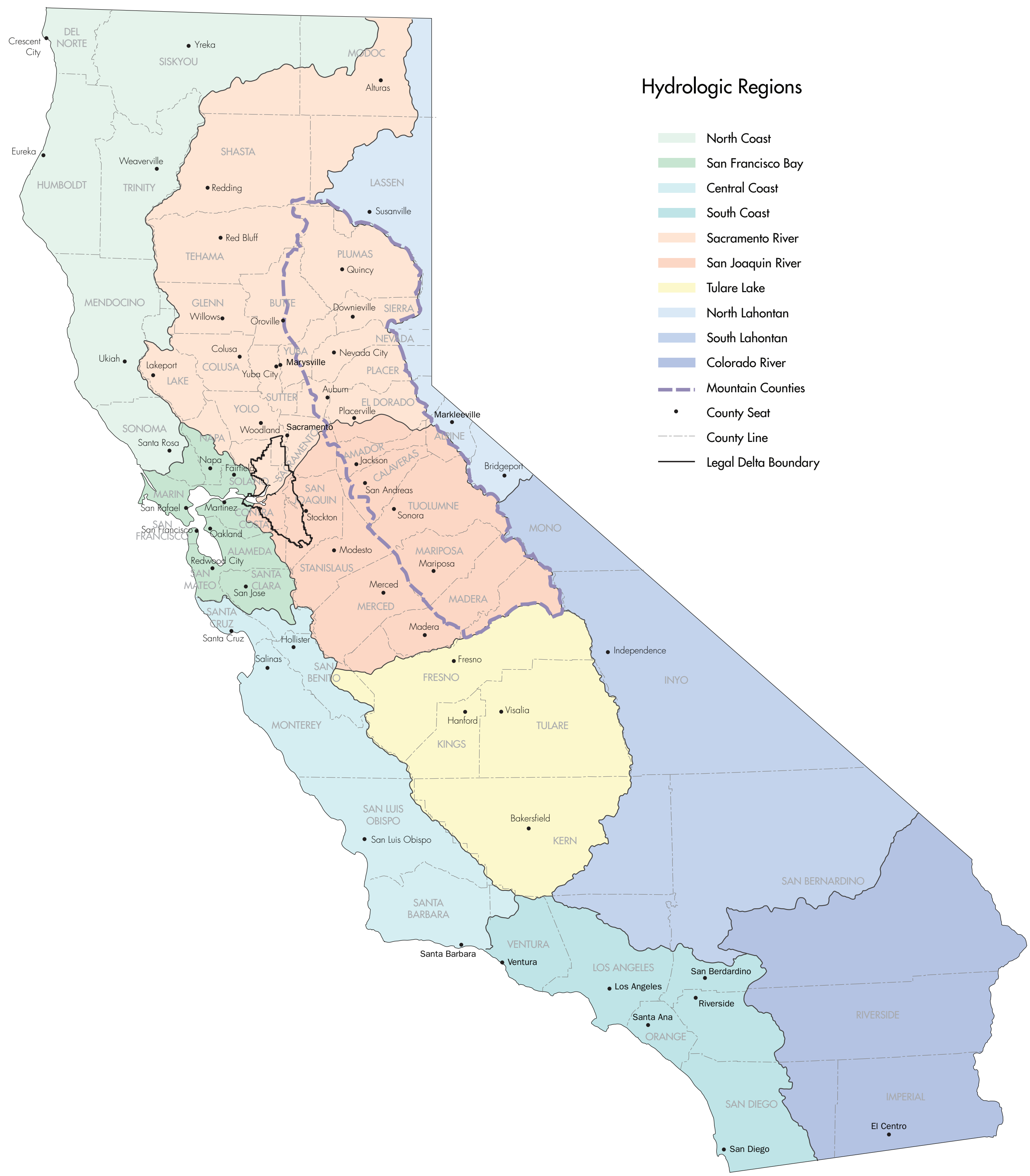
Phased Work Plan and Schedule

DWR will meet California Water Code requirements under a phased work plan and develop analytical tools and acquire data for the next water plan update. (See Box 1-5 Legal Requirements for California Water Plan and Volume 4 Reference Guide article "Work Plan for Meeting Legal Requirements for the California Water Plan.") The new, additional data and studies will help regional and local agencies in integrated water resource management.

- Phase 1: Distribution of the public review draft of the five-volume publication from April through July 2005 marked the end of the first phase. This water plan update is based on the best available data and information and input from an active and diverse advisory committee. Update 2005 recommends policy and priorities, documents gaps in data and analytical tools, and describes an approach for future quantitative analysis.
- Phase 2: This phase began in 2004 and provides a final California Water Plan Update 2005 with changes to the public review draft based on broad public input and numerous public workshops. Phase 2 also documents the data, analytical tools, methods, and assumptions DWR will use in Phase 3.
- Phase 3: Phase 3 begins in 2006 when DWR initiates the process for the next water plan update with participation of a broad public advisory committee. DWR will begin to quantify and evaluate 3 future scenarios and alternative management responses using the data and tools identified in Phase 2. A waterflow diagram will present evaluation results for wet and dry year conditions, and a California Department of Food and Agriculture food forecast will be used to estimate future irrigated crop water use for one future scenario.

As part of an ongoing strategic planning process, DWR will present Phase 3 evaluations to the public as they become available. And as a strategic plan, the findings, recommendations, and the implementation plan of California Water

Figure 1-1 Hydrologic Regions with Mountain Counties and Legal Delta



The California Department of Water Resources divides the state into 10 hydrologic regions that correspond to its major drainage basins. This water plan update also describes the Mountain Counties and Sacramento-San Joaquin Delta as two overlay areas of special interest.

Box 1-3 Water Management Objectives

Several of the goals and recommendations of this water plan relate to the water management objectives described here and shown in the strategy summary table in Volume 2 Resource Management Strategies. Local managing entities use water management objectives to identify and focus on the most important issues in meeting their resource needs. These objectives support the goal of a reliable supply for sustaining the beneficial uses of water in their particular area. There is no fixed set of management objectives for any given planning area. Management objectives may range from being entirely qualitative to strictly quantitative. Threshold values associated with management objectives may be locally determined. For example, in establishing a management objective for groundwater quality, one area may choose to establish an average value of total dissolved solids as the indicator of whether a management objective is met, and another may choose to have no constituents exceeding the maximum contaminant level for public drinking water standards.

Provide water supply benefits. Reduce water demands, improve operational efficiency, redistribute water, and/or augment water supplies.

Improve drought preparedness. Reduce the economic, environmental, and social impacts of drought on regions including activities that increase water conservation, reduce dry year demand, increase surface water or groundwater storage, allow short-term transfers of surplus water, or increase reuse of water.

Improve system flexibility and efficiency. Link and operate water management facilities in a way that increases beneficial use and reuse of water overall. For example, additional interconnection among neighboring water districts can help short-term water transfers during dry years and reduce the impacts of drought.

Improve water quality (all use sectors). Improve water quality by matching water quality to its use or by using treatment technology. Other water management strategies, such as storage, conveyance, and water use efficiency, may also benefit water quality. Water quality is also improved by preventing or reducing pollution, agricultural drainage, and urban runoff.

Reduce groundwater overdraft. Reduce the condition in which over the long term the amount of groundwater with drawn by pumping exceeds the amount of water that recharges the basin. Groundwater overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years.

Reduce flood impacts. Reduce flood damage to life and property by minimizing flow impacts to developed land, maintaining or restoring natural floodplain processes, removing obstacles within the floodplain voluntarily or with compensation, educating the public about avoiding flood risks and planning for emergencies, developing policies for appropriate land use in undeveloped floodplains.

Provide environmental benefits. Protect, restore, or enhance watersheds and ecosystems. This may include instream flow and timing changes, temperature management, habitat restoration, physical modification to water bodies, reduction of diversion impacts to fisheries (for example, fish screens), control of waste discharge in waterways, exotic species control, removal of barriers to anadromous fish migration, land and water acquisitions, managed wetlands, and fire management.

Increase energy generation or reduce use. Generate additional energy supplies or reduce energy consumption.

Increase recreational opportunities. Provide or enhance recreational opportunities in freshwater bodies, such as lakes, reservoirs, and rivers, and outdoor recreation activities near water, such as wildlife viewing, picnicking, camping, and hiking.

Integrate and optimize management strategies. Improve the ability of resource planners and managers to optimally mix and match the maximum number of resource management strategies in their regional plans.

Reduce uncertainty to minimize risk. Reduce the uncertainty and risks associated with water planning and management decisions because of data gaps, insufficient analytical capabilities, incomplete scientific understanding, short- and long-term climate variations, and unpredictable and catastrophic events.

Plan Update 2005 will be reviewed and revised periodically. DWR plans to publish five other water plan updates during this plan's 2030 planning horizon.

Organization of California Water Plan Update 2005

California Water Plan Update 2005 is organized in five volumes: (1) The Strategic Plan, (2) Resource Management Strategies, (3) Regional Reports, (4) Reference Guide, and (5) Technical Guide. It includes recently compiled water data, information, and studies used to develop the strategic plan. It identifies the most pressing water management issues and challenges affecting the state and its regions. It describes short-term and long-term actions that can be implemented at the state and regional level. It considers future uncertainties, scenarios, and their water demands; and describes a comprehensive set of resource management strategies and an approach for improving data and analytical tools needed to make better water management and planning decisions. All the volumes plus the brochure "California Water Plan Highlights" and supporting data and information are available on the water plan Web site (www.waterplan.water.ca.gov).

Box 1-4 Analytical Changes

Water portfolios

The water portfolios and water balances in this water plan update include actual data for a recent dry water year—2001. Planning for drought conditions, that is, extreme and prolonged dry years, is significant for water resources planners, managers, and decision-makers. A drought cannot be described by using actual data for a single water year. Previous water plans considered drought conditions by using trend-based data from a sequence of dry years.

Regional reports

It is important to note that estimates of future statewide average-year water demands, however small or large, do not adequately characterize the challenges facing California water. Increases in water demand must be addressed at regional and local scales because available supplies in one part of the state cannot necessarily be used to meet rising demands in another part. As local demands increase, more severe local water shortages could occur than in recent experience during drier water years. Moreover, the challenges of flood management, protecting water quality, and managing water systems to help restore the environment will all require California's water managers to develop strong water plans that go well beyond just meeting water demand increases in average years.

Future scenarios

Rather than use the prior method for forecasting future water conditions, the Department of Water Resources with advisory committee input decided to initiate a phased work plan to develop the data and analytical tools that can be used to analyze multiple future scenarios and alternative mixes of resource management strategies. Consequently, California Water Plan Update 2005 does not include quantified water balances for future conditions with a shortage analysis as presented in prior updates. Until this quantification occurs, the narratives for three future scenarios and the preliminary scenario water demand estimates cannot be compared to forecasts of shortage from previous updates because of significant differences in the method and level of analysis.

Resource management strategies

In this update, the estimates of potential water supply benefits for the resource management strategies (summarized in Strategy Summary Table in Volume 2) are quantified on a statewide basis. Therefore, they cannot be used to evaluate local shortages. For example, water supply benefits achieved in an area that does not have a water shortage may not contribute to reducing a shortage elsewhere. However, the supply benefit may serve other useful purposes in the area it occurs. The Department of Water Resources plans to work with regional and local partners to develop the necessary data and analytical tools to allow future phases of the California Water Plan update to provide a more comprehensive evaluation of a variety of management responses for a number of plausible scenarios.

Water Plan Update 2005 Highlights and Introductory Video

A brochure highlights key findings and recommendations of the water plan update and describes foundational actions that must be central to California water management to assure sustainable water resource use. It discusses the initiatives needed to achieve the foundational actions to stimulate progress toward assuring that our water supplies are reliable through 2030. It also notes a number of essential support activities needed to accomplish the foundational actions and initiatives. An introductory video, "Water for Tomorrow," is available on DVD.

Box 1-5 Legal Requirements for California Water Plan

At a minimum, California Water Plan Update 2005 must meet requirements specified in the California Water Code regarding its purpose, content, and process. The advisory committee, extended review forum, and public may suggest additions to the water plan update that do not conflict with the Water Code. For details see Volume 4 Reference Guide article "Work Plan for Meeting Legal Requirements for the California Water Plan."

Purpose

The following excerpts from the Water Code and other legislation address the purpose of the California Water Plan and its updates:

- A long-term, reliable supply of water is essential to protect and enhance California's natural resources and economic climate. (Stats 2000, ch. 720, § 1(a))
- The plan for the orderly and coordinated control, protection, conservation, development, management and efficient utilization of the water resources of the State, which is set forth and described in Bulletin No. 1 of the State Water Resources Board titled "Water Resources of California," Bulletin No. 2 of the State Water Resources Board titled, "Utilization and Requirements of California," and Bulletin No. 3 of the Department of Water Resources (DWR) titled, "The California Water Plan," with any necessary amendments, supplements, and additions to the plan shall be known as "The California Water Plan." (Water Code, § 10004(a))
- The California Water Plan is accepted as the master plan which guides the orderly and coordinated control, protection, conservation, development, management and efficient utilization of the water resources of the state. (Water Code, § 10005(a))
- The California Water Plan "does not constitute approval for the construction of specific projects or routes for transfer of water or for financial assistance by the state without further legislative action, nor shall [The California Water Plan] be construed as a prohibition of the development of the water resources of the state by any entity."(Water Code § 10005(b)).

Content

The following excerpts from the Water Code and other legislation address the content of the California Water Plan and its updates:

- Without credible and accurate estimates of water supply needs, it is impossible to ensure that water programs, policies, and investments are appropriate to meet all residential, commercial, industrial, agricultural, and environmental needs (Stats 2000, ch. 720, § 1(c))
- ... to ensure the state makes appropriate investments in water programs, policies, and facilities, there needs to be a credible and objective assessment of the state's future water supply needs. (Stats 2000, ch. 720, § 1(e))
- As part of the requirement of the department to update The California Water Plan ... the department shall include in the plan a discussion of various strategies that may be pursued to meet the State's future water needs, including, but not limited to, those relating to the development of new water storage facilities, water conservation, water recycling, desalination, conjunctive use, and water transfers that may be pursued to meet the future water needs of

continued

Volume 1 Strategic Plan

Chapter 1 (Introduction). This chapter outlines the public process that figures significantly in California Water Plan Update 2005. This process is intended to become the standard for future water plan updates. It also discusses new features of this water plan update and describes the organization of the multivolume water plan update.

Chapter 2 (A Framework for Action). This chapter lays out State government's role in supporting regions through leadership, assistance, and oversight as they assume a central role in California water management. The water plan's strategic plan with vision, mission, goals, and recommendations is described here. It identifies foundational actions, key initiatives, and near-term actions that will stimulate progress toward meeting our water challenges while building a future that assures sustainable water uses and reliable water supplies. The near-term actions are part of the implementation plan in Chapter 5.

Chapter 3 (California Water Today). This chapter reviews California water conditions, challenges, and State, federal, and regional responses since the previous water plan update. Challenges from regional reports are summarized here and detailed in Volume 3 Regional Reports.

Chapter 4 (Preparing for an Uncertain Future). This chapter examines a new planning and analytical approach for addressing future uncertainties; includes discussion of significant factors affecting future conditions; and describes a partial implementation of the new analytical approach, including three future scenarios.

Chapter 5 (Implementation Plan). For the first time, the water plan includes proposals for carrying out its recommendations. Chapter 5 lists the 14 recommendations of the strategic plan and for each one includes specific near-term and comprehensive long-term actions, resources assumptions, implementation challenges, and performance measures. This implementation plan will focus State leadership and guide State and regional actions in managing California's water resources through 2030.

Volume 2 Resource Management Strategies

Volume 2 includes narratives for 25 resource management strategies (presented alphabetically). As used in this water plan, a resource management strategy is a project, program, or policy that helps California's local agencies and governments manage their water and related resources. Strategies can be combined in various ways to meet the water management objectives and

Box 1-5 continued from previous page

the state. The department shall also include a discussion of the potential for alternative water pricing policies to change current and projected uses. (Water Code § 10004.5)

- The department shall include in the plan a discussion of the potential advantages and disadvantages of each strategy and an identification of all federal and state permits, approvals, or entitlements that are anticipated to be required in order to implement the various components of the strategy. (Water Code, § 10004.5)

Recently Enacted Legislation

SB 1062 (Stats 1999, ch. 210) - The California Water Plan. Requires DWR to include in water plan updates various strategies for meeting the state's water supply needs. The update must identify all federal and State permits, approvals, or entitlements that may be required in order to implement the strategies. It also establishes an advisory committee to help DWR update the plan.

SB 1341 (Stats 2000, ch. 720) - State Water Plan. Requires DWR to release a preliminary draft of the water plan's assumptions and estimates and restructures Water Code section 10004 relevant to the California Water Plan.

SB 672 (Stats 2001, ch. 320) - Regional Planning & Water Plan Update. Requires that the California Water Plan include a report on each hydrologic region's development of regional and local water projects to improve water supplies to meet municipal, agricultural, and environmental water demands and minimize the need to import water from other hydrologic regions. It also requires that urban water suppliers describe in their urban water management plans the management tools and options they use to maximize resources and minimize the need to import water from other regions.

continued

values of different regions and to achieve benefits for many natural resources. The volume's introduction gives an overview of the 25 resource management strategies and describes how each strategy narrative is organized. Each strategy narrative includes recommendations to facilitate its implementation.

Volume 3 Regional Reports

Volume 3 includes regional reports for the state's 10 hydrologic regions, the Delta, and a Mountain Counties overlay area, as well as a state summary. Each report includes a discussion of the region: key challenges; ongoing programs; and water portfolio data and information on water supplies and uses for water years 1998, 2000, and 2001.

Volume 4 Reference Guide (The Encyclopedia Water Plan)

Volume 4 includes general reference information on California water resources and facilities from prior water plan updates and articles prepared for, or related to, this water plan that support material in volumes 1, 2, or 3. In past water plans, this information was interspersed throughout the document. DWR has consolidated this reference material in the Reference Guide to make it more accessible and to streamline Volume 1. The articles are organized by topic and presented alphabetically by title. The Reference Guide will be updated periodically on the water plan Web site (www.waterplan.water.ca.gov).

Volume 5 Technical Guide (Online Documentation)

Volume 5 documents the data, analytical tools, and methods used to prepare Update 2005. The Technical Guide is organized and formatted as a Web site to document the data, analytical tools, and methods used to prepare California Water Plan Update 2005. (For link to Volume 5, go to (www.waterplan.water.ca.gov.)

Box 1-5 continued from previous page

SB 1672 (Stats 2002, ch. 767) - Integrated Regional Water Management Planning. Authorizes local public agencies to form regional water management groups and adopt regional plans to address "qualified programs or projects." This bill requires DWR and other departments to give preference to "qualified programs or projects" when establishing criteria for funding under various programs.

AB 857 (Stats 2002, ch. 1016) - State Strategic Planning. Establishes three specific planning priorities for State strategic plans:

- To promote infill development and equity by rehabilitating, maintaining, and improving existing infrastructure, particularly in underserved areas, and to preserving cultural and historical resources.
- To protect, preserve, and enhance environmental and agricultural resources, including working landscapes (farm, range, and forest lands), natural lands (wetlands, watersheds, wildlife habitats, and other wildlands), recreation lands (parks, trails, greenbelts), and other open space.
- To encourage efficient development patterns.

AB 2587 (Stats 2002, ch. 615) – Food: Water Usage Forecasts. Requires the Department of Food and Agriculture to estimate production of food, fiber, livestock, and other farm products and to provide that information to the DWR for estimating related water usage reported in Bulletin 160.

Volume 1

Chapter 2 – A Framework for Action

Chapter 2 A Framework for Action

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Boxes

Integrated regional water management is an approach that will help communities and regions incorporate sustainability actions into their water management efforts. (DWR photo)

Chapter 2 *A Framework for Action*

About This Chapter

Chapter 2 A Framework for Action describes the role of State government in supporting regional water management and improving statewide water management systems. It lays out the foundational actions that must be followed as part of sustainable water resource management, and it explains key initiatives that will stimulate progress and assure that Californians have enough water through 2030. The near-term actions listed under each initiative are part of the implementation plan outlined in Chapter 5.

- The Framework
- Fundamental Lessons
- Ensuring Sustainable Water Uses
- Ensuring Reliable Water Supplies
- Performing Essential Support Activities
- Looking to the Future

The Framework

California can contend with its water resources challenges. However, we must take action now and be prepared to make significant investments. In facing these challenges, we must apply the fundamental lessons of recent decades. Notable among those lessons, and a primary theme of California Water Plan Update 2005, is that our policies, decisions, and actions must lead to long-term, sustainable water resource use that enhances our environment, our economy, and our communities. With creativity, flexibility, discipline, and innovation we can use our groundwater and surface water resources wisely in ways that sustain their viability, expand the economy, protect the environment, and assure Californians a high quality of life. The framework outlined in this chapter sets forth policies and actions to ensure sustainable water uses and reliable water supplies.

The water plan provides a Framework for Action, or roadmap, that lays out the role of State government and the water community to ensure that California has sustainable water uses and reliable water supplies in 2030 for all beneficial uses.

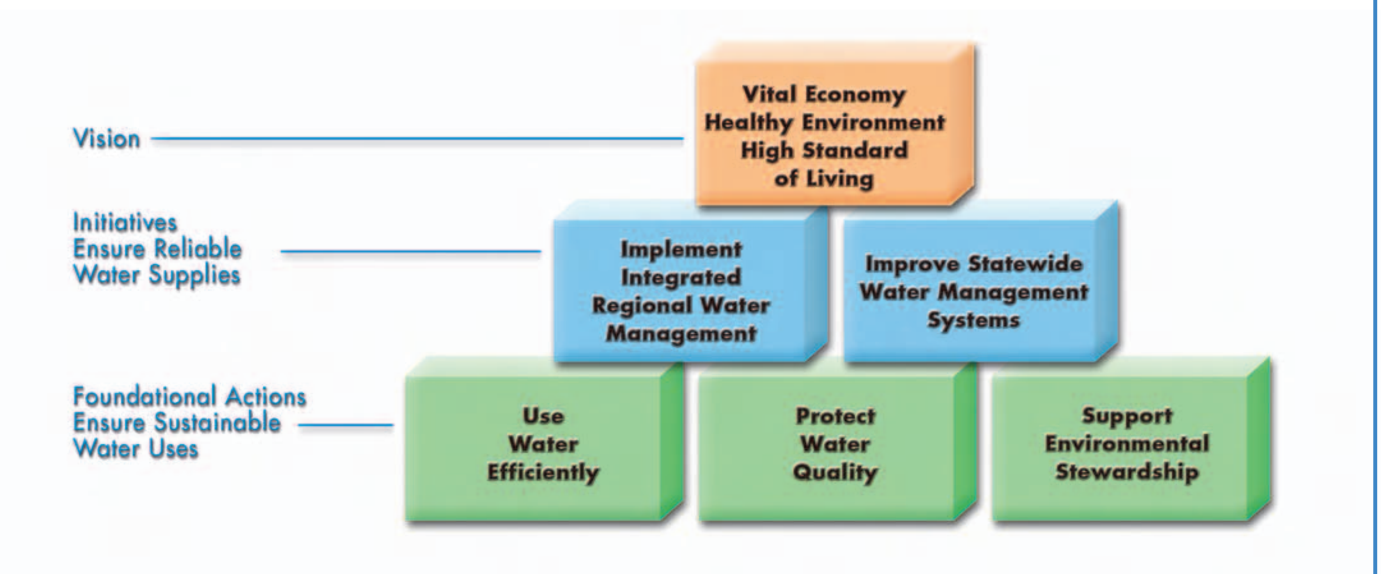
As a strategic document, California Water Plan Update 2005 can guide us toward meeting statewide and regional water challenges through 2030. It is the first water plan update to include a strategic plan with a vision, mission, recommendations, and implementation plan (See Box 2-1 The Strategic Plan: Vision, Mission, Goals, and Recommendations).

The water plan provides a Framework for Action, or roadmap, that lays out the role of State government and the water community to ensure that California has sustainable water uses and reliable water supplies in 2030 for all beneficial uses.

The framework identifies three foundational actions—use water efficiently, protect water quality, and support environmental stewardship—that will ensure sustainable water uses. These foundational actions must be central to California water management and will guide us in carrying out two key initiatives that can ensure that we have reliable water supplies through 2030: 1) implement integrated regional water management and 2) improve statewide water management systems.

This water plan update also identifies a number of support activities that are essential to all the foundational actions and initiatives.

Figure 2-1 A Framework for Action



By basing California water management on key features of the Framework for Action—foundational actions and initiatives—we can attain the water plan's vision of a vital economy, a healthy environment, and a high standard of living.

The Framework for Action is intended to stimulate progress toward meeting California's water challenges while building a future that assures water resources are available for future generations. By basing California water management on the framework's foundational actions and concurrently implementing its two initiatives, we can attain the water plan's vision of a vital economy, a healthy environment, and a high standard of living (see Figure 2-1 A Framework for Action).

Fundamental Lessons

The Framework for Action embodies the following fundamental lessons, learned by California's water community through the experience of recent decades.

- Solutions to California's water management issues are best planned and carried out on a regional basis. Hydrological, demographic, geopolitical, socioeconomic, and other differences among California's regions demand that the mix of water management strategies be suited to meet each region's needs for the long term.
- State government has a lead role in coordinating the water management activities of federal, regional, and local governments and agencies, and to develop sustainable methods for financing water management actions.
- The practice of water conservation and recycling in California has grown dramatically and must continue as a fundamental strategy for all regions and individual water users in California. The cumulative effect of each decision to use water more efficiently has an enormous impact on future water supplies and water quality.
- California must protect the quality of its water and use available supplies with great efficiency because water will always be a precious resource.
- California needs additional groundwater and surface water storage capacity. Storage gives water managers tremendous flexibility to meet multiple needs and provide vital reserves in drier years.

- Sustainable development and water use foster a strong economy, protect public health and the environment, and enhance our quality of life. Sustainable development relies on the full consideration of social, economic, and environmental issues in policy- and decision-making. Sustainable water use ensures that we develop and manage our water and related resources in a way that meets present needs while protecting our environment and assures our ability to meet the needs of the future.
- Science and technology are providing new insights into threats to our watersheds, including our waterways and groundwater basins. California must use this knowledge to take protective actions and manage water in ways that protect and restore the environment.

Box 2-1 The Strategic Plan: Vision, Mission, Goals, and Recommendations

The Department of Water Resources (DWR) has changed the process for preparing the California Water Plan update and the type of information it contains. The water plan has become a strategic planning document that describes the role of State government and the growing role of California's regions in managing the state's water resources. As a strategic planning document, this water plan provides California's water communities with a vision, mission, and goals for meeting challenges of sustainable water uses through 2030 in the face of uncertainty[1].

Vision

The vision statement of Update 2005 describes the desired future for California water resources and management and serves as a foundation for water planning during the next 25 years.

California's water resource management preserves and enhances public health and the standard of living for Californians; strengthens economic growth, business vitality, and the agricultural industry; and restores and protects California's unique environmental diversity.

Mission

The mission statement of Update 2005 describes the water plan's unique purpose and its overarching reason for existence. It identifies what it should do and why and for whom it does it.

To develop a strategic plan that guides State, local, and regional entities in planning, developing, and managing adequate, reliable, secure, affordable, and sustainable water of suitable quality for all beneficial uses.

Goals

The following goals are the desired outcome of this water plan over its planning horizon to 2030. The goals are founded on the statewide vision. Meeting the goals requires coordination among State, federal, and local governments and agencies.

- *State government supports good water planning and management through leadership, oversight, and public funding.*
- *Regional efforts play a central role in California water planning and management.*
- *Water planning and urban development protect, preserve, and enhance environmental and agricultural resources.*
- *Natural resource and land use planners make informed water management decisions.*
- *Water decisions and access are equitable across all communities.*

continued

[1] AB 857 (Stats 2000; ch. 1016) establishes three planning priorities and requires that all State strategic plans, including the California Water Plan be consistent with them. (See "Coordination of Water and Land Use Planning" in Chapter 3 California Water Today.)

Box 2-1 continued from previous page

Recommendations

California Water Plan Update 2005 provides recommendations for the next 25 years. These recommendations are directed at decision-makers throughout the state (referred to as California), the executive and legislative branches of State government, and DWR and other State agencies. (See Chapter 5 Implementation Plan for details.)

1. California must invest in reliable, high quality, sustainable, and affordable water conservation, efficient water management, and development of water supplies to protect public health, and improve California's economy, environment, and standard of living.

2. State government must provide incentives and assist regional and local agencies and governments and private utilities to prepare integrated resource and drought contingency plans on a watershed basis; to diversify their regional resource management strategies; and to empower them to implement their plans.

3. State government must lead an effort with local agencies and governments to remediate the causes and effects of contaminants on surface water and groundwater quality.

4. California must maintain, rehabilitate, and improve its aging water infrastructure, especially drinking water and sewage treatment facilities, operated by State, federal, and local entities.

5. State government must continue to provide leadership for the CALFED Bay-Delta Program to ensure continued and balanced progress on greater water supply reliability, water quality, ecosystem restoration, and levee system integrity.

6. State government must lead in water planning and management activities that: (a) regions cannot accomplish on their own, (b) the State can do more efficiently, (c) involve inter-regional, inter-state, or international issues, or (d) have broad public benefits.

7. California must define and articulate the respective roles, authorities, and responsibilities of State, federal, and local agencies and governments responsible for water.

8. California must develop broad, realistic, and stable funding strategies that define the role of public investments for water and other water-related resource needs over the next quarter century.

9. State government must invest in research and development to help local agencies and governments implement promising water technologies more cost effectively.

10. State government must help predict and prepare for the effects of global climate change on our water resources and water management systems.

11. DWR and other State agencies must improve data, analytical tools, and information management and exchange needed to prepare, evaluate, and implement regional integrated resource plans and programs in cooperation with other federal, tribal, local, and research entities.

12. DWR and other State agencies must explicitly consider public trust values in the planning and allocation of water resources and protect public trust uses whenever feasible.

13. DWR and other State agencies must invite, encourage, and assist tribal government representatives to participate in statewide, regional, and local water planning processes and to access State funding for water projects.

14. DWR and other State agencies must encourage and assist representatives from disadvantaged communities and vulnerable populations, and the local agencies and private utilities serving them, to participate in statewide, regional, and local water planning processes and to get equal access to State funding for water projects.

Ensuring Sustainable Water Uses

To ensure that our water uses are sustainable, water management at all levels—State, federal, regional, and local—must be based on three foundational actions:

- Use water efficiently
- Protect water quality
- Support environmental stewardship

A number of resource management strategies that can be used to accomplish the foundational actions are listed in the following sections and described in more detail in Volume 2 Resource Management Strategies.

Use Water Efficiently

To minimize the impacts of water management on California's natural environment and ensure that our state continues to have the water supplies it needs, Californians must use water efficiently to get maximum utility from existing supplies. Californians are already leaders in water use efficiency measures such as conservation and recycling. Because competition for California's limited water resources is growing, we must continue these efforts and be innovative in our pursuit of efficiency. Water use efficiency will continue to be a primary way that we meet increased demand.

In the future, we must broaden our definition of efficient water use to include other ways of getting the most utility out of our groundwater and surface water resources and water management systems:

- Increase levels of urban and agricultural water use efficiency
- Increase recycled municipal water and expand its uses
- Reoperate water facilities to improve their operation and efficiency
- Facilitate environmentally, economically, and socially sound transfers to avoid regional shortages
- Reduce and eliminate groundwater overdraft

As California's population grows from 36.5 million to a projected 48 million in 2030, there is bound to be an effect on California's environment. By wringing every bit of utility from every drop of water, Californians can stretch water supplies and help ensure continued economic and environmental health.

By wringing every bit of utility from every drop of water, Californians can stretch water supplies and help ensure continued economic and environmental health.

Water supply and water quality are inseparable in water management.

Protect Water Quality

California must also protect and improve water quality to safeguard public and environmental health and secure the state's water supplies for their intended uses. Water supply and water quality are inseparable in water management. While implementing projects to reduce water demand or to augment supply, water managers must employ methods and strategies that protect and improve water quality:

- Protect surface waters and aquifers from contamination
- Explore new treatment technologies for drinking water and groundwater remediation
- Match water quality to its intended uses
- Improve management of urban and agricultural runoff
- Improve watershed management

Support Environmental Stewardship

To ensure sustainability, California must also manage water in ways that protect and restore the environment. Water is a vital natural resource for people and the environment, so water management activities must occur in the context of resource management and environmental protection. Water development in California has a rich history of conflict, at times pitting water supply projects against ecosystem protection. Water supplies and the environment must be considered together.

Water management activities will often have unavoidable environmental consequences: When water is removed from the natural environment for other beneficial uses, the environment is affected. In carrying out water management activities, Californians must acknowledge these environmental costs and ensure that restoration actions are carried out to maintain and improve environmental health.

Water managers must support environmental stewardship as part of their management responsibilities. As managers develop and deliver reliable water supplies, environmental stewardship can be incorporated in many ways:

- Integrate ecosystem restoration with water planning and land use planning

- Restore and maintain the structure and function of aquatic ecosystems
- Assist in the recovery of aquatic and riparian species listed in the federal and State Endangered Species Act.
- Minimize the alteration of ecosystems by water management actions
- Improve watershed management
- Protect public trust resources (See Box 2-2)
- Integrate flood management with water supply management

Ensuring Reliable Water Supplies

Two key initiatives in California Water Plan Update 2005 outline ways to ensure that Californians have reliable water supplies—enough clean and affordable water supplies for homes, industry, business, and agriculture through the year 2030. These initiatives must be based on three foundational actions—use water efficiently, protect water quality, and support environmental stewardship. As part of the Framework for Action, State, federal, regional, and local agencies and governments must work cooperatively on these two critical initiatives:

1. Promote and practice integrated regional water management
2. Maintain and improve statewide water management systems

The following sections describe each initiative, outline State government's role in promoting them, and identify specific actions that should be completed before the next water plan update.

Initiative 1 Promote and Practice Integrated Regional Water Management

Promote integrated regional water management to ensure sustainable water uses, reliable water supplies, better water quality, environmental stewardship, efficient urban development, protection of agriculture, and a strong economy.

The first initiative is to continue recent progress in implementing integrated regional water management. This is an approach that will help communities and regions incorporate sustainable actions into their water management efforts. Integrated regional programs will be most successful in providing reliable water supplies when they use water efficiently, protect water quality, and restore the environment.

This initiative includes the following elements:

- Foster regional partnerships
- Develop and implement integrated regional water management plans
- Diversify regional water portfolios

Over the past 50 years, California has met much of its increasing water demands with interregional projects. Although these State, federal, and local projects now serve as the backbone of California water management, by themselves they cannot provide for our growing population, changing agricultural production patterns, and environmental needs. However, regional partnerships can efficiently solve water management problems, consider multiple resource issues, and account for the distinct regional hydrology, infrastructure, and political institutions.

With State government leadership, assistance and oversight, regional water planning and management will help meet water needs through 2030. Integrated regional water management relies on a diversified portfolio of water strategies. The resulting regional plans can provide efficient solutions, consider other resource issues, and enjoy broad public support.

Foster Regional Partnerships

The physical and institutional realities within California do not allow for a one-size-fits-all approach to water management and planning. The California Water Plan serves as a critical tool for coordinating water planning and management throughout the state, but integrated resource planning must be applied on a regional level to develop integrated regional water management plans that contain the mix of resource management strategies best suited for each region's particular conditions and goals.

Regions have opportunities not available to individual water suppliers. Water suppliers that form partnerships with other entities in their region can accomplish projects and provide benefits that no single agency could do alone. For example, partnerships may allow agencies to improve their water supply reliability by establishing emergency connections with neighboring water suppliers; increase operational flexibility by participating in regional groundwater management and conjunctive use; protect water quality by participating in regional watershed management; reduce costs by cooperating with other agencies on water conservation and outreach programs; facilitate new projects by contributing to local habitat conservation plans; and help achieve many other regional resource management objectives.

Water management activities must occur in the context of resource management and environmental protection.

Box 2-2 Public Trust Responsibilities of State Agencies

The Public Trust Doctrine imposes trust responsibilities on State agencies that have authority over trust resources (certain types of property of high public value held for the benefit of all citizens) or whose activities might affect the resources. Examples of these responsibilities include the following:

The Department of Fish and Game, under Fish and Game Code section 1802, must exercise its responsibilities as trustee for the resources of the State with jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species. DFG acts as a permitting agency for streambed alteration permits, reviews and comments on environmental documents, participates in water rights hearings to present evidence regarding the needs of fish and wildlife, determines instream flow requirements of certain streams, implements and enforces the California Endangered Species Act and the Natural Community Conservation Planning Act.

The Department of Water Resources must consider the public trust in connection with the planning, design, construction, and operation of State Water Project (SWP) facilities or other projects in which DWR is a participant. Where a project will require a new water rights permit, the State Water Resources Control Board will usually make a public trust determination during the course of the water rights process. DWR should assist SWRCB by conducting and presenting studies and investigations regarding the needs of trust resources. Fish and Game Code section 5937 requires all dam owners to release or bypass sufficient water to keep fish in the stream below the dam in good condition.

When acting as a party to a transfer, or when approving use of SWP facilities by others, DWR must take the public trust into account. Where SWRCB approval of a transfer is required, SWRCB may take the lead in determining what is required to protect the public trust resources. Where SWRCB approval is not required, as in the case of transfers of pre-1914 rights, DWR should consider all available information and protect public trust uses whenever feasible and reasonable. DWR may put conditions on its participation in a transfer, or condition the use of SWP facilities to protect public trust uses or resources. If a transfer would cause undue harm to trust resources, DWR may decline to participate, or deny the use of SWP facilities.

DWR also has the obligation to consider the public trust when carrying out its role in water planning, including the preparation of this water plan.

The State Lands Commission, which holds and administers state sovereign lands, including tidelands and the beds of navigable streams, must protect the public's interest in trust uses of those properties.

The State Water Resources Control Board must consider the public trust when granting water rights permits or licenses or approving transfers or other change petitions. SWRCB may fulfill its duty of continuous supervision under the Public Trust Doctrine by responding to complaints of violation or initiating investigations. If it determines that the trust is being violated, it may reconsider and amend existing water rights.

In acting on permits, transfer petitions, or complaints, SWRCB considers all available information, including NEPA or CEQA documents, input from DFG, information or evidence presented by other State agencies or local agencies or other parties, and other evidence regarding appropriate instream flows and non-flow conditions necessary to protect trust resources. The balance between the need to use water out of the stream and the requirement to protect trust uses will vary with the circumstances of the particular diversion. Trust resources must be protected where feasible.

Regions may require intergovernmental cooperation to reduce controversy over distribution and use of water. For example, the Klamath River Compact Commission, created by the 1957 Klamath River Compact, is a cooperative relationship between the states of Oregon and California and the US Bureau of Reclamation. The commission promotes the orderly, integrated, and comprehensive development, use, conservation and control of water for irrigation, protection of fish and wildlife, domestic and industrial use, hydropower, navigation, and flood protection.

Partnerships can lead to integrated regional water management plans and regional eligibility for certain grant funds. Integrated regional water management relies on a diversified portfolio of water strategies. Early coordination with land planning agencies may help water suppliers and land planners anticipate and plan for future growth, and ensure that additional regional growth will not exceed water suppliers' capabilities. Ultimately, regional partnerships will enable optimum management of water and other resources within a region, and the resulting regional plans can provide efficient solutions, consider other resource issues, and enjoy broad public support.

Develop and Implement Integrated Regional Water Management Plans

To quote the great American naturalist John Muir, "When we try to pick out anything by itself, we find it hitched to everything else in the Universe." This concept is the premise of integrated resource planning, the basis for integrated regional water management (see Box 2-3 Integrated Resource Planning, the Basis for Regional Water Management). The approach requires that we become better systems thinkers and take into account how resource management practices and land use changes affect the long-term reliability and quality of water supplies. Our perspective should be broad—include economic growth, environmental quality, and social equity. Given the projected population increases and strain that new development can impose on ecosystems, an integrated, regional approach throughout California

Box 2-3 Integrated Resource Planning, the Basis for Regional Water Management

Overview

Integrated resource planning is a comprehensive approach to resource management and planning that emerged in the late 1980s in the electric power industry. As applied to water management, integrated resource planning is a systems approach that explores the cause-and-effect relationships affecting water resources wherever the planning entity's operations affect water use, quality, and supply. The process analyzes all the interrelated water management components in a given region. The focus is on the interrelation of the different water management components with the understanding that changes in the management of one component will affect the others. Because these components are often not confined to the boundaries of a single water management agency, a consensus-based, cross-jurisdictional, regional approach may be required to formulate comprehensive, win-win solutions to identified problems.

The overriding goals of the process are to ensure reliable, affordable, good quality water from a diversity of sources; and design a comprehensive plan that achieves water supply reliability and quality objectives but allows planned programs to adapt to changes in environmental, institutional, and socioeconomic conditions. By its nature, integrated resource planning is technical and political because a plan for managing water resources in any basin affects ecosystems; socioeconomic systems; and water storage, treatment, and conveyance systems. Integrated resource planning identifies the appropriate mix of demand-side and supply-side management components (for example, urban water conservation, agricultural water conservation, water reuse and recycling, water transfers, conjunctive use, expanded conveyance flexibility, and new groundwater and surface water storage) that are expected to provide long-term, reliable water service and maximize benefits at the lowest reasonable cost. The process is employed to:

- evaluate the current state of water resources in a watershed or region;
- determine the variety of current and future demands for water and how demand, quality, and supply patterns are affecting land use, fish and wildlife resources, and local and regional economies; and
- balance demand management and supply enhancement options to produce a comprehensive, adaptive water management plan that specifies long-term goals, objectives, and programs to provide sustainable water uses in a basin.

continued

is the best approach to protect the environment and manage urban growth. California must implement integrated regional water management to ensure reliable water supplies, environmental stewardship, and efficient urban development. (See Box 2-4 Elements of Integrated Regional Water Management).

California is placing more emphasis on integrated regional water management. With this inclusive systems approach, local agencies and governments can be more flexible and act more efficiently. This approach makes better use of existing local resources. It integrates multiple aspects of managing water and related resources such as water quality, local and imported water supplies, watershed protection, wastewater treatment and recycling, and protection of local ecosystems.

With State government leadership, assistance and oversight, regional water planning and management will help meet water needs through 2030.

The principles of integrated regional water management have a broad and long-term perspective. By applying the principles, regions develop plans that have multiple benefits. As an example, in some areas of the state, agricultural users have developed projects that simultaneously conserve water, reduce contaminants, preserve the agricultural economy, and improve aquatic habitat.

State government must help cities, counties, local water agencies, and private utilities to prepare useful integrated regional water management plans. State government should develop incentives to promote and support integrated regional water management. With the State's technical assistance and partnership, local and regional agencies and governments can apply balanced portfolios of water resource management strategies to help meet their water demands, and put into effect existing legislation and State policies that improve coordination between water and land use planning.

Box 2-3 continued from previous page

When integrated resource planning is applied rigorously, it considers all competing needs and identifies the different resource management strategies that the planning entity can employ (See Volume 2 for a discussion of 25 resource management strategies). Integrated resource planning evaluates various response packages, which are different mixes of resource management strategies used to manage water resources over a designated planning horizon, and indicates when and under what future conditions a management strategy would be added or changed. The costs (socioeconomic and environmental) of employing each response package are also derived during the planning process.

Selecting the timing of adding or changing individual strategies to a region's management response requires completion of a risk analysis. The risk analysis takes into account the expected frequency and severity of not meeting current and future water demands; how additional water management strategies are likely to affect that frequency and severity; and how available contingency measures can reduce the impact of shortages when they occur.

Integrated resource planning includes many elements of traditional planning. It also includes thorough analyses of water use efficiency programs, levels of uncertainty acceptable to the planning entity, and coordinated efforts to involve the public in the planning process. Integrated resource planning is multi-objective planning that recognizes decisions must balance competing objectives in a sustainable way. Integrated resource planning often includes the following activities:

- Define planning objectives and associated evaluation criteria (see Chapter 4 for suggested criteria). The objectives must be specific and the criteria measurable, so they can be used to evaluate alternative response packages.
- Involve the appropriate constituencies. The level and breadth of involvement will vary depending on local area needs and the level of interest in the resource strategies being considered.
- Assess demand-reduction strategies such as agricultural and urban water conservation. These strategies must be identified and analyzed in the same multi-tiered way that supply-side strategies are analyzed.
- Assess operational efficiency and supply redistribution strategies such as conveyance, system operation, and water transfers.

continued

Box 2-3 continued from previous page

- Assess supply augmentation strategies such as conjunctive management, water recycling, desalination, and storage.
- Assess water quality management strategies such as drinking water treatment, groundwater/aquifer remediation, pollution prevention, and runoff management.
- Assess resource stewardship strategies such as agricultural land stewardship, urban land use management, ecosystem restoration, floodplain management, and watershed management.
- Formulate and evaluate different response packages. The resource management strategies selected from the above activities are combined into alternative response packages (25 strategies are described in Volume 2). Each response package then goes through multilevel screening using approved evaluation criteria, until (one to three) responses emerge that best meet the planning objectives and evaluation criteria. Each response package (mix of strategies) must explicitly demonstrate the tradeoffs among the different evaluation criteria. Often, a decision analysis method must be approved before screening the individual resource management strategies and the response packages.

Guiding Principles

Use a broad, long-term perspective. Use a comprehensive stakeholder-based planning process to (1) promote multi-objective planning with a regional focus, (2) emphasize both local and regional initiatives, (3) recognize distinct regional problems and resources, and (4) emphasize long-term planning (30-50 year planning horizon).

Identify broad benefits, costs, and tradeoffs. Evaluate programs and projects recognizing economic growth, environmental quality, and social equity as co-equal objectives. Based on this comprehensive assessment, determine potential economic, environmental, and social benefits, beneficiaries, costs, and tradeoffs and include a plan to avoid, minimize, and mitigate for adverse impacts.

Promote sustainable resource management. Promote the wise use of all natural resources to ensure their availability for future generations. This can be done by promoting activities with the greatest benefit for the entire region and activities that consider the interrelationship between regional water supplies, water quality, water infrastructure, flood protection, recreation, land use, economic prosperity, and the environment.

Increase regional self-sufficiency. Increase regional self-sufficiency by considering activities that reduce the need to import water from another hydrologic region, particularly during times of limited supply availability such as during a drought or after a catastrophic event like an earthquake.

Increase regional drought preparedness. Evaluate and implement strategies that among other benefits would reduce the impacts of drought in the region. In California, drought contingency planning is an important component of regional water planning. Examples of such strategies include water use efficiency and recycled municipal water, system reoperation, conjunctive management and groundwater storage, surface storage (CALFED and regional), and ocean and brackish water desalination.

Promote environmental justice. All projects sponsored by or partnered with the State, or using public funds must promote environmental justice, which is the fair treatment of people of all races, cultures,and incomes with respect to the development, funding and implementation of resource management projects.

Promote coordination and collaboration among local agencies and governments. Promote and improve coordination and collaboration among local agencies and governments within a region, particularly those that are involved in activities that might affect the long-term sustainability of water supply and water quality within the region. Regional planning should include a public review process with open and transparent decision-making, as well as education and outreach for public, stakeholders, and decision-makers.

Use sound science, best data, and local knowledge. Use the best available data and information and, when possible, use planning methods and analytical techniques that have undergone scientific review.

Box 2-4 Elements of Integrated Regional Water Management

A water management plan created through integrated resource planning includes the following elements:

Content and Principles

- Short-term goals and objectives (prioritized to the extent possible)
- Long-term goals and objectives (prioritized to the extent possible)
- Description of current resource characteristics and conditions
- Description of resource management strategies to address cross-cutting water management issues such as flood control, water quality, environmental water management, land use planning, water allocation and appropriation
- Inclusion of information from a variety of interests through broad public participation–especially when developing goals, objectives, and evaluation criteria
- Information regarding management strategies, costs, risks and tradeoffs (more details offered under "Analysis" below)
- Transparency of evaluation methods, tools, assumptions, and data

Analysis

- Initial conditions for water management information such as water uses, supplies, quality, water infrastructure and operational criteria, and water-related resource management
- Employment of a systems approach to water management assessment
- Current water management objectives
- Current water management capabilities, such as ability to meet current water management objectives
- Employment of a least-cost planning framework[1] that identifies all economic costs and other implications of adding reliability, as well as all costs and implications of forgoing additional reliability
- Identification of risks and uncertainties associated with different resource management strategies
- Evaluation criteria for comparing alternative response packages (different mixes of management strategies)
- Identification of response packages that achieve an acceptable level of supply reliability and meet other water management objectives, while considering risks and tradeoffs.

Implementation

- Finance plan based on prioritized objectives and preferred response packages
- Implementation plan that includes roles, tasks, and challenges, such as regulatory compliance, lead agencies, timelines, legal issues, etc.
- Performance measures to track plan implementation (for example, how well the preferred response packages meet goals and objectives)
- Data collection and management needed to evaluate performance of regional programs and projects

[1] Least-cost planning is a cornerstone of integrated resource planning. It assists a comprehensive examination of all water management alternatives including the option of forgoing additional reliability measures if the cost (economic or other) of implementation exceeds the cost of coping with current reliability levels.

Diversify Regional Water Portfolios

Every region of California must build a diverse water portfolio that balances cost-effective water supplies and demands while protecting the environment. The foundational actions, which are necessary for sustainable water uses and reliable water supplies, must guide how a region balances its water portfolio—for example, increasing water use efficiency while maximizing the return on investment in sound water management policies. Every time water is wasted, money and a precious resource go down the drain. Continued investment in our existing facilities and carefully planned new water developments will provide the strong foundation to meet future needs. But Californians also must promote water conservation and recycling, enhance groundwater storage, provide adequate supplies of water for the environment, and support innovative water technologies such as desalination to reduce the impacts of droughts, support a vibrant economy, and meet future water demands for all beneficial uses.

California's regions cannot meet all of their water objectives with a single strategy. Volume 2 of this water plan update describes 25 resource management strategies. These strategies are like individual tools in a tool kit. Just as the mix of tools will vary depending on the job, the combination of strategies will vary from region to region depending on the individual situations surrounding water supply and use, climate, projected growth, and environmental and social conditions. A diverse portfolio of water management strategies is essential to provide the flexibility needed to cope with changing and uncertain future conditions.

Near-term Actions to Implement Initiative 1

State government is responsible for ensuring that regional projects and initiatives protect the public trust and the environment, evaluating the interaction of water supply between regions, and evaluating the adequacy of statewide water supplies for all beneficial uses. To ensure that state water planning and future decisions about water use and urban development are in line with the State's sustainable development goals, State and local governments and agencies should carry out the following near-term actions:

- Regional efforts should incorporate integrated water management to meet multiple water management objectives consistent with the principles advanced in this water plan.
- The degree and nature of the need for more ground water and surface water storage varies from region to region; therefore, DWR will work with regional entities to evaluate the best ways to meet their ground water and surface storage needs and the possible means of sharing storage capacity among regions.
- Local governments and agencies should improve coordination between land use planning and water planning and management to ensure that new infra structure has adequate water supply and that land uses are protective of water quality.
- State government should give preference to applicants of Proposition 50, Chapter 8 grants[1] who have plans that apply DWR and State Water Resource Control Board (SWRCB) grant program guidelines[2].
- DWR will adapt its existing programs and develop new ones to give incentives and technical assistance to regional and local agencies and governments to prepare comprehensive, integrated water management plans that include actions to protect public trust resources and promote efficient, beneficial water use.
- DWR will develop guidelines for technical and financial assistance and templates for integrated regional water management plans, urban and agricultural water management plans, and drought contingency plans.
- DWR will facilitate the next phases of this water plan update, use the water plan update process as a forum to identify and resolve conflicts between regional plans, and integrate the water plan into a future State strategic planning process.

Regional partnerships will enable optimum management of water and other resources within a region. California's regions cannot meet all of their water objectives with a single strategy. Just as the mix of tools will vary depending on the job, the combination of strategies will vary from region to region.

[1] Proposition 50: Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, Chapter 8 "Integrated Regional Water Management."
[2] DWR and SWRCB. 2004. Integrated Regional Water Management Grant Program Guidelines: Proposition 50, Chapter 8. Nov
www.grantsloans.water.ca.gov/grants/integregio.cfm

Initiative 2 Maintain and Improve Statewide Water Management Systems

Maintain and improve statewide water management systems to provide reliable water supplies, improve drought and flood management, and sustain the Sacramento-San Joaquin Delta.

The second initiative for ensuring reliable water supplies is to maintain and improve statewide water management systems. California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from flood, withstand drought, and sustain environmental values. These water management systems include physical facilities and statewide water management programs.

Facilities - the backbone of water management in California – include over 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees. Systems are often interconnected. The operation of one system can depend on the smooth operation of another. The successful operation of the complete system can be vulnerable if any parts fail.

This initiative also includes statewide water management programs, which contribute to better operation of water systems. These programs include water quality standards, monitoring programs, economic incentives, water pricing policies, and statewide water efficiency programs such as appliance standards, labeling, and education. These statewide water management programs help meet major State government responsibilities for statewide water planning and ecosystem restoration. The State needs to continue providing technical assistance to efforts involving interregional, interstate, or international issues, and to efforts resulting in broad public benefits, such as protecting and restoring the Sacramento-San Joaquin River system and Delta, Salton Sea, Mono Lake, Klamath basin, and Lake Tahoe.

This initiative includes the following actions by State, federal, and local agencies and governments. Their success depends on the concurrent implementation of three foundational actions—use water efficiently, protect water quality, and support environmental stewardship.

- Improve aging facilities
- Implement the CALFED Program
- Improve flood management
- Sustain the Sacramento-San Joaquin Delta

These water management systems include physical facilities and statewide water management programs.

Improve Aging Facilities

California must rehabilitate and improve its aging water facilities, especially those that provide drinking water, sewage treatment, water delivery, and flood control. These are operated by State, federal, and local entities. Aging facilities risk public safety, water supply reliability, and water quality. The State Water Project is over 30 years old; the federal Central Valley Project is over 50 years old. Some local facilities were constructed nearly a century ago. These and other aging facilities must be carefully maintained, rehabilitated, and improved to protect public investment and ensure that our water management systems continue to provide intended services.

The maintenance and rehabilitation of California's water facilities as they age will be costly. In addition, these facilities will face many challenges, such as changing water demands and use patterns, withstanding catastrophic natural events like earthquakes and floods, and adapting to the potential impacts of global climate change.

By maintaining, rehabilitating, and improving our water facilities, we enhance the efficiency and flexibility of our water management systems. Improvements may include new water storage, additional conveyance capacity, and refinements in the way water systems are operated. These improvements are intended to increase reliability and flexibility in the system, improving our ability to deal with the uncertainty of a highly variable water supply.

Implement the CALFED Program

The CALFED Bay-Delta Program is intended to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System. The program significantly reduced conflicts over Delta operations through better agency coordination and implementation of comprehensive resource management solutions.

California must rehabilitate and improve its aging water facilities, especially those that provide drinking water, sewage treatment, water delivery, and flood control.

Box 2-5 CALFED Bay-Delta Program

The San Francisco Bay-Sacramento-San Joaquin River Delta is one of California's unique and valuable resources. The Bay-Delta system provides drinking water for 22 million people and is an integral part of California's water system. It supports California's trillion dollar economy, including its $28 billion agricultural industry. Its levees protect farms, homes and infrastructure. It is the largest estuary on the West Coast and is home to 750 plant and animal species. The Bay-Delta supports 80 percent of the state's commercial salmon fisheries.

The Bay-Delta has been in decline for decades. Growth and development in California have increased demands on the Bay-Delta for water supply. At the same time, the health of the Bay-Delta ecosystem has deteriorated and populations of important fish species are at risk.

The CALFED Bay-Delta Program is a collaborative effort among 25 state and federal agencies to improve water supplies in California and the health of the San Francisco Bay-Sacramento-San Joaquin River Delta Watershed. In 2000, the agencies drafted a 30-year plan described in the CALFED Record of Decision. The plan sets general goals and describes a science-based planning process through which the agencies can make better, more informed decisions on future projects and programs within their jurisdictions.

The CALFED agencies working with local partners are implementing hundreds of projects to improve the quality and reliability of the Bay-Delta system. As a result, conflict in the Delta has been reduced. Water supplies are becoming more reliable, water quality issues are gaining the attention they deserve, and the Bay-Delta environment is showing some favorable responses.

The mission of the CALFED Bay-Delta Program is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System. The program's four objectives are water supply reliability, water quality, ecosystem restoration, and levee system integrity. The objectives are being achieved through implementation of 11 major program elements:

- Conveyance
- Drinking Water Quality
- Ecosystem Restoration
- Environmental Water Account
- Levee System Integrity
- Science
- Storage
- Water Management
- Water Transfers
- Water Use Efficiency
- Watershed Management

continued

Box 2-5 continued from previous page

The following is a summary of the major components of the four CALFED objectives:

Water Supply Reliability

- Assist local partners in developing 500,000 to 1 million acre-feet of groundwater storage.
- Pursue planning and other actions at state and federal levels to expand surface storage capacity by up to 3.5 million acre-feet.
- Optimize water conveyance facilities in the Delta and in other locations to maximize operational flexibility, protect water quality and fish species, and increase water supply reliability.
- Invest in local projects that boost water use efficiency through annual water conservation and recycling competitive grants and loan program.
- Streamline the water transfer approval process and develop an effective water transfer market that protects water rights, the environment and local economies.

Water Quality

- Develop and implement source control and drainage management programs.
- Invest in treatment technology.
- Implement aggressive measures to improve Delta water quality and water quality science.
- Improve or maintain water and sediment quality to support healthy and diverse aquatic ecosystems and to the extent possible, eliminate toxic impacts to aquatic organisms, wildlife and humans.
- Improve dissolved oxygen conditions in the San Joaquin River near the Port of Stockton as part of ecosystem restoration efforts.

Ecosystem Restoration

- Conduct a grant program to fund local projects in habitat restoration, fish passage, invasive species management and environmental water quality.
- Recover at-risk native species and their habitats.
- Augment stream flow in upstream areas to benefit native fish and invest in fish passage improvements through dam removal and improved fish ladders.
- Provide local and technical assistance to assess watershed conditions and develop plans to address watershed problems.
- Manage the Environmental Water Account to acquire water from willing sellers to protect fish species without reducing water supply reliability.
- Conduct an annual science review to assess effectiveness.
- Develop opportunities for working farms and ranches to contribute to ecosystem restoration objectives.

Levee System Integrity

- Maintain and strengthen Delta levees, provide protection and enhancement of Delta habitats and drinking water quality.
- Develop best management practices for beneficial reuse of dredged material.
- Improve the Delta Emergency Management Plan and develop a Risk Management Strategy to identify risks to Delta levees, evaluate consequences and recommend actions.

See also CALFED Web site at www.calwater.ca.gov

The CALFED program proposes actions to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta, reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses, provide good water quality for all beneficial uses, and reduce risks from catastrophic breaching of Delta levees. See Box 2-5 CALFED Bay-Delta Program.

State government must provide leadership to revitalize the CALFED Bay-Delta Program. This will continue our progress toward meeting CALFED objectives of improved water supply reliability, good water quality, ecosystem restoration, and levee system integrity.

Consistent with the commitment in the Governor's budget, **a three-point plan has been developed that will allow the CALFED Program to move forward** and focus on addressing the highest priority issues associated with the conflicts of the Delta. To be completed by December 2005, the plan includes:

- An Independent Review and fiscal review of the CALFED Program to ensure accountability, highlight accomplishments, determine program status, and guide adjustments to the Program.
- A public process to refocus the efforts of the California Bay-Delta Authority and the other CALFED State agencies on solving conflicts associated with Delta water supply, water quality levee stability, and the environment.
- A 10-year action plan for financing to be developed in coordination with stakeholders and our federal partners that will focus on solving the highest priority Delta issues.

Improve Flood Management

The need for adequate flood management is more critical now than ever before. While the flood protection system—constructed over the past 100 years—continues to age, budget shortfalls have meant the deferral of maintenance. In addition, new knowledge of levee instability factors, changing rainfall patterns, and increased development in floodplains has combined with the above trends to put the State's financial stability and the safety of its people at risk. California needs aggressive investment in the State's flood management system and a change in the way we think about flood management.

Compounding these challenges are recent court rulings. Appellate court decisions have exposed the State and local agencies to enormous liability for failing to investigate the condition of flood control facilities that were made a part of a larger system, and for failing to challenge environmental constraints on maintenance activities.

It has become clear that a new approach to flood management is needed. Flood management in the Central Valley needs an approach that will achieve both short-term and long-term solutions. This approach should include a set of strategies that involve policy changes, program reforms, and funding proposals to better protect California from the devastating consequences and economic impacts caused by floods. These strategies include: improved maintenance, system rehabilitation, removal of structures from some flood-prone areas, and restoration of ecological/geomorphological/hydrological functions, better emergency response, sustainable funding for flood management programs, better flood mapping, and public education. Legislative and constitutional actions may include stronger flood insurance requirements, a Central Valley flood control assessment district, or a reduction in taxpayer exposure for funding flood disaster claims. These actions will ensure that people who choose to live or work in floodplains are aware of the hazards, pay for flood protection systems, and bear the consequences of floods.

Flood management cannot occur in isolation; whenever possible it must be a part of multi-objective management of floodplains, integrated with other objectives such as ecosystem restoration and farmland protection. For example, the priorities of the CALFED Bay-Delta Program Ecosystem Restoration Program include restoration of floodplain habitat, riparian corridors, and dynamic river processes such as river meandering. The ERP identifies ways to copy natural flows using reservoir releases; copy natural flows of sediment and woody debris; and provide enough high flows to cover floodplains. The program recognizes that reconnection of rivers with their floodplains may be essential for recovering many at-risk species.

Sustain the Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta is the hub of California water management and a vital aquatic ecosystem. Public and private entities carry out myriad activities to maintain the benefits that California derives from this great estuary: the State Water Resources Control Board sets water quality standards; the State Water Project and Central Valley Project operate to meet these standards; federal, State, and private entities preserve land as habitat; farmers till 500,000 productive acres.

The common denominator among all these pursuits is the Delta levee system. These levees protect water supplies needed for the environment, agriculture, and urban uses. Delta levees also protect roadways, cities, towns, agricultural lands, as well as terrestrial and aquatic habitat. The CALFED Levee System Integrity Program Element was established to help protect the Sacramento-San Joaquin River Delta from flooding and the Delta's ecosystem and water supply functions from damage and disruption due to levee failure. **DWR is working with other agencies to develop the Delta Risk Management Strategy.** Development of the DRMS includes an assessment of levee failure risks; a detailed analysis of the consequences of levee failure, including water supply, environmental, and economic impacts; and the development of a strategic plan to reduce risks, as described in Box 2-6 Delta Risk Management Strategy.

Despite their importance, there are many factors that make it quite challenging to sustain the Delta levees and the benefits they protect.

- Subsidence of Delta islands continues to occur where peat soils oxidize, increasing the pressure on levees that protect the islands.
- A catastrophic earthquake in or near the Delta might cause multiple levee failures that would draw seawater into the Delta, rendering the water unfit for irrigation or human consumption until levees were repaired and seawater was flushed from the Delta.
- Climate change is causing sea levels to rise and may also increase the magnitude of floodflows.
- Maintenance and improvement of Delta levees is costly, and available funds have not kept pace with needs.
- Levee failures are extremely costly to repair, further burdening the ability to fund adequate maintenance and rehabilitation.

Box 2-6 Delta Risk Management Strategy

The Sacramento-San Joaquin Delta is susceptible to catastrophic damage according to various possible levee failure scenarios. Among many possible consequences, levee failure in the Delta could result in the loss of human life, irreparable harm to the Delta's fragile ecosystem and its listed and endangered species, temporary or long-term disruption of the water supply for about two-thirds of the state's residents and much of its agriculture, and economic losses in the billions of dollars.

The Department of Water Resources and the U.S. Army Corps of Engineers, in conjunction with the California Department of Fish and Game, are developing the Delta Risk Management Strategy. Development of the DRMS will require an intensive multiyear effort for:

- evaluation of the ongoing and future probability of levee failure due to a variety of possible causes over the next 50 years;
- identification and assessment of the probable physical and related economic consequences of levee failure, including the loss or impairment of human life, property, public infrastructure, water supply operations, ecosystems, agriculture, recreation and navigation;
- identification and evaluation of actions that can be taken to reduce the probability and consequence of levee failure;
- setting of both short-term and long-term priorities for reducing the probability and impact of levee failure; and,
- development of an action plan to include alternate risk reduction strategies for the Delta.

Development of the DRMS is consistent with the 2000 CALFED Record of Decision Preferred Action Alternative which describes actions, studies, and conditional decisions necessary for preserving and improving the Delta. Development efforts will include a public and stakeholder involvement process.

Additional information concerning the development of the DRMS can be obtained from the Department of Water Resources' Division of Flood Management.

The Sacramento-San Joaquin Delta, like the Central Valley flood control system, needs a comprehensive, long-term vision and plan that will achieve both short-term and long-term solutions. This approach should maintain the services and values we get from the Delta and should be sustainable over the long term.

Near-term Actions to Implement Initiative 2

In addition to maintaining and improving statewide water management systems, we must use water and operate facilities more efficiently in all regions of the State. Water conservation must play a key role in this process because conservation practices increase efficiencies, are generally cost-effective, and reduce overall demands on facilities. Increasing operational flexibility will also be important, especially with the SWP and CVP. Projects that increase operational flexibility, such as the SWP-CVP intertie planned as part of the Delta Improvements Package, can provide water managers with a wider range of options to meet water supply reliability needs (see Box 2-7 Delta Improvements Package). During critically dry periods, a Water Transfers Dry Year Program[3] similar to earlier programs could also add flexibility and help optimize water infrastructure operations.

As efficiency increases and water is made available for longer-term use, additional groundwater and surface water storage will be needed in some regions for operational flexibility. However, some regions may not need to invest in more storage facilities because existing storage capacities and available water supplies vary from region to region. Water storage needs should be considered from a more local perspective in integrated regional water management plans to more accurately account for regional conditions.

Improvements for more efficiency and flexibility in statewide water management systems include new, suitably located physical facilities, operational commitments, and special water transfer programs.

- DWR, in cooperation with the California Bay-Delta Authority (CBDA) and CALFED implementing agencies, will implement actions in the CALFED Record of Decision, namely the Delta Improvements Package and other CALFED programs, including the Ecosystem Restoration, Water Quality, Levees, and Water Use Efficiency programs, its Science Program and the Interagency Ecological Program.
- DWR will develop and carry out a comprehensive flood management plan. DWR has prepared a White Paper that addresses the need for an aggressive investment in the State's flood management system (DWR 2005).

Box 2-7 Delta Improvements Package

The Delta Improvements Package outlines actions related to water project operations in the Sacramento-San Joaquin Delta that will result in increased water supply reliability, improved water quality, environmental protection and ecosystem restoration, protection of the Delta Levee system, and analyses and evaluation to support improved real-time and long-term management.

It also outlines conditions under which the State Water Project would be allowed to increase its permitted export pumping capacity from 6,680 to 8,500 cubic feet per second. In addition to the commitments in the CALFED Record of Decision to avoid adverse fishery impacts and to protect in-Delta water supply reliability and water quality, these conditions include the following:

- Construction of permanent operable gates in the South Delta
- Development of a salinity management plan for the San Joaquin River
- Improvements to protect water quality near the Contra Costa Canal
- Environmental protection for important native fish species, including implementation of the Ecosystem Restoration Program
- Development of a long-term Environmental Water Account

See Volume 3, Chapter 12 "Sacramento-San Joaquin Delta Region" for discussion of some package components.

More on Web site at: http://www.calwater.ca.gov/DeltaImprovements/DIP/DeltaImprovementPackage.shtml#CURRENT

[3] http://www.watertransfers.water.ca.gov/water_pgms/water_pgms_index.cfm

- DWR and the U.S. Army Corps of Engineers, in conjunction with the California Department of Fish and Game, will prepare the Delta Risk Management Strategy to evaluate the probability of Delta levee failures in the next 50 years, estimate the impacts and economic consequences from levee failures, propose actions to reduce the probability of levee failures and their con sequences, and develop a strategic action plan with alternative strategies to reduce risk for the Delta.
- DWR, in cooperation with the regional partners, will complete feasibility studies of additional surface storage in the CALFED Record of Decision. California should pursue projects that have regional support and viable financing plans.
- DWR will help resolve long-standing water quality issues in the state, such as Delta salinity, dissolved oxygen in the San Joaquin River near Stockton, salinity at Vernalis, and ecosystem restoration flow needs, extending from the Klamath River in the north to Salton Sea in the south.
- DWR will develop and administer a Dry Year Water Transfer Program when needed to meet critical water needs during shortages while protecting regions with available supplies.
- DWR, in cooperation with the CBDA and other State and federal agencies, will continue to evaluate and, if feasible, implement a long-term Environmental Water Account.
- DWR and State agencies should advance water planning and management that restore and protect watersheds and assess instream flow demands needed to protect and restore aquatic ecosystems.
- CBDA works with CALFED agencies to develop a comprehensive list of tasks being conducted under the CALFED Bay-Delta Program, to prioritize the tasks in cooperation with the CBDA public advisory committee, to develop a schedule for completing the tasks, and to estimate funding necessary to continue work.

Performing Essential Support Activities

Critical parts of the Framework for Action are the foundational actions needed for sustainable water uses and the two initiatives for reliable water supplies. Underlying these parts are essential activities that provide support for the Framework over the long term. A number of the water plan's recommendations focus on these essential support activities (see Chapter 5 Implementation Plan for details).The essential support activities are:

- Provide State Government Leadership and Develop Funding Methods to provide more effective leadership, assistance, and oversight in order to gain efficiency, clarify roles and responsibilities, develop funding strategies, and clarify the role of public investments

Box 2-8 Benefit-based Approach for Financing

The use of a benefit-based approach for financing will involve certain requirements. Cost-benefit analysis should ensure that the value of a project is greater than its costs and non-monetary benefits are captured in the process. Because the nature of certain types of benefits will not always allow for comparison of costs and benefits on a dollar-for-dollar basis, it is crucial that decision-makers carefully characterize all project benefits and that potential beneficiaries participate in determining how much they are willing to pay for specific levels of those benefits.

Fundamental to all these activities is a need for clear, consistent, and mutually agreed-upon terms that can be used in discussions and decision-making about financing. Terms such as benefit and baseline must be defined or replaced to ensure that all groups participating in project financing have a consistent frame of reference. In addition, principles of environmental justice must be used to protect groups such as disadvantaged communities from being unfairly burdened by project costs.

As part of a benefit-based process, public funds should be used responsibly and not create unfair advantages for private interests. Public funds should be used to pay for project actions that lead to broad public benefits, such as ecosystem restoration or other benefits that cannot be linked to a particular set of beneficiaries. The exceptions to this include actions that initiate local investment in new water management approaches and technology and situations where environmental justice calls for public assistance to help communities in need.

- Invest in Promising Technology to capitalize on new water technologies, increase scientific understanding, adapt for global climate change impacts, and improve water data management and analyses
- Ensure Equitable Decisions by increasing tribal participation and access to funding and assuring water decisions are equitable across all communities.

Provide State Government Leadership and Develop Funding Methods

California has a large network of complex water systems with a highly decentralized system of governance involving State and federal agencies; thousands of local agencies, governments, and private firms; and millions of households and farms. The differing roles of various agencies can create coordination problems, especially when integrating regional management efforts.

Moreover, legal mandates often prevent State agencies responsible for managing natural resources from making the tradeoffs needed for comprehensive, regional solutions to water management problems. Competing or conflicting agency mandates often complicate coordination of regional efforts. Also, these mandates and agency organizational structures can impede communication and cooperation between the numerous State agencies and departments responsible for water resource management. State government should realign its expertise and resources to better support integrated regional water management, both by integrating the activities of government agencies and by developing better methods for financing water management projects.

To begin to address the maze of roles and jurisdictions governing water management in California, State government should lead an effort to examine where the mandates and jurisdictions of State, federal, and local governments and agencies managing water resources conflict with or complement each other. Efforts should include providing timely regulatory approvals and preventing conflicting rules or guidelines.

One of the key problems facing policymakers is deciding who ultimately should pay for the different actions needed to improve California's water management system. A great deal of debate surrounds the State and federal roles in funding local and regional projects, and local, State, and federal governments and water agencies all have significant financing and implementation roles. The CALFED Bay-Delta Program has advanced a benefit-based approach where costs are repaid in a way that considers what groups are receiving the benefits and the relative magnitude of those benefits obtained by each beneficiary. (See Box 2-8 Benefit-based Approach for Financing and also Volume 4 Reference Guide article "Financing Strategies and Guidelines for Water Resource Projects."). A benefits-based approach, used in conjunction with the principles of fairness and environmental justice, should serve as a solid foundation for financing water resource projects throughout the state. The 2005-2006 State Legisla-

Box 2-9 Long-term, Reliable, and Stable Funding Sources for California Water Management

California must make significant investments in its water management system in order to assure a vital economy, a healthy environment, and a reliable water supply for its citizens. No single source of funding will meet these needs. Instead, a mix of federal, State, and local (public and private) funds will be needed to assure adequate investment.

A realistic funding strategy requires long-term, reliable, and stable funding sources for California water management. Two widely agreed upon components of a realistic funding strategy are:

- Local public and private funding is most appropriate for water projects and programs that provide directly assignable water supply reliability benefits to specific water users. Sources of local public and private funding include local water use fees, assessments, and locally financed bonds.
- Statewide public funding is best used for the broadest public benefits, such as enhancing our environment, protecting the quality of the state's water supplies, and advancing water management initiatives of statewide importance. Sources of statewide public funding include general obligation bonds, revenue bonds, State General Fund, and federal appropriations.

continued

ture is considering Senate Bill 113 (Machado), related to the beneficiary pays principle: "The bill would provide that, for the purposes of implementing the act and subject to certain exceptions, State funds shall fund projects that have public benefits, non-State funds shall fund projects that have private benefits, and both project beneficiaries and the public are responsible for costs associated with a project that has both private and public benefits."

In order to develop reliable, long-term funding sources for water initiatives in California, State government should use alternative financing methods such as revenue bonds, regional partnerships, joint powers authority bond pooling arrangements, infrastructure-for-water transfers, and other innovative techniques. User fees, suggested under the CALFED Bay-Delta Program, should also be considered as a potential long-term funding source. **While general obligation bonds will continue to have a place in water project financing, new methods that follow a benefit-based approach broaden the portfolio of funding tools available to the State.** (See Box 2-9 Long-term, Reliable, and Stable Funding Sources for California Water Management.)

To meet future governance and funding challenges, the following near-term activities are recommended:

- State government should continue to provide leadership, assistance, and oversight to protect public health and safety, especially with regard to drinking water quality, dam safety, and flood management.
- State government should provide technical assistance for efforts involving interregional, interstate, or international issues or for efforts creating broad public benefits.
- State agencies should integrate their expertise and resources to support integrated regional water management.
- State government should lead an effort to examine where the mandates and jurisdictions of State, federal, and local governments and agencies conflict with or complement each other to streamline and coordinate theroles and jurisdictions governing California water management.
- State government should use a benefit-based approach to develop long-term, reliable funding sources for water projects in a way that accurately characterizesbenefits, uses public funds responsibly, and follows the principles of equity and environmental justice.

Invest in New Water Technology

California must capitalize on promising technologies, increase our scientific understanding, and improve data management and analysis to support better business and policy decisions related to water resources. To produce and carry out useful integrated water management plans, managers and planners need access to promising and affordable water technologies, as well as current, accurate data and reliable analytical tools to evaluate the benefits and risks of planned water management actions. Knowledge from such evaluations allows water managers to make better decisions.

Box 2-9 continued from previous page

To provide a base level funding source, California Department of Water Resources proposes the establishment of a new investment fund that would be sustained primarily through a modest fee on each retail water bill. The fee will provide a stable base level of funding to supplement and leverage other State and local funding. The fee will generate annual funds towards implementation of integrated regional water management plans throughout the state and in advancing statewide water management initiatives. The Department of Water Resources also proposes using general obligation bonds to provide water management investments under the new fund. Most of this bond money would provide grants to communities and regions, and would leverage substantial local investments.

Cost estimates for implementing all the strategies in California Water Plan Update 2005 range from about $40 billion to $120 billion over 25 years. However, the overlap among some strategies (such as conservation and recycling) means that not all strategies need be fully implemented. The new investment fund, periodic general obligation bonds, federal appropriations and local financing together could provide reliable and stable water management funding in a range of $2 billion to $3 billion per year, making a 25-year investment of about $50 billion to $75 billion achievable.

State government should invest in research and development for promising water technologies and those that improve our ability to predict the effects of global climate change. State government should also encourage pilot projects and focused research incorporating knowledge and experience specific to each region (see Box 2-10 Case Study of State Investment in Research and Development). For its part, DWR will carry out the following actions in the near-term:

- DWR will work with other State agencies to develop biannual reports on the impacts of global climate change, including impacts to water supply, and will prepare and report on mitigation and adaptation plans in accordance with Executive Order S-3-05 signed by the Governor of California June 1, 2005.
- DWR will work with other State agencies to develop and help implement strategies to reduce greenhouse gas emissions in the State in accordance with the goals established by Executive Order S-03-05. DWR will provide expertise to help identify means of energy savings for the storage, conveyance, distribution, and use of water. DWR will describe the energy use characteristics of various resource management strategies in the next California Water Plan.
- DWR will evaluate management responses to potential impacts of global climate change on the State Water Project and California's hydrology.
- DWR will work with California research and academic institutions to identify and prioritize applied research projects.
- DWR will work with other State agencies and in coordination with the Interagency Ecological Program and CALFED Science Program to invest in a broad and diverse scientific agenda that will fill the gaps of knowledge about California's water resources.
- DWR will work with State agencies to help in the collection of data and analysis of instream flows.
- The Resources Agency should continue to support development and use of statewide natural resource databases, analytical tools and evaluation criteria to identify priorities for ecosystem restoration and provide information to planners and decision-makers. This investment would provide a coor-dinated and comprehensive ecosystem restoration plan for the entire state by region. See other recommendations of Resource Management Strategy Ecosystem Restoration in Volume 2, Chapter 9.

Box 2-10 Case Study of State Investment in Research and Development

As part of the deregulation of California's electric power sector in the late1990s, the Legislature and Governor established within the California Energy Commission the Public Interest Energy Research (PIER) Program to offset the reduction of certain resources, including the expected loss of research-and-development resources provided by Investor-Owned Utilities (IOUs). The PIER Program mission is to support research, development, and demonstration (RD&D) activities that are not otherwise adequately supplied by energy markets, such as energy planning and forecasting, efficiency, reliability, and environmental benefits and impacts.

Through partnerships with organizations in various economic sectors, the PIER program focuses primarily on six subject areas: renewable energy; environmentally preferred advanced generation; buildings end-use energy efficiency; demand-side technologies (which include pollution mitigation, pumping, and water treatment technologies); energy-related environmental research; and energy systems integration. The Legislature has authorized approximately $60 million per year for PIER through 2012, funded by an electrical consumption surcharge collected via the IOUs. Funding decisions incorporate an open stakeholder-based process to help identify RD&D needs, seek to leverage research funds with other sources and organizations, and use an independent program review and evaluation process. Of course, beyond the PIER Program, other RD&D models exist, including water industry organizations such as the National Water Research Institute, academic institutions such as the International Center for Water Technology at California State University, Fresno, and federal agencies operating pursuant to the Federal Technology Transfer Act.

Box 2-11 Consideration of All Competing Needs

Environment, economy, and social equity—known as the three E's—are vehicles to sustainability and help ensure that competing needs are met when evaluating and implementing the management strategies included in integrated resource planning. Many agencies already consider these factors in their resource evaluations. In most areas of government decisions, the application of environmental justice policy takes place at the local level.

Environmental Evaluation

As the linkage between water management and the health of the natural infrastructure are understood, the benefits of restoration to water supply reliability and water quality improvements become increasingly evident. Environmental evaluation begins with recognition that "environment" consists of both the natural environment and the environment built by people so they can live, work, and produce. Environmental evaluation includes an assessment of environmental protection and ecosystem restoration opportunities relative to water supply reliability and water quality. Storing and transporting water from one part of the environment for use in another creates change, which needs to be evaluated. Change in water use affects water quality and ecological, hydrological, biological, and other environmental resources in the natural and the constructed environment. Tradeoffs between existing and new water uses need to be evaluated. Water uses that benefit the natural environment must be considered even if they adversely impact agricultural and urban water users. In addition, when changes in trust-protected resources are proposed, public trust values must be considered and protected when feasible.

Social Equity Evaluation

The environmental justice movement began as a grassroots response to unequal enforcement of environmental, civil rights, and land use laws. The most obvious disparities involved environmental harms and benefits (for example, water quality) affecting some communities, faulty assumptions in risk assessment, discriminatory land use practices, and exclusionary policies and practices that limit public participation. Disparities can be less obvious when it comes to water use and allocation. For example, third party impacts from transferring water from agriculture to accommodate urban growth can disproportionately impact migrant worker communities. Although the relevance of environmental justice in this case is limited to the extent that economic conditions drive human and environmental health, the State has enacted eight laws specifically regarding environmental justice since 1999 (see Volume 4 Reference Guide article "Environmental Justice in California Government").

Economic and Financial Evaluation

Economic evaluation includes a range of considerations such as capital, operations, maintenance, mitigation, and financing. Capitalization of annual costs and benefits is also necessary because it provides a common basis for comparing alternatives that are subject to (1) benefit-decay (for example, some plumbing retrofit incentives) and (2) inter-annual variability of costs and benefits.

Historically, water agencies have primarily accounted for the direct construction and operation costs of additional water supply facilities. Today, most cost accounting also includes demand management programs and project mitigation costs. Increasingly, people are identifying additional costs for more complete mitigation they believe should be included in cost accounting for water systems.

Beyond quantification, how the costs and benefits are allocated among stakeholders is an important component of any plan. Cost recovery mechanisms must be framed and in place prior to implementation. In addition, nonmonetary costs and benefits must be taken into account.

Water managers need the data and advanced modeling tools to answer a complex array of questions about water use patterns, surface water and groundwater interactions, water quality, and the environmental and economic effects of water management decisions. For planning purposes the data and analytical tools must help planners predict a range of plausible future conditions and interactions on statewide and regional levels; they must enable planners to compare outcomes of various combinations of water resource management strategies. To begin tailoring data and analytical tools for use in predicting plausible future conditions and interactions on statewide and regional levels, DWR will carry out the following actions:

- DWR with regional input will develop a general checklist of issues, resources, data, and analytical tools as well as guidelines to aid regional integrated resource planning.
- DWR will select and/or develop the analytical tools and data in support of the next water plan update.
- DWR will develop the Water Plan Information Exchange (Water PIE) for collecting and sharing data and networking existing databases and Web sites, among State, federal, regional, and local agencies and governments and citizen monitoring efforts, to improve analytical capabilities and developing timely surveys of statewide land use, water use, and estimates of future implementation of resource management strategies.
- DWR will participate in efforts by the California Water and Environmental Model Forum to develop a vision and carry out a plan for long-term improvement of analytical tools and data for statewide planning.

Because State government is responsible for evaluating the interaction of water supplies between regions, it must assess the potential system-wide impacts and tradeoffs of proposed integrated regional water resource management plans to help ensure that, taken together, they will protect public trust resources and provide for beneficial use of water supplies. To accomplish this, **State government should invest in cooperative data collection and management for regional integrated water management plans.** At a minimum, this investment of resources should develop data standards, improve water data management systems, and expand and simplify public access to water resource data.

Ensure Equitable Decisions

To provide reliable, affordable, good quality water from a diversity of sources and design comprehensive, integrated regional water management plans that are likely to succeed, California water planners and decision-makers must consider all competing needs and develop plans that take into account potential impacts on social equity, as well as the environment and the economy. Water management decisions that adversely affect disadvantaged communities can incur costs that ripple through broader, regional communities and undermine long-term, sustainable water resource use. (see Box 2-11 Consideration of All Competing Needs).

As much as possible, **water managers evaluating water management strategies must make decisions that promote environmental protection, ecosystem restoration, social equity and environmental justice —** the fair treatment of people of all races, cultures, and incomes with respect to the development, funding, and implementation of resource management projects. The following actions are recommended to promote equitable water management decisions:

- DWR and other State agencies should invite, encourage, and assist tribal government representatives to participate in statewide, regional, and local water planning processes and access State funding for water projects.
- State agencies should include tribal water concerns and water uses in future water plan updates and should engage appropriate local, State, and federal agencies to resolve tribal water issues that are identified.
- DWR and other State agencies should encourage and assist representatives from disadvantaged communities and vulnerable populations, and the local agencies and private utilities serving them, to participate in statewide, regional, and local water planning processes and to get equal access to State funding for water projects.

Looking to the Future

California needs sustainable water uses and reliable water supplies through 2030. Californians can secure this water supply for the future by making the right choices and the necessary investments. To ensure that water use is sustainable, California groundwater and surface water management must be based on three foundational actions: use water efficiently, protect water quality to get maximum utility from existing supplies, and manage water in ways that protect and restore the environment. These actions support two initiatives that water management must pursue to ensure reliable water supplies: first, promote and practice integrated regional water management; and second, maintain and improve statewide water management systems, the backbone of water management in California.

California faces big water management challenges in the future, especially during extended drought periods and flood events. Fortunately, there are tools available to cope with these challenges. There are a host of strategies that will help ensure successful management of groundwater and surface water and related natural resources. Californians need only to marshal the cooperation and dedication to implement these strategies.

In future Water Plan updates, we will refine our ability to measure water use and project the effects of our management strategies. For now, California Water Plan Update 2005 provides a guide to invest in the right choices so our state has the water needed for our people, our growing economy, and the environment in the years to come. Working together, we can secure our water future for the next generation of Californians.

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Statewide water management systems include physical facilities and statewide water management systems. Facilities are the backbone of water management in California. Water management systems, like water quality standards, monitoring programs, and statewide water efficiency programs help meet major State government responsibilities for statewide water planning and ecosystem restoration. (DWR photo)

Chapter 3 *California Water Today*

About This Chapter

Chapter 3 California Water Today describes our natural resources and their influence in building the nation's largest economy and attracting a growing population. The chapter reports statewide and regional water challenges and how we are meeting those challenges with a variety of responses, including task forces and advisory committees, partnerships and integrated regional water management, programs, water bonds, water management systems, research and reports, legislation and regulation. Finally, the chapter recounts the many facets of California's water rights, usage, and allocation.

- Setting
- Challenges
- Responses
- Understanding How Water Is Allocated, Used, and Regulated

Setting

California boasts some of the world's most beautiful land and richest soil, which support an economy that is the largest and most diverse in the nation. Planning and management of California's water resources require full and balanced consideration of its people, environments, businesses, land uses, climates, geology, and variable hydrology.

Climates, Ecosystems, Physical Settings

California is a state of contrasts and diversity. The highest (Mount Whitney) and lowest (Death Valley) points in the contiguous United States are not far from each other. The range of annual rainfall varies greatly from more than 140 inches in the northwestern part of the state to less than 4 inches in the southeastern part (DWR 2003 Bulletin 118). Being about a thousand miles from its northwest to southeast corners, California is the third largest state in the nation. Its geomorphic features include the Klamath Mountains, Modoc Plateau, Cascade Range, Central Valley, Sierra Nevada, Coast Range, Great Basin, Transverse Ranges, Mojave Desert, Peninsular Ranges, and Colorado River Desert (Figure 3-1 Map of California's major geomorphic features).

Precipitation varies widely in California—from place to place, from season to season, and from year to year. Climate is dominated by the Pacific storm track. Most precipitation and runoff occur in the northern part of the state. The numerous mountain ranges cause orographic lifting of clouds, producing precipitation mostly on the western slopes and leaving a rain shadow on most eastern slopes. Snowmelt and rain falling in the mountains flow into creeks, streams, and rivers. As flows make their way into the valleys, much of the water percolates into the ground.

Groundwater and surface water are inextricably linked in the hydrologic cycle. The vast majority of California's groundwater that is accessible in significant amounts is stored in alluvial groundwater basins, which cover nearly 40 percent of the geographic area of the state (DWR 2003 Bulletin 118). Groundwater supplies contribute water used for beneficial purposes. Interbasin storage and transfer projects allow for redistribution of water to where it is needed for crops, people, and industry (Figure 3-2 Map of California with major rivers and facilities).

The state's ecosystems, from mountain watersheds to coastal beaches to inland deserts have been called California's natural infrastructure, supporting its population and economic growth. These varied environments also support an estimated 5,000 native flora species—more than one-third are unique

Figure 3-1 Map of California's major geomorphic features

Being about 1,000 miles from its northwest to southeast corners, California is the third largest state. Its geomorphic features include the Klamath Mountains, Modoc Plateau, Cascade Range, Central Valley, Sierra Nevada, Coast Range, Great Basin, Transverse Ranges, Mojave Desert, Peninsular Ranges, and Colorado River Desert.

Figure 3-2 Map of California with major rivers and facilities

Snowmelt and rain flow into creeks, streams and rivers, and much of the water percolates into the ground as it makes its way into the valley. Interbasin storage and transfer projects allow redistribution of water to where it is needed for crops, people, and industry.

to California—and 1,000 introduced species (CERES 2003). Diverse landforms have preserved unusual species like giant redwoods and made homes for hundreds of species of birds, mammals, and reptiles.

Since the 1800s, California's natural infrastructure has experienced aquatic and riparian habitat degradation and declines in freshwater biodiversity. Hydraulic mining and gold extraction in the 1800s, dam construction and operation, pollution, flood control, urbanization, increases in Sacramento-San Joaquin Delta exports and upstream diversions, and introduction of non-native species have all contributed to a decline in the state's watersheds, wetlands, and the health of our ecosystems. Flows on many rivers and streams currently do not resemble natural hydrographs. This is a contributing factor to impaired ecosystem functions, reduction and destruction of native species and habitats, impacts on commercial fisheries, and degraded water quality.

Industry, People, Social Setting

California has the largest and most diverse economy in the nation with a gross product of more than a trillion dollars, 13.5 percent of the U.S. total (DOF 2003). The economy is a mix of long-established industries such as agriculture and mineral extraction and emerging industries such as biotechnology, telecommunications, and computer technology. California has the largest manufacturing complex in the nation. Its natural beauty has helped make California the No. 1 travel destination in the United States. In addition to world-renowned beaches and rivers, we have wetlands and wildlife refuges for bird watching and hunting, activities that contribute hundreds of millions of dollars annually to the state's economy (See Figure 3-3 Gross state product, 1980-2001).

The state's multibillion dollar agribusiness makes California the nation's leading agricultural producer. California contributes more than half of the nation's fruit, nut, and vegetable production. Many counties rely on agriculture as a primary economic contributor. Providing food and fiber crop products to Californians, as well as to other states and countries, consumes more water than is consumed by all municipal and industrial uses. And it will continue to do so.

The location and timing of our variable water uses do not coincide with the state's natural water supplies. The Gold Rush spawned a technology of water movement that helped cultivate California's agricultural landscape and was used in the early 1900s to urbanize the San Francisco area and the Los Angeles Basin (Starr 2000). With the population boom after World War II, the state's urban centers spread, and a suburban, automobile-dependent style of community development became the hallmark of California. (See Box 3-1 Historical Perspective of Water Development in California.)

California's population increased from about 30 million in 1990 to about 36.5 million in 2004. The nation's most populous state is now growing by about 600,000 people per year. The California Department of Finance (DOF) projects that the population may exceed 48 million by 2030—an additional 12 million people[1]. By 2050 California's population may jump by more than 20 million people to reach a total of nearly 55 million, according to long-range population projections issued by DOF in May 2004. Figure 3-4 depicts the state's total population and growth from year 1960 through year 2000, plus DOF's most recent projections to year 2030.

The DOF projections indicate the majority of Californians will continue to reside in Southern California, and Los Angeles will remain the most populous county in California, exceeding 11 million people in 2050. Riverside is projected to overtake Orange County and become the third most populous county behind San Diego.

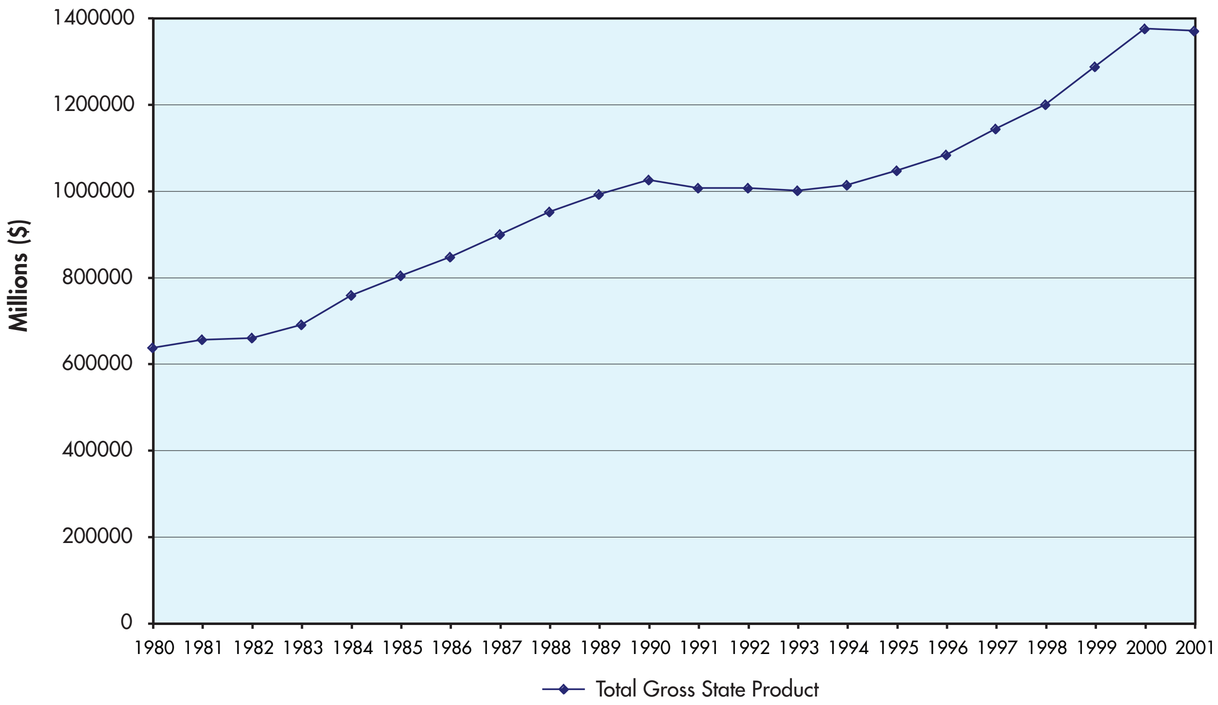
In California's Central Valley, San Joaquin County is expected to triple in size and experience the greatest percentage increase over the 50-year period—200 percent. Other counties with large projected percentage increases include Merced, Placer, and Madera (DOF 2004).

Water Uses, Supplies, and Quality

From a statewide perspective, California meets most of its agricultural, municipal, and industrial water management objectives in most years. Most of our demands are being met with the help of advances in water conservation and recycling, combined with infrastructure improvements including new storage and conveyance facilities. Except in multiyear droughts, most urban areas have sufficient supplies for existing populations. Cities use about the same amount of applied water today as they did in the mid-1990s, but accommodate 3.5 million more people. Water conservation and demand reduction strategies are expected to continue playing a prominent role in achieving future goals.

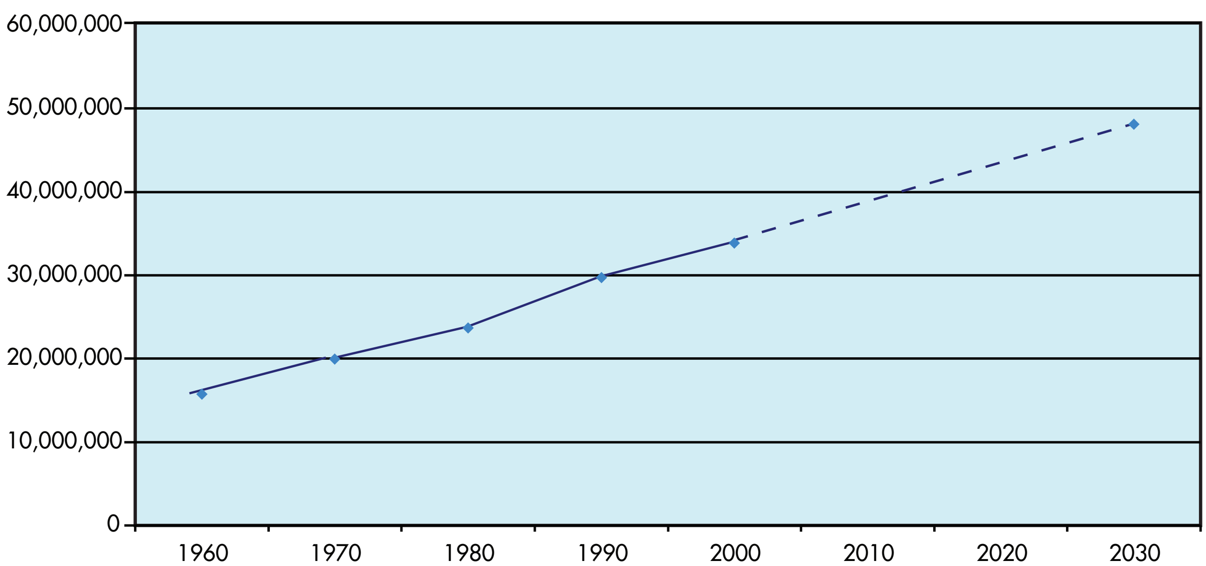
[1] The estimates of changes in future water demands presented in this water plan update are based on assumptions about future population growth for the period 2000 to 2030. For the Current Trends and Less Resource Intensive scenarios this corresponds to the Department of Finance estimates with a population increase of 14 million, from about 34 million in 2000 to 48.1 million in 2030. For the More Resource Intensive scenario this corresponds to a population increase of 18 million to a total population of 52.3 million in 2030.

Figure 3-3 - Gross state product, 1980-2001



California has the largest, most diverse economy in the nation with a gross product of more than a trillion dollars. It is a mix of long-established industries such as agriculture and mineral extraction, emerging industries such as biotechnology, telecommunications, and computer technology, entertainment and tourism.

Figure 3-4 California population, 1960–2030



The nation's most populous state is now growing by about 600,000 people per year. The California Department of Finance projects that the state's population may exceed 48 million by 2030 and 55 million by 2050.

Significant water supply and quality challenges persist on local and regional scales. Water quality is generally good, but many areas face specific water quality problems. Many rural residents on small water systems or wells experience limited water supply as well as water quality impacts during droughts. (See Regional/ Local Challenges later in this chapter.) Water supply and water quality are inseparable in water management. Some areas of California rely on over-pumping groundwater basins, which reduces long-term available water supply, increases pumping costs, and in some areas degrades groundwater quality. In many areas surface water and groundwater are impaired by natural and human-made contaminants that can threaten human health, degrade the natural environment, increase water treatment costs, and effectively reduce the available water supply.

Most agricultural water demands are met in average water years. Farmers have learned to grow more crops per acre-foot of applied water by improving productivity and efficiency. For example, from 1980 to 2000 the annual statewide harvest increased by 40 percent measured in tons of crops per acre-foot of applied water. However, in some areas, water sources once used for agriculture are now used for urban needs, environmental restoration, and groundwater replenishment. Even in average water years, some growers forgo planting and other agricultural operations because they lack a firm water supply.

From a statewide perspective, California meets most of its agricultural, municipal, and industrial water management objectives in most years. Most of our demands are being met with the help of advances in water conservation and recycling, combined with infrastructure improvements including new storage and conveyance facilities.

Box 3-1 Historical Perspective of Water Development in California

(From Water Education Foundation. Layperson's Guide to California Water, 2003 Edition)

During the Gold Rush, California miners developed a system of claiming rights to take and transport water. These fortune seekers built the state's first hydraulic works—reservoirs and more than 4,000 miles of ditches and flumes—to sluice out the elusive shining metal. Water was harnessed and blasted into hillsides to dislodge gold in a practice called "hydraulic mining." Debris resulting from these mining practices washed down from the mountains and choked rivers, inundated native salmon spawning grounds, and caused serious problems with flooding for navigation and downstream water users.

As the gold began to diminish, farming grew in the Delta and Central Valley and so did the need for a dependable water supply. While many areas experienced too little water, others had too much. In the maze of swamps, sloughs and marshlands that form the Delta, farmers began building levees around periodically submerged islands and pumped water from behind them to reclaim the land for agriculture. Between 1860 and 1930, most of the Delta's 1,150 square-mile area of freshwater marsh was leveed, drained, and planted.

Elsewhere, groundwater pumping enabled farms and cities to flourish despite the aridity of southern and central California. However, groundwater levels began to drop, which caused an increase in pumping costs. This pointed out the need for a more efficient distribution of the state's surface water supplies.

Groups of farmers banded together, and cooperatives and development companies formed to finance and construct water projects in the San Joaquin Valley and southern California. The inherent problems associated with placing control of such a vital, public resource in private hands brought a move toward increasing public control. The first irrigation district, Turlock Irrigation District, was formed under the Wright Irrigation District Act of 1887. The act evolved into the California Irrigation District Act of 1917 and paved the way for other types of water development and delivery districts, such as county water districts and special services districts. California's two major population centers, the Los Angeles and San Francisco Bay areas, recognized the need to augment local water supplies and were the first to develop faraway sources.

continued

Environmental requirements are not always met, although a considerable amount of water is dedicated to restoring ecosystems. Many flow regimes no longer resemble natural hydrographs, largely because of efforts to manage water storage and diversions to meet competing demands. We do not sufficiently understand ecosystem needs and their response to flow, but significant scientific advancement is taking place. We are seeing improvements when ecosystem needs are integrated with water management and project operations. (See Volume 2 Resource Management Strategies, Chapter 9 Ecosystem Restoration.)

California Water Plan Update 2005 presents a range of actual water conditions that have occurred in recent water years. Water year 1998 represents a recent wet year in California. Year 2000 is a representative average water year, and year 2001 provides a snapshot of a dry water year. (See Table 3-1 California water balance summary and Figure 3-5 California water balance [water source and applied water uses] for water years 1998, 2000, and 2001)

In average water years like 2000, California receives about 200 million acre-feet of water from precipitation and imports from Colorado, Oregon, and Mexico. Of this total supply, about 50 to 60 percent is either used by native vegetation, evaporates to the atmosphere, provides some of the water for agricultural crops and managed wetlands (effective precipitation), or flows to Oregon, Nevada, the Pacific Ocean, and salt sinks like saline groundwater aquifers and Salton Sea. The remaining 40 to 50 percent (denoted as dedicated supply) is distributed among urban and agricultural uses, used to protect and restore the environment, or stored in surface and

Box 3-1 continued from previous page

The federal government has long played a major role in development of the West's water resources. As early as 1875, the U.S. Army Corps of Engineers began work on the Sacramento and Feather rivers to improve navigation. In 1920, the U.S. Geological Survey proposed a comprehensive, statewide plan for conveyance and storage of California's water supplies. This plan served as the framework for an eventual State Water Plan, which later formed the basis for the federal Central Valley Project.

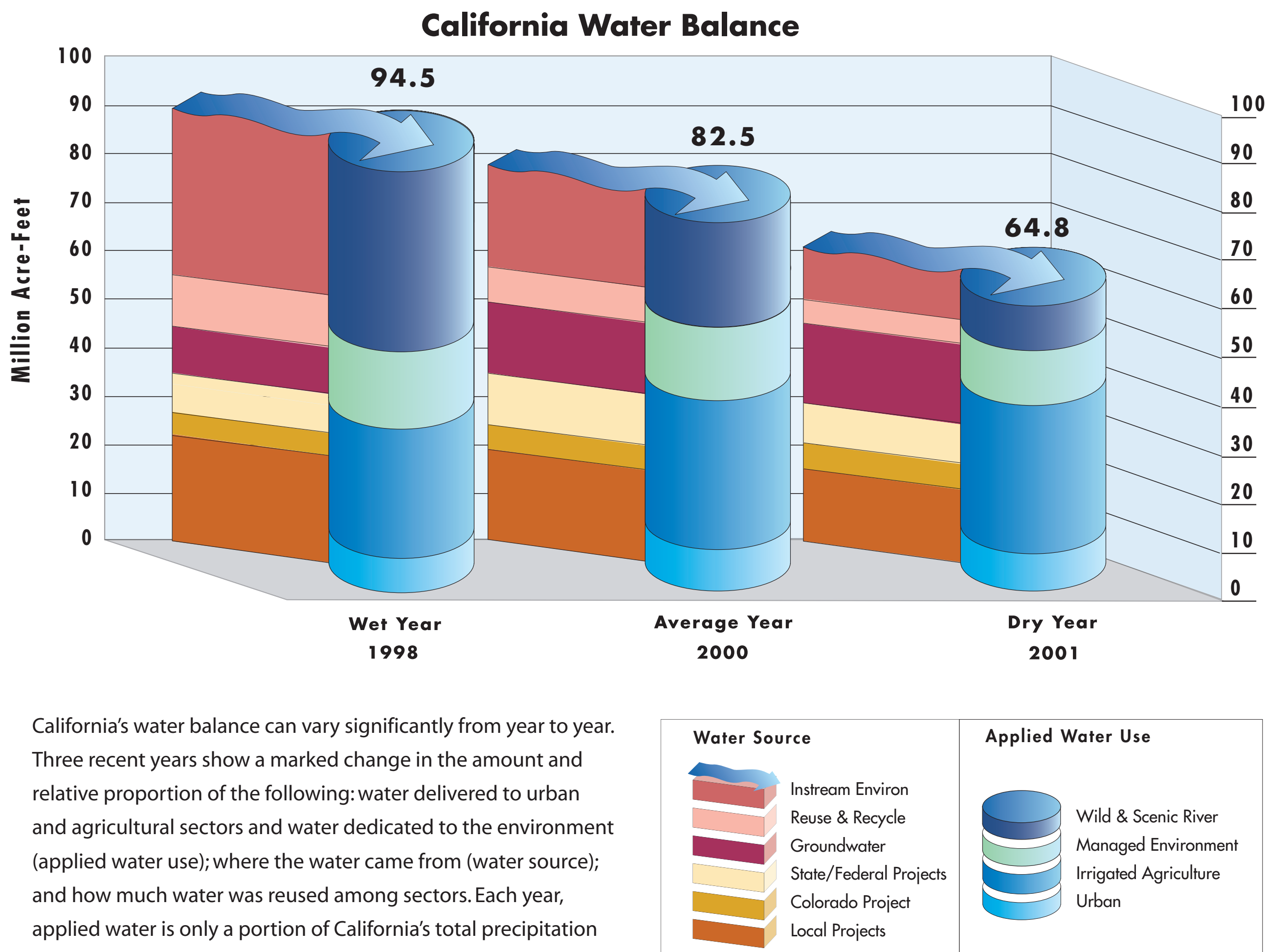
California's population doubled between 1940 and 1960. It appeared the state could not rely solely on federal or local sources to help meet future water needs. Water planners recognized the need for Delta improvement and for supplemental water to support growing southern California and prevent groundwater overdraft in the Central Valley. Additionally, the need for flood control on the Feather River was recognized, as was the San Joaquin Valley's need for an outlet for saline irrigation drainage for fields. After years of debate and study, the Porter-Burns Act and a $1.75 billion bond measure launched what was to become the State Water Project.

During the two decades following World War II, development of California's water was virtually unimpeded. But by the 1970s, environmental awareness had grown to an extent that environmental considerations came to be factored into the water supply equation. As a result of enactment of new laws, attention was focused on "instream use" of water to benefit fish and wildlife, recreation, water quality, and aesthetics—uses to which price tags cannot easily be attached. By 1990, these uses rivaled such traditional benefits as irrigation and navigation in importance. Such instream uses are recognized by the State constitution and Water Code as beneficial and must be considered in administrative decisions and in issuing water rights permits. Rising costs and the enactment of State and federal environmental legislation have resulted in few major water development projects being built since 1980.

Today hundreds of water utility districts supply Californians with water purchased by contract from the state or the federal government, bought wholesale from another water agency, or development with local resources. It is estimated that there are more than 3,700 public and private agencies in California dealing with some aspect of water supply, use, or treatment.

See also "A California Water Chronology" in Volume 4 Reference Guide.

Figure 3-5 California water balance for 1998, 2000, and 2001



California's water balance can vary significantly from year to year. Three recent years show a marked change in the amount and relative proportion of the following: water delivered to urban and agricultural sectors and water dedicated to the environment (applied water use); where the water came from (water source); and how much water was reused among sectors. Each year, applied water is only a portion of California's total precipitation and inflows. The rest—about 120 maf in an average year—either evaporates, is used by native vegetation, provides rainfall for agriculture and managed wetlands, or flows out of state or to salt sinks. (See Volume 3 for state and regional waterflow charts.)

groundwater reservoirs for later use. In any year some of the dedicated supply includes water that is used multiple times (reuse) and water stored from previous years. Ultimately, about a third of the dedicated supply flows to the Pacific Ocean (in part to meet environmental requirements) or to other salt sinks. Statewide, local surface water and groundwater supplies make up about 50 percent of California's total dedicated supply in an average water year (percentage varies regionally). Water also moves great distances in California within and between its 10 hyrological regions (see Figure 3-6 Regional inflows and outflows, year 2000 [an average water year]).

In wet and drier years, like 1998 and 2001, respectively, the total supply and the distribution of the dedicated supply to various uses differ significantly from the example above for an average year. For more information on the state's recent water supplies and uses, see Volume 3 Regional Reports, Chapter 1 State Summary.

Challenges

Californians continue to face a variety of water challenges, and State, federal, and regional agencies are meeting those

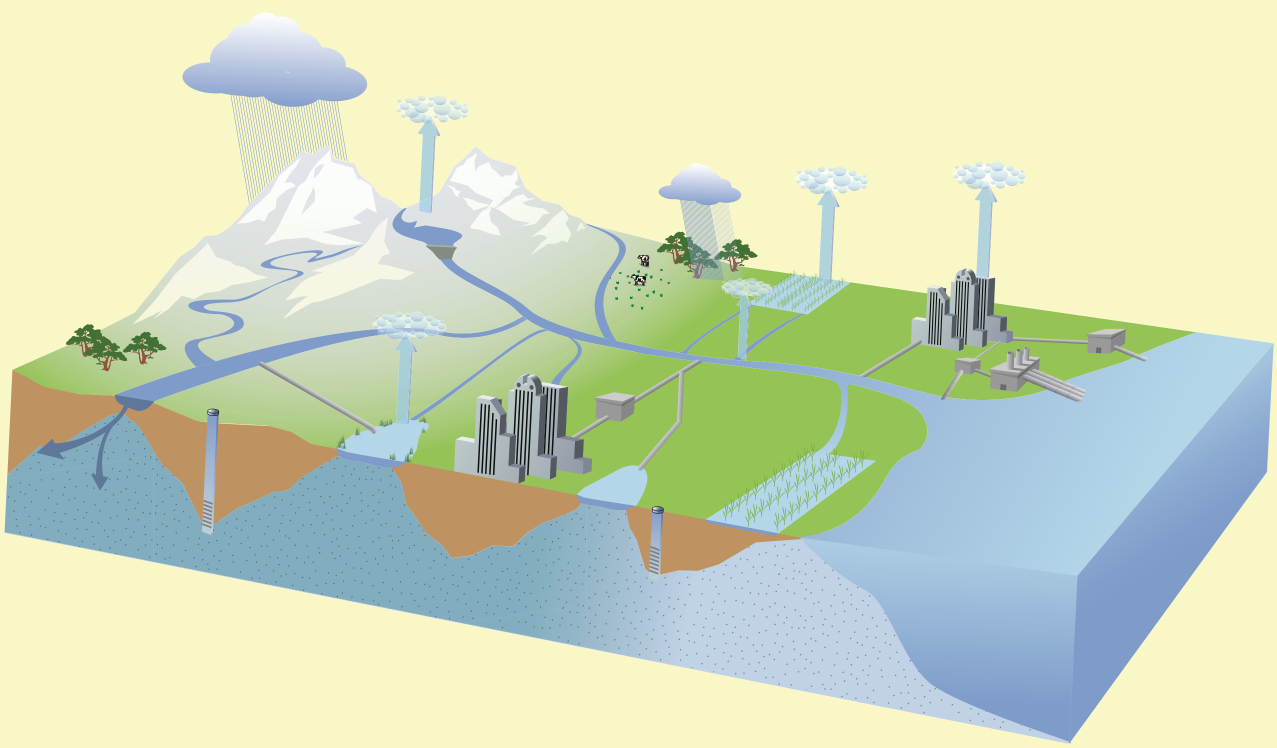
Table 3-1 California water summary (maf)

	1998 (171% of normal)[a]		2000 (97% of normal)[a]		2001 (72% of normal)[a]	
Total supply (precipitation & imports)	336.9		194.7		145.5	
Total uses, outflows, & evaporation	331.5		200.4		159.9	
Net storage changes in state	5.5		-5.7		-14.3	
Distribution of dedicated supply (includes reuse) to various applied water uses						
Urban uses	7.8	(8%)	8.9	(11%)	8.6	(13%)
Agricultural uses	27.3	(29%)	34.2	(41%)	33.7	(52%)
Environmental water[b]	59.4	(63%)	39.4	(48%)	22.5	(35%)
Total dedicated supply	**94.5**		**82.5**		**64.8**	

maf = million acre-feet

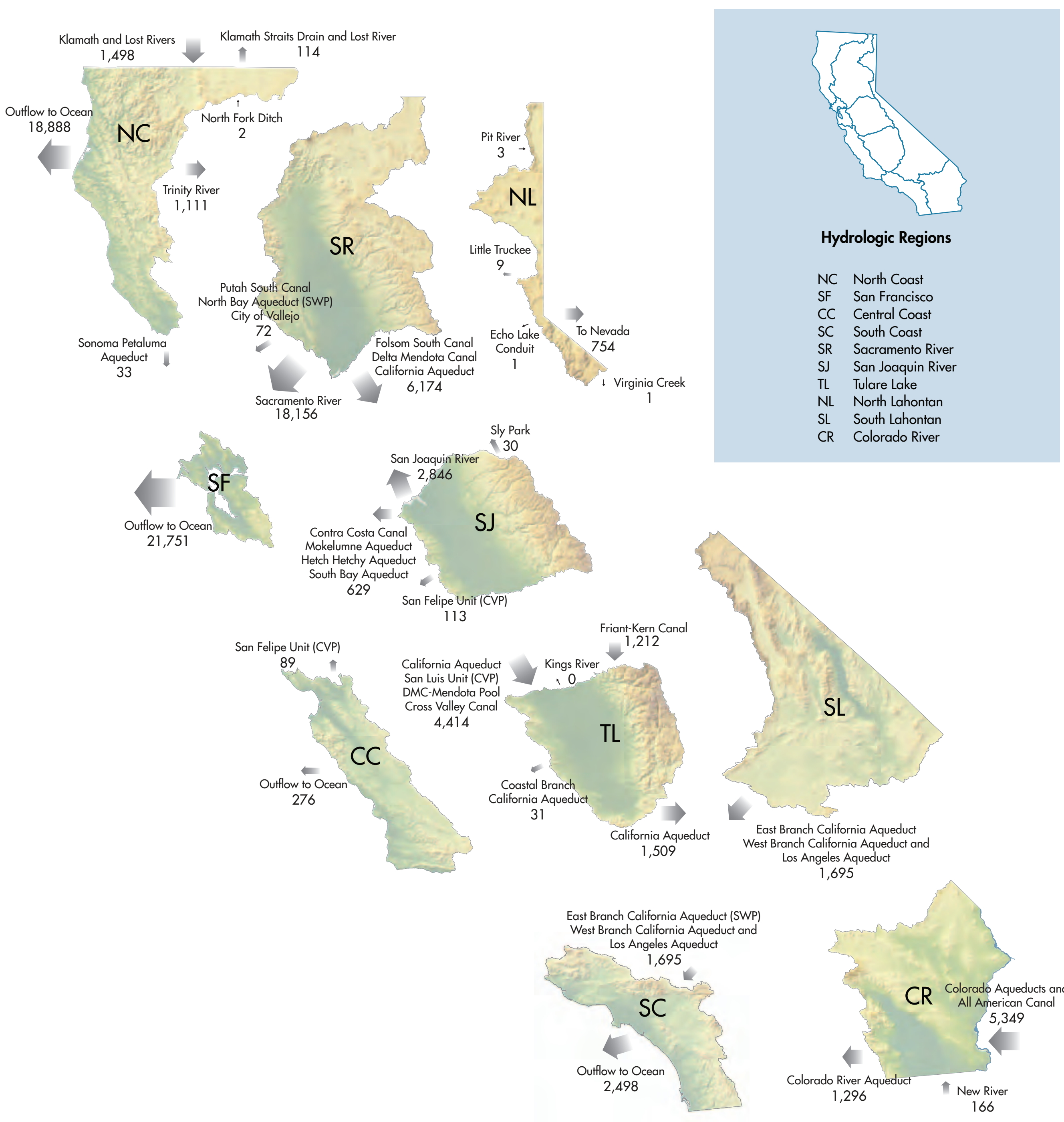
a. Percent of normal precipitation. Water year 1998 represents a wet year; 2000, average water year; 2001, drier water year.

b. Environmental water includes instream flows, wild and scenic flows, required Delta outflow, and managed wetlands water use. Some environmental water is reused by agricultural and urban water users.



Key components of the illustrated flow diagram are shown as characteristic elements of the hydrologic cycle. Volume 3 Regional Reports has flow diagrams for statewide water summary (in Chapter 1) and for regional water summaries in their respective chapters.

Figure 3-6 Regional inflows and outflows in TAF for year 2000 (an average water year)



Water moves great distances within and between California's 10 hydrologic regions, some through natural waterways and some through constructed water systems. Shown are the volumes of water in million acre-feet that flowed from one region to another in 2000, an average water year.

**Outflow to Ocean includes Wild and Scenic Rivers, regulated flows, and estimated wastewater outflows.*

challenges by responding with a variety of methods: task forces and advisory committees, partnerships and integrated regional water management, programs, water bonds, water management systems, research and reports, legislation, regulation, and more. (For further discussion, see the Response section that follows.)

The biggest challenge for California water resources management remains making sure that water is in the right places at the right time. This challenge is at its greatest during dry years: When water for the environment is curtailed sharply, less water is available from rainfall for agriculture and greater reliance on groundwater results in higher costs for many users. In the mean time, those who have already increased water use efficiency may find it more challenging to achieve additional water use reductions.

During the past 50 years, the growing water demands of many areas were met by large State, federal, and interregional projects that moved water significant distances across the state. Because of a variety of issues and uncertainties, new large, interbasin projects on the scale of the State Water Project (SWP) and the federal Central Valley Project (CVP) are less foreseeable in the near term. These State, federal, and local projects continue to serve as the backbone of California water management, and water supplies from these sources will incrementally increase. However, they will not, by themselves, provide for California's growing population and meet the State's agriculture production and environmental objectives.

The quality of California water is of particular and growing concern. Various water management actions potentially have water quality impacts. These include transfers, water use efficiency, water recycling, conjunctive use of aquifers, storage and conveyance, Delta operations, crop idling, and hydroelectric power. Degraded water quality can limit, or make very expensive, some water supply uses or options because the water must be pretreated. Furthermore, water managers increasingly recognize that the water quality of various water supplies needs to be matched with its eventual use and potential treatment. Overall, the State should develop and adopt an integrated "source-to-tap" strategy for meeting future water quality challenges.

As competition grows among water users, management of the water system becomes more challenging, complex, and at times contentious. Water issues are being resolved through coalitions and partnerships among government, public and private water suppliers, and users. Local, regional, State, and federal governments and water suppliers all have a role in assuring water resource sustainability and improving water supply reliability for the existing and future population and the environment.

Ongoing Concerns

Challenges persist for California water management at statewide, regional, and local levels. Significant statewide challenges that require improved water management are summarized here; a section on specific regional and local challenges follows.

Dry-Year Challenges

California has not experienced the hardships and environmental pressures of a prolonged statewide drought since the early 1990s, but similar or worse conditions of unreliable water supplies will recur. During long or extreme droughts, water supplies are less reliable, heightening competition and at times leading to conflicts among water users. Water quality is degraded, making it difficult and costly to make drinkable. Business and irrigated agriculture are adversely affected, jeopardizing California's economy. Ecosystems are strained, risking sensitive and endangered plants, animals, and habitats. Groundwater levels decline, and many rural residents who are dependent on small water systems or wells run short of water.

California's most severe recorded drought statewide occurred in 1976–1977. Two consecutive years with little precipitation (fourth driest and the driest year in recorded history) left California with record low storage in its surface reservoirs and dangerously low groundwater levels. Socioeconomic and environmental impacts were very severe during these extreme drought conditions. The total economic loss due to this drought exceeded $ 2.5 billion ($6.5 billion at today's cost).

The most recent prolonged statewide drought lasted 6 years from 1987 to 1992. During the drought's first 5 years, the groundwater extractions in San Joaquin Valley exceeded the recharge by 11 million acre-feet, which caused increased land subsidence in some areas. Department of Water Resources (DWR) studies indicate that in 1990–1992 the drought resulted in reduced gross revenues of about $670 million to California agriculture. Energy utilities were forced to substitute fossil fuel power for less costly hydroelectric power at an estimated statewide cost of $500 million in 1991. The drought also adversely affected snow-related recreation businesses; some studies suggest a financial loss of about $85 million during the winter of 1990–91.

The biggest challenge for California water resources management remains making sure that water is in the right places at the right time.

Data released in early February 2005 suggest a lessening of the drought that has been affecting the greater Colorado River Basin. The 5-year drought may have left conditions in this basin worse than that of the Dust Bowl years during the 1930s, according to Bureau of Reclamation Commissioner John Keys III (USBR 2003). The Colorado River is California's largest interstate water source and a significant source of hydroelectric power, and in 2004 the river's two major reservoirs, Lake Powell and Lake Mead, were expected to fall below 50 percent full.

During drought periods, some areas rely on interregional water transfers to supplement local water supplies. Meanwhile, concerns of groundwater overdraft and environmental impairment have led some counties to pass ordinances meant to control out-of-basin water transfers. State statute (Stats 2001, ch. 320, SB 672) requires that the California Water Plan describe water management tools and options that "will maximize resources and minimize the need to import water from other regions."

Water managers today use hydrologic records of the past century to estimate how climatic conditions would affect future water availability and water needs. Planners take into account the normal fluctuations of wet and dry years in allocating deliveries from reservoirs and in determining how much water will be provided from other sources. Public and private urban water suppliers must adopt urban water management plans[2] at least every five years (next updates are due by the end of 2005). These suppliers are those who provide water for municipal purposes either directly or indirectly to more than 3,000 customers or supply more than 3,000 acre-feet of water annually. The urban water management plan must include an analysis and a contingency plan for water supply reliability in case of a severe drought, which includes up to 50 percent reduction in water supply. Water management plans lay out shortage contingency scenarios that water agencies use as guidelines when reducing water use and augmenting short-term supply. Some of the tools that water districts use to plan against a multiyear drought are long- and short-term conservation measures, recycled water, water transfers, short-term sources of water, and long-term storage including conjunctive use.

In its July 2000 report, "Preparing for California's Next Drought," DWR reviewed items for near-term drought planning, putting California's conditions today into perspective with experiences gained in the 1987–1992 drought. Major findings of the report focused on the characterization of drought conditions as a gradual phenomenon and their impacts on water users. The report also addressed the vulnerability of existing water users based on past droughts and discussed current actions that affect drought preparedness planning.

Since the drought of 1987–1992, many notable changes—increases in water demands, changes in regulations, and improvements in conservation and infrastructure—have occurred that will alter the impacts of future droughts. While developing drought management plans, planners must continue to consider changes like the following and determine the impact on their region.

- California's population has increased to about 36.5 million people as of July 1, 2004.
- The State Water Resources Control Board (SWRCB) adopted Decision 1630 in 1995, which requires higher flows to protect the Delta.
- The Central Valley Project Improvement Act of 1992 (Title 34 of PL 102-575) made significant changes to the CVP's legislative authorization, amending the project's purposes to place fish and wildlife mitigation and restoration on a par with water supply, and to place fish and wildlife enhancement on a par with power generation.
- Completion of construction of Coastal Aqueduct (DWR), Morongo basin pipelines (Mojave Water Agency), Diamond Valley Lake (Metropolitan Water District), Los Vaqueros Reservoir (Contra Costa Water District), and five large-scale groundwater recharge/storage projects should add flexibility in operating the water system.
- Despite the increase in population, advances in water conservation and recycling, combined with infrastructure improvements including new storage facilities, have helped meet most municipal and industrial demands. Cities use about the same amount of applied water today as they did in the mid-1990s, but accommodate 3.5 million more people.
- The Colorado River Quantification Settlement Agreement has been adopted, limiting California's access to Colorado River water.

People Without Clean and Safe Drinking Water

Census figures from 1990 indicate that in California almost 32,000 housing units obtained water from shallow wells and another 49,000 housing units obtained their water from some source other than dug wells, drilled wells, or public or private water systems. The Census counted about 68,000 housing units (less than 1 percent of the state's population) that disposed of their sewage by means other than a public sewer, septic tank, or cesspool.

[2] Required by the California Urban Water Management Planning Act (Water Code, ch.1, §§ 10610—10610.4)

Californians lacking access to clean and safe drinking water are vulnerable to a higher incidence of disease than is the general population. Untreated water can contain bacterial, parasitic, and viral contaminants. People at risk most often get their water from untreated surface water such as rivers, lakes, or springs. They may also have shallow unsealed wells or use irrigation ditch water. Surface water and shallow wells can become contaminated from rain runoff or flooding. A further concern is sewage disposal. Many rural communities have problems associated with failing septic drainfields and sewage surfacing in yards. This lack of wastewater infrastructure may cause cross-contamination with potable water (see Volume 4 Reference Guide article "Californians Without Safe Water").

Contamination of Surface Water and Groundwater

Nonpoint-source pollution, including urban and agricultural runoff, is the largest contributor of human-induced contamination of surface water and groundwater in the state. Regarding surface water, about 13 percent of the total miles of California's rivers and streams and about 15 percent of its lake acreage are listed as impaired. Regarding groundwater, samples analyzed from all 10 hydrologic regions showed that 5 to 42 percent of public water supply wells exceeded one or more drinking water standards, depending on the region. The exceedance was usually for inorganic chemicals or radioactivity and, in particular, nitrate, which presents a known health risk. Largely agricultural or industrial regions had high percentage of exceedances for pesticides and volatile organic chemicals, respectively. Seawater intrusion in the Delta and in coastal aquifers, agricultural drainage, and imported Colorado River water can increase salinity in all types of water supplies, adversely affecting many beneficial uses.

Groundwater Overdraft

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin. Overdraft is characterized by groundwater levels that decline

Box 3-2 Critical Conditions of Overdraft

In 1978, the Department of Water Resources was directed by the legislature to develop a definition of critical overdraft and to identify those basins in a critical condition of overdraft (Water Code §12924). DWR held public workshops around the State to obtain public and water managers' input on what the definition should include and which basins were critically overdrafted. Bulletin 118-80, Ground Water Basins in California was published in 1980 with the results of that local input. The definition of critical overdraft is:

> A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.

No time is specified in the definition. Definition of the time frame is the responsibility of the local water managers, as is the definition of significant adverse impacts, which would be related to the local agency's management objectives.

Eleven basins were identified as being in a critical condition of overdraft. They are:

Pajaro Basin
Ventura Central Basin
Chowchilla Basin
Kings Basin
Tulare Lake Basin
Kern County Basin
Cuyama Valley Basin
Eastern San Joaquin County Basin
Madera Basin
Kaweah Basin
Tule Basin

The task was not identified by the Legislature, nor was the funding for Bulletin 118 update (2003) sufficient to consult with local water managers and fully re-evaluate the conditions of the 11 critically overdrafted basins. Funding and duration were not sufficient to evaluate additional basins with respect to conditions of critical overdraft. (From DWR 2003 Bulletin 118 Update) over a period of years and never fully recover, even in wet years. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts. A comprehensive assessment of overdraft in California's groundwater basins has not been conducted since 1980 (DWR 1980). It is estimated that overdraft is between 1 million and 2 million acre-feet annually (DWR 2003 Bulletin 118), but the estimate is only tentative with no current corroborating data. (See Box 3-2 Critical Conditions of Overdraft.)

In some cases the term overdraft has been incorrectly used to describe a short-term decline in groundwater in storage during a drought, or to describe a one-year decline of groundwater in storage. A one-year decrease of the amount of groundwater in storage is an annual change in storage and does not constitute overdraft. During a drought the aquifer is being used as a reservoir, and water is being withdrawn with the expectation that the aquifer will be recharged during a wet season to follow.

Deferred Maintenance and Aging Facilities

California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from floods, withstand drought, and sustain environmental values. These water management systems include physical facilities and their operational policies and regulations. Facilities include over 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees. Systems are often interconnected. The operation of one system can depend on the smooth operation of another. The successful operation of the complete system can be vulnerable if any parts fail.

California's facilities require costly maintenance and rehabilitation as they age. In addition, they face many challenges: meeting the needs of a growing population and changing water use patterns, withstanding catastrophic natural events like earthquakes and floods, and adapting to the changes that accompany global climate change. Bottlenecks develop when physical and operational changes of existing water management systems do not keep pace with changes in capacity, regulations, and new environmental data.

Aging facilities risk public safety, water supply reliability, and water quality. The SWP is more than 30 years old; the federal CVP is more than 50 years old. Some local facilities were constructed nearly a 100 years ago. Current infrastructure disrepair, outages, and failures and the degradation of local water delivery systems are in part the result of years of underinvestment in preventive maintenance, repair, and rehabilitation. The Public Policy Institute of California estimated the state's water supply and wastewater treatment systems maintenance backlog to be about $40 billion (Dowall and Whittington 2003).

Flood Management

California's Central Valley flood control facilities are deteriorating and, in some places, literally washing away. Flood events in 1986, 1995, and 1997 cost lives, billions of dollars in property and economic losses, and caused severe disruptions to public infrastructure. At the same time, the Central Valley's growing population is pushing new housing and job centers to areas that are particularly vulnerable to flooding. Yet, in recent years, funding to maintain and upgrade flood protection facilities has sharply declined. Compounding these challenges are recent court rulings that hold State and local agencies liable for flood-related damages when levees fail (for details, see "Flood Warnings: Responding to California's Flood Crisis," DWR January 2005).

Delta Vulnerabilities

The Sacramento-San Joaquin Delta is the hub of California water management and a vital aquatic ecosystem. Flows from the Sacramento, San Joaquin, Calaveras, Cosumnes, and Mokelumne rivers run through the Sacramento San-Joaquin Delta. These rivers and the channels and levees within the Delta are some of the major water conveyance systems of California. They are interconnected, and failure of one part of the network affects operations throughout the network. Failing infrastructure leads to unreliable, poor-quality, and expensive water supplies.

The common denominator among pursuits in the Delta is the levee system. These levees protect water supplies needed for the environment, agriculture and urban uses. Despite their importance, many factors make it challenging to sustain the Delta levees. Subsidence of Delta islands continues to occur where peat soils oxidize, increasing the pressure on levees that protect the islands. A catastrophic earthquake in or near the Delta might cause multiple levee failures that would draw seawater into the Delta, rendering the water unfit for irrigation or human consumption until levees were repaired and seawater was flushed from the Delta. Climate change is causing sea levels to rise and may also increase the magnitude of flooding. Maintenance and improvement of Delta levees is costly, and available funds have not kept pace with needs. Levee failures are extremely costly to repair, further burdening the ability to fund adequate maintenance and rehabilitation.

On June 3, 2004, a levee breach occurred on Upper Jones Tract in the southern region of the Delta. A roughly 300-foot wide section collapsed. There was no warning, the time was outside the normal flood season, and it was a nonproject area. Seawater flooded about 12,000 acres of farmland and pulled salty water into the Delta, the major drinking water source for more than 23 million Californians. Responding agencies held concerns about risks to State Highway 4 and nearby islands and the Kinder-Morgan gasoline pipeline.

The breach demonstrates the vulnerability of the Delta levees, which are needed for the environment, agriculture, and urban uses. These levees protect roadways, cities, towns, agricultural lands, as well as terrestrial and aquatic habitat. The CALFED Delta levee program is intended to reduce the risk of catastrophic breaching of these levees.

Also, recent studies have alerted the water community to low levels of Delta/Suisun Bay pelagic fish (delta smelt, longfin smelt, threadfin shad, and striped bass). The decrease was unexpected given the relatively moderate hydrology over the past three years. Three general factors may be acting individually or in concert to lower pelagic productivity: (1) toxins, (2) invasive species, and (3) water project operations. The Interagency Ecological Program has undertaken an aggressive interdisciplinary, multi-agency study to evaluate these factors and consider possible responses. The work falls into four general tasks: (1) an expansion of existing monitoring, (2) analyses of existing data, (3) ongoing studies, and (4) new studies. (See Box 3-3 Delta Pelagic Fish Decline.)

Global Climate Change

California's water systems have been designed and operated based on data from a relatively short hydrologic record. Mounting scientific evidence suggests that forecasted climate changes could significantly change California's precipitation pattern and amount from that shown by the record. Less snowpack would mean less natural water storage. More variability in rainfall, wetter at times and drier at times, would place more stress on the reliability of existing flood management and water systems. California's high dependence on reservoir storage and snowpack for water supply and flood management makes us particularly vulnerable to these types of projected hydrologic changes. (See Chapter 4 in this volume and articles in Volume 4 Reference Guide under Global Climate Change for further discussion.)

Historical records reveal changes in the pattern of April–July runoff; an example is plotted here for the Sacramento River (Figure 3-7 Sacramento River April-July runoff in percent of water year runoff). From the 1950s to the present, the percentage of April–July runoff has shown a progressive decline.

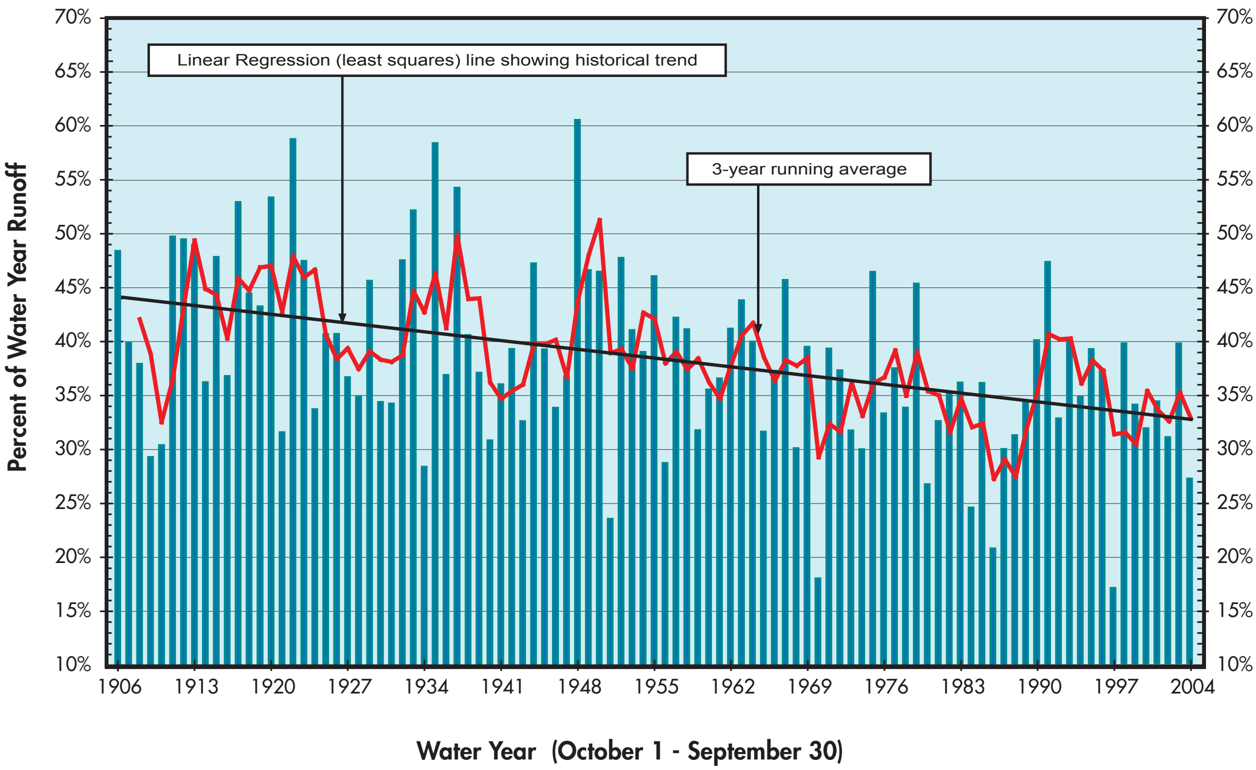
Global climate change is already leading to sea level rise. Figure 3-8 (Golden Gate annual average and 19-year mean tide levels) shows historical sea level rise at the Golden Gate. During the 20th century, sea levels increased by 0.2 meters (0.7 feet). During the 21st century, models project a median rise of 0.5 meters (1.6 feet) due to climate change (IPCC 2001). This could eventually disrupt ecosystems and communities in coastal areas and ongoing tidal wetland restoration. The biggest impact of sea level rise on California water supply could

Box 3-3 Delta Pelagic Fish Decline

A recent (2002-2005) decline in estimates of several pelagic (open water spawning) fish species in the Sacramento-San Joaquin Delta, referred to as the pelagic organism decline (POD), has raised concern about the resiliency of the Delta aquatic ecosystem. Species potentially at increased risk include threadfin shad (Dorosoma petenense), striped bass (Morone saxatilis), longfin smelt (Spirinchus thaleichthys), and the federally and State-listed endangered delta smelt (Hypomesus transpacificus).

As part of a multi-agency effort aimed at establishing potential causes of and identifying an appropriate research strategy to further characterize the POD, the CALFED Science Program, in collaboration with the Interagency Ecological Program (IEP), convened a panel of independent scientists to provide a review of the IEP data synthesis associated with the 2005 IEP POD work plan. The independent review panel will also review the 2006 draft IEP POD work plan and provide recommendations relevant to continued POD investigations. This independent panel will address the need for appropriate peer review for CALFED Science Program-associated activities as outlined in the CALFED 2000 Programmatic Record of Decision.

Figure 3-7 Sacramento River April - July runoff in percent of water year runoff



Historical records reveal changes in runoff pattern from April through July in a number of California rivers. Since the 1950s, the percentage of total annual runoff occurring during these months has declined progressively, an indication of earlier snowmelt and warmer temperatures.

be in the Delta where sea level rise would increase pressure on the levees that protect low-lying lands, much of which already is below sea level.

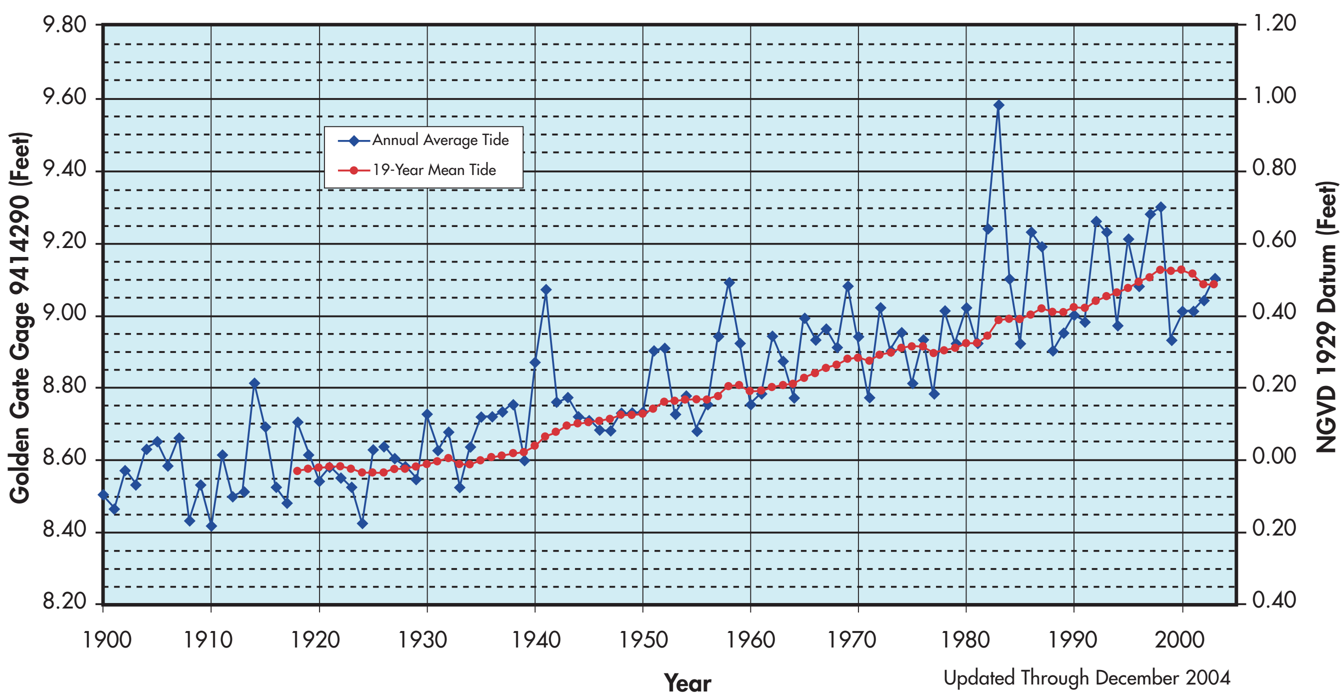
Water and Energy

Water and energy are two resources that are inherently linked, especially in California. Taken together, pumping, treating, and distributing potable water, groundwater pumping, desalination, heating and cooling processes, pressurization, and the collection, treatment, recycling, and discharge of wastewater, consume approximately 20 percent of the state's total electricity, 30 percent of the natural gas, and 88 million gallons of diesel. Some water systems are net energy producers, for example, the federal CVP as well as San Francisco's Hetch Hetchy and the Los Angeles Aqueduct water systems. Others are net energy consumers, for example, Metropolitan Water District's Colorado River Aqueduct and the SWP. In fact, the SWP is the single largest user of electricity in the state, although the project produces about half of the energy it consumes.

Just as water and energy are inherently linked, so are water and energy efficiencies. For instance, improvements in water use efficiency related to washers and shower heads inevitably lead to energy efficiency benefits related to water heating. On the other hand, some energy- and water-efficiency measures are inversely related (for example, the need to pressurize drip irrigation systems may require more on-form energy per unit of water). Distributed water and wastewater treatment and reuse facilities could also reduce energy use in the water sector, by treating water and wastewater on-site for use (and reuse) locally, thereby decreasing the need for transporting (pumping) water to and from existing regional treatment facilities.

In general, water use in the municipal and industrial sector is more energy intensive than in the agricultural sector because surface water used for irrigation usually takes advantage of gravity flow and only a small percentage flows to waste water treatment plants after being used. In Southern California importing water is by far the largest use of electricity for a typical water system, and the total energy used to get water

Figure 3-8 Golden Gate annual average and 19-year mean tide levels



Global climate change is already leading to sea level rise, which can disrupt coastal communities, ecosystems, and tidal wetland restoration. It can also increase pressure on Delta levees, whose failure would disrupt water supply for about two-thirds of the state's residents and about one-half of its irrigated agriculture.

to a typical Southern California home (from source to tap) can be the second or third largest household electrical use. In response to the recent energy crisis, the State has sited some new power plants, often using fresh water for cooling and sometimes in water-scarce regions. This can potentially impact local water supplies through both diversion and discharge. (See Box 3-4 Hydroelectric Facilities.)

DWR has assisted the California Energy Commission (CEC) with updating the water resource-related portions of the 2005 Integrated Energy Policy Report. A draft IEPR was released in September 2005, and the final report is expected by the end of November 2005. Chapter 8 of the draft, titled Integrating Water and Energy Strategies, provides an assessment of current water-energy relationships as well as policy guidance regarding future water-energy management strategies. DWR also contributed to the development CEC's Water-Energy Relationship Study (WERS). The WERS provides details and information that support recommendations published in the IEPR. The final WERS is expected in by the end 2005. The commission's Web link to the IEPR update process is www.energy.ca.gov/2005_energypolicy/.

Tribal Water Rights

In the more arid western areas of the United States, including California, state water rights framework and federal Reclamation Act policies have evolved over the past 100 years largely without regard to water resources reserved for tribal lands. Tribal water rights to meet economic and cultural needs are often encroached upon or unmet. Unlike previous water plan updates, this update recognizes tribal water needs and suggests ways to engage tribal interests in California water planning and program and project implementation.

Environmental Justice

Californians from disadvantaged and under-represented communities continue to face economic and environmental inequities with respect to water supply, participation in water policy and management decisions, and access to State funding for water projects. All Californians do not have equal opportunity or equal access to State planning processes, programs, and funding for water allocation, improving water quality, and determining how to mitigate potential adverse impacts to communities associated with proposed water programs and projects. (See Volume 4 Reference Guide article "Environmental Justice in California Government.")

Regional/Local Challenges

Following is a summary of challenges faced by California's 10 hydrologic regions, a Mountain Counties overlay area, and the Delta (see Figure 3-9 Map of California's 10 hydrologic regions, the Delta, and Mountain Counties and Box 3-5 Description of California's 10 Hydrologic Regions, the Delta, and Mountain Counties). (See Volume 3 Regional Reports for more discussion of each region's challenges, a sampling of their management plans, and regional water balance summaries.)

North Coast Hydrologic Region

Water supply reliablity. The Klamath River Basin is an interstate watershed with surface storage facilities in both California and Oregon, and competing water needs for agriculture, tribal water rights, waterfowl refuges, and endangered fish. In the U.S. Bureau of Reclamation (USBR) Klamath River Project, environmental and agricultural demands compete for limited water in dry years. During the recent dry period from years 2001 through 2004, the lack of water in storage severely affected agricultural diversions and total crop acreage. The low flows in the river and associated warm water temperatures also contributed to significant reduction of the salmon population.

In the Trinity River system the need for downstream flows for fish versus water diversions to the Sacramento River basin has resulted in litigation and a revised operations plan at the USBR Lewiston Reservoir diversion. Recent federal court decisions allocate more water for Trinity River fish populations, but the timing and volume of these increased releases remain controversial.

Box 3-4 Hydroelectric Facilities

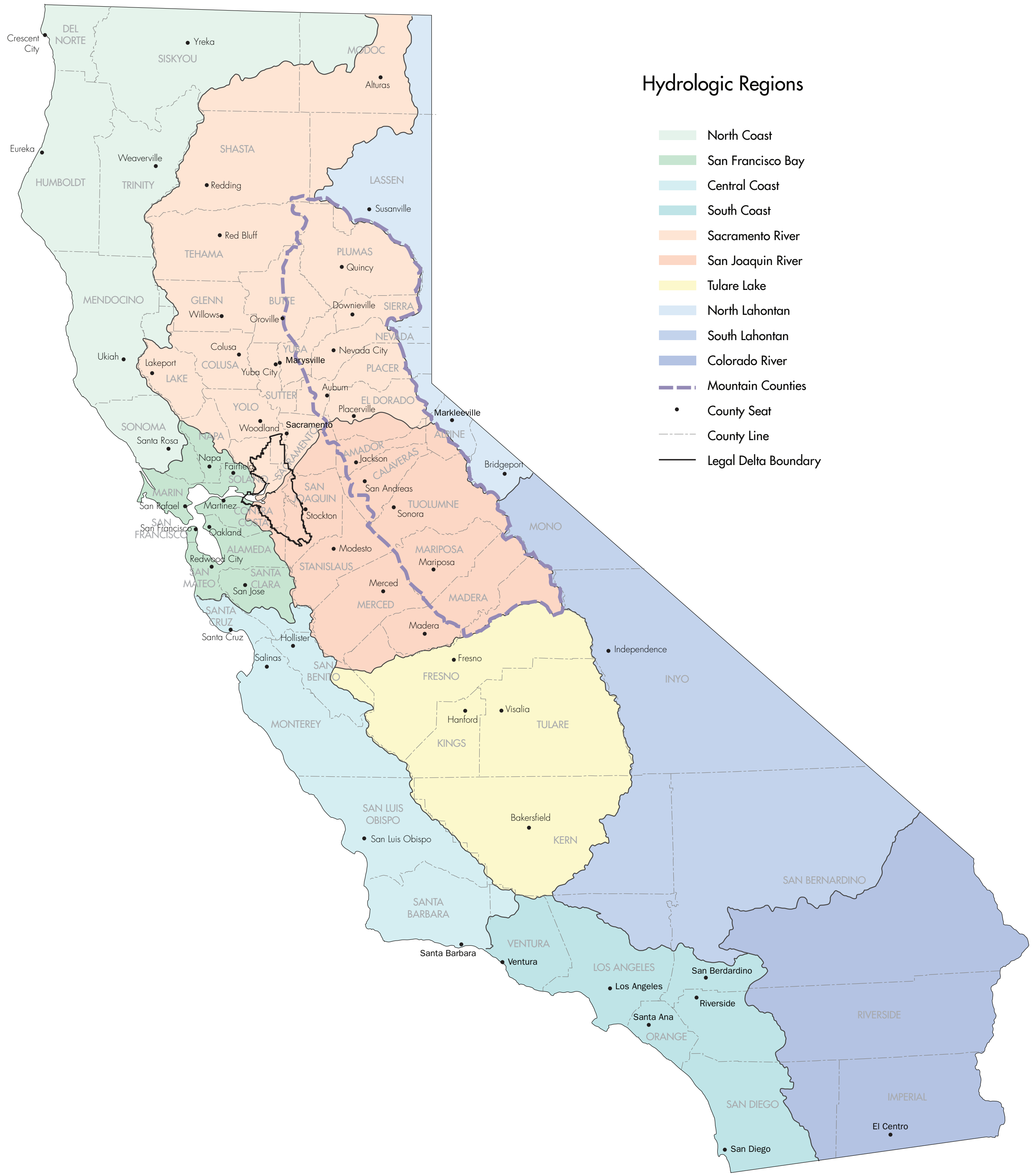
Hydroelectric facilities account for approximately 25 percent of California's electricity production capacity and on average produce about 15 percent of the state's electricity, with relatively low production costs, no greenhouse gas emissions, and the ability to meet critical peak demands. Because hydropower obviously depends on water for fuel, hydroelectric output is quite variable, ranging from 9 to 30 percent in terms of electricity sales during the period 1983 to 2002.

Unlike most of the United States, California hydropower is characterized by numerous low-volume, high-head (large elevation drop) facilities, that divert water from rivers into forebays and then into penstocks and powerhouses. The Central Valley is the state's most important hydropower region because of its considerable generating and water storage capacities. California is also dependent upon hydropower generated in the Pacific Northwest and on the Colorado River. Compared to the Columbia Basin, large and extensive reservoir storage in California provides greater reliability to the state's hydropower capability, making this energy source less vulnerable to single-year droughts.

Along with the development and benefits of hydroelectric facilities in California have come environmental impacts. Dams have significantly changed river flows, stages, and temperatures and created barriers to fish passage, impacting two-thirds of the state's freshwater fish species. In the North Coast, hydropower facilities blocked a significant amount of historical spawning grounds for salmonids. A symptom of peaking power production, which in itself is a distinct benefit of hydropower, is fluctuating water levels downstream of dams, which can strand downstream migrating salmonid fry as well as upstream migrating adults and their redds. The California Energy Commission has concluded that decommissioning low energy production-high environmental impact hydropower facilities may be an economically viable way to restoring ecosystems.

Hydroelectric projects are licensed by the Federal Energy Regulatory Commission (FERC), and the licenses of more than 100 existing facilities in California will be up for federal license renewal within the next 10 years. As part of the FERC license renewal process, the project owners must conduct studies to evaluate the future use, impacts, and alternatives for each hydroelectric project. For local water agencies this relicensing process will provide key opportunities to develop and improve integrated resource planning, so that the proposed operation of hydroelectric projects can also consider improved benefits to local water supplies, instream flows, and recreation uses.

Figure 3-9 Map of California's 10 hydrologic regions, the Delta, and Mountain Counties



The California Department of Water Resources divides the state into 10 hydrologic regions that correspond to its major drainage basins. This water plan update also describes the Mountain Counties and Sacramento-San Joaquin Delta as two overlay areas of special interest.

Box 3-5 Description of California's 10 Hydrologic Regions, the Delta, and Mountain Counties

The Department of Water Resources subdivides the state into regions for planning purposes. The largest planning unit is the hydrologic region. California has 10 hydrologic regions corresponding to the state's major drainage basins. This water plan update also includes the Sacramento – San Joaquin Delta and the Mountain Counties overlay area.

Hydrologic Regions

North Coast. Klamath River and Lost River Basins, and all basins draining into the Pacific Ocean from the Oregon stateline southerly through the Russian River Basin.

San Francisco Bay. Basins draining into San Francisco, San Pablo, and Suisun bays, and into Sacramento River downstream from Collinsville; western Contra Costa County; and basins directly tributary to the Pacific Ocean below the Russian River watershed to the southern boundary of the Pescadero Creek Basin.

Central Coast. Basins draining into the Pacific Ocean below the Pescadero Creek watershed to the southeastern boundary of Rincon Creek Basin in western Ventura County.

South Coast. Basins draining into the Pacific Ocean from the southeastern boundary of Rincon Creek Basin to the Mexican boundary.

Sacramento River. Basins draining into the Sacramento River system in the Central Valley (including the Pit River drainage), from the Oregon border south through the American River drainage basin.

San Joaquin River. Basins draining into the San Joaquin River system, from the Cosumnes River basin on the north through the southern boundary of the San Joaquin River watershed.

Tulare Lake. The closed drainage basin at the south end of the San Joaquin Valley, south of the San Joaquin River watershed, encompassing basins draining to Kern Lakebed, Tulare Lakebed, and Buena Vista Lakebed.

North Lahontan. Basins east of the Sierra Nevada crest, and west of the Nevada stateline, from the Oregon border south to the southern boundary of the Walker River watershed.

South Lahontan. The closed drainage basins east of the Sierra Nevada crest, south of the Walker River watershed, northeast of the Transverse Ranges, north of the Colorado River Region. The main basins are the Owens and the Mojave River Basins.

Colorado River. Basins south and east of the South Coast and South Lahontan regions; areas that drain into the Colorado River, the Salton Sea, and other closed basins north of the Mexican border.

Overlay Areas

Sacramento-San Joaquin Delta. The Legal Delta includes about 740,000 acres of tidally influenced land near the confluence of the Sacramento and San Joaquin rivers. While it occupies portions of the Sacramento, San Joaquin, and a small part of the San Francisco hydrologic regions, the Delta is described as an overlay area because of its common characteristics, environmental significance, and its important role in the State's water systems.

Mountain Counties. The Mountain Counties region includes the foothills and mountains of the western slope of the Sierra Nevada and a portion of the Cascade Range. The area includes the eastern portions of the Sacramento River and San Joaquin River hydrologic regions. This area shares common water and other resource issues and is the origin for much of the State's developed surface water supply.

Water quality. Erosion and runoff from logging, rural roads, agriculture (including grazing), and cities cause sedimentation that can adversely affect rivers and streams, including habitat for spawning and rearing of anadromous fish, and contaminate growing areas for shellfish. Water diversions, channel modification, temperature, and nutrients have also impacted commercial and recreational fisheries. Groundwater quality problems include seawater intrusion and nitrate contamination in shallow coastal aquifers, salinity and alkalinity in the lake sediments of Modoc Plateau basins, and iron, boron, and manganese in the inland basins of Mendocino and Sonoma counties. Septic tank failures in western Sonoma County are a concern for recreation-water quality in the Russian River; boating fuel constituents from recreational activities are pollution concerns in Trinity, Lewiston, and Ruth lakes.

Environmental water supply. A primary water management issue in the North Coast Hydrologic Region centers around balancing water demands of both agriculture and fish in the Klamath River Basin and its largest tributary, the Trinity River. Water supplies for farmers in the basin have been reduced because of habitat restoration for endangered species such as the Lost River and shortnose suckers, coho salmon, and steelhead trout. In 1997 the National Marine Fisheries Service listed steelhead trout as threatened and in 2002 listed coho salmon as endangered along part of the California coast that includes the Russian River Basin.

The region must also balance Eel River fishery restoration needs with existing basin exports to the Russian River through Pacific Gas and Electric's Potter Valley Project. The 2004 decision to amend the power license with a 15 percent export reduction is being litigated in federal courts.

San Francisco Bay Hydrologic Region

Water supply reliability and water quality. Some of the major challenges of this region include improving water supply reliability during drought periods and after earthquakes. More than 65 percent of the region's surface water is imported from other regions, and many aging water delivery systems are vulnerable to earthquake damage. San Francisco is planning a $4.3 billion upgrade of the Hetch Hetchy water transmission system, while Contra Costa Water District is studying an alternate point of water diversion for its Contra Costa Canal intake from the Delta. To reduce water system risk regional water agencies continue to plan and construct water facility upgrades, replacements and interconnections between the different systems. The quality of San Francisco Bay Area drinking water supplies varies by source and method of treatment. Agencies are continuously pursuing activities that will improve water quality, such as groundwater conjunctive use, improved treatment technology, and blending of water from alternate sources of supply. Other challenges include the expansion of integrated regional planning efforts, in order to link local land use planning with water system planning and management.

Environmental water supply. Environmental water quality issues naturally focus on the San Francisco Bay Estuary, including control of storm water, urban runoff, sediment, and pollutants from local watersheds as well as the Central Valley and Delta watersheds. Water quality in the estuary is better than in previous decades due to the implementation of secondary treatment of domestic wastewater. However, sediment deposits in the estuary are still widely contaminated by legacy pollutants such as mercury and polychlorinated biphenyls, which contaminate fish.

Central Coast Hydrologic Region

Water supply reliability. With a limited surface water supply and few surface water storage facilities, the region increasingly depends on imported water and groundwater resources. Surface water for agricultural and urban purposes is imported through the federal CVP San Felipe project (in the northern region) and via the SWP Coastal Branch Aqueduct to San Luis Obispo and Santa Barbara counties (in the south). For the Salinas River and the Monterey Peninsula, future sources of water supply are being studied from recycling, conjunctive management, and desalination.

In 1995 SWRCB ruled that California-American Water Company, the primary water supplier to most of the Monterey Peninsula, did not have a legal right to about 70 percent of the water it takes from the Carmel River, its main source. In response Cal-Am has been taking more water from wells that draw from groundwater below the lower valley, while evaluating new alternative sources of water supply.

Environmental water supply and water quality. Sedimentation poses the greatest water quality threat to Morro Bay, one of 28 estuaries in the National Estuary Program. The primary tributary to Monterey Bay, the Salinas River watershed, suffers from nitrate and pesticide contamination related to agriculture, which is the valley's main land use. Seawater intrudes up to 6 miles inland in the shallow aquifer around Castroville. The nearby Pajaro River watershed faces a variety of water quality threats such as erosion, urban runoff, sand and gravel mining, flood control projects, off-road vehicles, and historical mercury mining in the Hernandez Lake area.

South Coast Hydrologic Region

Water supply reliability. Projected population increases will have a significant impact on water demands. More than 50 percent of the region's water supplies are imported from other parts of the state through the SWP, the Los Angeles Aqueduct, and the Colorado River Aqueduct. By year 2016 California's Colorado River allocation will be reduced from the current 5.3 million acre-feet per year to 4.4 million acre-feet per year. Several water exchange, conjunctive use, and conservation programs must be developed to offset this reduction. Drought impacts are a long-term concern and require the development of other local sources of supply to meet dry year demands, including recycling, expanded conservation, conjunctive use, and desalination.

Water quality. Population growth (to more than 23 million residents by year 2030) and associated urban sprawl will present several water quality challenges, including the need for treatment facilities for the increased wastewater and urban runoff. Storm water, urban runoff, and overflows from sanitary sewers can adversely affect coastal water quality, causing beach closures and swimming restrictions. Extensive shipping and recreational boating can also affect ocean water quality. Imported surface water supplies have water quality problems including high levels of total dissolved solids (TDS) and low levels of perchlorate from the Colorado River, and the presence of organic carbon and bromide in SWP Delta supplies. In particular, high TDS levels in source water can inhibit wastewater reuse. Salinity also intrudes into local groundwater basins near the ocean, which is respulsed by hydraulic groundwater barriers in Los Angeles and Orange Counties. Inland, some local aquifers are polluted by MTBE, perchlorate, chromium 6, and organic chemicals. A large concentration of dairies in the Chino Basin has led to salt, nutrient, and microbial contamination of groundwater. The Los Angeles, San Gabriel, and Santa Ana Rivers are the focus of many watershed planning and restoration activities.

Sacramento River Hydrologic Region

Water supply reliability and water transfers. During extended periods of drought, surface water allocation cutbacks from the SWP and the CVP limit water districts reliant on these supplies. Agricultural users turn to groundwater, switch to lower water-use crops, or allow prime farmland to lie fallow. With a growing demand for high quality water throughout the state, water transfers from Sacramento Valley to other parts of the state are evaluated more closely. Several counties have adopted groundwater ordinances that regulate or impede water transfers outside of the county of origin.

DWR and USBR, under the CALFED Bay-Delta Program and in cooperation with the California Bay-Delta Authority (CBDA), are studying the feasibility of two proposed surface storage improvements within this region: the enlargement of Shasta Reservoir and a new offstream storage reservoir on the west side of the Sacramento River called Sites Reservoir. Flood protection and the adequacy of existing flood control structures is a major concern for the low-lying areas of the Sacramento Valley floor, particularly in areas where urban expansion is occurring.

Water quality. Much of the region's groundwater and surface water are of high quality, but there are some local groundwater problems, from natural contaminant sources and past industrial processes. For instance, at the north end of the Sacramento Valley, wells typically have high TDS content and in the western volcanic and geothermal areas, moderate levels of hydrogen sulfide are found in groundwater In the Sierra foothills, uranium and radon-bearing rock or sulfide mineral deposits containing heavy metals may contaminate groundwater. In addition, a history of gold mining activities has produced a legacy of mercury, especially in the Cache Creek watershed, and other toxic heavy metals in surface water supplies. Water temperature is a concern in the Sacramento River and its tributaries that provide habitat for four runs of salmon. Along the lower American River, a plume of perchlorate contamination spreads, causing closure of several municipal wells in the vicinity.

Environmental water supply. Additional ecosystem protection and restoration efforts are needed to continue improving habitat for threatened and endangered species while maintaining water quality on tributaries that flow into the Sacramento River and eventually into the Delta. Existing and proposed projects include federal and State partnerships with landowners, agricultural water districts, Pacific Gas and Electric Company, and several other entities in the region.

San Joaquin River Hydrologic Region

Water supply reliability. Plans to restore the river habitat and fish populations on the San Joaquin River through higher releases of water from Friant Dam have spurred growing concerns over the long-term availability of the Sierra water supplies for the San Joaquin River. USBR, in cooperation with CBDA, is studying the feasibility of a new surface storage reservoir in the upper San Joaquin basin, with the primary location identified as Temperance Flat.

Extensive groundwater pumping in the Stockton area has generated groundwater overdraft, leading to declining groundwater levels and saline groundwater intrusion. A groundwater recharge program that is under development would divert surplus river water during winter months to help restore groundwater levels and stop the saline groundwater intrusion.

Water quality. The major surface water quality problems of San Joaquin Valley streams are a result of depleted freshwater flows, significant salt and other pollutant loads from agricultural runoff and wetland drainage, and municipal and industrial wastewater discharges. Dairies, stockyards, and poultry ranches are also a concern in the region for their loadings of pathogens, nutrients, salts, and emerging contaminants (such as antibiotics) to water bodies. High salinity groundwater can be found along the western edge of the valley floor where marine sediments of the Coast Range exist. Agricultural pesticides, nitrates, naturally occurring selenium, and industrial organic chemicals have also contaminated some groundwater supplies in the region.

Environmental water supply. One of the major challenges facing the San Joaquin River Hydrologic Region is restoring the ecosystem along the San Joaquin River below Friant Dam while maintaining water supply reliability for other purposes. The river's historical salmon populations upstream of the Merced River were extirpated when river water was diverted after the construction of Friant Dam in the 1940s. In August 2004, a federal judge ruled that the USBR violated State Fish and Game Code 5937 by not providing enough water downstream to sustain fish populations. This litigation continues, and the resolution will be challenging because of the potential to impact water supplies for the Friant Water Users Authority. Surface water quality is also a significant concern. High salinity caused by agricultural drainage and wastewater return flows is a problem for fish in the lower San Joaquin River. Specific water quality concerns are dissolved oxygen problems in the Stockton Deep Water Ship Channel and salt and boron load limitations. There is a lot of activity and interest in the use of San Joaquin River water for environmental purposes as well as for water transfers between agriculture and municipalities, additional surface storage, conjunctive use operations, and the South Delta Improvement Program.

Tulare Lake Hydrologic Region

Water supply reliability. Uncertainty and limitations of surface water deliveries from the Delta are exacerbating groundwater overdraft because groundwater is used to replace much of the shortfall in surface water supplies. Land subsidence from long-term groundwater overdraft has caused some damage to canals, utilities, pipelines, and roads. Water transfers within these areas have and will become more common as farmers seek to minimize water supply impacts on their operations. In urban areas water conservation and water recycling programs are being accelerated to help offset short-term water reliability, and several major groundwater recharge programs store excess water during wet periods for extraction and use during dry periods.

Water quality. Much of the groundwater in the western Valley floor area is not suitable for use because of its high salinity and the presence of other toxic elements resulting from water percolation through the marine sediments on the west side. Naturally occurring arsenic is a serious concern for domestic water well supplies. Some areas of groundwater contain elevated levels of nitrates, sulfates, selenium, and boron, as well as pesticides such as dibromochloropropane (DBCP) used in agriculture, and the industrial solvents trichloroethylene (TCE) and dichloroethylene (DCE). Dairy operations can contribute salinity, nutrients, and microbes to both surface and groundwater.

Drainage. The lack of an agricultural drainage system plagues the poorly drained areas along the western side of the San Joaquin Valley, from Kern County northward into the San Joaquin River basin. The drainage water is sometimes contaminated with naturally occurring, but elevated, levels of selenium, boron, and other toxic trace elements that threaten water quality and fish and wildlife. Irrigation with high salinity imported water has exacerbated the drainage problem. In 2002, USBR supported an "in-Valley" solution to the drainage problem on the Valley's west side. Also in 2002, the Westlands Water District and the United States reached a settlement agreement regarding drainage service in the San Luis Unit, which reduced the acreage of irrigated lands and the associated drainage problems. More recently, the federal government is continuing to work with local interests to evaluate and select a long-term solution for the poor-quality drainage water.

Environmental water supply. The Tulare Lake Hydrologic Region encompasses four major watersheds of the Kings, Kaweah, Tule and Kern rivers. Each of these river systems have unique environmental water needs. There has been significant activity on both the Kings and Kern Rivers to restore flows for habitat as well as recreation. Modification to outlet structures and timing of releases on the Kings River provide cooler water temperatures to protect the resident trout populations. Gravel augmentation is also carried out to provide spawning habitat as well. The Kern County Water Agency has implemented a successful and innovative program of delivering supplies down the river through the City of Bakersfield for instream uses and then extracting the water farther downstream through the use of wells. Environmental water supplies on the Kaweah and Tule rivers are being modified due to the mitigation requirements tied to reservoir enlargement projects on both systems.

North Lahontan Hydrologic Region

Water supply reliability. Much of the northern third of the region is chronically short of water. During dry years, in areas with little or no surface storage, irrigation may be limited unless surface water is supplemented with groundwater. In Modoc and Lassen counties drought is a way of life for agriculture, and seasonal irrigation continues as long as water is available. Some groundwater pumping capacities diminish very rapidly when used extensively during drought periods.

While the Truckee River Operating Agreement (TROA) has the potential to settle 50 years of interstate disputes over Truckee and Carson River waters, the execution and implementation of that agreement will require considerable effort in the coming years. California and the U.S. Department of Interior are preparing the final environmental impact statement/environmental impact report for evaluation of the TROA and potential impacts. The TROA cannot be signed and submitted for federal courts approval until after the final EIS/EIR is completed in 2006. Interstate water allocation issues are also being evaluated and negotiated for the Walker River basin, where the primary issue is the declining level of Walker Lake at the river's terminus in Nevada and the resulting increased salinity in the lake. To preserve the Lahontan cutthroat trout, which reside in the lake, significant increases in fresh water entering Walker Lake will be needed, which would likely impact upstream water users in both states.

Water quality. Water quality is generally excellent, but some communities face local water quality problems, such as the MTBE contamination of wells in South Lake Tahoe. The abandoned Leviathan Mine impacts local creeks in the upper Carson River watershed with acid mine drainage. Activities in the Lake Tahoe basin are subject to extensive prohibitions, BMPs, and analysis, intended to restore and preserve the Lake's water quality.

Environmental water supply. The principal consumptive uses of water for environmental uses in the region are those of State wildlife areas around Honey Lake. The Honey Lake Wildlife Area in southern Lassen County consists of the 4,271-acre Dakin Unit and the 3,569-acre Fleming Unit. The two units provide important habitat for several threatened or endangered species, including the bald eagle, sand hill crane, bank swallow, and peregrine falcon. River segments that have been designated as wild and scenic constitute a large part of the environmental water use within the region. Lake Tahoe is subject to extensive analysis and restoration activities to restore and preserve its water quality.

South Lahontan Hydrologic Region

Water supply reliability. Many urban areas in the developing southwestern portion of this region are now experiencing shortfalls in water supplies. Meeting water demands for projected growth and development is a concern for many water agencies. A study by the Antelope Valley Water Group concluded that the valley's existing and future water supply reliability from groundwater, the SWP, Littlerock Reservoir, and recycling is low and that current water demands could be met only half the time without overdrafting groundwater resources. The Mojave River groundwater basin adjudication was finalized in 1996 as a mechanism to permanently control groundwater usage and overdraft in that region.

Water quality. Like the North Lahontan region, water quality is generally excellent, though there are local impairments. When drinking water standards are exceeded in public water supply wells, it is most often for TDS, fluoride, or boron. Water quality and quantity are inherently related in the Owens River watershed due to the large exports of surface water and groundwater by the City of Los Angeles. Arsenic is a health concern in the Owens River basin, and therefore, in the water exported to Los Angeles as well.

Environmental water supply. Ecosystem protection and restoration efforts are continuing to raise the level of Mono Lake and restore the migratory bird habitat of the South Lahontan Hydrologic Region. In the Owens River basin, plans are under way to restore surface flows to a 60-mile stretch of the lower river that was dewatered after the Los Angeles Aqueduct was completed in 1913. This ambitious restoration project will return live flows to the riverbed on a year-round basis, rebuild the riparian habitat, and reintroduce fish and other native wildlife. At the lower end of this 60-mile stretch, the remaining water would be recaptured and returned to the Los Angeles Aqueduct.

Colorado River Hydrologic Region

Water supply reliability. One of the most significant challenges of this region will be adapting to requirements of the new Quantification Settlement Agreement (QSA) for distribution and use of California's legal entitlement of Colorado River water. Under this 2003 agreement California agencies must reduce total consumptive use of Colorado River water to 4.4 million acre-feet per year; whereas, past usage often exceeded 5.0 maf/year. The QSA also assists the transfer of water to meet urban needs in the South Coast region and provides water for Salton Sea. Other regional issues include the potential impacts of Colorado River fish restoration programs on the availability of water for diversions and the development of solutions to groundwater overdraft problems in the upper (urbanized) and lower (agricultural) part of the Coachella Valley.

Water quality. The Colorado River provides irrigation and domestic water to much of Southern California. The water's salinity (generally between 600 to 700 parts per million) is a concern for salt-sensitive crops. Municipal water agencies blend this supply with low salinity water supplies, including groundwater (except in the Imperial Valley, which lies above a saline aquifer). Low levels of perchlorate in the Colorado River (originating from the Las Vegas Wash area) and high levels of hexavalent chromium in wells near the river at Needles, are recent concerns for drinking water quality. Aging septic systems at recreational areas along the Colorado River are also a cause of water quality concern for both domestic and recreational water uses.

Ecosystem restoration. Salton Sea is the focus of international water quality and ecosystem restoration efforts in Southern California. An important stop along the Pacific Flyway, the saline and eutrophic sea supports a productive fishery and more that 400 species of resident and migratory birds, of which more than 50 have status as threatened, endangered, or species of concern. The largest sources of the sea's inflow are (1) the New River, which originates in, and conveys industrial and agricultural wastes from Mexico into the United States; (2) the Alamo River, which also originates south of the border and consists mainly of agricultural return flows from the Imperial Valley; and (3) the Imperial Valley agriculture drains, which transmit pesticides, nutrients, selenium, and silt to the sea. Nutrient input to the sea can contribute to algal blooms and odors, and lead to low dissolved oxygen conditions that are dangerous to fisheries. If a solution is not developed and implemented soon, Salton Sea is likely to become too saline to support many of the current fish and the bird populations.

Sacramento-San Joaquin Delta

Water supply reliability. Because local Delta water users draw from adjacent channels, they normally have immediate access to water. But Delta water quality and channel water levels can be influenced by pumping plant operations of the SWP and CVP, especially in the vicinity of south Delta islands. Lower water levels in the south Delta in combination with low river inflows from the San Joaquin River can make it difficult for local irrigation diversions to access the water. State and federal agencies are coordinating efforts to design and launch the South Delta Improvements Program, which proposes construction of gates to improve water levels and flows.

The maintenance and operational flexibility of SWP and CVP export pumping plants is critical toward meeting present and future water needs, especially for those who depend on the projects for delivery of water supply, which includes most of the San Joaquin Valley, Southern California, and portions of the San Francisco Bay Area. Periodic pumping limitations due to water quality and salinity issues and because of environmental restrictions for endangered fish (salmon and delta smelt) pose significant operational challenges. Among the proposals under study are improvements to pumping capabilities and the coordinated use of the SWP and CVP to create more flexibility in meeting export needs without causing adverse impacts to the Delta environment and water quality.

Water quality. The Delta is a major water source for portions of the San Francisco Bay Area, the San Joaquin Valley, and Southern California. Salinity (from saltwater intrusion and from agricultural drainage), organic carbon, and pathogens are among the major constituents of concern for water agencies that divert water for domestic purposes. Water quality threats include population growth and increased wastewater discharge and urban runoff in Delta tributaries, recreational use within Delta waterways, and agricultural runoff and drainage from the Central Valley. Environmental water quality concerns also include mercury, organophosphate pesticides, selenium, and toxicity throughout the Delta, as well as low dissolved oxygen in the lower San Joaquin River.

Levee stability. The historical construction of levees on unstable peat soils has made Delta levees vulnerable to failure, especially during earthquakes or floods. Levee failures cause substantial flooding and damage to the agricultural lands on Delta islands (such as the Jones Tract levee break in early June 2004), and also can adversely impact Delta water quality. Long-term programs are being developed by DWR, in cooperation with CBDA, to address levee stability problems and to develop solutions and funding resources to strengthen levees and protect the Delta's water quality.

Environmental water supply. Over the past century, the health of the Delta ecosystem has declined with the destruction of habitat for both aquatic and terrestrial biota. Habitat quality has also declined due to diversion of water, toxics, exotic species, and other factors. Conversion of agricultural land to other uses to accommodate ecosystem improvements and other environmental restoration programs are being developed by the CALFED Bay-Delta Program as part of the long-term efforts to restore the Delta environment. The CALFED Ecosystem Restoration Program is funding several projects to monitor and identify the source of specific episodes of toxicity in the Delta. As part of the ERP projects, studies are being conducted on splittail and delta smelt exposure to unknown toxics.

Mountain Counties

Water supply reliability. The rapid urban growth and associated increases in water usage in the western foothill portion of this region is stressing available water supplies for many local districts and agencies. New surface water supplies are difficult to obtain because most of the available rights were previously appropriated and are now assigned to downstream users in the Sacramento and San Joaquin valleys and the coastal regions. More than 75 percent of the available surface water is stored and exported to water service areas outside of the region. Groundwater supplies in this region are also very limited because the underground geology consists of mostly fractured rock formations with very few significant aquifers. The lack of available new water supplies and the high cost of developing new water are posing major development problems for the growing communities in the region. Water agencies will need to consider a wide array of water management strategies to meet future needs, including increased water recycling, conservation, reclamation, conjunctive use programs, water exchanges, and water purchases. Some local agencies may test the State's "Area of Origin and Watershed Protection" laws as a mechanism for obtaining a larger share of the available water supply.

Water quality. Domestic water users generally benefit from high quality water supplies, but in some of the smaller rural delivery systems water quality can be degraded because of open reservoirs and delivery canals and inadequate water disinfection facilities. In some watersheds, drainage from abandoned mines contributes metals and other toxic elements to rivers that create water quality problems in downstream water bodies. Erosion from natural flooding, logging, land development, and areas devastated from forest fires, causes increased stream sedimentation to downstream areas as well.

As a result of the rapidly increasing population growth, the capacities of wastewater treatment systems for many water agencies is being stressed or exceeded, in some areas, resulting in wastewater treatment plant overflows to rivers and streams. The widespread use of septic tank systems is also problematic in relation to groundwater quality. Rural water agencies often have limited financial resources that restrict the ability to plan and construct wastewater system expansions to keep pace with the rate of urban growth.

Responses

Today's water management considers a broad range of resource management issues, competing water demands, and diverse water management tools. In recent decades, water management methods like storage and conveyance have been adapted to include more water conservation and recycling and other water management strategies. Moreover, regional and local agencies play an increasingly significant role in water planning. Regional initiatives that are under way are described in Volume 3 Regional Reports.

Moving Toward Regional Water Reliability

Water managers have learned that even though imported supplies will continue to be important, they cannot be relied on to satisfy growing water demands. In the 1980s concerns for protecting the environment were manifested in strong new laws and regulations. These regulations affected the ability of imported water projects to deliver water. The resulting uncertainty also contributed to hesitancy to invest in additional facilities for these interbasin systems and forced water agencies to face difficult decisions about how to provide a reliable water supply.

Local and regional agencies are looking more intensely at local water management options such as water conservation and recycling measures and groundwater storage. Water managers are learning that planning for sustainable water use must address multiple resource objectives—water use efficiency, water quality protection, and environmental stewardship—and consider broad needs—economic growth, environmental quality, and social equity.

Throughout California, stakeholders have begun working together to develop regional and watershed programs that cover multiple jurisdictions and provide multiple resource benefits. In several regions, agencies formed partnerships to combine capabilities and share costs. Integrated regional water management has taken a foothold and is on the rise. (See Box 3-6 Examples of Ongoing Regional Water Planning Efforts.)

Integrated Regional Water Management

California is placing more emphasis on integrated regional water management because it

- makes better use of existing local resources,
- provides for coordination and improved efficiency and flexibility in the actions of local agencies and governments within a region,
- integrates all aspects of water management, including water quality, local surface water, groundwater, conservation, recycled water, conveyance, ecosystem restoration, and imported supplies.
- reflects regional diversity and values when setting management objectives.

Box 3-6 Examples of Ongoing Regional Water Planning Efforts

One of the ways in which broad public benefits can be achieved is through the establishment of partnerships that combine the capabilities of individual agencies to create opportunities that would not otherwise be possible. Following are some examples. Those listed with an asterisk (*) are given more detail below.

- Klamath River Watershed Framework
- Sacramento Valley Water Management Program and Basin Wide Management Plan*
- Regional Water Authority*
- [Sacramento] Water Forum*
- Freeport Regional Water Project
- Bay Area Water Forum
- San Joaquin River Agreement
- Mokelumne River Basin Collaborative Planning Process
- Westside San Joaquin Valley Integrated Resource Planning Program
- San Joaquin Valley Water Coalition
- Kern County Water Agency Conjunctive Management Program
- Upper Kings River Basin Water Forum
- Metropolitan Water District of Southern California Integrated Resources Planning Program*
- Santa Ana River Watershed Program*
- Colorado River Quantification Settlement Agreement (QSA)

Sacramento Valley Water Management Program

The purpose of the Sacramento Valley Water Management Program is to promote better water management in the Sacramento Valley and develop additional water supplies through a cooperative water management partnership. The SVWM Program was developed to help resolve water quality and water rights issues arising from the need to meet the flow-related water quality objectives of the 1995 Bay-Delta Water Quality Control Plan and the State Water Resources Control Board's Phase 8 Water Rights Hearing process. The participants include the U.S. Bureau of Reclamation, the California Department of Water Resources, Northern California Water Association, and various Sacramento Valley and export water users.

To implement the program, Northern California water districts and companies have proposed more than 50 projects that will be part of both short- and long-term work plans being developed by a team of leading hydrologists and engineers. These projects will protect Northern California water rights and include groundwater planning and monitoring projects, providing for unmet demands in the Sacramento Valley, system improvement and water use efficiency measures, conjunctive management and surface water re-operation projects.

Groundwater protection is central to the work plan. Local water users have proposed these work plan projects, which will be managed and controlled by local interests. Additionally, the parties are preparing a program environmental review and will jointly seek public funds, including Proposition 50, to help implement many of these projects.

Regional Water Authority

The Regional Water Authority (RWA), inaugurated in June 2001, serves as a joint powers authority for 18 member agencies and 3 associate agencies in the greater Sacramento, Placer, and El Dorado County region. RWA works to protect and improve the reliability, availability, affordability, and quality of water resources in the region, and was formed through the consolidation of several regional associations after two years of workshops with dozens of water interests.

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Box 3-6 continued from previous page

To meet the needs of the more than a million people within the region, RWA has created several new initiatives, including a water efficiency program for local purveyors and the $43 million American River Basin Regional Conjunctive Use Program, which has been assisted by a $22 million grant from the Department of Water Resources through RWA funding efforts. RWA has also been a key player in the Sacramento Area Water Forum discussions over the American River and has organized workshops and classes to provide educational and technical assistance to local organizations and individuals.

RWA has been widely identified as a good example of using regional partnerships to coordinate water management efforts and to secure funding for water projects. Around $19 million has been awarded to RWA in the form of grants to support its innovative water efficiency program. The authority has developed good working relations with State and local agencies throughout the region.

[Sacramento] Water Forum

In the American River watershed, individual groups, water suppliers, environmentalists, local governments, business groups, agriculturalists, and citizen groups were all independently pursuing their own water objectives with little or no success. For more than 20 years, the various stakeholders were locked in a litigious battle over the American River. Even though millions of dollars had been spent pursuing single purpose solutions, there was little to show for these fragmented efforts.

In 1993, the City of Sacramento and the County of Sacramento came up with a possible solution to these water wars – the Water Forum. Bringing together a diverse group of business, agricultural leaders, citizens groups, environmentalists, water managers and local governments; the Water Forum was created. It was a six-year crusade of intense interest-based negotiations which required each stakeholder to put aside their demands ("positions") and instead focus on the underlying reasons ("interests") behind both their own and their adversaries' concerns. This creative approach resulted in the Water Forum Agreement.

Signed by each of the stakeholder organizations in April 2000, the Water Forum Agreement is a comprehensive document that allows the region to meet its needs in a balanced way through implementation of seven elements. These elements include detailed understandings among stakeholder organizations on how this region will deal with key issues to the year 2030. The seven elements are:

1. Increased surface water diversions
2. Actions to meet customers' needs while reducing diversion impacts on the lower American River in drier years
3. An improved pattern of fishery flow releases from Folsom Reservoir
4. Lower American River Habitat Management Element
5. Water Conservation Element
6. Groundwater Management Element
7. Water Forum Successor Effort

To ensure implementation of the Water Forum Agreement, the seventh element, the Successor Effort was created to oversee, monitor and report on implementation of the Agreement. The signatories to the Water Forum Agreement committed their organizations to continued participation in the partnership. Since the signing, there has been significant progress toward implementing many of its projects.

The Water Forum Agreement acknowledges that there is no single-purpose program that will secure our water future; therefore, it is necessary to implement a full range of complementary actions through 2030 that will achieve the Water Forum's two co-equal objectives: Provide a reliable and safe water supply for the region's economic health and planned development to the year 2030; and preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River.

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Box 3-6 continued from previous page

Metropolitan Water District Integrated Water Resources Plan

The Metropolitan Water District of Southern California (MWD) is a large consortium of 26 cities and water districts that provides an average of 1.7 billion gallons per day of drinking water to almost 18 million customers. Because of its important role in distributing water in California and maintaining adequate quantity and quality of supplies for its members, MWD developed its integrated water resources plan in 1996. It identified a "Preferred Resource Mix" that includes recommendations for meeting full service retail demands through 2020.

In 2001 the MWD Board of Directors initiated an effort to update the 1996 plan to review past goals and achievements, determine what conditions related to water resource development had changed since 1996, and to update the targets contained in the "Preferred Resource Mix" through 2025. The 2003 Metropolitan Water District Integrated Water Resources Plan, which was approved July 2004, was developed with the assistance of the MWD Board, a plan workgroup, MWD member agencies, environmental organizations, agricultural representatives, and other parties, and included several changes from the earlier plan. Higher conservation savings are stressed in the 2003 plan, along with increased use of desalination, recycling, and groundwater recovery, to meet 100 percent reliability needs through 2025. The 2003 MWD plan is a useful example of using integrated resource planning in conjunction with regional partnerships to develop goals and objectives for comprehensive water resource management.

According to Chief Executive Officer Ronald R. Gastelum, Metropolitan's preparations and ability to deal with water shortages, drought and emergencies have expanded in recent years. "The great strides that Metropolitan and its member public agencies have made in water storage, conservation, recycling, transfer and option programs have helped the region through recent periods that otherwise could have been called droughts and have prepared us well for future droughts and emergencies. We anticipate working with all of our member agencies to further strengthen our resources management in both wet times and dry," Gastelum stated in a March 2005 press release issued in response to a State Appellate Court upholding MWD's water allocation formula.

New partnerships should be explored in other parts of the state to determine other opportunities to collaborate and pool resources for more effective, regional water management. As shown in these examples, partnerships can provide broad public benefits that otherwise would not be possible through actions of the individual agencies. By employing the principles of integrated resource planning, these partnerships can develop well-structured objectives and holistic strategies to meet objectives while responsibly managing California's precious water resources.

Santa Ana Watershed Project Authority

Formed as a planning agency in 1968, the Santa Ana Watershed Project Authority (SAWPA) was later reorganized and in 1975 officially became a joint powers authority (classified as a Special District under California law). SAWPA has five member agencies: Eastern Municipal Water District (EMWD), Inland Empire Utilities Agency (IEUA), Orange County Water District (OCWD), San Bernardino Valley Municipal Water District (SBVMWD), and Western Municipal Water District (WMWD). The agencies span almost 2,000 square miles and include more than 4 million people.

The purpose of creating SAWPA was to better implement projects focused on several key objectives: water quality control; pollution abatement using waste treatment management plans for the watershed area; disposal of wastewater, storm water, and other wastes; irrigation, municipal, and industrial water supply development; aquifer rehabilitation; and water reclamation, recycling, and desalting. SAWPA has authority to issue bonds and take on other forms of indebtedness to fund projects, and has additional powers granted to joint power authorities.

continued

Integrated regional water management is a comprehensive, systems approach for determining the appropriate mix of demand and supply management options that provide long-term, reliable water supply at lowest reasonable cost and with highest possible benefits to customers, economic development, environmental quality, and other social objectives. (See Chapter 2 Framework for Action for a full discussion of integrated regional water management.)

Water agencies in many regions are successfully employing a mix of resource management strategies with State and federal incentives. Experience is showing that these regional efforts can better resolve regional needs, especially when paired with statewide water management systems. Regional water management options can reduce physical and economic risks and provide regional control over water supplies. More is being done to meet water demands with water conservation, reoperation of facilities, water recycling, groundwater storage and management, transfer programs, and, in limited cases, regional or local surface storage reservoirs. (See Volume 2 Resource Management Strategies for further discussion of regional management options.) Overall, this increased focus on integrated regional water management solves water management problems more efficiently, considers other resource issues, and enjoys broader public support.

With integrated regional water management, regions have been able to take advantage of opportunities that are not always available to individual water suppliers: reduce dependence on imported water and make better use of local supplies; enhance use of groundwater with greater ability to limit groundwater overdraft; increase supply reliability; security; and improve water quality. The extent to which regions have carried these out has been driven by considerations like economics, environment, engineering, and institutional feasibility. (See Box 3-7 Complementary Management Approaches: IRWM and Watershed Management)

Integrated regional water management results in plans that address multiple water and related resources objectives to produce multiple benefits. As an example, in some areas of the state where it is feasible, agricultural users are developing water use efficiency projects that simultaneously help stretch limited water supplies, reduce loads of contaminants, preserve the agricultural economy, and improve aquatic habitat. Similarly, some urban areas are looking at multipurpose projects that use storm water for groundwater recharge thereby increasing water supply, reducing urban runoff, improving water quality, and decreasing costs for drainage facilities. Although they may not yet be making significant contributions to urban water supply reliability, these types of projects produce a diverse and valuable mix of other benefits.

The California Legislature has enacted several regulations to improve integrated regional water management (see Box 3-8 New Laws Support Integrated Regional Water Management). Recent legislation has also encouraged improvements in recycling, desalination, and groundwater management. These statutory changes provide incentives for pursuing integrated regional water management and reflect the goals of managing water supplies with more flexibility while addressing an array of benefits and interests. For example, Water Code section 10530 et seq. (SB 1672 Stats. 2002, ch. 767 and AB 2469 Stats. 2002, ch. 949) provide for Integrated Regional Water Management plans and specify that a planning group developing these plans be composed of at least 3 local agencies, 2 of which must have statutory authority over water supply. The emphasis in this part of the Water Code is on integrating local water management to create greater flexibility and diversity in managing water demands and supplies while potentially addressing other water issues such as flood management, wastewater treatment, and ecosystem health.

Water managers are learning that planning for sustainable water use must address multiple resource objectives—water use efficiency, water quality protection, and environmental stewardship—and consider broad needs—economic growth, environmental quality, and social equity.

Box 3-6 continued from previous page

Because the Santa Ana watershed is one of the fastest-growing regions in California and because of the high regional demand for good-quality water supplies, SAWPA has faced severe challenges since its creation. By forming a regional partnership, SAWPA has been able to obtain funds that might otherwise be inaccessible or overly expensive, and the authority has been able to speak with a common voice for its members before the Legislature and in other policy and management forums.

Coordination of Water and Land Use Planning

Three bills enacted by the Legislature to improve the coordination between water supply and land use planning processes at the local level became effective January 1, 2002 (see Box 3-9 SB 221, SB 610, and AB 901). In general, the new laws are intended to improve the assessment of water supplies during the local planning process before approval of land use projects that depend on water. The new laws require verification of sufficient water supplies as a condition for approving developments, and they compel urban water suppliers to provide more information on groundwater reliability if used as a supply. They also require average and drought year conditions be addressed when evaluating water supply reliability.

The State of California General Plan Guidelines, updated in 2003 (OPR), recommends that local government include an optional water element in their general plans. Several jurisdictions have developed, or are now preparing, water management elements and chapters for their general plans.

AB 857 (Stats. 2002; ch. 1016) establishes three planning priorities and requires that all State strategic plans and capital improvement plans—including the next update of the Governor's Environmental Goals and Policy Report and the California Water Plan—be consistent with them. The Governor and Legislature set the following planning priorities to promote equity, strengthen the economy, protect the environment, and promote public health and safety in California. The overarching purpose is to establish a tie in State policy between planning, social equity, and the human environment.

- Promote infill development and equity,
- Protect environmental and agricultural resources, and
- Encourage efficient development patterns.

Increased focus on integrated regional water management solves water management problems more efficiently, considers other resource issues, and enjoys broader public support.

Statewide and Interregional Response

We have learned that solutions to California's water management issues are best planned and carried out on a regional basis. However, the State has led collaborative efforts to find solutions to water issues having broad public benefits such as protecting and restoring the Delta, Salton Sea, Lake Tahoe, and Mono Lake. Statewide and interregional responses to water resource emergencies and management needs are summarized in this section, including programs, task forces, reports, water bonds, legislation, and federal programs. (See Box 3-10 Recent Statewide and Interregional Responses to Challenges.)

Programs and Planning

CALFED Bay-Delta Program's Record of Decision Stage 1 Actions. In August 2000, the CALFED Bay-Delta Program issued a Programmatic Record of Decision (ROD) that set forth a 30-year plan to address ecosystem health and water supply reliability problems in the Bay-Delta. The Program plan addresses four interrelated, interdependent resource management objectives concurrently: water supply reliability, water quality, ecosystem restoration, and levee system integrity. (See Box 2-5 CALFED Bay-Delta Program.) The program's mission is to:

- Provide good water quality for all beneficial uses.
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.

Box 3-7 Complementary Management Approaches: IRWM and Watershed Management

Many overlapping characteristics and issues confront integrated regional water management and watershed management. Both approaches are being used in California to combine local, State, and federal resources to create a broader, more flexible water management system. Watershed management is a process of evaluating, planning, managing, and organizing land and other resource use within a watershed while maintaining a sustainable ecosystem. For regional planning purposes in California, a watershed includes living (including the people who live and work in the watershed) and nonliving elements within a defined geographical area that is generally characterized by the flow of water. Watershed management seeks to balance changes in community needs with evolving ecological conditions. (See Volume 2 for more discussion of watershed management as a resource management strategy.)

- Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system.
- Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

The CALFED Bay-Delta Program began Stage 1 implementation after signing of the ROD. (Stage 1 covers the first seven years of program implementation.) Actions taken during Stage 1 build the foundation for future, long-term actions specified in the Program's Programmatic Environmental Impact Statement/Report. Through 2003 CALFED had invested nearly $2 billion in water supply, water quality, and ecosystem restoration programs; significantly reduced conflicts over Delta operations through better agency coordination and the new Environmental Water Account; and launched an independent science program, which brings national experts together to conduct workshops and reviews of all major program activities. The California legislature established the CBDA as a new governance structure to oversee the Program and the CALFED agencies.

Consistent with the commitment in the Governor's budget 2005-06, a three-point plan was developed that will allow the CALFED Program to move forward and focus on addressing the highest priority issues associated with conflicts in the Delta.

Colorado River Agreement. In legislation enacted in 2003 to start the Colorado River QSA, the State of California accepted significant responsibilities and liabilities for mitigation of the agreement's environmental impacts and for Salton Sea ecosystem restoration. The State's actions were to enable the QSA's local agency signatories to reach agreement on how to reduce their use of Colorado River water to California's basic interstate apportionment of 4.4 million acre-feet annually. The QSA implementing legislation is contained in three bills chaptered in 2003—SB 277, SB 317, and SB 654.

Included in the QSA are water transfers—from Imperial Irrigation District to San Diego County Water Authority and to Coachella Valley Water District—that will reduce the inflows of agricultural runoff that constitute Salton Sea's chief source of fresh water. The sea's present salinity of about 48,000 milligrams per liter (mg/l) is about 30 percent higher than ocean water. As the sea's salinity increases through evaporation and concentration of salts, it will become too saline to support its present fish and wildlife resources.

Global Climate Change. On June 1, 2005, Governor Schwarzenegger signed Executive Order S-3-05. The Executive Order, in part, states:

- California is particularly vulnerable to the impacts of climate change;

Box 3-8 New Laws Support Integrated Regional Water Management

SB 672 (Stats. 2001, ch. 320) and SB 1341 (Stats 2000, ch. 720). Increased the focus on regional and integrated water planning in preparing the California Water Plan Update.

The Integrated Regional Water Management Planning Act of 2002 (Stats. 2002, ch. 767). Authorizes regional water management groups to prepare and adopt regional plans and requires the Department of Water Resources and other State agencies to include the status of regional water management planning in the set of criteria used to select projects for grant and loan programs.

SB 1938 (Stats. 2002, ch. 603). Requires agencies seeking funding for groundwater projects to include a plan for coordinating with other agencies within a region.

California Bay-Delta Authority. The governor and Legislature encouraged the regional approach by including regional representatives on the new California Bay-Delta Authority to oversee the Bay-Delta Program.

Proposition 50, "Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002." The voters of California provided further support for regional solutions with approval of this proposition, which includes $500 million for Integrated Regional Water Management.

SB 221 (Stats. 2001, ch. 642) and SB 610 (Stats. 2001, ch. 643). Require greater coordination and more extensive data to be shared between water suppliers and local land use agencies for large development projects and plans.

These and other legislation passed since Bulletin 160-98 are described in Volume 4 Reference Guide article "Recent Water Legislation."

- Climate change threatens the State's water supply, as well as other resources;
- California must take efforts to reduce greenhouse gas emissions; and,
- the State must prepare for the consequences of global climate change.

The Executive Order:

- establishes greenhouse gas emission reduction targets;
- directs the Secretary of the California Environmental Protection Agency to coordinate with other State agencies to meet the reduction targets;
- directs that biannual reports be submitted to the Governor and the Legislature to report on progress made toward meeting the targets; and,
- directs that biannual reports be submitted to report on the impacts of global climate change on California and to report on mitigation and adaption plans.

The first biannual reports required by Executive Order S-3-05 are due January 2006.

Hetch Hetchy Valley. The Resources Agency directed DWR and the Department of Parks and Recreation to review and summarize studies and analyses prepared over the last 20 years on the feasibility of restoring Hetch Hetchy Valley. DWR and State Parks are reviewing existing reports, along with applicable local, State, and federal resource plans, and will provide an evaluation of pertinent water supply, water quality, flood management, recreation, environmental, economic, and energy issues. The review includes evaluation of options and likely costs of replacing water and energy supplies, increased water treatment, removal of O'Shaughnessy Dam, and recreational opportunities in and restoration of Hetch Hetchy Valley. No new analytical studies are being conducted as part of this project. The final report, scheduled for release by the end of 2005, will also identify the necessary next steps for a more comprehensive study. The State is working with and obtaining information from the San Francisco Public Utilities Commission and its retailers, American Indian tribes, the National Park Service, those affected downstream of Hetch Hetchy, and environmental interest groups.

Box 3-9 SB 221, SB 610, and AB 901

SB 221 (Bus. and Prof. Code, § 11010 as amended; Gov. Code, § 65867.5 as amended; Gov. Code, §§ 66455.3 and 66473.7) prohibits approval of subdivisions consisting of more than 500 dwelling units unless there is verification of sufficient water supplies for the project from the applicable water supplier(s). This requirement also applies to increases of 10 percent or more of service connections for public water systems with less than 500 service connections. The law defines criteria for determining "sufficient water supply, such as using normal, single-dry, and multiple-dry year hydrology and identifying the amount of water that the supplier can reasonably rely on to meet existing and future planned uses. Rights to extract additional groundwater must be substantiated if used for the project.

SB 610 (Water Code, §§ 10631, 10656, 10910, 10911, 10912, and 10915 as amended; Pub. Resources Code, § 21151.9 as amended) and AB 901 (Water Code, §§10610.2 and 10631 as amended; Water Code § 10634) make changes to the Urban Water Management Planning Act to require additional information in Urban Water Management Plans (UWMPs) if groundwater is identified as a source available to the supplier. Required information includes a copy of any groundwater management plan adopted by the supplier, proof that the developer or agency has rights to the groundwater, a copy of the adjudication order or decree for adjudicated basins, and if not adjudicated, whether the basin has been identified as being overdrafted or projected to be overdrafted in the most current California Department of Water Resources publication on the basin. If the basin is in overdraft, the UWMP must include current efforts to eliminate any long-term overdraft. A key provision in SB 610 requires that any project that is subject to the California Environmental Quality Act and supplied with water from a public water system be provided a water supply assessment, except as specified in the law.

State of California General Plan Guidelines (OPR 2003) recommends facilitating SB 610 by having strong water elements in local general plans that incorporate coordination between the land use agency and the water supply agency. AB 901 requires the plan to include information relating to the quality of existing sources of water available to an urban water supplier over given periods and include the manner in which water quality affects water management strategies and supply reliability.

Box 3-10 Recent Statewide and Interregional Responses to Challenges

Programs and Planning

- CALFED Bay-Delta Program's Record of Decision (2000)
- California's Colorado River Quantification Settlement Agreement (2003)
- Lower Owens River Project (2003)
- Sacramento and San Joaquin River Basins Comprehensive Study
- San Joaquin River Agreement
- San Joaquin River Management Program
- Trinity River Basin (2000)
- Truckee River Basin (since 1991)

Regional Initiatives

- See Volume 3 for regional initiatives that are under way

Task Forces and Advisory Panels

- California Commission on Building for the 21st Century
- California Floodplain Management Task Force Recommendations
- California Watershed Council
- Desalination Task Force
- Governor's Advisory Drought Planning Panel's Critical Water Shortage Contingency Plan
- Landscape Task Force (AB 2717)
- State Recycling Task Force
- State Watershed Management Guidelines Initiative (formed Joint Task Force on California Watershed Management)

State Bulletins and Reports

- California's Groundwater Update 2003 (Bulletin 118)
- Fish Passage Improvement (Bulletin 250-2003)
- General Plan Guidelines Update 2003 (recommends new Water Element)
- Management of the California State Water Project (annual publication of Bulletin 132)

Water Bonds

- Proposition 204, November 1996, $995 million
- Proposition 13, March 2000, $1.97 billion
- Proposition 40, March 2002, $2.6 billion
- Proposition 50, November 2002, $3.4 billion

Water Legislation

- See Volume 4 article "Recent Water Legislation"

Water Litigation

- See Volume 4 articles "Joint Statement on the Monterey Amendments Litigation" and "Summary of Significant Litigation 1998-2005"

Klamath Basin. Since the drought of 2001, some Klamath Basin farmers have switched to groundwater as a source of water supply for their crops, which has been encouraged by USBR financial support. Oregon has issued more than 130 new permits for well construction in the Klamath Basin, yet very little is known about the capacity and recharge capability of this underground supply source. In 2004 it was reported that groundwater levels are declining—in some areas by as much as 20 feet. This has raised new concerns about the adequacy of the groundwater basin, and Oregon is now working with the U.S. Geological Survey (USGS) and the State of California to evaluate and report on the capabilities of this interstate groundwater system.

In March 2002 the federal administration established a cabinet-level Klamath River Basin Federal Working Group that includes the departments of Interior, Agriculture, and Commerce to address concerns raised by farmers, ranchers, anglers, tribes, and others affected by the difficult conditions in Klamath. As part of the working group, the Department of Agriculture is helping farmers and ranchers start a variety of conservation programs. For example, the Natural Resources Conservation Service is working with a number of landowners to improve wetland and wildlife habitat through the Wetlands Reserve Program. This includes an additional 2,500 acres enrolled in permanent easements during 2002. The projects are on Upper Klamath Lake and the Williamson River, both major water sources of the Klamath Basin. These projects will benefit water quality and improve wildlife habitat, thereby providing benefits to the endangered Lost River sucker and shortnose sucker fish (USDA 2004).

Mono Lake and Owens River. In the Mono Lake and Owens River basins, extensive long-term water diversions through the Los Angeles Aqueduct to Southern California have negatively affected the region for decades. In 1993 after years of litigation the Los Angeles Department of Water and Power (LADWP) began final flow releases to restore Mono Lake to previous levels, with a desired water surface elevation of 6,392 feet. Under this restoration program, Mono Lake's surface elevation has been rising and reached an elevation of 6,382 feet by year 2003.

In December of 2003 the LADWP and the City of Los Angeles approved a tentative agreement with several Owens Valley interest groups called the Lower Owens River Project (LORP) that will return water to a 62-mile stretch of the lower Owens River to restore the riparian ecosystem. After modifications to existing diversion structures are completed, this program is expected to start operations in the fall of 2005 with a base flow of 40 cubic feet per second. If successful, LORP has the potential to become one of the most significant river restoration projects undertaken in the United States.

Sacramento and San Joaquin River Basins Comprehensive Study. State and federal legislation authorized the development of comprehensive plans for flood damage reduction and ecosystem restoration along the Sacramento and San Joaquin rivers following the disastrous floods that occurred in January 1997. Although there is widespread agreement that changes are needed to improve the system, there is no agreement at this time where the various measures should take place. What did evolve from these planning efforts is a process to develop future projects to meet the system's comprehensive public safety, flood damage reduction, and ecosystem restoration objectives. This process consists of guiding principles for integrating flood damage reduction and ecosystem restoration in future changes to the flood management system. The process provides an approach to develop projects that ensures system-wide effects are evaluated regardless of project scale and an administrative structure to oversee consistent application of the process.

The December 2002 interim report (USACE) recognizes the water supply conveyance benefits of the levee system and suggests that a broader responsibility for maintenance of the flood management system should be considered. The Reclamation Board of the State of California endorsed the interim report on December 20, 2002.

As a result of the comprehensive study, a draft feasibility study/EIS/EIR has been prepared for the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project about 85 miles north of Sacramento on the Sacramento River. This study proposes replacing the existing "J" levee with a new setback levee that will protect the Hamilton City community of about 2,000 people plus surrounding agricultural lands while restoring about 1,500 acres of native vegetation along the Sacramento River.

San Joaquin River Basin. AB 3603 (1990) authorized the San Joaquin River Management Program (SJRMP) to provide a regional forum for identification, discussion, and development of projects and programs intended to improve the river's water quality, fisheries, water supply, flood control, and recreation. In 1995 the completed SJRMP Plan identified approximately 80 consensus-based projects and studies that could be undertaken to improve the river system. Although some projects and programs have been successfully started, many others are on hold until sufficient funding and sponsors can be obtained.

The San Joaquin River Agreement was approved in 1999 to support and implement the Vernalis Adaptive Management Plan, which establishes procedures to meet the river's provisions of the SWRCB's 1995 Water Quality Control Plan. VAMP is a 10-year test program that evaluates the capability of April-May pulse flows in the lower San Joaquin River to improve the survival of salmon smolt migrating to San Francisco Bay. The agreement facilitates the funding and purchase of water from upstream reservoirs, which is released per VAMP pulse flow criteria in April and May.

Trinity River Basin. The Secretary of the Interior in December 2000 approved significant change in use of Trinity River basin water. As part of an effort to restore Trinity River fish habitat, the river's instream flows were increased from 340,000 acre-feet per year (roughly 25 percent of average annual flow at the CVP diversion point on the Trinity River) to an average of 595,000 acre-feet per year. This decision, which would reduce the amount of water available for export from the Trinity River to the Central Valley, was challenged by water and power interests in U.S. District Court in 2001. On July 13, 2004, the 9th U.S. Circuit Court of Appeals overturned the injunction and ruled that the original year 2000 Record of Decision was adequate. The water allocated to downstream fish flows is now being increased to the new flow schedule, which ranges from a minimum of 368,600 acre-feet in a critically dry year up to 815,000 acre-feet in an extremely wet year.

Truckee River Basin. In the interstate Truckee River Basin, which includes Lake Tahoe, efforts continue to resolve years of disputes over the waters of the Truckee and Carson rivers. In 1990 Congress passed the Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Public Law 101-618), which makes an interstate allocation of the waters between California and Nevada, provides for the settlement of certain American Indian rights claims, and provides for water supplies for specified environmental purposes in Nevada. California's water entitlements under this act will be established as 23,000 acre-feet annually in the Lake Tahoe Basin and 32,000 acre-feet annually in the Truckee River Basin below Lake Tahoe with the remainder of the basin water supply assigned to water interests in Nevada. However, provisions of the Settlement Act, including the interstate water allocation, will not take effect until several conditions are met, which include negotiation and approval of a new Truckee River Operation Agreement (TROA).

Negotiation of a proposed TROA and preparation of its EIS/EIR began in 1991 involving the federal government, the states of California and Nevada, the Pyramid Lake Paiute Indian Tribe, and water purveyors from both states. The revised draft EIS/EIR for this agreement was distributed in 2004, and public comments are now being reviewed for preparation of the Final TROA EIS/EIR in 2006. When executed, the TROA would establish river operations procedures to meet water rights on the Truckee River and to enhance spawning flows in the lower Truckee River for cui-ui and Lahontan cutthroat trout. TROA would provide for management of water within the Truckee River Basin in California, including instream flow requirements and reservoir storage for fish and recreation uses, and would include procedures for operation and accounting of surface and groundwater diversions in California's part of the Truckee Basin.

Programs to manage Lake Tahoe water quality by regulating development and preventing pollutants from reaching the lake are being implemented at the federal, State, and local levels. The Tahoe Regional Planning Agency (TRPA), a bistate agency created by Congress, sets regional environmental standards, issues land use permits (including conditions to protect water quality), and takes enforcement actions throughout the basin. TRPA's regional plan provides for achievements and maintenance of environmental targets by managing growth and development. In addition to its regulatory activities, TRPA carries out a capital improvement program to repair environmental damage done before the regional plan was adopted.

Task Forces and Advisory Panels

California Commission on Building for the 21st Century. The commission was directed to "study the building and infrastructure needs of California, with the intent of identifying existing critical infrastructure needs and developing a comprehensive long-term capital investment plan for financing public building needs, including responsible financial approaches and efficiency improvements." In 2000 at the recommendation of this commission and with the support of the Governor and the Legislature, more than $4 billion in parks and water bonds were placed on the ballot (propositions 12 and 13) and approved, constituting the largest such State investment in the nation's history (California Commission on Building for the 21st Century 2001).

California Floodplain Management Task Force. This task force was established in early 2002 to examine specific issues related to State and local floodplain management. The diverse group of private, nonprofit, and local interest groups and State, federal, and local agencies created more than 30 recommendations for improved floodplain management. (See Volume 2 Resource Management Strategies, Chapter 10 Floodplain Management for summary of task force recommendations.)

Desalination Task Force. AB 2717 called for DWR to establish a Desalination Task Force. On Oct. 9, 2003, DWR submitted "Water Desalination—Findings and Recommendations" to the Legislature on potential opportunities for desalination of seawater and brackish water in California, impediments to using desalination technology, and what role, if any, the State should play in furthering the use of desalination. (See Volume 2 Resource Management Strategies, Chapter 6 Desalination for recommendation summary of task force.)

The Governor's Advisory Drought Planning Panel. This panel was formed in 2000 to develop a contingency plan to address the impacts of critical water shortages with the recognition that health, welfare, and economy of California are among those severely impacted. As part of a five-year planning program to implement specific actions of the CALFED Bay-Delta Program, the panel made recommendations for actions that State government could take (December 2000 report, "The Critical Water Shortages Contingency Plan"). The recommendations included a critical water shortage reduction marketing program to facilitate intraregional, short-term, and dry-year transfers, financial and planning assistance to local agencies for drought-related response activities, and assistance to small water systems and homeowners in rural counties. The work on these programs started early 2002 and is ongoing through bond measures Proposition 13 (March 2000) and Proposition 50 (November 2002). (See Volume 4 Reference Guide article "Selected Task Force and Advisory Panels" for this panel's recommendations.)

Landscape Task Force. Governor Arnold Schwarzenegger signed AB 2717 in September 2004. It asks the California Urban Water Conservation Council to set up a landscape task force to evaluate landscape water use efficiency and make recommendations for improvements. The task force, convened in February 2005, includes representatives from water suppliers and agencies, landscape contractors, the green industry, cities and counties, environmental groups, and state and federal agencies. The main charge of the task force is to recommend changes to the Model Water Efficient Landscape Ordinance and to look at other landscape issues to promote water conservation. The task force plans to submit a final report to the California Legislature and Governor by December 31, 2005. (See Volume 2, Chapter 22 Urban Water Use Efficiency for the task force's draft recommendations.)

State Recycling Task Force. Noting the importance of water recycling to our state, a 40-member California Recycled Water Task Force was established pursuant to AB 331(Goldberg, Chapter 590, Statutes of 2001).The task force was charged with evaluating the framework of State and local rules, regulations, ordinances, and permits to identify the opportunities, obstacles, or disincentives to maximizing the safe use of recycled water. (See Volume 2 Resource Management Strategies, Chapter 16 Recycled Municipal Water for recommendation summary of the task force's report (2003).)

State Watershed Management Guidelines and Initiative. AB 2117 (Stats. 2000, ch. 735) required a report to the Legislature on California's watershed status and any needed changes in State laws. The State Secretary for Resources and chair of SWRCB formed the Joint Task Force on California Watershed Management, an interagency and stakeholder effort, to discuss the results of the 10 case studies, to refine the findings, and to craft major recommendations to move the state in a new direction to protect and restore watersheds, lakes, rivers, and estuaries in California. The task force issued its recommendations in "Addressing the Need to Protect California's Watersheds: Working with Local Partnerships" (SWRCB 2002).

The Watershed Subcommittee of the Bay-Delta Public Advisory Committee. The Watershed Subcommittee meets monthly, usually in Sacramento, to review progress in watershed management and provide input and advice to the CBDA Watershed Program. Participants come from state and local government, nonprofit corporations, and the private sector. Highlights of watershed work in various watersheds throughout the state are provided as part of each meeting.

DWR Bulletins and Reports

California's Groundwater Update 2003 (Bulletin 118). DWR has long recognized the need for collection, summary, and evaluation of groundwater data as tools in planning optimal use of the groundwater resource. Bulletin 118 presents the results of groundwater basin evaluations in California.

Fish Passage Improvement Program. A part of the CALFED Ecosystem Restoration Program, the Fish Passage Improvement Program is a partnership-building effort to improve and enhance fish passage in Central Valley and San Francisco Bay Area rivers and streams. Local, State, and federal agencies and stakeholders cooperatively plan and implement projects that remove barriers impeding migration and spawning of anadromous fish. The inaugural issue of Bulletin 250 (DWR 2003) presented for the first time aggregated information on fish passage impediments and activities to address the decline in riverine habitat within the Fish Passage Improvement Program geographic scope.

Flood Warnings: Responding to California's Flood Crisis. This Flood Management White Paper (DWR 2005) presents an overview of the current condition of flood management in the Central Valley and outlines a plan to reduce flood risks through an integrated approach for better planning, new investments, improved management of our infrastructure and closer collaboration between water agencies and users.

Management of the California State Water Project. Bulletin 132 is a series of annual reports that began in 1963 and describe the status of SWP operations and water deliveries. The most recent issue is Bulletin 132-03, which covers the period from January 1, 2002, to December 31, 2002 (DWR 2004). The report updates information regarding project costs and financing, water supply planning, power operations, and significant events that affect the management of the SWP. Bulletin 132-03 also discusses water supply and delivery, the continuation of construction of the East Branch Extension, Delta resources and environmental issues, including the CALFED Bay-Delta Program; Oroville facilities relicensing; financial analysis of the SWP; and the update of business systems in DWR.

Water Bonds

Voters have approved three additional major California water bonds since the last water plan update:

- Proposition 13. $1.97 billion in bonds to support safe drinking, water quality, flood protection, and water reliability projects throughout the state. Approved by voters March 2000.
- Proposition 40 "California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002." A $2.6 billion in bonds administered by 18 departments for various programs, including water quality, watershed protection and restoration, and protection of wildlife habitat. Approved by voters March 2002.
- Proposition 50 "Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002." This $3.4 billion bond provides $825 million (Chapter 7 funding) for CALFED for a variety of programs. Also, DWR is to administer one-half of the $500 million (Chapter 8 funding) for Integrated Regional Water Management grants for projects to "protect com munities from drought, protect and improve water quality, and improve local water security by reducing dependence on imported water." Approved by voters November 2002.

AB 303 (Local Groundwater Management Assistance Act of 2000). The intent of AB 303 is to provide grant funding to help local agencies conduct groundwater studies or carry out groundwater monitoring and management activities, including the development of groundwater management plans. The maximum grant available is $250,000.

Federal Planning (Water 2025)

Water 2025: Preventing Crises and Conflict in the West calls for concentrating existing federal financial and technical resources in key western watersheds and in critical research and development such as water conservation and desalinization that will help to predict, prevent, and alleviate water supply conflicts. Water 2025 proposes modernizing aging water supply structures (from dams and reservoirs to pumping stations, pipelines, and canals) and improving regional water planning and tools to help stretch existing water supplies with improved conservation, more efficiencies, and better monitoring.

A primary principle of Water 2025 is that solutions to complex water supply issues must recognize and respect state, tribal, and federal water rights, contracts, and interstate compacts and decrees of the U.S. Supreme Court that allocate the right to use water. (See Box 3-11 Water 2025 (Federal) Principles, Realities, and Key Tools).

In support of watershed management, federal agencies are subject to the Unified Federal Policy for Watersheds. The UFP guides the actions of key federal agencies such as the departments of Agriculture, Commerce, Energy, and Interior as well as the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers. This policy emphasizes the following:

- Assessing the functions and condition of watersheds
- Incorporating watershed goals in federal agency planning and programs
- Enhancing pollution prevention
- Improving monitoring
- Restoring watersheds
- Identifying waters of exceptional value
- Expanding collaboration among federal agencies, States, tribes, and interested stakeholders.

Understanding How Water Is Allocated, Used, and Regulated

California has a very large and complex water system with a highly decentralized system of governance involving State and federal agencies, thousands of local agencies, governments and private firms, and millions of households and farms. Decentralization has a major influence on daily management, planning, and policymaking. Competing and conflicting roles and responsibilities make it difficult to integrate regional water management. Differing roles of the various State, federal, and local governments during planning can create coordination problems. The organizational structure of State government can cause insufficient communication, coordination, and cooperation among numerous State agencies and departments responsible for water.

Institutional Framework

In California water use and supplies are controlled and managed under an intricate system of common law principles, constitutional provisions, State and federal statutes, court decisions, and contracts or agreements. All of these components constitute the institutional framework for the protection of public interests and their balance with private claims in California's water allocation and management. (See Box 3-12 Some Regulations Governing Water-related Resources Management and more details in Volume 4 Reference Guide articles "Water Allocation, Use and Regulation in California" and "Recent Water Legislation.")

Constitutional, Statutory, and Common Law Framework for Water Uses

Water rights in California are subject to State constitutional prohibition of wasteful or unreasonable use. California's water law and policy requires that "water resources of the State be put to beneficial use to the fullest extent of which they are capable" (Cal. Const., art. X, § 2). It places a significant limitation on water rights by prohibiting the waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water. However, the interpretation of what is wasteful can vary significantly depending on the circumstances and may depend on opinions of the SWRCB or, ultimately, the courts.

Public Trust Doctrine

Rights to use water are also subject to the State's obligation under the Public Trust Doctrine as trustee of certain resources for Californians. The Public Trust Doctrine imposes legal responsibilities on State agencies to protect trust resources associated with California's waterways, such as navigation, fisheries, recreation, ecological preservation, and related beneficial uses. In *National Audubon Society v. Superior Court of Alpine County*, the California Supreme Court concluded that the public trust is an affirmation of the duty of State government to protect the people's common heritage of streams, lakes, marshlands, and tidelands, surrendering such protection only in rare cases when the abandonment of that right is consistent with the purposes of the trust. Thus, California agencies have fiduciary obligations to the public when they make decisions affecting trust assets.

In *National Audubon*, the court addressed the relationship between the Public Trust Doctrine and California's water rights system and integrated them. The court reached three major conclusions:

1) The State retains continuing supervisory control over its navigable waters, the lands beneath them, and the flows of their tributary streams. This prevents any party from acquiring a vested right to appropriate water in a manner harmful to the uses protected by the public trust. SWRCB may reconsider past water allocation decisions in light of current knowledge and current needs.
2) As a practical matter, it will be necessary for the State to grant usufructuary licenses to allow appropriation of water for uses outside the stream, even though this taking may unavoidably harm the trust uses of the source stream.
3) "The State has an affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible."

Thus, while the State may, as a matter of practical necessity, have to approve appropriations that will cause harm to trust uses, it "must at all times bear in mind its duty as trustee to consider the effect of such taking on the public trust, (cite omitted) and to preserve, so far as consistent with the public interest, the uses protected by the trust."

Surface Water Rights

California's system for surface water rights recognizes both riparian rights and appropriative rights. Riparian rights were adopted in California as a part of the English common law when California became a state in 1850. At that time, gold miners were already operating under their own system that recognized claims to water rights based on prior appropriation.

- Riparian. A riparian right is the right to divert, but not store, a portion of the natural flow for use based on the ownership of property adjacent to a natural watercourse. Water claimed through a riparian right must be used on the riparian parcel. Such a right is generally attached to the riparian parcel of land except where a riparian right has been preserved for noncontiguous parcels when land is subdivided. Generally, riparian rights are not lost through non-use. All riparian water users have the same priority; senior and junior riparian water rights do not exist. During times of water shortage, all riparian water users must adjust their water use to allow equal sharing of the available water supply.
- Appropriative. Under the prior appropriation doctrine, a person may acquire a right to divert, store, and use

water regardless of whether the land on which it is used is adjacent to a stream or within its watershed. When water in a stream is over-appropriated, a priority system determines which appropriators may divert water. The rule of priority between appropriators is "first in time is first in right." A senior appropriative water rights holder may not change an established use of the water to the detriment of a junior, including a junior's reliance on a senior's return flow. Acquisition of appropriative water rights is subject to the issuance of a permit (followed by a license) by SWRCB with priority based on the date that the associated application for the appropriation of water was received by the SWRCB and was complete. Permit and license provisions do not apply to pre-1914 appropriative rights (those initiated before the Water Commission Act took effect in 1914), but pre-1914 rights are still subject to reasonable and beneficial use. Appropriative rights may be sold or transferred.

Groundwater Use and Management

California does not have a statewide permitting system or a statutory scheme to regulate groundwater extraction. However, case law has defined the nature of rights to groundwater, and there are several institutional mechanisms by which groundwater is managed on a local or basin-wide level. A landowner whose property overlies a groundwater basin has an "overlying" right to build a well and extract groundwater for reasonable and beneficial uses. That overlying right is correlative with the rights of all other overlying landowners in the basin.

In California, correlative rights are not defined unless the basin has been adjudicated. When a basin is adjudicated, the court identifies who can legally extract groundwater and the amount they can extract. There are 20 adjudicated groundwater basins in which the rights to groundwater have been determined by the court and groundwater is managed under court supervision.

In a basin that has not been adjudicated, if there is surplus groundwater after the reasonable and beneficial needs of the overlying landowners are met, the surplus groundwater can be appropriated for use on non-overlying land. This is called an appropriative right, and it has a lower priority than an overlying right. There is no codified procedure for determining either when

Box 3-11 Water 2025 (Federal) Principles, Realities, and Key Tools

Six principles to guide the federal Department of the Interior in addressing water problems:

- Recognize and respect state, tribal, and federal water rights, contracts, and interstate compacts or decrees of the U.S. Supreme Court that allocate the right to use water
- Maintain and modernize existing water facilities so they will continue to provide water and power
- Enhance water conservation, use efficiency, and resource monitoring to allow existing water supplies to be used more effectively
- Use collaborative approaches and market based transfers to minimize conflicts
- Improve water treatment technology, such as desalination, to help increase water supply
- Existing water supply infrastructure can provide additional benefits for existing and emerging needs for water

Five realities that drive water crises:

- Explosive population growth is taking place in areas of the West where water is already scarce
- Water shortages occur frequently in the West
- Over-allocated watersheds can cause crisis and conflict
- Water facilities are aging
- Crisis management is not effective in dealing with water conflicts

Four key tools to help manage scarce water resources:

- Conservation, efficiency, and markets
- Collaboration
- Improved technology
- Removal of institutional barriers and increased interagency cooperation

http://www.doi.gov/water2025/

Box 3-12 Some Regulations Governing Water-related Resources Management

Regulations protecting water quality. Water quality is an important aspect of water resource management.

- Clean Water Act-National Pollutant Discharge Elimination System
- Porter-Cologne Water Quality Control Act
- Safe Drinking Water Act
- California Safe Drinking Water Act

Environmental laws and regulations. Several laws outline the state and federal obligations to protect and restore degraded habitats and species.

- Federal Endangered Species Act
- California Endangered Species Act
- Natural Community Conservation Planning
- Clean Water Act and River and Harbors Act (Dredge and Fill Permits)
- Water Code (Public Interest Terms and Conditions, etc.)
- Fish and Game Code (Streambed Alteration Agreements, Releases of Water for Fish, etc.)
- Migratory Bird Treaty Act
- Fish and Wildlife Coordination Act
- Central Valley Project Improvement Act
- State and Federal Wild and Scenic Rivers System
- National Wilderness Act
- Unified Federal Policy for Watersheds

Regulating project planning, implementation and mitigation. Another set of environmental statutes compels governmental agencies and private individuals to document and consider the environmental consequences of their actions.

- National Environmental Policy Act
- California Environmental Quality Act

Regulations for water use efficiency. Water Code section 275 directs the Department and SWRCB to "take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste or unreasonable use of water."

- Urban Water Management Planning Act
- Water Conservation in Landscaping Act
- Agricultural Water Management Planning Act
- Agricultural Water Suppliers Efficient Management Practices Act
- Agricultural Water Conservation and Management Act (AB3616) of 1992
- Water Recycling Act of 1991
- CALFED Water Use Efficiency Program

Local land use. Water planning is influenced by local land use requirements.

- Local General Plans and Specific Plans
- SB 221
- SB 610

Other regulations. Some other regulations that influence water resource management include:

- Cloud Seeding Regulations
- Federal Power Act
- State Water Resources Control Board decisions

there is a surplus of groundwater, or how much groundwater is surplus. An appropriator can use the groundwater outside the basin, or the appropriator may be a municipal water purveyor that serves water to users in the same basin. In groundwater basins that have been overdrafted, a public agency may establish a prescriptive right by openly and publicly pumping water in excess of the available supply for five years.

In many basins, groundwater is managed by a local agency. Over 200 local agencies have prepared and adopted groundwater management plans in accordance with AB 3030, (1992; Water Code § 10750, et seq.). Thirteen other agencies have been granted specific authority to manage groundwater through special acts of the Legislature. Twenty-seven counties have adopted a groundwater ordinance, many of which require a permit before any groundwater can be exported. To obtain a permit, most ordinances require a project proponent to show that the project will not deplete the groundwater supply, degrade groundwater quality, or cause land subsidence. While an appellate court has affirmed a county's police power to regulate groundwater extraction and export, the full scope of a county's power to manage groundwater is not clear.

Tribal Water Rights

Some Indian reservations and other federal lands have reserved water rights implied from acts of the federal government, rather than State law. When tribal lands were reserved, their natural resources were implicitly reserved for tribal use. Because reserved tribal rights were generally not created by state law, states' water allocations did not account for tribal resources. In the landmark Winters v. U.S. case in 1908, the U.S. Supreme court established that sufficient water was reserved to fulfill the uses of a reservation at the time the reservation was established. The decision, however, did not indicate a method for quantifying tribal water rights. Winters rights also retain their validity and seniority over State appropriated water whether or not the tribes have put the water to beneficial use. Only after many years did tribes begin to assert and develop their reserved water rights. In 1963 the U.S. Supreme Court decision Arizona v. California reaffirmed Winters and established a quantification standard based on irrigation, presupposing that tribes would pursue agriculture. Despite criticisms of the "practicably irrigable acreage" (PIA) quantification standard from various perspectives, the PIA standard provided certainty to future water development. Quantifying water needs in terms of agricultural potential does not accurately show the many other needs for water. Even urban water quantity and quality assessments that look at the adequacy of the domestic water supply and sanitation do not provide a complete picture of tribal water needs. A large part of the tribal water needs are for instream flows and other water bodies that support environmental and cultural needs for fishing, hunting, and trapping.

The 1902 Reclamation Act provided for the establishment of irrigated agriculture and settlement throughout the Western states. Historical perspective indicates this policy was pursued generally without regard to Indian water rights or the 1908 Winters decision. In 1952 Congress passed the McCarran Amendment which waived sovereign immunity and authorized the adjudication of federal water rights in stream adjudications brought in state courts. The court later ruled that state adjudications may also apply to Indian reserved water rights held in trust by the United States. In asserting their Winters rights, tribes have come into conflict with water-using development that grew out of substantial federal and private investment. Costly litigation, negotiation, or both are the usual means of resolving Indian water disputes, and some cases can take decades to reach agreement. Some tribes request assistance from the federal government to pursue their water rights settlements, reminding concerned parties of the conflicting roles the federal government can assume on two or more sides of a judicial or administrative issue.

Law of the River

The Colorado River is managed and operated under numerous compacts, federal laws, court decisions and decrees, contracts, and regulatory guidelines collectively known as the "Law of the River." In 1922 the seven Colorado River Basin states negotiated the Colorado River Compact, which divided the states into two basins—upper and lower—and apportioned 7.5 million acre-feet per year to each basin. The compact also referenced Mexico's right to the Colorado River. The Boulder Canyon Project Act of 1928 ratified the compact and established California's apportionment at 4.4 million acre-feet per year[3]. In 1944 the United States signed a water treaty in which it agreed to deliver a quantity of 1.5 million acre-feet of water annually to Mexico.

While compact negotiators estimated the flow of the river to be at least 17 million acre-feet per year, today's records indicate a flow of 15 million acre-feet at Lee Ferry just below Lake Powell. Consequently, the sum of the actual compact apportionments and the Mexican treaty exceed the flow of the river in most years.

[3] See Colorado River Agreement under Programs and Planning section for discussion of 2003 QSA.

Water Contracts

Water contracts are a way for an entity to obtain short-term or long-term access to water without having specific water rights. State, federal, and many local water agencies have written contracts for delivery of water to other water purveyors or customers. Both the SWP and CVP have water rights that are subject to area of origin protections (see following section). The Operating Criteria and Plan provides detailed analysis of proposed CVP and SWP operations (see www.usbr.gov/mp/cvo/ocap.html). Both projects have written contracts to deliver water to water agencies that repay capital and operating costs. During some years, water deliveries are lower than the contract amounts shown below. (For actual deliveries in 1998, 2000, and 2001, see the water portfolios for each region in Volume 3 Regional Reports).

- State Water Project—DWR has long-term water supply contracts for water service from the SWP with 29 local agencies for about 4.2 million acre-feet annually. The majority of the SWP goes to urban uses. These long-term contracts were updated in the Monterey Amendments, and their provisions were revised in 2003 as part of a settlement agreement with the Planning and Conservation League (see "Joint Statement on the Monterey Amendments Litigation" in the Volume 4 Reference Guide).
- Central Valley Project—The CVP supplies water to more than 250 long-term water contractors extending from Shasta County in the north to Kern County in the south. Collectively, the contracts call for a maximum annual delivery of 9.3 million acre-feet: 4.8 million acre-feet is classified as project water, and 4.5 million acre-feet is classified as water right settlement water. In October 2004, the Bureau of Reclamation released the draft environmental impact statement (EIS) for the proposed long-term renewal of contracts between Reclamation and up to 145 Sacramento River Settlement Contractors. Starting in February 2005, USBR began signing long-term contracts for 25 or 40 years, depending on contract type. The contracts will provide water for 3.4 million acres of farmland in the Sacramento and San Joaquin Valleys that produce billions of dollars in gross farm revenue and provide municipal and industrial water for more than 3 million people and businesses, including Silicon Valley. Delivering this water also generates enough electricity for 2 million households.

Area of Origin Protections

During the years when California's two largest water projects, the CVP and SWP, were being planned and developed, area of origin provisions were added to the Water Code to protect local Northern California supplies. County of origin statutes reserve water supplies for counties in which the water originates. The Delta Protection Act, enacted in 1959 (not to be confused with the Delta Protection Act of 1992), requires the SWP and the CVP to provide salinity control in the Delta and an adequate water supply for water users in the Delta. In 1984 additional area of origin protections were enacted to prohibit the export of groundwater from the combined Sacramento River and Delta basins, unless the export is in compliance with local groundwater plans.

Water for Environmental Uses

Several laws outline the state and federal obligations to protect and restore degraded habitats and species:

- Federal Endangered Species Act
- California Endangered Species Act
- Natural Community Conservation Planning Act
- Clean Water Act and River and Harbors Act (Dredge and Fill Permits)
- Water Code (Public Interest Terms and Conditions, etc.)
- Fish and Game Code (Streambed Alteration Agreements, Releases of Water for Fish, etc.)
- Migratory Bird Treaty Act
- Fish and Wildlife Coordination Act
- Central Valley Project Improvement Act
- State and Federal Wild and Scenic Rivers System
- National Wilderness Act.
- Unified Federal Policy for Watersheds

For more information on these and other laws and regulations, see Volume 4 article "Water Allocation, Use, and Regulation in California."

Water Transfers

Every year hundreds of water transfers (totaling hundreds of thousands of acre-feet) take place between water users for a wide variety of reasons. Some provide water on a short-term basis for drought-year emergency water supplies and some provide for long-term water supplies. Water transfers occur within districts and projects and between regions. The State has helped transfers by purchasing and selling water through the Drought Water Bank and, more recently, the Dry Year Water Transfer Program. Short-term water transfers also include SWP supplemental water purchases and Central Valley Project Improvement Act and Environmental Water Account water acquisitions. (See Volume 2 Resource Management Strategies, Chapter 23 Water Transfers for more detail.)

Institutional Roles

The State and federal governments are responsible for representing and protecting the public trust (certain types of property of high public value held for the benefit of all citizens). Together, the State and federal governments provide assistance, guidance, and oversight to local governments (city- and county-owned municipal water systems, etc.), American Indian tribes, and special districts.

California Government

Many State departments and agencies oversee California's water resources. DWR operates the SWP and is responsible for overall water planning. SWRCB integrates water rights and water quality decision-making authority. SWRCB and the nine Regional Water Quality Control Boards are responsible for protecting California's water resources. Pursuant to the Porter-Cologne Water Quality Control Act, water quality control plans for each of the nine regions become part of the California Water Plan. Other State agencies and their roles in water management follow:

- California Bay-Delta Authority—Oversees the 23 State and federal agencies working cooperatively through the CALFED Bay-Delta Program to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem.
- California Coastal Commission—Plans for and reg-ulates land and water uses in the coastal zone consistent with the policies of the Coastal Act.
- California Department of Conservation—Provides services and information that promote environmental health, economic vitality, informed land-use decisions, and sound management of California's natural resources.
- California Environmental Protection Agency—Restores, protects, and enhances the environment to ensure public health, environmental quality, and economic vitality.
- California Integrated Waste Management Board—Manages the estimated 76 million tons of waste generated each year by reducing waste whenever possible, promoting the management of all materials to their highest and best use, and protecting public health and safety and the environment.
- California Public Utilities Commission—Regulates privately owned water and other utility companies.
- Colorado River Board—Protects California's rights and interests in the resources provided by the Colorado River.
- Delta Protection Commission—Responsible for preparation of a regional plan for the "heart" of the Delta.
- Department of Fish and Game—Regulates and conserves the state's wildlife and is a trusteefor fish and wildlife resources (FDC § 1802).
- Department of Food and Agriculture—Supports California's agricultural economy.
- Department of Health Services—Oversees programs to protect and improve the health of all Californians, regulates and permits drinking water.
- Department of Pesticide Regulation—Regulates pes-ticide sales and use and plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the water resource.
- Department of Toxic Substances Control—Provides technical oversight for the characterization and remediation of soil and water contamination.
- Reclamation Board—Plans flood controls along the Sacramento and San Joaquin rivers and their tributaries in cooperation with the U.S. Army Corps of Engineers.

Federal Government

USBR operates the CVP, the largest water project in California, and regulates diversions from the Colorado River. Other federal agencies play important roles in the regulation and management of California's water resources:

- Army Corps of Engineers—Plans, designs, builds, and operates water resources projects (navigation, flood control, environmental protection, disaster response, etc.).
- Federal Energy Regulatory Commission (FERC)—Regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to license hydropower projects.
- National Marine Fisheries Service (NOAA Fisheries)—Protects and preserves living marine resources, including anadromous fish.
- National Park Service—Manages national parks, including their watersheds.
- U.S. Bureau of Land Management- Manages federal lands.
- U.S. Bureau of Reclamation—Constructs federal water supply projects and is the nation's largest wholesaler of water and the second largest producer of hydroelectric power.
- U.S. Department of Agriculture (USDA)—Manages forests, watersheds, and other natural resources.
- [USDA] Natural Resource Conservation Service- Provides technical and financial assistance to conserve, maintain, and improve natural resources on private lands.
- U.S. Environmental Protection Agency—Protects human health, safeguarding the natural environment.
- U.S. Fish and Wildlife Service—Conserves, protects, and enhances fish, wildlife, and plants and their habitats.
- U.S. Geological Survey—Provides water measurement and water quality research.

- Western Area Power Administration—Manages power generated by the Central Valley Project.

American Indian Tribes

American Indian tribes exist under a unique relationship with the federal government—as beneficiary and trustee, respectively. In a broad sense, the federal government has a fiduciary responsibility to tribes; however, the execution and effectiveness of this responsibility differ between the three branches of the federal government.

When reservation lands were set aside, the natural resources of the reservations also were reserved for tribal people. The federal government is legal titleholder to all trust resources. American Indian tribes operate in this government-to-government relationship and help plan water resource projects affecting tribal land. Several landmark decisions have defined legal principles for intergovernmental relationships and tribal rights. In California and elsewhere, tribes without federal recognition do not enjoy governmental status or benefits. Tribal water rights are discussed under the section Institutional Framework.

Reversing a long trend of administrative and economic failures in the administration of the government's trust relationship with tribes, President Richard Nixon in 1970 issued a statement in support of strengthening tribal governments and improving the trust relationship. The federal government has initiated programs to encourage development of Indian resources and tribal self-determination. The socioeconomic and political history of California Indians is documented in many published reports. Some are cited in the list of references for this water plan. At the request of the California State Senate, in 2003 the California Research Bureau published an online report, "Early California Laws and Policies Related to California Indians" (CRB-02-014).

Public Agencies, Districts, and Local Governments

Local city and county governments and special districts have ultimate responsibility for providing safe and reliable water to their customers. In general, California has two methods for forming special districts that develop, control, or distribute water: (1) enactment of a general act under which the districts may be formed as set forth in the act, and (2) enactment of a special act creating the district and prescribing its powers. (See Volume 4 Reference Guide for article "What's So Special about Special Districts? A Citizen's Guide to Special Districts in California.")

Cities and counties are the land management and planning entities as well as resource management agencies that most influence the location and amount of population growth within the state. Many counties have adopted ordinances that require permits for certain uses of groundwater within their boundaries.

Private Entities

In addition to public agencies, private entities may provide water supply. Mutual water companies, for example, are private corporations that perform water supply and distribution functions similar to public water districts. Investor-owned utilities are also involved in water supply activities, sometimes as an adjunct of hydroelectric power development. These investor-owned water companies are regulated by the California Public Utilities Commission.

International Trade Agreements

Since January 2000 more than 140 World Trade Organization (WTO) member governments have been negotiating to further liberalize the global services market. The General Agreement on Trade in Services (GATS) is among WTO's most important agreements. It is a set of multilateral rules covering international trade in services. GATS recognizes "the right of Members to regulate, and to introduce new regulations, on the supply of services ... in order to meet national policy objectives." No international trade treaty now in effect or being negotiated by the United States prevents local, state, or federal government agencies from reviewing and regulating water projects that involve private companies with multinational ties. Such projects include desalination plants, water transfers, water storage projects (above and below ground), and wastewater reclamation projects. There is no conflict with international trade treaties as long as government regulations are applied to water projects involving multinational corporations in the same manner they are applied to water projects owned or operated by domestic companies or public utilities.

Individual Water Users

Collectively, the millions of urban businesses, individual households, and farms fund the operation and maintenance of California's water systems through payment of taxes and water bills. Each makes decisions on water use and conservation for its own circumstances. Individual water users must dispose of used water, usually through a sewer or gutter, which in turn can create water pollution. This return flow can provide water to downstream water users. During drought periods, many households modify outdoor watering to conserve water. Each year, farmers make decisions on planting and water application based on weather conditions, forecasted water supply, and individual tolerance for market risk. Taken together, these individual decisions about water use have an enormous impact on both water demand and water quality and present many opportunities for individuals to play positive roles in better managing California's water quantity and quality.

Institutional Tools for Managing Resources

In many cases, several institutional tools interact in managing resources:

- Collaborative decision-making—A decision made through collaboration can avoid the need for new legislation, regulation, and litigation.
- Education—Educational programs can be the least expensive way to influence public action. Information on water use efficiency practices, water costs, habitat conditions, and other important subjects can help the public become active participants in plan implementation.
- Legislation—Legislation can provide new statutes for managing resources. (See Volume 4 Reference Guide article "Recent Water Legislation.")
- Voter-approved propositions—Voters can directly enact new laws by approving propositions. In many cases, voters decide on major funding requests. Since 1996, voters have approved four major California water bonds (propositions 204, 13, 40, and 50).
- Regulation—State regulatory agencies adopt regulations (rules) to implement, interpret, or make specific the law enforced or administered by it, or to govern its procedure.
- Litigation—Lawsuits provide a dispute-resolution tool that most, if not all, water stakeholders will employ when it appears to be their best alternative. These judicial proceedings can provide greater certainty to water rights holders and to public trust values in California in ways that the collaborative process may fail to accomplish. Legal precedents create a framework for setting up water resource management programs, but do not themselves create or implement the programs. (See Volume 4 Reference Guide article "Summary of Significant Litigation 1998-2005.")

Volume 1

Chapter 4 – Planning for an Uncertain Future

Chapter 4 Preparing for an Uncertain Future

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Water is a vital natural resource for people and the environment. Water managers must support environmental stewardship as part of their management responsibilities. (DWR photo)

Chapter 4 *Preparing for an Uncertain Future*

About This Chapter

Chapter 4 Preparing for an Uncertain Future describes how the State of California is adapting to the changing needs of decision-makers, water managers, and planners. It lays out a new analytical approach and multiple future scenarios. The Department of Water Resources (DWR) will use these to develop and share information essential for making many difficult choices about how to manage California's water resources over the next 25 years.

A Common Approach

California's water management system is large and complex. Making wise choices will require a great deal of cooperation and collaboration among decision-makers at all levels. State, federal, regional, and local entities throughout California will have to make many decisions to implement the Framework for Action as described in Chapter 2. The framework's foundational actions, initiatives, and essential support activities are central to ensuring that California has sustainable water uses and reliable water supplies through 2030.

Our decisions must include making sound investments that balance risk with reward, given the uncertainties that may occur in the future. Some of the risks associated with potential changes in California's future run quite high and require our consideration. Fortunately, the potential rewards are equally compelling, and a broader understanding of these opportunities can help people work together for collective gains.

People can work together more effectively if they all have access to the same information. **As part of this and future California Water Plan updates, DWR is promoting ways to develop a common conceptual framework, data standards, and analytical approach for understanding, evaluating, and improving regional and statewide water management systems.** A common analytic approach is particularly important when multiple agencies are proposing actions that may compete for the same resources. This can occur, for example, when State government solicits funding proposals for water management projects or when agencies identify new management strategies for meeting future water demands. It is difficult to evaluate the benefits and impacts of multiple projects that affect the same water management system when the projects are not described using a common analytical framework.

Changing Times, Changing Questions

Decision-makers and the public are asking different questions than those addressed in earlier California Water Plan updates. This reflects the increasing complexity and interdependence of managing California's water resources for all our human and environmental needs. Recent scientific studies indicate that there is a great deal of uncertainty about future climate conditions like the severity of droughts and global climate change. We know that climatic conditions can affect our water supplies—but how and to what extent? Our water supplies face increased competition from a population that is growing by about 600,000 a year and from our desire to protect and enhance the environment and maintain our agricultural production.

As in other areas of our lives, we routinely rely on timely and trustworthy information to make prudent, high-stake decisions about how and where to best use our water resources and funding. While preparing Update 2005, DWR worked extensively with a broad range of stakeholders to identify their information needs for improving water planning and management. DWR asked what information local and regional water agencies and governments need to plan and successfully implement actions to meet water demands now and in the future, and what information would be most useful to assess risk and rewards regarding public and private investments in our water resource management systems. DWR also addressed the role that State government should play in helping produce and distribute this information.

Information Needs

DWR conducted a series of public workshops to understand the kind of information most needed by decision-makers, water managers, and planners (see Box 4-1 Desired Information for the California Water Plan). Topics included what we want to accomplish with our water resources, the current water management system and how it might be changed, what the future may hold and how to prepare for future uncertainties, how statewide and regional water and resource planning overlap, and how different approaches to preparing for the future compare to one another in light of our objectives and available resources.

Existing Limitations

Several factors have led DWR to rethink how it evaluates California's future water conditions. There is a need to provide policymakers and the public with more detailed quantitative information about the costs, benefits, and tradeoffs associated with different water management strategies. See Box 4-2 Types of Quantitative Information for definition of four types of quantitative information that the California Water Plan can provide. **Data, analytical tool development, and data management have not kept pace with growing public awareness of the complex interactions among water-related resources.** Finally, California lacks a consistent framework and standards for collecting, managing, and providing access to data and information on water and environmental resources essential for integrated regional resource management. More accurate data and analytical tools and better information management

Box 4-1 Desired Information for the California Water Plan

What do we want to accomplish with our water resources?

- Economic Objectives
- Environmental Objectives
- Equity Objectives

How does the current water management system work now and how might it change with respect to the following?

- Water use and environmental interactions
- Basic hydrology including groundwater
- Economics, price, and water use
- Interregional transfers
- Quantity and quality interactions
- Water law considerations
- Changes in technology that can affect water supply reliability

What can we expect to happen in the future? What are we preparing for?

How can we consider uncertainties about the future when making a decision?

- How will water management system performance change with respect to water supply reliability, water quality, and ecosystem health goals when faced with different circumstances?

How does (and should) regional and statewide water and resource planning intersect?

How do different approaches to prepare for the future compare to one another in light of our objectives and available resources? What are the expected tradeoffs?

can reduce many uncertainties about the state's current and future water resources: how water supplies, demands, and water quality respond to different resource management strategies; how ecosystem health and restoration can succeed; and how we can adapt our water system to reduce controversy and conflicts.

The need for enhanced quantitative information is not unique to the California Water Plan update process. The CALFED Surface Storage program and the California Water and Environmental Modeling Forum (CWEMF) have also identified the need for more integrated data and analytical tools, and more accessible and robust information management systems. Some areas where data and tools are inadequate for the analyses we need to conduct are described below and are further elaborated in Volume 4 article, "Improving Analytical Procedures Used to Describe Future Water Conditions for the California Water Plan."

Data Gaps

Data are needed to complete regional waterflow diagrams (see Volume 3 Regional Reports). Flow diagrams characterize a region's hydrologic cycle. Completing regional flow diagrams and water balances requires more detailed land and water use data and the ability to differentiate between applied and consumptive water uses. The following categories of data are simply not available or require a large amount of work to compile.

- Statewide land use data - native vegetation, urban foot prints, nonirrigated and irrigated agriculture
- Groundwater - total natural recharge, subsurface inflow and outflow, recharge and extractions, groundwater levels, and water quality
- Surface water - natural and incidental runoff, local diversions, return flows, total streamflows, conveyance seepage and evaporation, and runoff to salt sinks
- Consumptive use - evaporation and evapotranspiration from native vegetation, wetlands, urban runoff, and non-irrigated agricultural production

Data are available for some regions and not others. For example, methodologies and data to estimate natural runoff are available for regions like the Sacramento Valley where the Sacramento-San Joaquin Delta is a central outflow measurement. In areas like the South Coast Hydrologic Region, with no central point for outflow measurement and substantial groundwater, the natural runoff is more difficult to estimate. In addition to natural obstacles, existing data are not easily gathered or split apart to provide convenient access for all areas of interest. In addition, budget constraints limit extensive data collection and management necessary to quantify and track all the water in the state. (See Volume 4 Reference Guide article "Future Quantitative Analysis for California Water Planning" for a more comprehensive description of data gaps.)

Box 4-2 Types of Quantitative Information

To promote clarity and common understanding, we have defined four types of quantitative information that the California Water Plan can provide.

Observable data. This information is discrete data that can (or could) be measured or observed at a particular place and time. We also presume that if we could measure it in the future, we can predict what the values might be in the future.

Causal relationships. This information is what we believe to be true, or at least our best guess, about how different observable data are influenced by other factors, for example, How does urban water demand change with regard to shifts in prices charged to the consumer?, or How does groundwater production in Glenn County change with regard to temperature during the growing season for rice? Our entire understanding of how the water management system functions can be described using observable data and causal relationships.

Reporting metrics. This information contains a combination of observable data in a clearly defined way, for example, water supply reliability is reported as a function of water demand, water delivery, time, place, etc.

Evaluation criteria. This information describes the standard by which reporting metrics will be judged, for example, if water supply reliability is less than some threshold value during dry and critical years then additional management actions are required.

Fragmented Water Information

California needs better data and analytical tools to produce useful and more integrated information on water quality, environmental objectives, economic performance, social equity objectives, and surface water and groundwater interaction. Today, it is difficult to compare, much less integrate, water data and information from different local entities to understand and resolve regional and statewide water management issues. **To make significant progress toward a more comprehensive scientific understanding, California needs to create a new information exchange and management system and more integrated analytical tools** that can be used to document and share knowledge as it is developed.

New Analytical Approach

Current data and analytical tools are not sufficient to provide answers to some important questions from decision-makers, water managers, and resource planners. DWR is working with others to develop a new analytical approach to prepare the next California Water Plan update. DWR, CWEMF, and others are working to ensure that California continues to develop enough data and data analysis, including information management systems and analytical tools, for making crucial decisions about water resource investments. CWEMF members have recommended approaches to address important needs (see Volume 4 Reference Guide article "Strategic Analysis Framework for Managing Water in California"). DWR also describes some next steps in the Volume 4 Reference Guide article, "Recommended Next Steps for Improving Quantitative Information for the California Water Plan". With its concept paper, DWR will begin discussions with other planning entities, decision-makers, and stakeholders for developing a long-term approach for improving data and analytical procedures essential for statewide water planning.

The following sections describe an approach for analyzing responses to an uncertain future. Box 4-3 Evolving Analytical Approach briefly compares how analysis was done for the last water plan update (Bulletin 160-98) and the general approach proposed in this update. Volume 4 Reference Guide article "Future Quantitative Analysis for California Water Planning," provides more discussion of this new approach.

Box 4-3 Evolving Analytical Approach

Since the California Department of Water Resources published the California Water Plan in 1957, DWR has continued to evolve analyses to meet changing information needs for subsequent water plan updates. Early in the series of Bulletin 160 updates, reports included water budgets (water uses, supplies, and shortages) for a typical (that is, trend-based) average water year. In the 1993 and 1998 updates, water budgets were also included for an extreme drought condition (a critical water year). Bulletin 160-98 estimated the magnitude of dry-period water shortages in different areas of the state and also presented some options for reducing those shortages.

Rather than using water budgets to show a gap between future uses and supplies, DWR and stakeholders now want a more comprehensive analysis that includes economics, water quality, and environmental and social considerations. (For more information on desired changes to DWR's analytical approaches see the article, "Improving Analytical Procedures Used to Describe Future Water Conditions for the California Water Plan" in Volume 4). Considering the large amount of work required to include these changes, the analytical work could not be completed for this water plan update. Without this analysis, Update 2005 lacks the information to make the types of region-specific water budget comparisons afforded by Bulletin 160-98. However, Update 2005 provides qualitative discussions and presents the analytical approach for use in future California Water Plan updates. If the past is any indication, we expect the analytical approach to continue to evolve long after the next update is completed. Some changes in the analytical approach proposed by California Water Plan Update 2005 include:

Approach

- Bulletin 160-98 used and expanded the analytical methods that were developed in Bulletin 160-93
- Update 2005 presents a new analytical approach for multiple future baseline conditions (scenarios) and alternative response packages for potential use in the next California Water Plan Update.

continued

Developing and providing more comprehensive information will take time. DWR, advisory committee members, and other stakeholders put a lot of thought into how to develop more useful quantitative information. A lot of discussions focused on "What to expect in the future" and "How to account for uncertainties when making a decision." DWR and stakeholders have made good progress developing a conceptual analytic framework to address these questions, and DWR staff has taken initial steps to identify and develop methods and tools necessary for the required analyses. Because time is needed to develop this new approach, most of the detailed quantitative work will be presented in the next California Water Plan update.

Producing broader and more integrated quantitative information is an ongoing process. DWR plans to lead an effort with other State, federal, and local entities to continue developing and refining information. Credible and relevant answers to these questions require significant advances in our approach to learning about the system, testing hypotheses about change, and sharing information. Achieving these advances requires significant investments in better information management systems, additional data collection, and more sophisticated, transparent, and accessible analytical tools. One of the primary aims of the next two water plan updates is to collaborate with recognized experts to develop a foundation for a quantitative water information system that will support water plan updates and serve water managers and planners well into the future.

Improving Data Management and Scientific Understanding

DWR has determined that designing the details of this progressive quantitative approach can best be achieved through a consortium of public and private entities, with State leadership and stakeholder input. The consortium should prepare a long-term plan to improve and peer review data and analytical tools, as well as to develop presentation and decision-support tools to make complex technical information more accessible to decision-makers and resource managers.

Box 4-3 continued from previous page

Current Conditions

- Bulletin 160-98 used trend analysis to normalize year 1995 to represent a typical average year.
- Update 2005 presents water portfolio (see Volume 3) information for three actual years (1998, 2000, and 2001). These three years do not allow drought or other planning analysis that will be possible after water portfolios for several additional actual years are developed.

Future Conditions

- Bulletin 160-98 projected a single future condition to year 2020 for land use, water demands, and supplies.
- Update 2005 presents an approach to consider multiple plausible, yet very different, future scenarios to year 2030 for analysis in the next California Water Plan Update. Update 2005 also presents the concept of alternative response packages for each scenario for analysis in the next California Water Plan Update.

Water Shortages

- Bulletin 160-98 computed the difference between water demands and supplies as the shortage.
- Update 2005 presents an approach to balance water demands and supplies for each response package by including economics, water quality, and environmental and social considerations.

Potential Future Management Strategies

- Bulletin 160-98 presented options that could be used to reduce shortages by area of the state.
- Update 2005 presents an approach to allow comparison of many different response packages at the regional level using evaluation criteria.

Response packages are different mixes of the resource management strategies (see Volume 2). All of these changes need to be supported by developing better data and analytical tools. Data and modeling results will be presented in the water portfolio format (see Volume 3).

Box 4-4 Principles for Development and Use of Analytical Tools and Data for California Water Problems and Solutions

Strategy

- Data and analytical and communications tools should be based on expected long-term water problems and the decision-making processes they are expected to inform.
- A strategic analysis framework should identify the technical objectives, roles, and responsibilities of major data collection efforts and analytical tools.
- Strategic documents should be prepared and made available to the public. They should undergo periodic internal and external review, with substantial input from stakeholders, to identify needs for additional analytical tool and data development.
- A frequently updated implementation document should outline short-term and long-term efforts, budgets, and responsibilities for continuous improvement of models and data. A sustained process for stakeholders input should be defined and adopted.

Transparency

- All data and models should have sufficiently detailed documentation.
- Known limitations and appropriate applications should be documented.
- Model applications should include explanatory & self-critical discussions of results, including uncertainty analyses.
- Data, models, and major reports should be in the public domain, available on the web, and regularly updated.
- A common glossary of key terms and acronyms should be maintained.

Technical Sustainability

- Modularity: Major analytical tools should be designed and implemented to fit modularly in the larger strategic analysis framework, allowing models to be tested, refined, updated, and replaced without major adjustments to other components.
- Adaptive information management framework: Major data and information efforts should fall within a larger information management framework, including protocols for data documentation and updating, and documentation of limitations.

Coverage

- The spatial coverage of the basic data and analytical framework should be statewide and encompass a wide variety of water management options and processes.
- Local and regional water management interests and resources should be explicitly represented to allow consistency among local, regional, and statewide studies.

Accountability and Quality Control

- Explicit testing should be done, documented, and available for major analytical tools.
- Protocols and guidelines for model use should be developed and adhered to.
- Major analytical products should be reviewed by both external experts and local agencies whose systems are included in the model(s).
- In developing and maintaining models, serious efforts should be made to involve local agencies and stakeholders, including users groups or other cooperation mechanisms.

DWR plans to build and maintain an online information exchange system—called the Water Plan Information Exchange (Water PIE)—to assist regional and local agencies and governments. It is intended to include information from locally developed urban and agricultural water management plans and local general plans. This type of online information exchange system will be designed to support regional partnerships by providing a common way of developing and sharing information. It will streamline development of integrated regional water management plans by providing a common vocabulary and a check list of the types and format of information needed to develop an effective plan. An information management system such as Water PIE will also enhance the opportunities for collaboration with academic and research institutions by improving access to the most current data and information throughout the state.

Developing a Long-Term Vision for Data and Analytical Tools

DWR is participating in an effort by CWEMF to develop a long-term vision for analytical tools and data. This effort has derived a number of principles to guide the development and use of data and analytical tools over the next 10 to 15 years (see Box 4-4 Principles for Development and Use of Analytical Tools and Data for California Water Problems and Solutions). The technical scope and magnitude of the desired analyses are unprecedented in California water planning (See Volume 4 Reference Guide article by CWEMF, "Strategic Analysis Framework for Managing Water in California"). Fully implementing this work will take many years and significant resources. In the interim, qualitative approaches may be required for areas with insufficient data or inadequate tools to quantify all of the desired information.

The Planning Process

In a quantitative information approach, all of the quantitative information is intended to support a sound planning process that will lead to wise decisions about resource investments. As such, all analytical techniques should relate to one or more steps in the planning process. Typically, a formal planning process includes the following steps: identify problems, specify objectives, describe the relevant system, explore options, and make decisions (Box 4-5 The Planning Process). As planners explore options, they consider a range of ways to meet objectives. This step usually involves the most quantitative work and is further divided into three smaller steps: describe plausible changes, craft alternative responses, and compare performance.

DWR continues to provide ways to improve understanding of how the water management system works and how our water management actions interact with the environment. Chapter 3 California Water Today describes several aspects of the water management system as it has existed in recent years.

Box 4-5 The Planning Process

Typically, a formal planning process includes the following steps: identify problems, specify objectives, describe the relevant system, explore options, and make decisions. This planning process enhances understanding about the problem at hand and helps form a plan that is supported by those affected.

Identify Problems

What problem are we trying to solve? All stakeholders must agree on a clear statement of the problem before attempting to find a solution. Without agreement about the problem, the evaluation of possible solutions will be difficult or impossible. Problems may be existing conditions like too few returning salmon in a particular stream reach or challenges to future water management with a growing population.

Specify Objectives

What desirable performance characteristics are required to solve the problem? This is a crucial step in which stakeholders identify what the objectives are for solving the identified problem. Specifying objectives allows alternative plans to be developed that demonstrably address problems.

continued

Box 4-5 continued from previous page

Describe the Water Management System

What do we need to know to accomplish our objectives? This step in the planning process relates to the question, "How does the current water management system work now and how might it change?" Or asked differently, "What do we already know about the problem and potential solutions and how might the problem change in the future?" This is an area that will require continuous investigation and focused learning. Advancing scientific knowledge and using that knowledge effectively have been emphasized recently in the CALFED process and other planning efforts.

Explore Options

What are the implications of taking one action over another? This step in the planning process is where planners consider a range of possible means to meet the specified objectives. This step usually involves the most quantitative work. As a result, we have divided this step into three smaller steps: describe plausible changes, craft alternative responses, and compare performance. We will look at each one in succession.

Describe Plausible Changes

If we did not expect change to occur, we would not need to plan. If we were confident that our surroundings would stay the same and we were satisfied with the way things are, we could just maintain our current system. However, we recognize that change is occurring in our communities and in our world. Therefore, we have to predict what the future could be and how we can prepare for it.

Craft Alternative Responses

Having some idea of what is likely to happen in the future is necessary to plan for change. The other important piece of information is how the change will impact us if it does occur. If the change can cause a negative impact, we call this risk. If it can cause a positive impact, we call this reward. In simple terms, all of our planning is about balancing risk and reward. We want to avoid suffering a setback, or missing an opportunity for gain, as conditions change in the future. We all make these types of choices regularly in our personal lives. (For example, Should we buy life insurance or disability insurance? If yes, then how much should we buy and what type? When we save for our retirement, how much should we invest in stocks versus bonds versus real estate?)

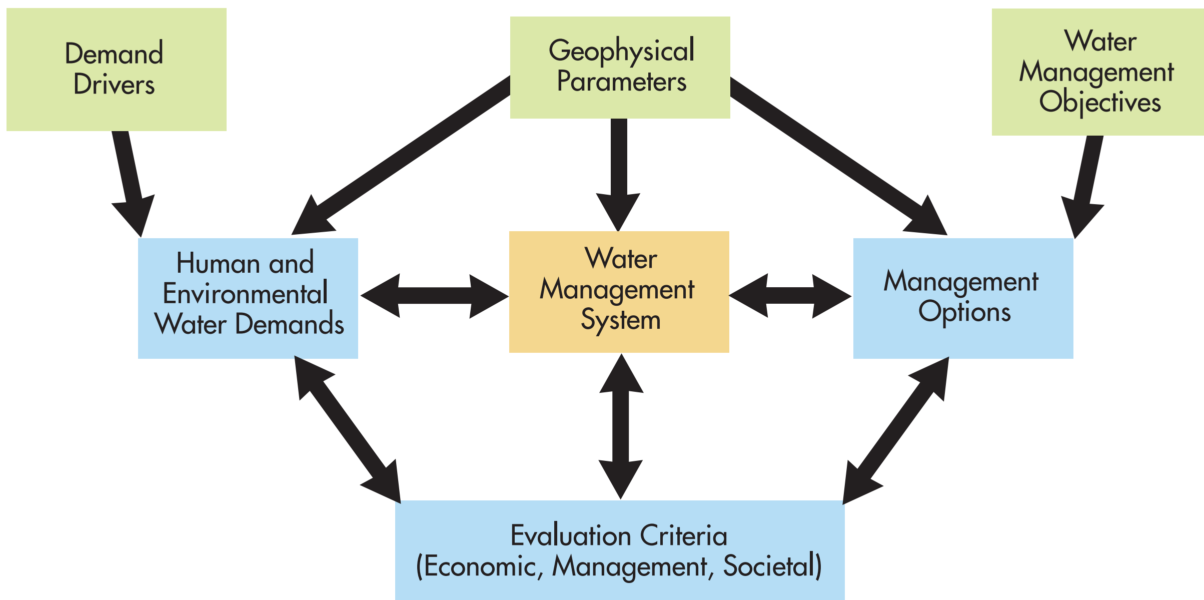
Compare Performance

Once we are clear about what changes we could face (future scenarios) and have assembled different combinations of promising management actions (response packages – mixes of resource management strategies) that could possibly meet our long-term objectives, we must try to predict how each of the alternative response packages will perform in a future that is uncertain. This comparison is usually attempted using some quantitative analyses.

Make Decisions

Choose one or more actions that appear to best satisfy the objectives. The goal of all planning is to make decisions that can be carried out to prepare for expected changes. Decisions regarding investments for water resource management will continue to be made in the political forums of public policy. However, if future water plan updates are successful, these decisions will be made in the context of a broader understanding of how the system works and what we can do to manage it successfully for the multiple objectives of California.

Figure 4-1 Conceptual framework diagram for analysis of water resources and management



DWR developed this conceptual diagram of the analytical framework to help promote common understanding of California's water management system. The diagram shows the management system (orange box), factors that can change (blue boxes), and factors held constant (green boxes) for each analytical study.

The waterflow diagrams in Volume 3 provide a useful view of how the parts of the system work. DWR has also developed a high-level conceptual framework as a basis to identify, document, and describe interactions and promote common understanding (see Figure 4-1 Conceptual framework diagram for analysis of water resources and management and Box 4-6 Conceptual Framework Diagram and Description). DWR plans to work closely with the advisory committee and other interested experts as we document what observable data and causal relationships are used for future analyses.

As we explore our options, we must describe plausible changes. When it comes to water, many things can change and affect our ability to provide the benefits that are important to our society. Some of the most important areas for change are described in the section "Changes to Consider When Preparing for the Future" later in this chapter. When considering the future, we know our predictions will never be completely accurate. Nonetheless, we rely on predictions about the future during our daily lives (for example, weather forecasts, expected commute times, investment appreciation, etc.). We recognize that uncertainty exists in all predictions, so we consider that uncertainty, along with other factors, when deciding how to use the information. The new approach in Update 2005 explicitly addresses these uncertainties.

We typically craft responses based on what we expect to change, the likelihood of that change occurring, and the risk we face if the change occurs and we are not prepared. Water managers must routinely decide how many resources to spend today to protect against future uncertainties, especially extreme events like multiple dry years. There are often multiple responses available to satisfy a given objective, so it is prudent to consider several alternatives to find responses that balance costs, benefits, and tradeoffs effectively and efficiently. Volume 2 describes 25 resource management strategies that planners have available to them when designing a response to the changes they are facing and may face.

Partial Application of Scenario Approach

The introduction of scenarios is a major difference between the approach used in previous updates and the new approach. The goal is to compare and contrast performance of possible management responses against plausible future conditions. As used in *California Water Plan Update 2005*, scenarios represent

Box 4-6 Conceptual Framework Diagram and Description

Demand Drivers. Factors that influence the calculation of water demands, which are not directly controlled by water management activities. For example, population, population density, land use patterns, and economic activity.

Geophysical Parameters. Factors that represent the basic hydrology, hydrogeology, geology, and climate, which form the natural constraints of the system. For example, precipitation, soil properties, and aquifer transmissivity.

Water Management Objectives. Objectives developed by policymakers for desired outcomes of the water management system while considering the various constraints, competing demands, and resource strategies. For example, desired water quality and desired water reliability at a particular location and time and for a particular use.

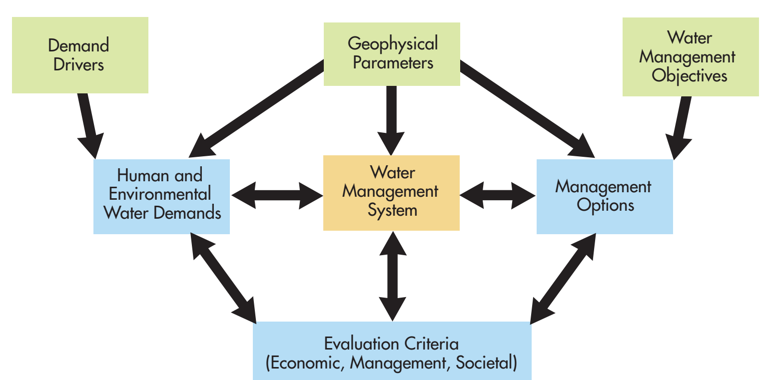
Human and Environmental Water Demands. Dynamic consumptive and nonconsumptive demands for water that fluctuate based on the climate, economy, changes in water use efficiency, population growth, and other factors. Consumptive demands include activities that deplete water from the water management system by evaporation, evapotranspiration, or flows to saline water bodies. Nonconsumptive demands include activities that require a specific quantity of water at a particular location and time, but do not deplete from the water management system. This includes releasing water for hydropower production, instream flows, or municipal water use that flows to a wastewater treatment facility and is later released to a stream or recharged to groundwater.

Management Options. Management options are the numerous resource strategies available to water managers to improve operation of the water management system and are heavily influenced by the desired water management objectives. This includes actions like water use efficiency, surface or groundwater storage, floodplain management, and ecosystem restoration.

Evaluation Criteria. Factors that serve as dynamic evaluation criteria to guide policymakers, water managers, and the public about how well a particular hypothetical scenario and operation of the water management system is at meeting water management objectives. This includes things like economic cost of implementing different resource strategies, environmental benefits, water reliability, and improvements in water quality.

Water Management System. The system of man made and natural water storage and conveyance features where the water management decisions are implemented. This includes location, storage and flow capacities, and operating criteria of reservoirs, canals, wetlands, floodplains, lakes, rivers, and groundwater basins.

Figure 4-1 Conceptual framework diagram for analysis of water resources and management



DWR developed this conceptual diagram of the analytical framework to help promote common understanding of California's water management system. The diagram shows the management system (orange box), factors that can change (blue boxes), and factors held constant (green boxes) for each analytical study.

baseline conditions that we could reasonably expect to face in the year 2030, based on what we know to be true today. DWR has developed three scenarios, each describing a different baseline for 2030. These scenarios are possible pictures of the future that depend on many assumptions. They are not predictions and do not include new water agency-sponsored conservation programs or climate change effects. The water community would use each scenario to compare the performance of possible management responses. Having multiple future scenarios can help identify management responses that perform well when compared across a wide array of baseline conditions that could occur in the future.

The scenarios presented in update 2005 are only part of the story of California's water future. The scenarios represent different baseline conditions for 2030 that could affect water demands and supplies, but that the water community has little or no control over. The other part of the story is the alternative management strategies (called response packages in Update 2005) that still need to be considered to prepare for the potential changes described in the scenarios. The next California water plan update will present quantitative information on the whole story—the baseline conditions water managers may face and the alternative strategies needed to address these conditions.

Baseline Scenarios to Describe Future Conditions

Although multiple future scenarios will be used in the quantitative work for the next California water plan update, DWR has not yet developed the analytical tools to quantify both scenarios and response packages. Three baseline scenarios in this section demonstrate how scenarios can be used to better understand the implications of future conditions on water management decisions. These scenarios are referred to as baseline because they represent changes that are reasonably likely to occur without additional management intervention beyond those currently planned. The narrative descriptions of these scenarios were developed by water plan staff and the advisory committee.

Previous water plan updates based planning assumptions on a single likely future condition. The use of multiple future scenarios provides decision-makers, water managers, and planners much more information about what they might expect in the future and how different management actions might perform across a range of possible futures. The scenarios are created by varying important assumptions about water and other resource conditions in order to highlight important categories of uncertainties.

These scenarios are referred to as baseline because they represent changes that are reasonably likely to occur without additional management intervention beyond those currently planned.

The primary reason to use multiple scenarios is that different assumptions about the future can significantly affect the nature and outcome of various mixes of management strategies. Some management strategies may be effective and economical regardless of the future scenario. Other strategies may only be suited if specific conditions develop in the future.

Developing quantitative estimates of water demands and supplies for multiple future scenarios and management responses requires using available data and assumed relationships. DWR and stakeholders considered numerous factors that could vary in the future and developed three preliminary narrative future scenarios that can be used to begin the analysis for the next California water plan update. However, DWR and stakeholders may develop other scenarios as work progresses.

Table 4-1 (Scenario factors affecting regional and statewide water demands and supplies) shows factors that were considered in developing the scenario narratives. These factors may vary across scenarios, and each factor must be quantified. The availability and resolution of data vary widely. Key factors have been identified, but much work remains before reaching agreement on the relationships between the factors and the methods that will be used to quantify them.

As work moves forward on the next California water plan update, DWR and stakeholders may add or eliminate factors to help answer questions about future scenarios. Although all the factors in Table 4-1 are needed to define the strategies, DWR began analysis by varying only the factors primarily related to land and water use patterns over which the water community has little control (those listed in the upper portion of Table 4-1). Other factors also may be varied to help us gain insight into specific questions. Following are brief descriptions of each example scenario.

Three Baseline Scenarios for 2030

This section describes some of the key assumptions used to develop the following three baseline scenarios for 2030.

- Scenario 1—**Current Trends.** Recent trends continue for the following: population growth and development patterns, agricultural and industrial production, environmental water dedication, and naturally occurring conservation

Table 4-1 Scenario factors affecting regional and statewide water demands and supplies

FACTOR [1]	SCENARIO 1 CURRENT TRENDS	SCENARIO 2 LESS RESOURCE INTENSIVE	SCENARIO 3 MORE RESOURCE INTENSIVE
Total Population	DOF	DOF	Higher than DOF
Population Density	DOF	Higher than DOF	Lower than DOF
Population Distribution	DOF	DOF	Higher Inland & Southern; Lower Coastal & Northern
Total Commercial Activity	Current Trend	Increase in Trend	Increase in Trend (Same as Scenario 2)
Commercial Activity Mix	Current Trend	Decrease in High Water Using Activities	Increase in High Water Using Activities
Total Industrial Activity	Current Trend	Increase in Trend	(Same as Scenario 2) Increase in Trend
Industrial Activity Mix	Current Trend	Decrease in High Water Using Activities	Increase in High Water Using Activities
Irrigated Crop Area (Includes Irrigated Land Area and Multi-cropped area)	Current Trend	Level Out at Current Crop Area	Level Out at Current Crop Area
Crop Unit Water Use	Current Trend	Decrease in Crop Unit Water Use	Increase in Crop Unit Water Use
Environmental Water-Flow Based	Current Trend	High Environmental Protection	Year 2000 Level of Use
Environmental Water-Land Based	Current Trend	High Environmental Protection	Year 2000 Level of Use
Naturally Occurring Conservation[2]	NOC Trend in MOUs	Higher than NOC Trend in MOUs	Lower Than NOC Trend in MOUs
Urban Water Use Efficiency	All Cost Effective BMP's in Existing MOU's Implemented by Current Signatories (present commitments)		
Ag Water Use Efficiency	All Cost Effective EWMP's in Existing MOU's Implemented by Current Signatories (present commitments)		
Per Capita Income	Current Trends		
Ratio of Seasonal to Permanent Crop Mix	Current Trends		
Irrigated Land Retirement	Currently Planned		
Hydrology	Essentially a Repeat of History		
Climate Change	Essentially a Repeat of History		
Colorado River Supply	Equal to 4.4 Plan		
Existing Inter-Regional Import Projects	Current Conditions		
Flood Management	Current capacities, management practices and operations		
Energy Costs	As Projected From Current Trends		
Ambient Water Quality	Current Conditions		
Drinking Water Standards	Current and Planned		
Ag Discharge Requirements	Current and Planned		
Urban Runoff Mgmt.	Current Level of Use		
Recreation	Present Demand Trends Continued		
Desalting	Current Level + Permitted/Financed		
Recycled Water	Current Level + Permitted/Financed		
Water Transfers Within Regions	Currently Approved Transfers		
Water Transfers Between Regions	Currently Approved Transfers		
Conjunctive Use and Groundwater Management	Current Level + Permitted/Financed		
Surface Water Storage	Current Level + Permitted/Financed		
Conveyance Facilities	Current Level + Permitted/Financed		
Rate Structure	Current Practices - pricing constrained to cost reovery		

(1) Factors should be considered as an initial list that will be modified, as needed, as analyses proceed for next Water Plan Update.

(2) Naturally Occurring Conservation is the amount of background conservation (changes in plumbing codes, etc.) occurring independently from the BMP and EWMP programs.

(like plumbing code changes, natural replacement, actions water users implement on their own, etc.).

- Scenario 2—**Less Resource Intensive.** Recent trends for population growth, higher agricultural and industrial production, more environmental water dedication, and higher naturally occurring conservation than Current Trends (but less than full implementation of all cost-effective conservation measures currently available).
- Scenario 3—**More Resource Intensive.** Higher population growth rate, higher agricultural and industrial production, no additional environmental water dedication (year 2000 level), and lower naturally occurring conservation than Current Trends.

All three scenarios include assumptions for two kinds of water use efficiency actions: (1) those that water users take on their own (called naturally occurring conservation) and (2) those encouraged by water agency programs, policies, and requirements. Only naturally occurring conservation was varied among the scenarios; and all scenarios include the same continued implementation of cost-effective actions by water agencies.

Scenario 1: Current Trends

- Population and Land Use: The population of California meets Department of Finance (DOF) estimates of 48.1 million in 2030 with increasing population pressure in the Central Valley and on the coast. Expanding metropolitan areas continue to dominate urban growth.
- Commercial and Industrial: Driven to reduce costs in the face of competition, industry becomes more efficient in water use. Due to cost efficiencies, businesses have been reducing water use over time, primarily by replacing old or broken-down equipment with high-efficiency machines.
- Agriculture: Farmers are increasingly using sprinklers and drip irrigation, moving away from flooding and furrows. Farmers produce more "crop per drop" through a variety of means, including changes in irrigation methods, although more improvement is possible. Increased cost of land is shrinking agricultural land availability. Irrigated crop area (including multicropping) is slightly less than in 2000. Multicropping area increases significantly from the 2000 level.
- Environment: Environmental flows reach half way to the levels needed to meet the objectives of CALFED's Ecosystem Restoration Program and the objectives in the Anadromous Fisheries Restoration Program. Water dedicated to wet lands reaches half way to "Level 4" supplemental water supplies for National Wildlife Refuges cited in Central Valley Project Improvement Act (CVPIA) sections 3405 and 3406(b). Urban development continues to encroach on functioning floodplains in some areas.
- Naturally Occurring Conservation: The background conservation that will occur as a result of emerging conditions (ongoing changes in plumbing codes, etc.) results in some increase in efficiency in all sectors.
- Other Factors: Other factors remain unchanged (see Table 4-1 Scenario factors affecting regional and statewide water demands and supplies).

Scenario 2: Less Resource Intensive

- Population and Land Use: Population in 2030 is 48.1 million. Californians live in mixed use developments with native vegetation requiring little or no irrigation. An increase in population density means infill in existing urban areas and less development of new urban land. This compact development has reduced impervious surfaces, which benefits open space, reduces runoff, increases groundwater recharge, and affects other related issues. The cost of land is shrinking the availability of housing in Southern California.
- Commercial and Industrial: Due to market conditions, industry has shifted from water-intensive processing to dry product assembly, reducing water use. Businesses have dramatically reduced water demand and have moved to machines with high-efficiency water use to accomplish standard tasks. Potential financial gains have accelerated the move to machines with high-efficiency water use to accomplish standard tasks. Urban areas have a high degree of commercial and industrial productivity. Also, California has emerged as a leading industrial producer of environmental products and continues as a force in producing hardware for the technology industry.
- Agriculture: Irrigated crop area is at the same level as in 2000. Land area removed from agriculture must be replaced by a combination of new land coming into production and increased multicropping. Improved water management is increasing water efficiency. A healthy, efficient agricultural sector produces more per acre and decreases applied water per irrigated crop acre.
- Environment: Projects are designed to achieve multiple benefits integrating ecosystem restoration with water supply reliability. Management actions are oriented toward the sustainability, restoration, and improvement of the natural infrastructure. Water dedicated to instream use and aquatic life enhancement is yielding increased populations. Environmental flows reach the levels needed to meet the objectives of CALFED's Ecosystem Restoration Program and the objectives in the Anadromous Fisheries Restoration Program. Water dedicated to wetlands reach

the "Level 4" supplemental water supplies for National Wildlife Refuges cited in CVPIA sections 3405 and 3406(b).

- Naturally Occurring Conservation: The background conservation that will occur as a result of emerging conditions is higher in the agricultural and urban sectors than under Scenario 1. Business and agriculture apply efficiency measures for reasons other than reducing water demand or water-related costs. Current plumbing codes and other existing policies have increased efficiency greater than in scenarios 1 and 3.
- Other Factors: Other factors remain unchanged from Scenario 1.

Scenario 3: More Resource Intensive

- Population and Land Use: Population in 2030 is 52.3 million and is dispersed regionally. Expanding urban areas are commonplace. The Central Valley is experiencing air and water quality problems due to the stress of the large population. The population is more widely distributed, resulting in more outdoor residential water use (for example, larger residential lot size). Individuals tend to drive long distances to the workplace.
- Commercial and Industrial: California has emerged as a leading industrial producer of environmental products and continues as a force in producing hardware for the technology industry. California's leadership in high tech hardware places constraints on its water resources because this industry is a high water user that has not advanced efficiency technology to limit its water use. The industry continues to rely on high water-using processes based on market conditions.
- Agriculture: Irrigated crop area is at the same level as in 2000. The healthy agricultural sector maintains past levels of food and fiber production. Low-density urban development expands onto prime farmland, but harvested acreage remains about the same due to increased multicropping and new lands coming into production. The annual volume of applied water per crop is high due to the changing nature of crops and the movement of agricultural production to lands with poorer soil quality.
- Environment: Environmental flows remain at year 2000 levels. Thus, the flow objectives of CALFED's Ecosystem Restoration Program and the Anadromous Fisheries Restoration Program remain unmet. Water dedicated to wetlands remain at year 2000 levels, and the "Level 4" supplemental water supplies for National Wildlife Refuges cited in CVPIA sections 3405 and 3406(b) are not achieved. Californians recognize the link between the environment and their health and personal well being, but there is less water made available to accomplish environmental objectives.
- Naturally Occurring Conservation: The background conservation that will occur as a result of emerging conditions in the agricultural and commercial and industrial sectors is lower than current trends.
- Other Factors: Other factors remain unchanged from scenarios 1 and 2.

Preliminary Water Demand Estimates for the Baseline Scenarios

Numerical estimates of water demand[1] for the three baseline scenarios are drawn from an informal collaborative study by DWR staff and a graduate student from the Pardee RAND Graduate School (hereafter, Groves, Matyac, and Hawkins (2005)). A detailed description of the methods used, results, and implications can be found in the Volume 4 Reference Guide article "Quantified Scenarios of 2030 California Water Demand."

Groves, Matyac, and Hawkins (2005) created a basic scenario water demand estimator (demand estimator) to quantify the water demands for the three narrative scenarios of 2030 described previously. Scenario water demand estimates were made individually for the urban, agricultural, and environmental sectors for each of the 10 California hydrologic regions. A unique set of input values was assigned for each scenario to reflect the qualitative narrative descriptions and scenario factors in Table 4-1 (Scenario factors affecting regional and statewide water demands and supplies). The demand estimator was run using visual programming software to assist collaboration between analysts, decision-makers, and stakeholders.

Future urban water demand was estimated individually for the residential, commercial, industrial, and public sectors. The demand for each urban sector was estimated by simulating plausible growth patterns in demand units such as houses, employees, and persons. The number of future demand units was then combined with estimates of plausible values for 2030 water demand per unit. The demand estimator includes factors that account for how changes in water price, personal

[1] During the preparation of Update 2005, many discussions occurred on how to describe what has traditionally been called water "demands." A primary concern is that "demand" is not static. In economic terms, a person's desire to use water is said to be elastic, that is, based on a number of factors such as the intended use for the water, the price of water, and the cost of alternative ways to meet the intended use. As used in this section, the word "demand" technically means, "the desired quantity of water that would be used if the water is available and a number of other factors such as price do not change."

Table 4-2 Scenario factors affecting urban water demand

Urban demand drivers (in millions)	Year 2000	Year 2030 scenarios		
		Current Trends	Less Resource Intensive	More Resource Intensive
Population	34.1	48.1	48.1	52.3
Coastal & northern	8.3	10.8	10.8	11.2
Inland & southern	25.8	37.3	37.3	41.1
SF houses	7.5	11.0	8.9	12.7
MF houses	4.1	5.6	7.0	5.1
Commercial employees	16.3	24.8	25.9	28.0
Industrial employees	3.5	4.0	4.1	4.5

Note: Numbers in millions
SF = single family
MF = multifamily

income, naturally occurring conservation, and the continuation of existing water use efficiency programs influence future per unit water demand values.

Agricultural water demand was estimated in similar fashion. Plausible projections of the number of irrigated acres by crop type and hydrologic region were combined with plausible values of per-acre crop water demand in 2030. Some factors describe how future acreage is influenced by changing land use, cropping patterns, and multicropping as well as how per-acre crop water demand responds to changes in irrigation method, improvements in irrigation technology, and water price.

Environmental water demand for each 2030 scenario was assumed to equal water dedicated to the environment in 2000 (an average water year) plus an additional scenario-specific amount. The authors based additional environmental allocations on a preliminary assessment by Environmental Defense of unmet environmental flow objectives (see Volume 4 Reference Guide article "Recommendations Regarding Scenarios and Application of Environmental Water 'Demands' in the State Water Plan Update & Quantification of Unmet Environmental Objectives in State Water Plan 2003 Using Actual Flow Data for 1998, 2000, and 2001"). These unmet objectives include the additional instream flows needed to meet the goals of CALFED's Ecosystem Restoration Program in an average water year, the objectives in the Anadromous Fisheries Restoration Program, and the additional water needed to reach the "Level 4" supplemental water supplies for National Wildlife Refuges cited in CVPIA sections 3405 and 3406(b).

Scenario Factors Affecting Water Demand

Values for the major factors that affect urban demand and are used in the demand estimator are reported in Table 4-2 (Scenario factors affecting urban water demand) for 2000 and 2030 under each of the three baseline scenarios. All three scenarios show large increases in population, housing, and number of employees. The 2030 housing stock reflects a significantly greater proportion of multifamily units in Less Resource Intensive (Scenario 2) and more single-family units in More Resource Intensive (Scenario 3), as compared to Current Trends (Scenario 1). The number of employees in the commercial and industrial sectors is greatest in the More Resource Intensive scenario.

For the agricultural sector, the irrigated crop area (including multicropping) decreases about 5 percent from 2000 to 2030 in the Current Trends scenario and remains the same as year 2000 in the Less Resource Intensive and More Resource Intensive scenarios (see Table 4-3 Scenario factors affecting agricultural water demand). Irrigated land area, the "footprint" of irrigated agriculture, decreases by 5 percent in the Less Resource Intensive scenario and by 10 percent under both the Current Trends and More Resource Intensive scenarios. Greater multicropping compensates the reduced irrigated land area, especially in the More Resource Intensive scenario.

The additional instream flows and water for managed wetlands used to set scenario environmental water demands are shown in Table 4-4 (Year 2000 unmet environmental water objectives, See Volume 4 Article by Environmental Defense, "Recommendations Regarding Scenarios and Application of Environmental Water

Table 4-3 Scenario factors affecting agricultural water demand				
Ag. demand drivers (area in millions of acres)		Year 2030 scenarios		
	Year 2000	Current Trends	Less Resource Intensive	More Resource Intensive
Irrigated crop area	9.51	9.05	9.52	9.50
Irrigated land area	8.98	8.08	8.53	8.08
Multicropped area	0.54	0.97	0.99	1.42

Table 4-4 Year 2000 unmet environmental water objectives	
Location	Unmet flow objective (taf)
Trinity River (Lewiston)	344
American River (Nimbus)	55
San Joaquin River (Vernalis, DAYFLOW)	96
San Joaquin River (Below Friant)	268
Stanislaus River (Goodwin)	34
Ecosystem Restoration Program #2 Flow Objective	65
Level 4 Refuge Water [a]	125
Total per year	*987*

taf = thousand acre-feet
a. Annual water needed in addition to current deliveries to 19 Sacramento and San Joaquin refuges

'Demands' in the State Water Plan Update & Quantification of Unmet Environmental Objectives in State Water Plan 2003 using actual flow data for 1998, 2000, and 2001"). In the Current Trends scenario, half of these additional flows are added to year 2000 environmental water use for 2030 environmental water demand; 100 percent of the flows are added in the Less Resource Intensive scenario; and no additional flows are added to 2000 use in the More Resource Intensive scenario. For this analysis, additional instream flows were assigned to hydrologic regions by river reach, and "Level 4" refuge water was distributed evenly between the Sacramento and San Joaquin River regions.

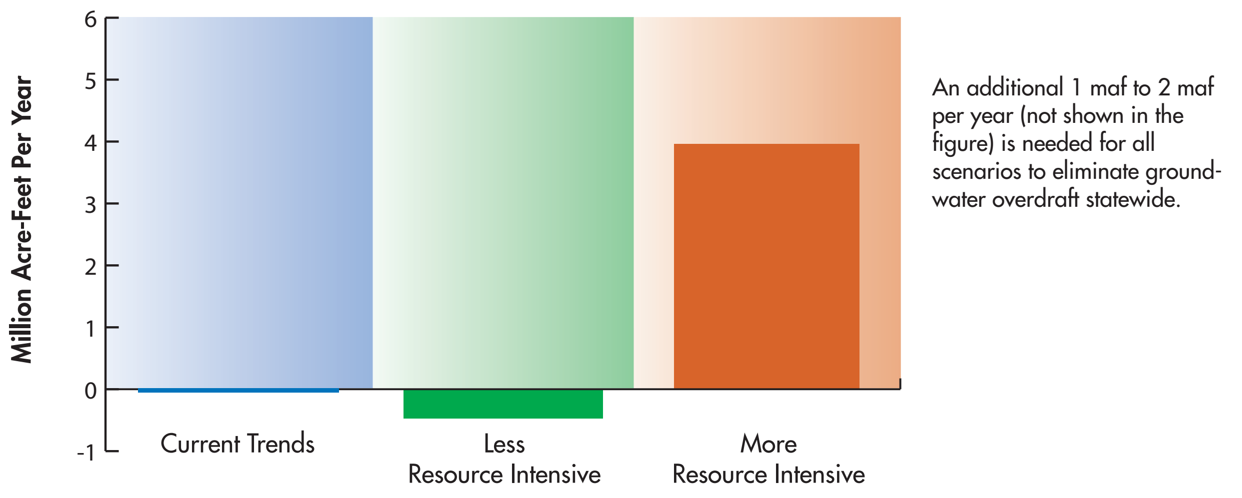
Scenario Water Demand Changes between 2000 and 2030

The combined (or net) change in scenario water demands for average water years is shown in Figure 4-2 (Net changes statewide in average-year water demand for baseline scenarios, 2000–2030). **For all three scenarios, an additional 1 million to 2 million acre-feet per year of water will be needed by 2030 to stop groundwater overdraft statewide** (DWR Bulletin 118 Update 2003).

As shown in Figure 4-2, for the three baseline scenarios, statewide change in average-year water demand ranges from a reduction of about 0.47 million acre feet per year to an increase of 4.0 million acre-feet per year. The magnitude of this range reflects the differences in assumptions used for the three scenarios. Total statewide water demand decreases only slightly under the Current Trends scenario, a pattern that may be surprising given projected population growth. The reason for this is revealed when we consider the components of net demand, namely statewide changes in urban, agricultural, and environmental demand for each of the three scenarios as shown in Figure 4-3 (Net changes statewide in average-year water demand for baseline scenarios by sector, 2000–2030). **The estimated slight decrease in total statewide water demand under the Current Trends scenario illustrates that California water issues are primarily regional in nature and that inappropriate use of statewide averages can mask significant issues.**

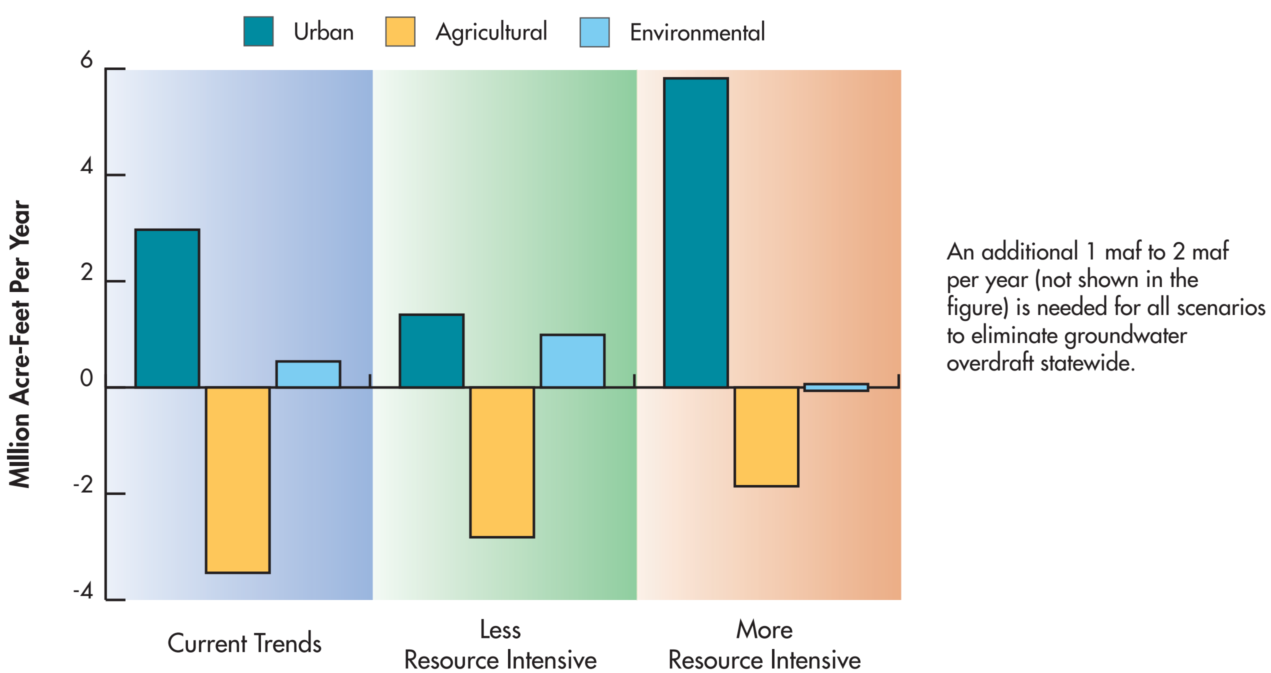
While instructive, these preliminary estimates cannot be used as indicators of potential future shortages because they describe the additional water demands California could face

Figure 4-2 Net changes statewide in average-year water demand for baseline scenarios, 2000–2030



Water demands may change between 2000 and 2030 for average water conditions. Statewide water demand changes are shown for three baseline scenarios.

Figure 4-3 Net changes statewide in average-year water demand for baseline scenarios by sector, 2000–2030



Water demands may change between 2000 and 2030 for average water conditions. Water demand changes are shown by water use sector statewide for three baseline scenarios.

in 2030 without additional demand management beyond current policies, and because they do not consider the future capability of the water management system to meet these demands under different hydrologic conditions.

Under all three scenarios, urban water demand increased between year 2000 and 2030 because of population growth. In the Current Trends and Less Resource Intensive scenarios, demand for environmental water was larger in 2030 but stayed the same as year 2000 in the More Resource Intensive scenario, consistent with the Table 4-1 (Scenario factors affecting regional and statewide water demands and supplies).

Agricultural water demand decreased by 2030 under all three scenarios. In the case of the Current Trends scenario, agricultural water demand decreased due to an assumed 5 percent decline in irrigated crop area (primarily because of urbanization), as well as a 5.6 percent reduction in crop unit water use—the irrigation water applied per unit of crop area—due to increased water use efficiency. Under the Less Resource Intensive and More Resource Intensive scenarios, irrigated crop area was kept the same as year 2000, but agricultural water demand was lower than 2000 because the crop unit water use was reduced by 8.3 percent and 5.3 percent, respectively.

The decrease in agricultural water demand was greater than the increase in urban and environmental water demand in the Current Trends and Less Resource Intensive scenarios. In the More Resource Intensive scenario, increases in urban water demand significantly outweighed demand reductions in the agricultural sector.

Potential transformations in statewide water demand patterns are further illustrated by examining the net water demand changes separated out by hydrologic regions as shown in Figures 4-4 (Net changes in average-year water demand for baseline scenarios by region, 2000–2030) and Figure 4-5 (Percent change in average-year water demand for baseline scenarios by region, 2000–2030). These charts shows that future changes in water demand will likely vary substantially by region and scenario.

Implications from Preliminary Analysis

It is important to note that estimates of future statewide average-year water demands, however small or large, do not adequately characterize the challenges facing California water. Increases in water demand must be addressed at regional and local scales because available supplies in one part of the state cannot necessarily be used to meet rising demands in another part. As local demands increase, future droughts could result in more severe local water shortages than in recent experience. Moreover, the challenges of eliminating groundwater overdraft, flood management, water quality protection, and water systems management to help restore the environment all require that California's water managers develop strong water plans that go well beyond just meeting water demand increases in average years.

The greater urban water demand predicted under all three plausible scenarios would present significant challenges to water planners. If future factors influencing water demand resemble the Current Trends scenario, we would need to offset an additional 3.5 million acre-feet of urban and environmental water demand per year with a combination of management strategies to reduce demand, improve system efficiency, and redistribute and augment supplies[2]. Although there may be commensurate reductions in the agriculture sector, much of this demand reduction would occur in the Central Valley; whereas, much of the additional urban demand would be in the southern part of the state. The ability to transfer water from the Central Valley to Southern California could be constrained by existing conveyance facilities, area-of-origin issues, environmental impacts, and other third-party effects. This fact underscores the need for strong integrated regional water management plans supported by strong statewide water management systems.

If future factors influencing water demand resemble the More Resource Intensive scenario, water management challenges would be even greater. Demand would increase in all areas of California; the demand to grow more crops for food and fiber would be greater than in the other two scenarios. Consequently, any reduction in agricultural demand would offset only a portion of the increase in urban demand.

The demand changes predicted in the Less Resource Intensive scenario would be more manageable than those for the other two scenarios. If, however, future water supplies are lower because of climate change, for example, then even this scenario could present considerable challenges for California water management. To help meet these challenges, DWR plans to work with

[2] Volume 2 describes 25 resource management strategies that can be combined in various ways to meet the water management objectives and goals of different regions and to achieve multiple benefits.

regional and local partners to develop the necessary data and analytical tools for of the next California water plan update. These will provide a more comprehensive evaluation of a variety of management responses for a number of plausible scenarios. DWR will quantify water demands and supplies for each of the future scenarios as part of the phased work plan of this and the next California water plan update.

Increases in water demand must be addressed at regional and local scales because available supplies in one part of the state cannot necessarily be used to meet rising demands in another part.

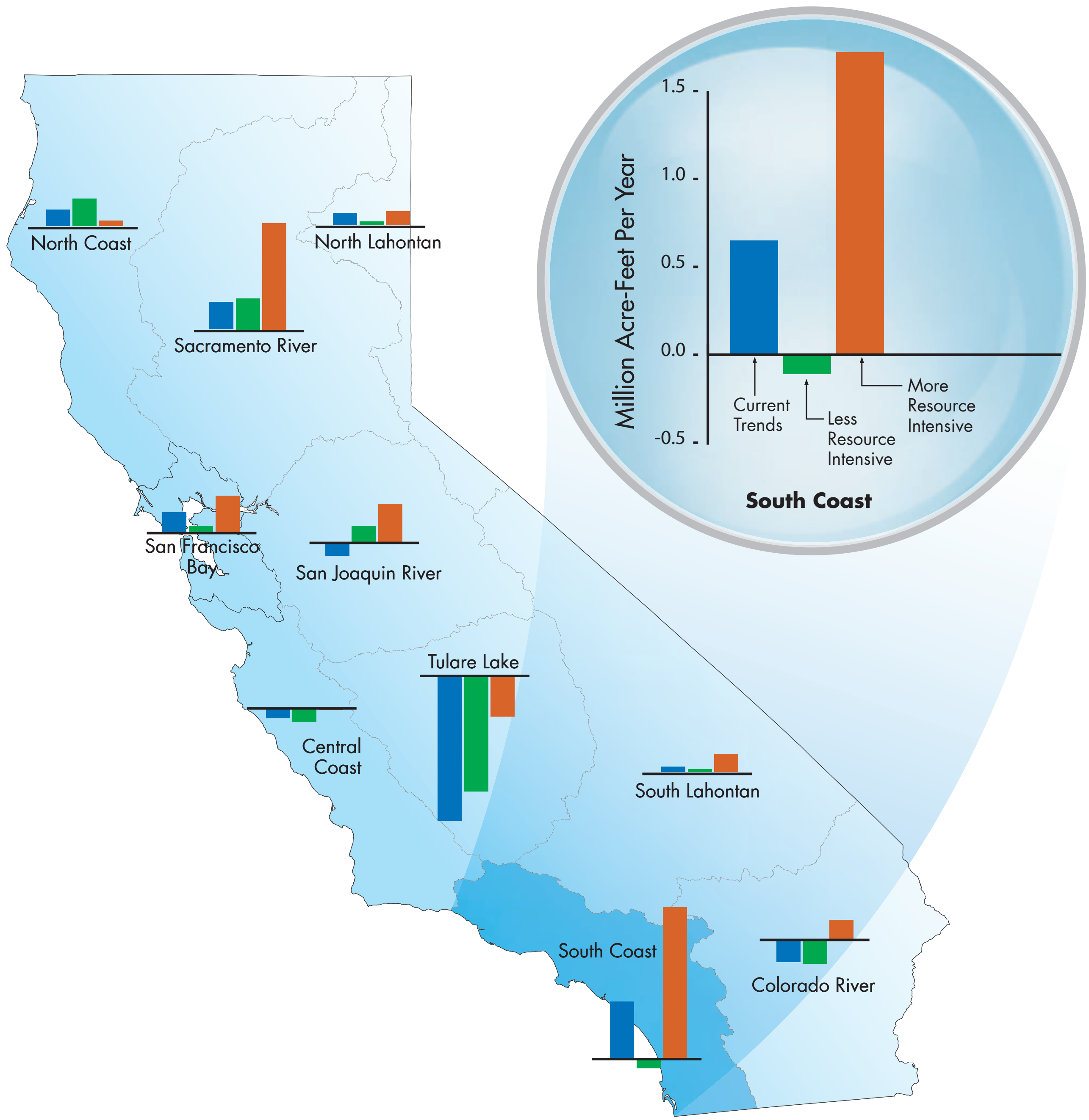
These preliminary estimates of water demand by baseline scenario (derived from Groves, Matyac, and Hawkins (2005)) illustrate how water demands can change over the next 25 years based on different assumptions about key factors that influence water demand. These results show that statewide demand can vary significantly and that demand can vary significantly across regions and across water use sectors. Although instructive, these preliminary estimates cannot be used as indicators of potential future shortages. They describe what additional water demands California may face in 2030, but without additional demand management beyond current policies. Further, they do not consider the future capability of the water management system to meet these demands under different hydrologic conditions. In order to assess how balanced the overall water management

Box 4-7 Crafting Sample Response Packages

The scenarios in California Water Plan Update 2005 represent different baseline conditions for 2030 that could affect water demands and supplies, but that the water community has little or no control over. In the next California water plan update, each future scenario will be used to test a number of different response packages, that is, different mixes of resource management strategies (see Volume 2 for discussion of 25 resource management strategies). Individual members of the Water Plan Advisory Committee have begun using the baseline scenarios and resource management strategies described in Update 2005 to develop two independent examples of how baseline scenarios can be extended to include a mix of management strategies or response packages. These examples include:

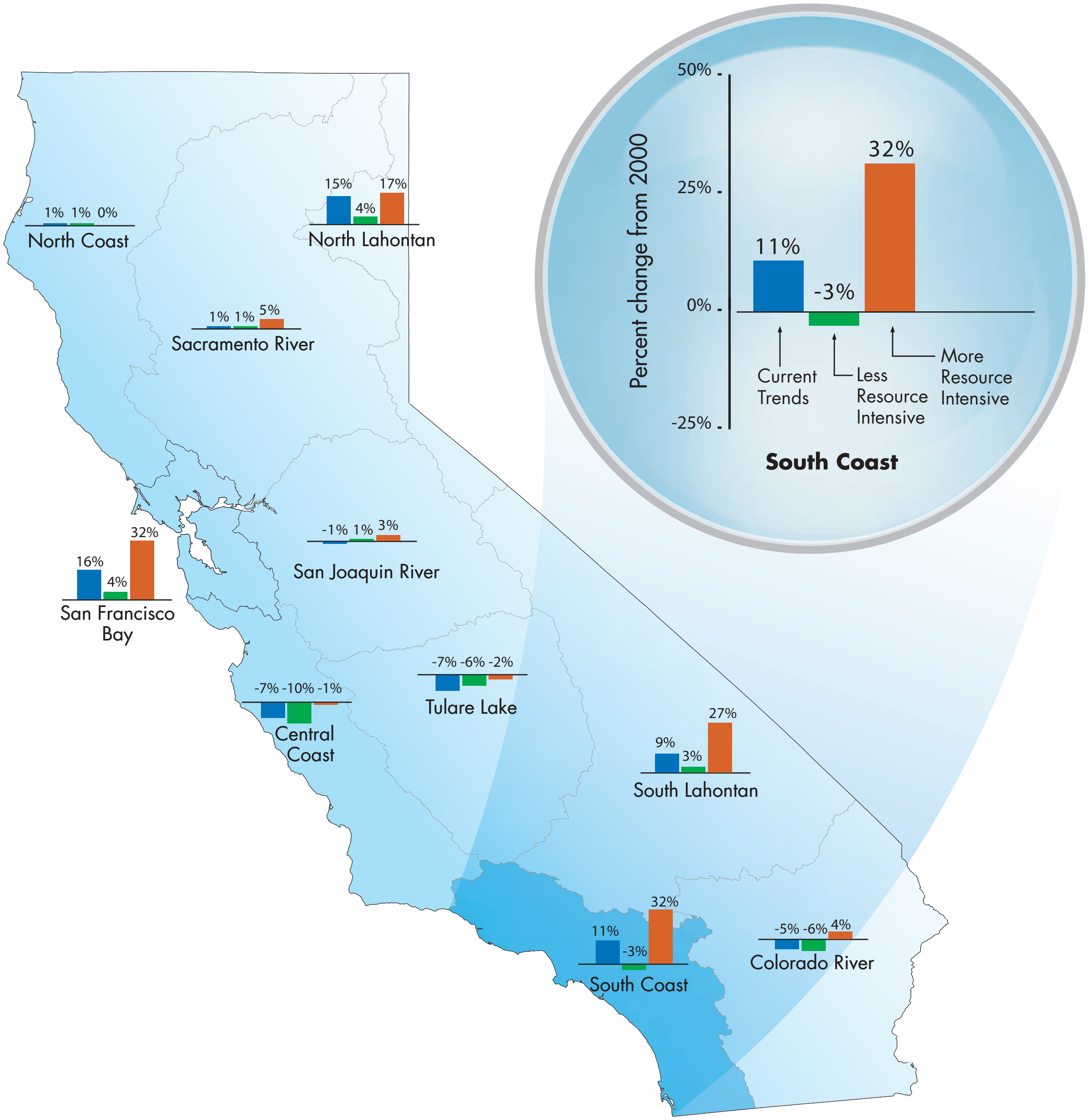
- An aggressive water use efficiency response package is presented in the publication by the Pacific Institute, "California Water 2030: An Efficient Future" (See www.pacinst.org/). The Pacific Institute High Efficiency response package is based on widespread adoption of existing water-efficiency technologies, not on the invention of new efficiency options, and on different estimates of water prices and trends. The Pacific Institute's High Efficiency response package estimated 2030 urban and agricultural water demands by (1) using the California Water Demand Scenario Generator (analytical tool) developed for Water Plan Update 2005, (2) adopting the same assumptions for population, housing distribution, agricultural land area, crop type and distribution, and income projections used in the water plan's Current Trends baseline scenario, (3) using different assumptions for urban and agricultural water price trends, and (4) including additional water use efficiency measures that have been shown to be achievable and cost-effective using existing technology (Mayer et al. 1999, Gleick et al. 2003). In the report, the High Efficiency response package is compared with the Water Plan Current Trends baseline scenario.
- In 2005, the Bren School at UC Santa Barbara and the RAND Corporation began collaborating to explore alternative response packages for the Southern California hydrologic region to assess the potential of increasing reliance on local water supplies and demand reduction. Using an enhanced version of the California Water Demand Scenario Generator developed for Water Plan Update 2005, this team is evaluating the performance of alternative response packages consisting of urban water use efficiency, conjunctive use and groundwater storage, and recycled municipal water, for multiple future conditions (see Volume 4 article, "Quantified Scenarios of 2030 California Water Demand"). The analytical tool and results will be used in a series of workshops with stakeholders and decision-makers in Southern California during the winter of 2005-06. For more information, see the Web sites of the Bren School's Water Policy Program (www.bren.ucsb.edu/academics/WaterPolicyProgram.htm) and the RAND Corporation's program on Improving Decisions in a Complex and Changing World (www.rand.org/ise/projects/improvingdecisions/).

Figure 4-4 Net changes in average-year water demand for baseline scenarios by region, 2000–2030



Water demand changes are shown in the 10 hydrologic regions for three baseline scenarios. South Coast region demands are magnified to show volumetric changes in million acre-feet per year, which can be either lower (negative bar) or higher (positive bar) than year 2000 water uses in the region. An additional 1 maf to 2 maf per year (not shown in the figure) is needed for all scenarios to eliminate groundwater overdraft statewide.

Figure 4-5 Percent change in average-year water demand for baseline scenarios by region, 2000-2030



Regional water demand changes in Figure 4-4 are presented as a percentage of the total water use in the region in year 2000. The South Coast region shows relative water demand changes in percent per year, which can be either lower (negative bar) or higher (positive bar) than uses in 2000.

system will be in 2030, after estimating possible demand, we must still incorporate supply conditions, craft alternative responses, and then compare performance of the response packages under each scenario (see Box 4-5 The Planning Proess). More refined estimates of future demand will be done as part of the next California water plan update along with a comparison of performance between specific noteworthy response packages.

Next Steps – Craft Responses and Compare Performance

In the next California water plan update, each baseline scenario will be used to test a number of different regional response packages, that is, different mixes of resource management strategies (see Volume 2 for discussion of 25 resource management strategies). Comparing the performance of different response packages will provide useful information to decision-makers and water managers that must choose actions to help achieve a desirable future condition. Stakeholders can identify areas of agreement and where short-term resource management strategies can work well regardless of the future conditions. In a long-term time frame, where uncertainties about future assumptions increase, plans can be revised to include resource management strategies that can better respond to the changed conditions.

Response packages can be modified and should be used as a basis for identifying short-, medium-, and long-term actions of a plan. DWR will work with stakeholders and other interested parties to develop several response packages on a regional basis during the preparation of the next California water plan update and post interim results on the California Water Plan Web site. See Box 4-7 (Crafting Sample Response Packages) for two examples of how response packages can be combined with baseline scenarios.

A significant part of the proposed analytical approach is the addition of quantitative comparisons for different response packages of resource management strategies. This performance evaluation of various mixes of strategies under plausible future scenarios will provide planners unprecedented access to relevant technical information and new insights. This quantitative insight can be used to help guide investments in regional and statewide water management actions. To help focus the quantitative analyses, DWR and stakeholders have developed a list of evaluation categories that represents the technical information required to compare response packages (see Table 4-5 Evaluation categories for assessing achievement of water management objectives).

In the next California water plan update, each baseline scenario will be used to test a number of different regional response packages, that is, different mixes of resource management strategies.

Initial Insights

Three baseline scenarios offer a useful view of how significantly water demand can vary with even relatively conservative estimates of different key factors. This idea will be developed further and refined during analyses for the next water plan update. **The results from these preliminary scenarios illustrate three significant points for water planning in California:**

- **Total demand for water in California in the year 2030 can vary a great deal. Even with relatively conservative adjustments in some key parameters, estimates of state-wide demand vary by almost 4.5 million acre-feet per year.**
- **Urban demand increases in all three scenarios; whereas, agricultural demand decreases in all three scenarios.**
- **Water demand changes differ between regions and by scenario.**

Better quantitative information is needed to assess how these changes could affect California if they are not addressed, and to compare the merits of different management strategies to prepare for these expected changes.

Changes to Consider When Preparing for the Future

When predicting changes, the following activities highlight those factors that should be considered for regional and statewide water plans for the next 25 years.

When planning to accommodate change, it is useful to consider two categories of how change occurs: gradual and sudden. These two characteristics can inform how best to prepare for and respond to changes. Gradual changes can include things like variation in population by region, shifts in the types and amount of crops grown in an area, or changes in precipitation patterns. Sudden changes can include episodic events such as earthquakes, floods, droughts, equipment failures, or intentional acts of destruction. The nature of these changes and their potential impacts on our water management systems can have a big influence on how we prepare to respond to them.

Table 4-5 Evaluation categories for assessing achievement of water management objectives

Water management objective	Evaluation category	Information source
Increase water supply, reallocate supplies or manage demand (all use sectors)	Urban, agricultural, and environmental reliability	Water portfolio / flow diagram; water management/system analysis; inventory of new projects
Improve drought preparedness	Urban, agricultural, and environmental reliability	Water management/system analysis
Improve operational flexibility	Urban, agricultural, and environmental reliability	Data monitoring/compilation and system analysis
Improve water quality (all use sectors)	Risks to human/ecosystem health and agricultural production	Water management/system analysis
Reduce groundwater overdraft	Salinity intrusion Subsidence Groundwater levels (long term)	Data monitoring/compilation and system analysis
Reduce flood impacts	Flood risk	Economic analysis and system analysis
Environmental benefits	Fisheries (populations and habitat) Native habitat/vegetation Wildlife (populations and habitat)	Data monitoring/compilation, biological opinion, and system analysis
Energy benefits	Energy availability	Data monitoring/compilation and system analysis
Recreational opportunities	Quantity, quality and variety of water-based recreation	Data monitoring/compilation and system analysis
Other considerations	Catastrophic vulnerability	Economic analysis and system analysis
	Third party impacts	Economic analysis and system analysis
	Economic/financial	Economic analysis and system analysis
	Public Trust and environmental justice	Participation in planning; assistance to low-income and disadvantaged communities

Sources for Gradual Change

The following categories are expected to change significantly, some dramatically. However, they will likely occur gradually over time. This type of change allows planners to be flexible regarding when management responses are implemented. Understanding the uncertainties around the future changes and the risks associated with these inaccuracies can help determine a prudent mix of management actions.

Future Landscape (Land Use Patterns)

The way that we use land (the types of use and the level of intensity) relates directly to water use, water supply, and water quality. It is impossible to predict precisely how land will be used in the future. By better understanding the uncertainties about land use change, we can plan to accommodate future changes more successfully.

Projecting current trends has been the traditional method for estimating future water demand. However, resource limitations and many economic, environmental, and social factors can cause future conditions to vary significantly from existing trends. For example, changes in job conditions can force people to move from one region to another or from state to state. Changes in the world food market can influence California farmers to alter crop types and crop acreage over time. Advances in scientific understanding of the environment can influence methods for habitat restoration or alter targets for instream flows. Many factors like these can lead to very different land and water use patterns than what may be expected by simply projecting current trends.

We do not currently have the capability to accurately predict a large number of factors that can influence future urban, agricultural, and environmental land and water use patterns. Although it is difficult to quantify some of the specifics, water managers still can prepare for these future uncertainties by formulating a diversified portfolio of complementary resource management strategies.

Even if planners are fairly sure that certain land use changes will occur in a specific area, the timing of those changes can be very uncertain. For example, an estimate that the population of a community will grow to be 500,000 people by 2030 gives planners some useful information. However, if they know that the timing is uncertain regarding when the population will be reached, they are wise to choose management strategies that can be implemented easily on a flexible timeline to accommodate actual population change over time.

Urban Use

According to DOF, California's year 2004 population of more than 36.5 million is expected to reach 48 million by year 2030. However, actual population growth will certainly be more or less than this estimate. More people lead to more urban development, which often changes urban runoff characteristics and water quality. For the California Department of Parks and Recreation, more people mean more demand for water-based recreation, some of which affect lakes that also serve as reservoirs for drinking water. This increasing mixed use raises concerns about the quality of those drinking water sources. (See Volume 2 Chapter 20 Urban Land Use Management and Chapter 24 Water-dependent Recreation.)

California's automobile-dependent lifestyle is reflected in the state's post-World War II urban development. Patterns are characterized by fragmented and segregated land uses, low-density residential and strip commercial development, and a lack of connectivity within and between neighborhoods that use large quantities of land per capita. This style of development has led to consumption of prime farmland and the water appurtenant to that land, open space, or natural habitat and an increased impact on other natural resources. Larger residential parcels tend to consume more water per capita than do smaller parcels. Large amounts of impervious surfaces such as roads and parking lots can degrade water quality and increase local flooding and urban runoff, alter streamflow and watershed hydrology, reduce groundwater recharge, and increase stream sedimentation. It also increases the need for infrastructure to control local storm runoff.

More population growth can also produce additional domestic wastewater discharges and urban runoff, which may in turn contaminate natural water bodies used as drinking water sources. Future water demands can vary widely depending on how urban land use patterns develop. Providing a growing population with a sufficient, affordable, safe, and reliable water supply is a major challenge facing local agencies and governments, especially in light of other challenges like potential water quality degradation that tend to diminish water supply (see Volume 4 Reference Guide article "General Plan Guidelines Chapter 2: Sustainable Development and Environmental Justice").

Agricultural Use

California agriculture will continue to consume more water than is consumed by all household uses for the foreseeable future. As population increases, the need for food and fiber crops also will increase. Over the last 20 years, some water has been redistributed from the production of food and fiber to environmental and urban uses. Furthermore, historically available water supply for agriculture and other uses has been reduced due to continued groundwater overdraft or environmental restrictions in some areas.

California's agricultural production is large, efficient, and diverse, producing more than 350 commodities. California leads the nation in production for 75 crop and livestock commodities, and 13 of those commodities are produced solely within this state. In addition, according to the 1997 Census of Agriculture's ranking of market value of agricultural products sold, 8 of the nation's top 10 producing counties are in California. The state grows more than half of the nation's total fruit, nuts, and vegetables, making California a net exporter of food to the rest of the United States and the world. The California Department of Food and Agriculture (CDFA) estimates that 14 percent of California's agricultural production is exported to other countries.

California has approximately 80,000 farming operations and about 27.6 million acres of farmland, about 9 million acres of which are irrigated. Agricultural land in California has been gradually shifting to urban or other nonagricultural uses. From 1990 to 2000, about 500,000 acres were converted from agricultural to urban or nonagricultural uses. Population growth and nonagricultural forces drive land use conversions (Kuminoff and others 2001). It is uncertain at what rate this land conversion will continue in the future. If farm-to-urban conversion continues to increase at the same per capita rate, approximately 700,000 acres of additional California farmland would be converted to urban use per decade. By 2030, the total conversion would be 2.1 million acres or about 10 percent of the California farmland that was in production in 2000 (Brunke and others 2004).

Although agricultural acreage may decline and will be relocated somewhat by urban development, yield growth in the quantity of agricultural crops produced per acre of land may continue to increase and will probably increase the dollar value of California food production over the next 30 years. Yield growth is expected to occur as a result of technological advances and more multicropping (harvesting multiple crops in a year on the same land), and may also be affected by the impacts of global climate change. In addition, the economic value of crops per acre-foot of water has increased in the past and is expected to continue to increase. Irrigation efficiencies have increased as more growers use drip and sprinkler irrigation. Also, there has been a shift toward agricultural commodities that generate more economic value per unit of water used to produce the commodity.

Since December 31, 2002, tail water discharges and storm water runoff from irrigated agriculture and timber harvesting areas must be monitored. Along with urban runoff, the U.S. Environmental Protection Agency has identified agricultural runoff as the most serious threat to water quality in the country. Municipal and industrial wastewater and even some urban runoff are already formally managed and regulated. However, agricultural runoff and agricultural drainage, especially in the Central Valley, will remain significant and potentially expensive challenges, with no obvious or simple solutions.

Groundwater subjected to overdraft is not a sustainable source of water. The cumulative effects of overdraft and water transfers diminish the reliability and sometimes the quality of irrigation water for food production. Agriculture cannot easily rebound in years of adequate water supply if surface water supplies are greatly curtailed during dry years and affordable groundwater is not available. Growers of permanent crops are particularly at risk. Even growers of annual crops may be unable to obtain long-term loans or short-term credit if they do not have access to a dependable water supply.

Future agricultural water demands can vary widely depending on future agricultural land use changes, crop selection and farming practices. Agricultural water demand is significantly driven by the crop mix grown in the state. Agricultural operations are businesses that seek to produce food and fiber profitably. Global markets, rather than water prices, generally dominate the grower's decision regarding which crop to grow. The grower considers the relative prices of agricultural commodities, the costs and regulations associated with labor, the costs of inputs needed to produce the crop, inter-state and international exchange rates (about 18 percent of California's agricultural production in value terms is exported to other states and countries), and the security of the water supply.

AB 2587 (Stats 2002, Ch. 615) requires the California Water Plan to estimate the water demand needed to substantially continue agricultural production in California. A key phrase in the law is "neither the state nor the nation should be allowed to become dependent upon a net import of foreign food." In particular, the law specifies that DWR consider a future scenario under which agricultural production in California is sufficient to assure that the state is a net food exporter and that the net shipments out of state are enough to cover its traditional share of "table food" use in the United States (assumed by law to be 25 percent) plus "growth in export markets." For the next California water plan update, DWR will examine the AB 2587 analysis based on a food forecast prepared by CDFA, as required by the bill. The CDFA food forecast was not available for Update 2005 because of time and resource limitations.

The University of California Agricultural Issues Center prepared "Future Food Production and Consumption in California under Alternative Scenarios" (see Volume 4 Reference Guide). The report concluded that, based on economics, California agriculture will continue to produce substantial quantities of food crops. The value of California food production will more than keep up with rising population and income growth in California and the rest of the United States.

Environmental Use

Beyond the broad public benefits of maintaining a vital ecosystem, ecosystem restoration serves to improve California's natural water management infrastructure. As we learn more about the link between watersheds, water management, and the health of the environment, the benefits of restoring and protecting California's ecosystem to water supply reliability and water quality improvements are becoming more evident. As actions to restore ecosystems help increase the health and abundance of species protected under the State and federal Endangered Species Acts, there will be fewer ESA conflicts. As ecosystems like wetlands and sloughs are restored, their natural pollutant-filtering capabilities will improve water quality. As floodplains and seasonal lakes and ponds are restored, groundwater recharge can increase. In addition to protecting the public's long-term interest in sustaining natural habitats, investments toward a healthy ecosystem also can contribute to a more reliable, better quality water supply.

The major issues facing ecosystems statewide are aquatic and riparian habitat degradation and freshwater biodiversity declines that are directly linked to:

- physical alterations to habitat associated with on-stream dams, diversions, levees, and bank armoring;
- deterioration of water quality including temperature, pollution, and low dissolved oxygen;
- the introduction of non-native invasive species; and
- long-term climate change.

Over the past century, the scope of these threats has increased dramatically, mirroring human population growth and demand for services provided by and within freshwater ecosystems (transportation, irrigation, recreation, land for development, municipal and industrial water supplies, and energy production).

In rural areas, the main pollution sources often come directly from land use practices both present and past. As an example, the Sierra Nevada Ecosystem Project notes the adverse impact that hydraulic mining, which ceased during the 19th century, is still having on numerous Central Valley rivers. In addition, logging and related road cuts are a major cause of high sediment loads in some North Coast streams. Roads cause significant erosion within watersheds throughout coastal and inland areas. Grazing impacts, such as increased erosion, loss of streamside vegetation, reduction of groundwater recharge ability in mountain meadows, and nutrient inputs, also have contributed to an overall water quality degradation.

Introduction of aquatic non-native species harm public health, compete with native fish, and impede or block water deliveries. Because invasive species interfere with natural processes and do not necessarily provide the full range of benefits associated with native species, management of these invasive species is essential.

The potential environmental impacts to marine species and habitats associated with the use of ocean water for cooling power plants is also an issue facing California water managers because existing seawater intakes for power plant cooling are proposed as the source of supply for almost all proposed desalting plants. In general these existing intake systems have had fairly significant impacts on the coastal zone. A number of aging coastal power plants that use once-through cooling from the ocean may cease operation in the future because they are inefficient. Also, as a result of changes in power plant cooling technology, power plants may convert to a "dry" cooling system. Future technologies used in coastal power plants will affect the ability to use power plant cooling systems to dilute the desalination salt concentrates resulting prior to discharge to the ocean.

How these factors will continue to influence environmental land use is unknown. A challenge is to protect and improve the environment given the continued need for water for urban and agricultural use, problems with non-native species, water quality concerns, and climatic variability. We expect that future environmental water demands can vary widely depending on how land use patterns change in the future and the effectiveness and efficiency of current and planned ecosystem restoration efforts. (For more information, see Volume 2 Chapter 9 Ecosystem Restoration strategy in and Volume 4 Reference Guide article, "Considering Water Use Efficiency for the Environmental Sector.")

Sources for Sudden Change

Some events may or may not occur within the planning horizon, but when they do occur, they can cause major impacts on large segments of the population or the environment. Natural causes or intentional acts can cause major disruption to water infrastructure. A drought, flood, earthquake, wildfire, system malfunction, or unintentional chemical spill is beyond our control, even if the strictest safety measures are in place.

Sooner or later, all of these extreme events will strike somewhere in California. The major uncertainties are when and where they will strike and how severe they will be. Will a future drought be similar to a past drought or will it be longer and more severe? Will the next earthquake cause even greater damage? Will the next levee failure in the Sacramento-San Joaquin River Delta cause catastrophic damage to the Delta and disrupt the delivery of a major portion of the state's water supply?

Formulation and implementation of strong integrated regional water management plans can lessen the impacts of extreme events. State, regional, and local entities can prepare risk assessments to aid decisions on how much protection they can afford to build into their system and in which management strategies to invest. The following sources of sudden change should be considered in preparing integrated regional water management plans.

Delta Vulnerabilities

The Sacramento-San Joaquin River Delta is highly susceptible to flooding. The Delta includes 70 islands and tracts, most of which have land surfaces at or below mean sea level. These islands and tracts are protected from the constant threat of inundation by about 1,100 miles of levees. Subsidence is occurring on most of the islands which serves to lower their land surface with time, thereby increasing the risk and consequence of flooding.

Most of the Delta's levees do not meet modern engineering standards and are highly susceptible to failure. Levees are subject to failure at any time due to seepage, piping, slippage, subsidence/sloughing, or earthquakes, including during dry weather (see section below for discussion of the threat posed by earthquakes to Delta levees). The Upper Jones Tract levee failure of June 3, 2004, is the most recent example of a levee failure during dry weather. The Jones Tract failure may have occurred due to a problem with piping or with the levee's foundation, although the exact cause is unknown. Levee failures in the Delta can also occur during periods of high tides, high winds, and high water.

Levee failures and flooding in the Delta are not rare occurrences. Figure 4-6 (Map of flooded islands in the Delta for different high flow periods) shows flooding in the Delta, from 1967 to 1992. Each of the Delta's 70 islands and tracts have flooded at least once since they were originally dewatered. About 160 individual levee failures have occurred over the past century. Climate change is causing sea levels to rise and may also increase the magnitude of floodflows. Major levee failures are difficult and expensive to repair. In some cases the cost to remove the flood water and repair the damage greatly exceeded the appraised value of the flooded land. Among many possible consequences, Delta levee failure could result in the temporary or long-term disruption of the water supply for about two-thirds of the state's residents and for about half of the state's irrigated agriculture. Levee failure can cause large amounts of saline ocean water to be drawn into the Delta when an island floods. Water supply pumping operations in the Delta for the State Water Project (SWP), Central Valley Project, and other supply systems must stop when a large amount of ocean water is drawn into the Delta and salinity levels in the Delta increase to unacceptable levels. Water supply pumping operations can be restarted when salinity returns to acceptable levels. Salinity conditions can take many months to return to normal depending on the amount and location of levee failures and hydrologic conditions.

Droughts

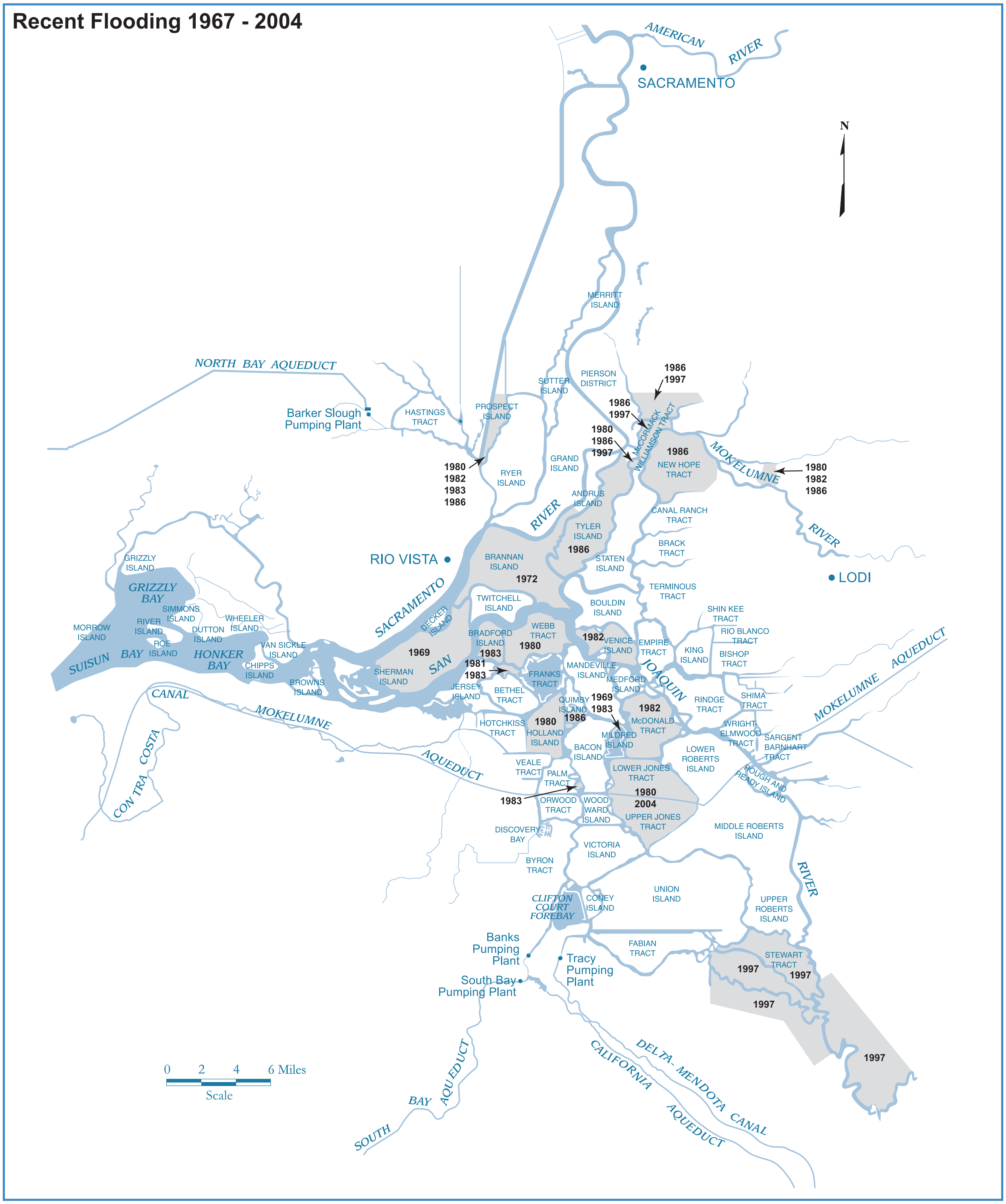
California's most recent severe statewide drought was from 1987 through 1992. In planning water supplies for future needs, the hydrologic record of the past century may not be a reasonable measure of future climate conditions. The state's available hydrologic record is rather short for determining hydrologic risks; it traces back only about 100 years with mostly qualitative information extending back another 100 years. Tree ring studies have shown extensive dry periods far exceeding the 6-year maximum drought recorded during the last century. (See Volume 4 Reference Guide articles "Severity of Extreme Droughts in Sacramento and San Joaquin Valley" and "Planning for Extreme and Prolonged Drought Conditions.")

Floods

Flood magnitude in a watershed depends on several factors such as the intensity and duration of precipitation, location of the storm center, area of precipitation, rain on snowpack, and antecedent soil moisture. The most severe storms for large watersheds are slow-moving frontal storms, with a long southwesterly fetch extending from Hawaii, commonly referred to as the "pineapple express." The most severe storms for smaller watersheds in mountain areas are generally intense thunderstorms.

In January 2005 DWR released the report, "Flood Warnings: responding to California's Flood Crisis", which describes the current risks to the Central Valley from flooding. This report identifies several factors that have put public safety and the State's financial stability at risk for even greater calamity in the future (Box 4-8 Flood Risks Identified in 2005 'Flood Warnings' Report).

Figure 4-6 Map of flooded islands in the Delta for different high flow periods



Levee failures and flooding in the Delta are not rare. Each of the Delta's 70 islands and tracts has flooded at least once since originally dewatered. Major levee failures are difficult and expensive to repair, in some cases exceeding the value of the flooded land.

Earthquakes

Water control and management structures including Delta levees are vulnerable to failure, especially during earthquakes. Because Delta levees and the California Aqueduct system span a large area, their vulnerability to an earthquake is higher than that of an individual structure. Figure 4-7 (Map of San Francisco Bay Region earthquake probability) illustrates the location of major faults in the vicinity of the Delta and the probability of an earthquake of a selected magnitude from those faults.

Water collection and delivery systems in many other areas of the state are at risk of damage or failure due to earthquakes. Several water districts already have plans in place and have taken action to reduce earthquake impacts. Some measures include seismic vulnerability assessment, water supply augmentation, delivery system improvement, and groundwater recharge programs. For example, Calleguas Municipal Water District lost its water supply when the 1994 Northridge earthquake damaged its single feeder pipeline from the SWP. The North Los Posas Storage Program (210,000 acre-feet capacity, groundwater recharge program) now augments the water supply to this district to help lessen risks posed to the area's water supply by earthquakes.

Box 4-8 Flood Risks Identified in 2005 'Flood Warnings' Report

Aging facilities. California's Central Valley flood control system of levees, channels and weirs is old. Many levee reaches were built more than a century ago on foundations that are subject to seepage and movement. Over time, the levee system has significantly deteriorated, pa rtly due to deficiencies in the original design and partly due to deferred maintenance.

Data uncertainties. Traditionally, levee heights and channel capacities have been designed using historical data related to precipitation and runoff. However, due to either limited historical data or climate change, the general trend is for floodflows to be higher than anticipated.

Susceptibility to flooding. The potential impacts on people and communities of a single failure or multiple failures are catastrophic. These risks tend to be disproportionately higher in rural and economically disadvantaged communities that are often unable to invest in flood control improvements.

Increasing potential for flooding. Much of the new development in the Central Valley is occurring in areas that are susceptible to flooding. In some cases, land use decisions are based on poor or outdated information regarding the seriousness of the flood threat.

State liabilities for local decisions. Local land use decisions that allow developments in floodplains protected by the State-federal levee system in the Central Valley greatly increase the risk of State liability for loss of life and property damage.

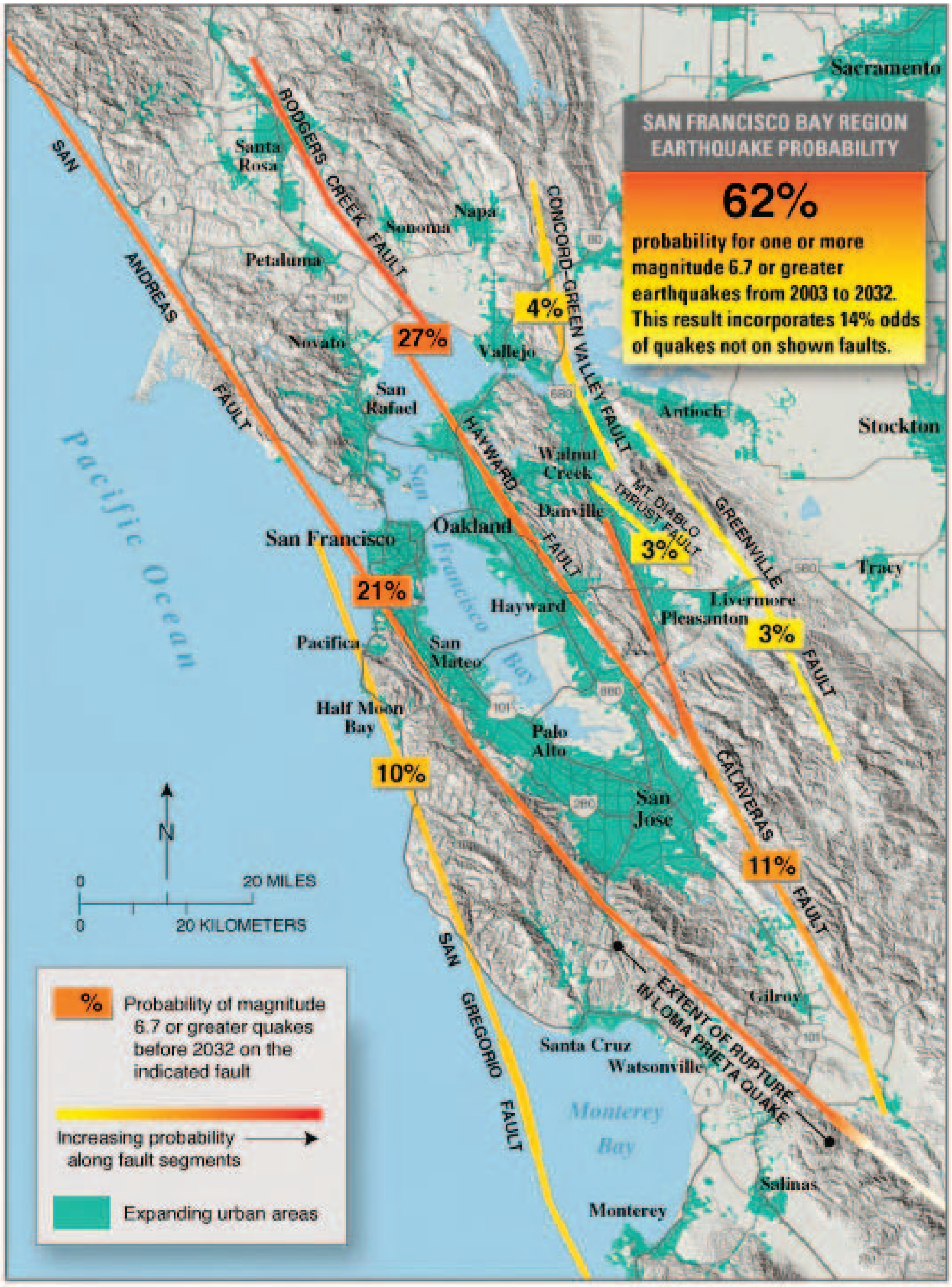
False sense of security. People who live and work behind levees have a false sense of protection. Many believe that the levees will protect them against any level of flooding. During a typical 30-year mortgage period, there is a 26 percent chance that a homeowner living behind a levee will experience a flood larger than the 100-year flood. This risk is many times greater than the risk of a major home fire during the same period.

Increasing State liability. As the risks of levee failure and corresponding damage increase, California's courts have generally exposed public agencies, and the State specifically, to enormous financial liability for flood damages. The November 2003 Paterno ruling held the State responsible for defects in a Yuba County levee foundation that existed when the levee was constructed by local agricultural interests in the 1930s.

Decreased funding. At a time when flood control maintenance and improvement efforts should be increased, the investment in flood management has instead been reduced at all levels of government. Local governments in California have been severely restricted by two constitutional amendments regarding the use of property tax or benefit assessments to generate revenue (Propositions 13 and 218). The federal government in 1996 reduced the maximum that it would pay for the cost of new flood control projects, from 75 percent to 65 percent of the total project cost.

Source: California Department of Water Resources. 2005. Flood Warnings: Responding to California's Flood Crisis. www.publicaffairs.water.ca.gov/newsreleases/2005/01-10-05flood_warnings.pdf

Figure 4-7 Map of San Francisco Bay Region earthquake probability



Probability of a 6.7 magnitude earthquake within 30 years in Bay Area *(2003 earthquake probability study - USGS)*
Water control and management structures including Delta levees are vulnerable to failure, especially during earthquakes. Because Delta levees and the California Aqueduct span a large area, they are more vulnerable to earthquakes than are individual structures.

Wildfire

Wildfire can result in short-term and long-term disruption to a water supply system and other resources. Wildfire can damage project facilities, including burning wooden flumes and power transmission lines. The loss of vegetation on the watershed can change runoff patterns, reduce natural water storage, increase sedimentation, and create other long-term impacts.

Facility Malfunction

Deferred maintenance and an aging infrastructure of State, federal, and local water projects present risks to public safety, water supply reliability, water quality, and ecological health. The infrastructure includes key water conveyance and delivery facilities and drinking water and sewage treatment systems that are subject to routine malfunction, short-term outage, or catastrophic failure.

The SWP is more than 30 years old, the federal Central Valley Project is more than 50 years old, and some local facilities are more than 100 years old. Some of their facilities have surpassed their design life and require significant rehabilitation or replacement. In recent years infrastructure failures have disrupted water deliveries. Much of the equipment and large fabricated components are unique. Spare parts would not be readily available if a sudden failure were to occur; it is generally impractical to store extremely large spare parts on site. The replacement of many of these items from sources outside the United States is time-consuming, thereby increasing the vulnerability of the projects.

Water systems are often interconnected or have coordinated operations for optimal, multiple benefits. When an operation of one system depends on the smooth operation of another, the successful operation of the complete system can become vulnerable to a failure in either part. The failure of the Jones Tract levee in the Delta was a reminder of the vulnerability of the Delta levee system and the interconnected nature between Delta levees and water supply operations. This incident required DWR and the U.S. Bureau of Reclamation (USBR) to take the following actions immediately to protect water quality and water supply operations in the Delta:

- USBR increased releases of fresh water from Shasta Dam to help control salinity and opened the gates of the Delta Cross Channel to move Sacramento River water into the central Delta to repel seawater intrusion.
- DWR and USBR reduced pumping at their south Delta export pumps to reduce the intrusion of sea water.
- DWR monitored Delta water quality at more than 20 sites and channel velocity changes in the Jones Tract area of the Delta.
- DWR conducted flood damage control efforts, reconstructed and repaired damaged levees, and removed flood water from the tract.

Chemical Spills

Truck and railroad tanker accidents and other unintentional spills can release toxic chemicals into California's rivers and other conveyance facilities. For example, a 1991 railroad accident near Dunsmuir resulted in a toxic spill that destroyed all aquatic life within a 38-mile reach of the Sacramento River above Shasta Dam. A similar accident in another location could shut down a community's drinking water supply for an extended period of time.

Intentional Disruption

Vandalism is defined as malicious destruction of property. Vandalism to water infrastructure could be acts like defacing concrete structures and important notice boards, stealing copper fittings and aluminum handrails, shooting at a turnout structure gate, dumping pesticides or other chemicals into California waterways, or dumping heavy material into the aqueduct. Most vandalism occurs in rural areas away from residential neighborhoods and frequent security patrols. For example, in the early 1980s, dredging of a one-mile stretch of the California Aqueduct revealed concrete blocks, farm equipment, and stolen vehicles. A similar stretch in the Delta-Mendota Canal in the early 1990s revealed more than 80 abandoned vehicles.

Terrorist acts are meant to cause major damage and loss of life, and there is a risk that water infrastructure could be targeted by terrorists. Many agencies have responded by reducing access to both the water-related facilities and information about the facilities that could be used by terrorists. Increased security is needed to reduce the chances of terrorism causing outages in water service and other damage caused by water system failures.

Cyber threats pose a serious potential impact to the operational capability of water delivery and treatment systems. Many new water delivery and treatment systems are SCADA (Supervisory Control and Data Acquisition) controlled through the Internet. The operational costs of these modern systems are low because of remote access capability from a single command center to operate segments of or the entire system. However, the entire operation becomes vulnerable to international hackers or cyber terrorists. The SWP, unlike many other water delivery systems, has a control system independent of the Internet.

Most water supply infrastructure was constructed at a time when vandalism, illegal dumping, and the threat of terrorism were uncommon. Fencing around the facilities and structures was installed primarily to prevent accidents. Today, the absence of active patrolling and lack of fencing along the waterways is attributed to the high rate of dumping in those areas.

Global Climate Change

As a result of global climate change, California's future hydrologic conditions will likely be different from patterns observed over the past century. Predictions include increased temperatures, reductions to the Sierra snowpack, earlier snowmelt, and a rise in sea level, although the extent and timing of the changes remain uncertain. These changes could have major implications for water supply, flood management, and ecosystem health. The prospect of significant climate change warrants examination of how California's water infrastructure and natural systems can be managed to accommodate or adapt to these changes, and whether more needs to be done.

Managing water resources with climate change could prove different than managing for historical climate variability because climate change could produce hydrologic conditions, variability, and extremes that are different from what current water systems were designed to manage; may occur too rapidly to allow sufficient time and information to permit managers to respond appropriately; and may require special efforts or plans to protect against surprises or uncertainties.

For over a decade, scientists have been publishing formal, peer-reviewed recommendations for integrating the results of climate change research into policy. The Public Interest Energy Research Program established a regional climate change research center (Box 4-9 PIER Program and Climate Change Research). The Pacific Institute, in a literature search report for DWR, summarized recommendations for coping and adapting to climate change from key peer-reviewed publications. The Pacific Institute's report "Climate Change and California Water Resources: A Survey and Summary of the Literature" and a DWR report on climate change impacts and recommendations for further research, "Accounting For Climate Change," are included in Volume 4 Reference Guide. The University of California, Davis used the CALVIN model to evaluate how California's water system might adapt to long-term climate warming (see Box 4-10 CALVIN: An Analytical Tool to Evaluate Effects of Climate Change).

At present, the extent of climate change impacts is uncertain. As more sophisticated tools are developed and more studies are completed, better quantification may be possible. One approach for planning for uncertainties associated with climate change is to perform sensitivity analyses with different assumptions about potential future conditions. Incorporating flexibility and adaptability into our current system can strengthen our ability to respond to change. Flexible systems contribute to beneficial operations both under current as well as future climate conditions by allowing management adjustments or midcourse corrections without causing major economic and social disruptions.

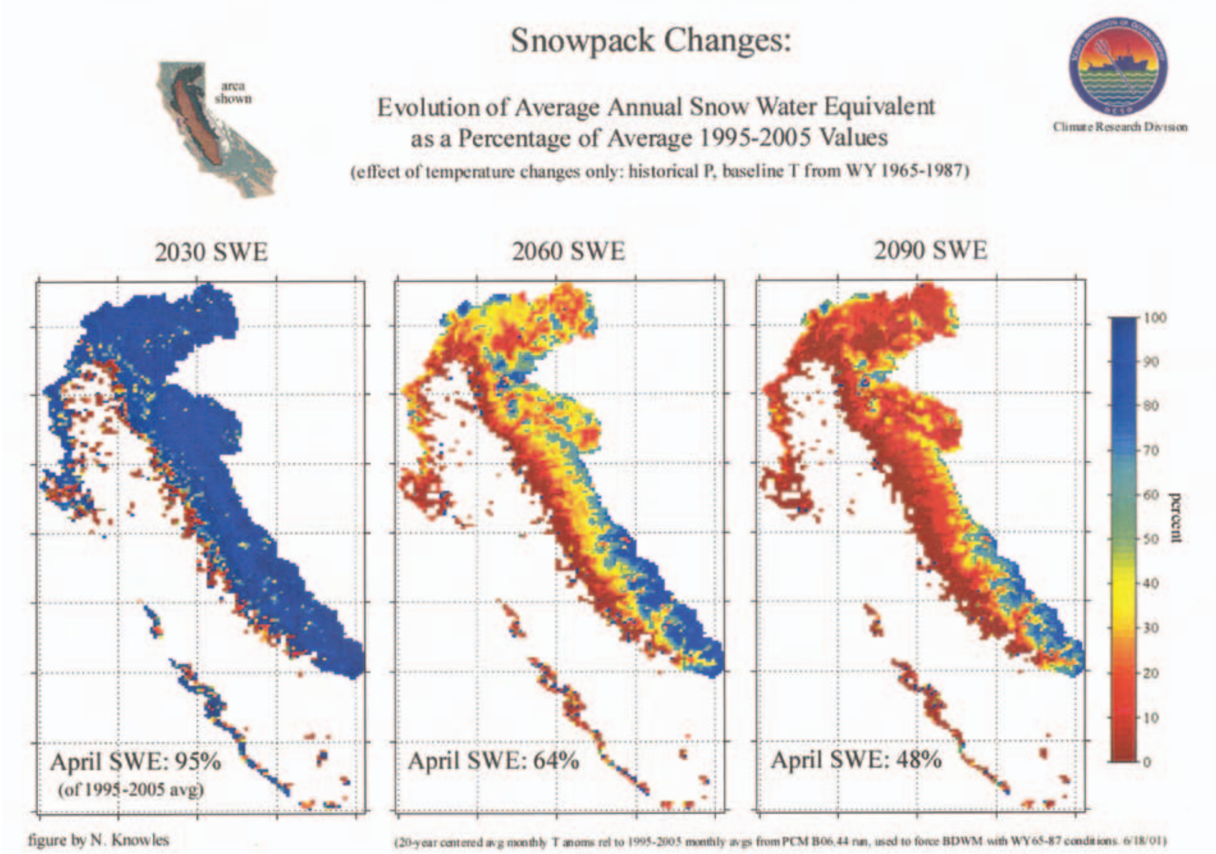
Box 4-9 PIER Program and Climate Change Research

In conjunction with affected state agencies, the Public Interest Energy Research Program administered by the California Energy Commission has developed and is implementing a climate change research plan for California. The PIER Program established a regional climate change research center with the goals of:

- Improving the understanding of the possible physical and economic impacts of climate change
- Developing robust adaptation and mitigation strategies for California.

In support of future updates of the California Water Plan, the California Climate Change Research Center is funding (1) the development and maintenance of a comprehensive climatic database for California and the analysis of meteorological and hydrological trends; (2) the monitoring of meteorological and hydrological parameters in some key remote locations using innovative remote sensing devices; (3) the development of climate projections for the state using regional climate models at levels of resolution appropriate for water resources impact analyses; and (4) the study of water resources impacts under different climatic projections. The Department of Water Resources is a key co-sponsor of these research activities.

Figure 4-8 Model simulation of potential changes in snowpack during 21st century



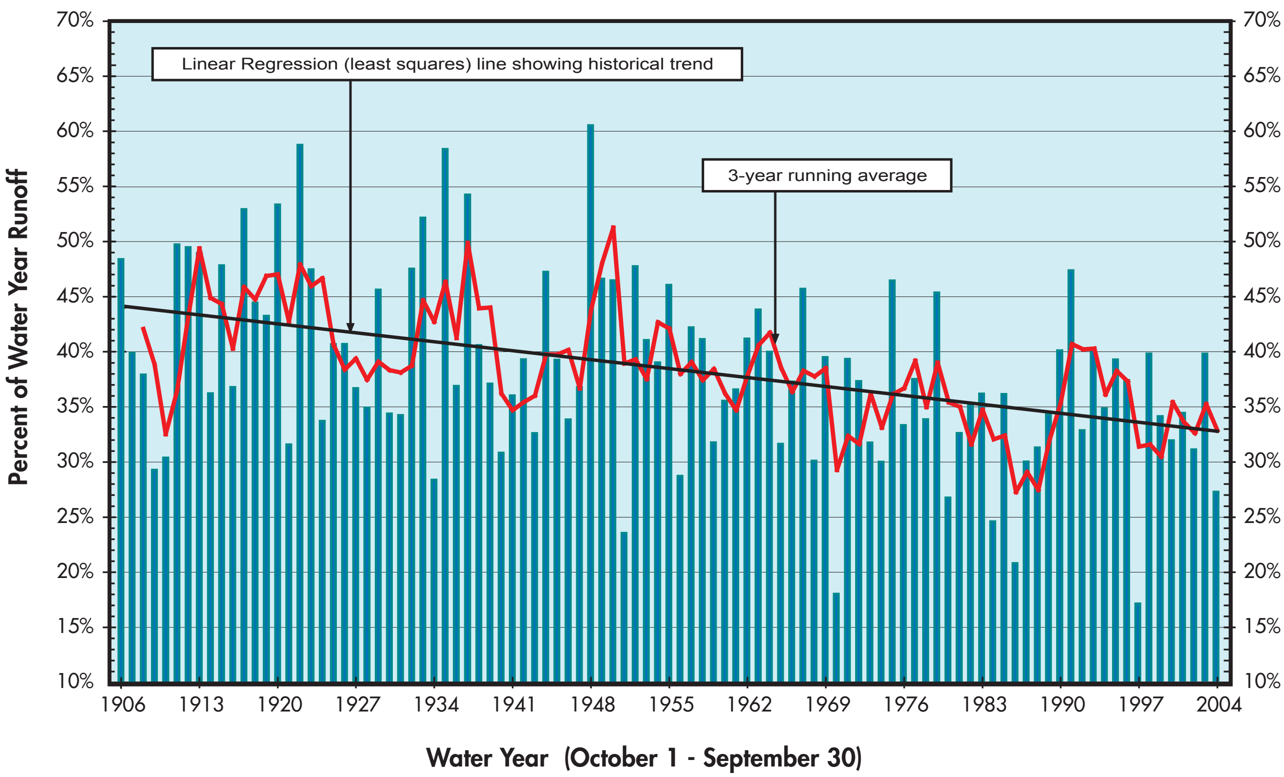
California relies on snowpack as a major part of annual water storage. Computer modeling of global climate change scenarios predict significant reductions in future snowpack. A 52 percent reduction in the annual April through July runoff would occur for a 2.1 degree C (3.8 F) of warming. (Source; Knowles and Cyan 2001)

Box 4-10 CALVIN: An Analytical Tool to Evaluate Effects of Climate Change

From 1998–2003 the University of California, Davis (with funding from the Resource Agency, CALFED, and California Energy Commission) developed a preliminary analytical tool, named CALVIN, to quantify the potential of integrated long-term solutions for California water management. The tool integrates existing surface water, groundwater, and water demand data in an integrated economic-engineering framework for California's intertied water system (covering 92 percent of California's population and 88 percent of its irrigated area).

In developing the computer model, significant weaknesses and gaps in water data were identified and documented. The model and its results have been peer reviewed and show preliminary insights into economically promising possibilities for California water management. More importantly, the tool demonstrated concepts in advanced data management, documentation, and analysis that may be useful for future statewide and regional water policy and planning analysis. The CALVIN model has been applied preliminarily to examine statewide potential for regional and statewide water markets and how California's water system might adapt to long-term climate warming (through the Public Interest Energy Research Program).

Figure 4-9 Sacramento River April-July runoff in percent of water year runoff



Historical records reveal changes in runoff pattern from April through July in a number of California rivers. Since the 1950s, the percentage of total annual runoff occurring during these months has declined progressively, an indication of earlier snowmelt and warmer temperatures.

Some of the expected impacts of global climate change are discussed in the following sections.

Snowpack Changes

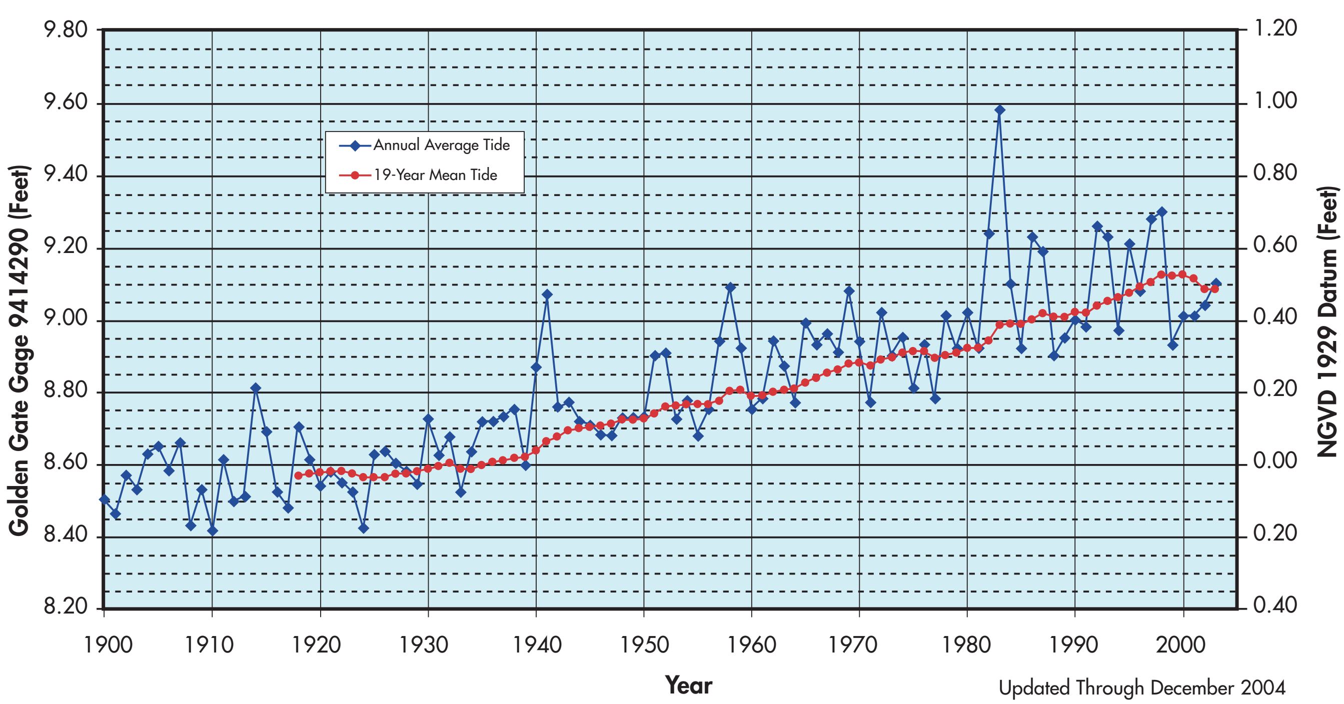
California's relies on snowpack as a major part of annual water storage. Annual runoff from the Sierra Nevada during April through July averages 14 million acre-feet and comes primarily from snowmelt. Computer modeling of global climate change scenarios predict significant future reductions in the Sierra snowpack. A reduced snowpack will reduce the total water storage for the state. Figure 4-8 (Model simulation of potential changes in snowpack during the 21st Century) shows a 52 percent reduction in the annual April through July runoff for a 2.1 degree C (3.8 F) of warming, well within the 1.4 to 5.8 degree C (2.5–10.4 F) range predicted by global climate models for this century.

Changes in the timing of snowfall and snowmelt, as a result of climate change, may make it more difficult to refill reservoir flood control space during late spring and early summer, potentially reducing the amount of surface water available during the dry season. Changes in reservoir levels also affect lake recreation, hydroelectric power production, and fish habitat by altering water temperatures and quality. Reductions in snowpack may require changes in the operation of California's water systems and infrastructure, and increase the value of additional flood control space in reservoirs.

Hydrologic Pattern

Historical records reveal long-term changes in the pattern of April–July runoff; an example is plotted here for the Sacramento River (Figure 4-9 Sacramento River April-July runoff in percent of water year runoff). From the 1950s to present, the percentage of April through July runoff has shown a progressive decline. This may indicate a decline in the amount of water stored annually in the Sierra snowpack leading to reduced spring and early summer river flows. The same effect is noted to a lesser degree on southern Sierra rivers. While these measurements are consistent with climate change model simulations, more extensive monitoring of runoff and snowpack is necessary for greater understanding of ongoing changes in hydrologic patterns.

Figure 4-10 Golden Gate annual average and 19-year mean tide levels



Global climate change is already leading to sea level rise, which can disrupt coastal communities, ecosystems, and tidal wetland restoration. It can also increase pressure on Delta levees, whose failure would disrupt water supply for about two-thirds of the state's residents and about one-half of its irrigated agriculture.

Sea Level Rise

Global climate change is already leading to sea level rise. Figure 4-10 (Golden Gate annual average and 19-year mean tide levels) shows historical sea level rise at the Golden Gate. During the 20th century, sea levels increased by 0.2 meters (0.7 feet). Models project a median rise of 0.5 meters (1.6 feet) over the 21st century due to climate change (IPCC 2001). Sea level rise could eventually disrupt ecosystems and communities in coastal areas and disrupt ongoing tidal wetland restoration efforts. The biggest impact of sea level rise on California's water supply and tidal wetlands restoration efforts could be in the Sacramento-San Joaquin River Delta. Sea level rise would increase pressure on Delta levees that protect low-lying lands, much of which are already below sea level. A single-foot rise in sea level would increase the frequency of the current 100-year peak high tide in the western Delta to about a 10-year event. Another effect of sea level rise is increased salinity intrusion from the ocean, which could degrade freshwater supplies pumped from the Delta unless more fresh water from upstream reservoirs is released to push back intruding sea water. Sea level rise could also threaten coastal aquifers.

Rainfall Intensity

Regional precipitation responses to climate change remain difficult to determine. If climate change results in larger individual precipitation events, it could affect current reservoir flood control operations and other flood management activities and infrastructure. Watershed protection activities would also be affected because changes in storm intensity could affect water quality and erosion.

Urban, Agricultural, and Environmental Water Demand

Climate change predictions include increased temperatures, as discussed earlier. Plant evapotranspiration increases with increased temperature. Another factor that may affect plant evapotranspiration is atmospheric carbon dioxide concentrations. Long-term increases in worldwide atmospheric carbon dioxide levels are expected to continue for some time. Some laboratory tests indicate that increased atmospheric carbon dioxide concentrations can act to reduce plant water consumption. Most researchers believe that the influence of warmer temperatures on increasing plant water consumption may be partially offset by the effect that rising carbon dioxide concentrations have on reducing consumption. More research is needed in this area.

Aquatic Life

Warmer air temperatures and changes in snowmelt will make it more difficult to manage reservoirs and reservoir releases to maintain rivers temperatures that are cool enough for anadromous fish. Higher water temperatures will also increase chemical and biological reaction rates in water bodies, which could adversely affect aquatic species. Many extensive studies on climate change provide more detailed impacts on the environment.

Changing Policies, Regulations, Laws, and Social Attitudes

This category of potential changes can also include elements of both gradual and sudden change. Evolving policies, regulations, laws and social attitudes have dramatically altered California's water management over the past few decades. Some examples include the CVPIA and State Water Resources Control Board Decision 1641, which require more water to meet water quality standards. Furthermore, additional listing of threatened and endangered species has required more water to address environmental needs.

It is difficult to anticipate precisely how changes in policies, regulations, laws, and social attitudes will affect future water management. However, there are methods that can be employed to consider potential impacts on the system if similar changes were to occur in the future. These kinds of potentially significant changes that are difficult to predict where, when, and what might happen emphasize the value of enhancing regional self-sufficiency and strengthening statewide water management systems to provide more flexibility.

Relationships between Water Operations and Environmental Impacts

Environmental restoration science is a work in progress. Rarely do we have the necessary scientific information on a species, much less an ecosystem, to identify an exact course of action that will restore natural communities and processes. When precious resources and endangered species are involved, we often do not have the time or money to fully develop our scientific understanding before action is needed. Yet, the uncertainty can result in hesitation and delay. Improved understanding of ecological processes can lead to changes in policies, regulations, and laws.

Understanding watershed characteristics allows the use of adaptive management to operate projects and programs that best fit into the ecological settings. In some cases the description of these characteristics will reveal that important infrastructure, programs, or projects are not sensitive to watershed processes or have not been designed to capture the full ecological value of the projects. In these cases reoperation and redesign may greatly improve the watershed compatibility of the projects. (See Volume 2, Chapter 19 System Reoperation and Chapter 25 Watershed Management.)

Changing Plumbing Codes

Future changes in plumbing codes, like the one for installing ultralow flush toilets, could allow use of innovative water fixtures to conserve water. Code changes could expand use of recycled water for various nonpotable uses. These and other changes could alter water use and supplies.

Emerging Contaminants

The nature and impact of contaminants themselves may be changing in the future. Future population growth and demographic changes may further impair the quality of water bodies with both known and emerging contaminants, increasing the risk of drinking water. Demographic change may create larger groups of people, including the very old and the very young, who are more vulnerable to drinking water contaminants. Information on pollutant sources and their impacts is insufficient to adequately respond to existing problems. As new health risk information is obtained, water quality standards may become more stringent to protect health and safety. Re-evaluation of health-effects research often leads to re-regulation of known contaminants. Moreover, there is a growing demand from consumers, expressed in opinion surveys as well as in the marketplace, for higher quality water.

Summary

All Californians have strong incentives to promote the development and exchange of better information about how to balance risk and reward related to water resource investments. These types of decisions have never been more complicated and, perhaps, more necessary. Preparing for the future in the face of tremendous uncertainties requires cooperation among all levels of government in California. There is much more to learn about how our complex water management systems work, and how they will respond to a multitude of future changes.

Three baseline scenarios offer a useful view of how significantly water demand can vary with even relatively conservative estimates of different key factors. This idea will be developed further and refined during analyses for the next California water plan update. The results from these preliminary scenarios illustrate three significant points for water planning in California:

1) Total demand for water in California in the year 2030 can vary a great deal. Even with relatively conservative adjustments in some key parameters, estimates of statewide demand vary by almost 4.5 million acre-feet per year.
2) Urban demand increases in all three scenarios; whereas, agricultural demand decreases in all three scenarios.
3) Water demand changes were different between regions and by scenario.

These scenarios clearly suggest that water demands can change significantly throughout the state by 2030. These kinds of changes are best managed using integrated regional water management supported by strong statewide water management systems.

Volume 1

Chapter 5 – Implementation Plan

Chapter 5 Implementation Plan

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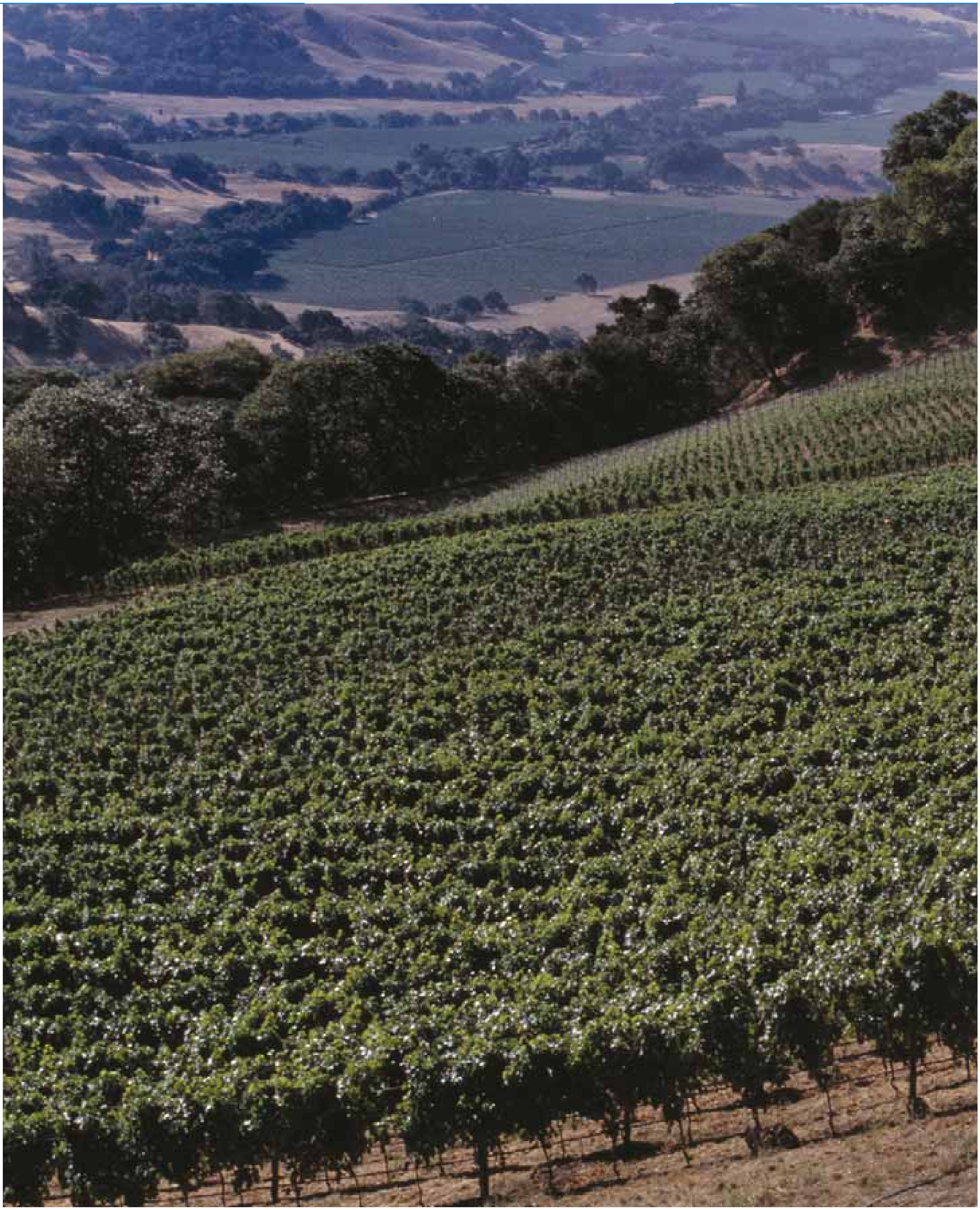

Drip irrigation in California's vineyards is one example of how using water efficiently can help us get maximum utility from existing supplies. (DWR photo)

Chapter 5 *Implementation Plan*

About This Chapter

Chapter 5 Implementation Plan lays out the implementation plan for California Water Plan Update 2005. It presents 14 recommendations. Each is followed by related action plan, intended outcomes, resource assumptions, implementation challenges, and performance measures.

- Implementation Plan Organization
- Implementation Costs
- Recommendations 1 through 14

Implementation Plan Organization

The implementation plan is organized around recommendations with related action plan, intended outcomes, resource assumptions, implementation challenges, and performance measures. (See Table 5-1 Elements of the implementation plan). The recommendations are directed at California (decision-makers throughout the state), State government (executive and legislative branches), DWR and other State agencies to lead our actions over the next 25 years. Additional details for actions assigned to the Department of Water Resources are presented in DWR's Strategic Business Plan (2005).

In each action plan, near-term high-priority actions, included in the Framework for Action (Chapter 2), are preceded by an hourglass symbol (⌛) to indicate that they should be completed before the next update.

Evaluating the performance of some actions plans requires a tracking system that will show whether and how well statewide and regional water management objectives are met. Table 5-2 (Evaluation categories for achieving water management objectives) lists categories developed for this purpose (see Chapter 4 for details). This table is cited in the performance measure section of applicable actions plans.

Implementation challenges specific to each of the 25 resource management strategies and recommendations on reducing or removing their challenges are presented in Volume 2 Resource Management Strategies and are not repeated in this chapter.

Implementation Costs

Carrying out the recommendations of *California Water Plan Update 2005* will require significant action and investment by all Californians. Local implementation of the 25 resource management strategies (see Volume 2 Resource Management Strategies) and performing the essential support activities (in Chapter 2 A Framework for Action), which include CALFED Bay-Delta Program actions, will require billions of dollars over the next 25 years (see Table 1-1 in Volume 2 Chapter 1). The support activities are essential to integrating the resource management strategies and reducing uncertainty and risk. These activities are statewide and integrated regional water planning and management, data and analytical tools improvements, research and development, and science programs. Many of the management strategies would be applied incrementally and adaptively to meet changing regional conditions and goals. However, other strategies and all of the essential support activities need significant upfront and ongoing funding.

Table 5-1 Elements of the implementation plan	
Element	**Description**
Action plan	Describes key activities to carry out each recommendation and the entities best positioned to play a key role. Action plans break recommendations into manageable parts including assignments, resource assumptions, implementation challenges, and performance measures for tracking progress.
Intended outcome	Describes the desired end result and may indicate an estimated and/or recommended timeframe for implementation.
Resource assumption	Estimates resources, including human and/or financial resources, required to accomplish the action plan.
Implementation challenge	Identifies factors that may restrict, limit, or regulate the action plan such as scope, funding, skill levels, policy, technology, dependency.
Performance measure	Method to ensure accountability by measuring work performed and results achieved. This describes what is to be measured and the methods of measurement. Measures may be short term, intermediate, and/or long term. In contrast, evaluation criteria represent the technical information used to help policy-makers, water managers, and the public compare how well scenarios and resource management strategies meet desired water management objectives. The criteria listed in Table 5-2 (Evaluation categories for achieving water management objectives) includes parameters like the cost of implementing different resource strategies, environmental benefits, water reliability, and water quality improvements (see Chapter 3 for details).

Since 1995 voters have demonstrated their support for managing our water resources by approving several bond measures, which total an average of $1 billion annually. These bonds, combined with local funding, have led to significant progress in new water conservation, groundwater storage, water recycling, and ecosystem restoration. Implementation of the CALFED Bay Delta Program was a major driver for these bonds, and the program will continue to be vital for improving water management in California.

Strategies, options, and guidelines for public investments and State financial assistance included in the implementation plan are described in Volume 4 Reference Guide article "Financing Strategies and Guidelines for Funding Water Resource Projects."

Table 5-2 Evaluation categories for assessing achievement of water management objectives

Water management objective	Evaluation category	Information source
Increase water supply, reallocate supplies or manage demand (all use sectors)	Urban, agricultural, and environmental reliability	Water portfolio / flow diagram; water management/system analysis; inventory of new projects
Improve drought preparedness	Urban, agricultural, and environmental reliability	Water management/system analysis
Improve operational flexibility	Urban, agricultural, and environmental reliability	Data monitoring/compilation and system analysis
Improve water quality (all use sectors)	Risks to human/ecosystem health and agricultural production	Water management/system analysis
Reduce groundwater overdraft	Salinity intrusion Subsidence Groundwater levels (long term)	Data monitoring/compilation and system analysis
Reduce flood impacts	Flood risk	Economic analysis and system analysis
Environmental benefits	Fisheries (populations and habitat) Native habitat/vegetation Wildlife (populations and habitat)	Data monitoring/compilation, biological opinion, and system analysis
Energy benefits	Energy availability	Data monitoring/compilation and system analysis
Recreational opportunities	Quantity, quality and variety of water-based recreation	Data monitoring/compilation and system analysis
Other considerations	Catastrophic vulnerability	Economic analysis and system analysis
	Third party impacts	Economic analysis and system analysis
	Economic/financial	Economic analysis and system analysis
	Public Trust and environmental justice	Participation in planning; assistance to low-income and disadvantaged communities

Recommendation 1 – Diversify Regional Water Portfolios

California must invest in reliable, high quality, sustainable, and affordable water conservation, efficient water management, and development of water supplies to protect public health, and improve California's economy, environment, and standard of living.

To provide for the future, California must rely on a diverse set of water management strategies to (1) use and manage its existing water supplies efficiently; (2) implement new technologies to further water conservation and recycling, augment supplies, and improve water quality; (3) increase water storage and improve conveyance to gain flexibility and complement the benefits of other water management tools; (4) reduce and eliminate groundwater overdraft; and (5) improve watershed management, restore ecosystems and promote stewardship of resources. To realize the full potential outlined in this water plan update, California needs significant and continuous investments for integrated regional water management, more public and private partnerships, project implementation, and better data and analytical tools.

Action Plan

- Regions invest in water conservation, efficient water management, and development of reliable, high quality, sustainable and affordable water supplies. The State should provide public funding for implementing local strategies that have broad public benefits.
- Local and regional planners diversify and increase the resource management strategies in their integrated regional water management plans.

- DWR will use its technical and financial assistance programs (including Proposition 50 funded programs) to effectively and equitably support planning and implementation of local and regional water use efficiency, water recycling, groundwater storage and management, ecosystem restoration, urban streams, flood management, and related planning efforts.
- DWR will continue to promote implementation of recommendations from California's Groundwater Update 2003 (DWR Bulletin 118-03) to improve groundwater management and work with local agencies to develop guidelines to reduce overdraft.
- DWR will work with local agencies and private utilities to overcome constraints to implement recycling and desalination projects.

Intended Outcomes

- Protect public health, and maintain and improve California's economy, environment and standard of living.
- Disbursement of Proposition 50 funding for implementation of integrated regional water management plans and other efforts to improve statewide water management objectives.
- Guidelines for reduction of groundwater overdraft in 2005.
- Reduce and eliminate groundwater overdrafts.

Resource Assumptions

- Many tasks in this recommendation can be accomplished with existing resources over time and through implementation of Proposition 50. Additional and ongoing funding and local assistance are required for implementing integrated regional water management plans after Proposition 50 has been fully implemented.
- Full and timely implementation of CALFED Bay-Delta Program elements and related local assistance programs will require new funding and resources or significant redirection of existing resources.

Implementation Challenges

- Developing institutional relationships with other agencies necessary for integrating information between different planning efforts.
- Uncertainty in continuity of federal, State, and local funding.
- Difficulty in achieving consensus among different stake holders about implementation actions and priorities.

Performance Measures

- Annual funding dedicated for CALFED Bay-Delta Program, local technical and financial assistance, data and analytical tools development, feasibility and implementation of resource management strategies, groundwater mananagement plans, urban water management plans, and regional water plans.
- Measured improvements in statewide water management objectives using criteria in Table 5-2 (Evaluation categories for achieving water management objectives).
- Progress in achieving implementation of intended outcomes.

Recommendation 2 – Promote and Practice Integrated Regional Water Management

State government must provide incentives and assist regional and local agencies and governments and private utilities to prepare integrated resource and drought contingency plans on a watershed basis; to diversify their regional resource management strategies; and to empower them to implement their plans.

State government recognizes the critical role regional efforts must play in California water planning and management, the need for integrated resources planning across jurisdictional boundaries as regionally-based efforts, and the need for more closely coordinated water planning with land use planning and urban development. State government should assist cities, counties, local water agencies and private utilities to prepare urban and agricultural water management plans, watershed and groundwater management plans, a Water Element for local General Plans, and to implement existing legislation and State policies to improve coordination between water and land use planning.

Action Plan

- Regional efforts should incorporate integrated resource planning to meet multiple water management objectives consistent with the principles advanced in this water plan.
- The degree and nature of the need for more groundwater and surface water storage varies from region to region; therefore, DWR will work with regional entities to evaluate the best ways to meet their groundwater and surface storage needs and the possible means of sharing storage capacity among regions.
- Local governments and agencies should improve coordination between land use planning and water planning and management to ensure that new infrastructure has adequate water supply and that land uses are protective of water quality.
- State government should give preference to applicants of Proposition 50, Chapter 8[1] grants who have plans that apply DWR and State Water Resource Control Board (SWRCB) grant program guidelines[2].
- DWR will adapt its expertise, resources, and existing pro grams and develop new ones to give incentives and technical assistance to regional and local agencies and governments to prepare comprehensive, integrated water management plans that include actions to protect public trust resources and promote efficient, beneficial water use.
- DWR will develop guidelines for technical and financial assistance and templates for integrated regional water management plans, urban and agricultural water management plans, and drought contingency plans.
- DWR will continue to provide technical, administrative, and financial assistance to implement actions under the California Urban Water Conservation Council, "Memo randum of Understanding Regarding Urban Water Conservation in California" and the Agricultural Water Management Council, "Memorandum of Understanding" to improve water use efficiency in California.
- The Resources Agency should continue to support development and use of statewide natural resource databases, analytical tools, and evaluation criteria to identify priorities for ecosystem restoration and provide information to planners and decision-makers.
- DWR will develop the necessary tools to assist local and regional agencies be successful with the integrated regional water management and planning and will monitor the development and implementation of these plans to ensure an equitable distribution of technical and financial assistance in planning efforts. Data from these plans can be integrated into future California water plan updates

Intended Outcomes

- Disbursement of Proposition 50 funding for development of regional water plans and related activities including data collection and public outreach.
- Guidelines for effective integrated regional water management in 2005.
- Guidelines and template for urban and agricultural water management plans in early 2005.
- Status report on groundwater basins management in 2006.
- Recommendations for groundwater management plans and model ordinance in 2006.
- Implement a Critical Water Shortage Reduction Purchase Program along with the required updates for Urban Water Management Plans in 2005.
- Coordinated development of a comprehensive ecosystem restoration plan for the entire state by region.

[1] Proposition 50: Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, Chapter 8 "Integrated Regional Water Management."
[2] DWR and SWRCB. 2004. Integrated Regional Water Management Grant Program Guidelines: Proposition 50, Chapter 8.
www.grantsloans.water.ca.gov/grants/integregio.cfm

- Communication plan to inform local and regional agencies of DWR's programs, available databases, and data collection and analysis by 2006.

Resource Assumptions

- DWR will implement the recommendation to the extent possible with existing resources, including disbursement of financial assistance funded by Proposition 50. Expansion or continuation of the program beyond that funded by Proposition 50 would require additional funding or a redirection of resources from other programs.
- It is anticipated that the full implementation of the recommendation would require many positions and annual funding within DWR. Funding and positions also would be required for other State agencies with watershed or water resource related local assistance programs.

Implementation Challenges

- DWR staff developing necessary relationships with local entities and identifying roles needed to initiate and develop integrated regional water management plans that are consistent with statewide water management objectives.
- Uncertainty in continuity of State and local funding to maintain participation.
- Maintaining interest over 3 to 5 years needed to build consensus and develop initial integrated regional water management plans for all regions of California.
- Ensuring that all areas of the state are equally served by regional planning efforts and funding.

Performance Measures

- Annual funding dedicated for the CALFED Bay-Delta Program, local technical and financial assistance, small and disadvantaged communities, data and analytical tools development, feasibility and implementation of resource management strategies, groundwater management plans, urban water management plans, and regional water plans.
- Number, distribution, and quality, including identification of disproportionate community impacts, of groundwater management plans, urban water management plans, drought contingency plans, and integrated regional water management plans.
- Progress in meeting actions under the California Urban Water Conservation Council, "Memorandum of Understanding Regarding Urban Water Conservation in California" and the Agricultural Water Management Council, "Memorandum of Understanding" to improve water use efficiency in California.
- Measured improvements in statewide water management objectives using criteria in Table 5-2 (Evaluation categories for achieving water management objectives).
- Implementation of projects identified in the plans.

Recommendation 3 – Remediate Surface Water and Groundwater Contaminants

State government must lead an effort with local agencies and governments to remediate the causes and effects of contaminants on surface water and groundwater quality.

The evaluation should inventory, evaluate, and examine the effect of contaminants on public health, long-term sustainability of water resources and treatment costs, and should identify cost-effective ways and propose management strategies to improve water quality. To safeguard water quality for all beneficial uses, State government should also adopt preventive programs that integrate source water protection, pollution prevention, matching water quality to use, and water treatment and distribution.

Action Plan

- DWR will help resolve long-standing water quality issues in the state, such as Delta salinity, dissolved oxygen in San Joaquin River (SJR) near Stockton, salinity at Vernalis, and ecosystem restoration flow needs, extending from the Klamath River in the north to Salton Sea in the south.
- DWR will work with the Department of Health Services, State Water Resources Control Board, Regional Water Quality Control Boards, and other State, federal, and local agencies to develop a coordinated process to monitor, evaluate, prevent, mitigate, and treat the effects of contaminants on surface water and groundwater quality. DWR could participate by sharing data, coordinating data collection efforts, identifying problem watersheds and aquifers, and conducting analysis of surface water and groundwater flow and transport of contaminants.

- SWP will complete feasibility studies and recommendations for re-operation of the Delta Cross Channel and the Through-Delta Facility in 2005 and feasibility studies for Franks Tract Improvements in 2006.

Intended Outcomes

- Joint agency inventory and response plan for dealing with causes and effects of contaminants.

Resource Assumptions

- Completing the work plan to implement the recommendation and a portion of the actual work could be accomplished with existing resources.
- Full implementation of the recommendation could require significant resources depending on DWR's role.

Implementation Challenges

- Difficulty in defining the scope of work and working with the myriad of entities responsible for water quality problems.
- Coordinating a program for identification and monitoring of contaminated sources

Performance Measures

- Level of implementation of water quality management strategies proposed in the joint agency plan.
- Meeting statewide, regional, and local water quality objectives.
- Number of water bodies removed from the list of impaired water bodies.

Recommendation 4 – Improve Aging Water Infrastructure

California must maintain, rehabilitate and improve its aging water infrastructure, especially drinking water and sewage treatment facilities, operated by State, federal, and local entities.

State government should lead an effort, with input from public and private owners of water infrastructure, to identify and prioritize water infrastructure maintenance of key components with regional or statewide significance. Improvements may include refinements in the way water systems are operated, additional conveyance capacity, and new water storage. This effort should also identify and implement financing strategies for continued public investments in the resulting infrastructure maintenance plan.

Action Plan

- DWR will develop and carry out a comprehensive flood management plan. DWR has prepared a White Paper that addresses the need for an aggressive investment in the State's flood management system (DWR 2005).
- State leads an effort with federal, State, regional, and local entities to inventory the current extent of unmet infrastructure and maintenance work, estimate the potential costs, and develop a strategy for funding the needed work, such as loans and grant programs.
- Develop a plan to replace and/or rehabilitate those portions of the SWP that are reaching the end of their design life in 2006.
- State works with regional water planning efforts to identify physical and operational constraints in statewide water management systems, and to find ways to improve operational efficiencies and supply reliability.
- To continue operating and maintaining the SWP, DWR will:
  - Establish and maintain a risk-based management process that integrates SWP operations, energy, and maintenance. This program addresses the 16 strategic initiatives identi-fied in the Future Operations Migration Strategy to be completed by 2009.
  - Improve fiscal information reporting for the State Water Project in 2005.
  - Obtain a new FERC License for Oroville Facilities by January 31, 2007.

Intended Outcomes

- Prioritized list of unmet infrastructure and maintenance work, potential costs, and strategy for funding the work in cooperation with federal, State, regional, and local entities.
- Evaluation of SWP pumping and power plant units for potential refurbishment work in 2006.
- Plan for evaluation and repair of the Santa Ana Pipeline and other pipelines, as necessary, in 2006.
- For SWP operations:
  - Power portfolio and risk policy and procedures in 2005.
  - Suite of timely, useful, and accurate operational reports for effective SWP management in 2006.
  - Suite of timely, useful and accurate financial reports specific to SWP needs in 2006.
  - Filed application with FERC to renew the Oroville Facilities FERC license (Project 2100) on or before Jan. 31, 2005 & completed documentation for issuance of the new license by Jan. 2007.

Resource Assumptions

- An inventory of the SWP's unmet infrastructure and maintenance work, potential costs, and strategy for funding the work could be accomplished with existing resources.
- Additional resources would be needed or redirected from other programs for DWR to serve as the major coordinator of this recommendation.

Implementation Challenges

- Resistance to implementing new water user fees or general taxes to fund the work.
- Making infrastructure rehabilitation projects cost-effective.
- Improvements to infrastructure should consider and implement measures that reduce impacts.

Performance Measures

- Level and continuity of funding and funding sources for infrastructure improvement projects.
- Number of completed improvements identified in inventory of the current unmet infrastructure and maintenance work, potential costs, and strategy for funding the work in cooperation with federal, State, regional, and local entities that are completed.
- Measured improvements in statewide water management objectives using criteria in Table 5-2 (Evaluation criteria for achieving water management objectives).

Recommendation 5 – Implement the CALFED Program

State government must continue to provide leadership for the CALFED Bay-Delta Program to ensure continued and balanced progress on greater water supply reliability, water quality, ecosystem restoration, and levee system integrity.

The CALFED Bay-Delta Program[3] needs greater federal commitment, agency involvement, spending authorization, and funding to ensure continued and balanced implementation. State government should cooperate with the federal government to review and revise the implementation plan for the CALFED Bay-Delta Program to reflect the current fiscal climate, and accordingly adjust the focus, scope, expectations, work plan, and budget for all elements of the Bay-Delta Program to achieve balanced and effective implementation.

Action Plan

- CBDA works with CALFED agencies to develop a comprehensive list of tasks being conducted under the CALFED Bay-Delta Program, to prioritize the tasks in cooperation with the CBDA public advisory committee, to develop a schedule for completing the tasks, and to estimate funding necessary to continue work.
- DWR, in cooperation with the California Bay-Delta Authority (CBDA) and CALFED implementing agencies, will implement actions in the CALFED Record of Decision, namely the Delta Improvements Package and other CALFED programs, including the Ecosystem Restoration, Water Quality, Levees, and Water Use Efficiency programs, its Science Program and the Interagency Ecological Program.
- DWR and the U.S. Army Corps of Engineers, in conjunction with the California Department of Fish and Game, will prepare the Delta Risk Management Strategy to evaluate the probability of Delta levee failures in the next 50 years, estimate the impacts and economic consequences from levee failures, propose actions to reduce the probability of levee failures and their consequences, and develop a strategic action plan with alternative strategies to reduce risk for the Delta.
- DWR, in cooperation with the regional partners, will complete feasibility studies of additional surface storage in the CALFED Record of Decision. California should pursue projects that have regional support and viable financing plans.
- DWR, in cooperation with the CBDA and other State and federal agencies, will continue to evaluate and, if feasible, implement a long-term Environmental Water Account.
- DWR, in cooperation with the CBDA and other state and federal agencies, should implement the Delta Smelt Action Plan recommendations.
- DWR works with the CBDA, CALFED agencies, the Governor, and the Legislature to develop acceptable mechanisms for funding the work.
- DWR promotes communication, cooperation, and collaboration among State and federal agencies involved in the CALFED Bay-Delta Program.

Intended Outcomes

- Inventory of tasks being conducted under the CALFED Bay-Delta Program and a schedule and budget for completing the tasks.
- Developing the Delta Risk Management Strategy.
- Improve environmental and water quality conditions in the Delta.
- A long-term Environmental Water Account.
- Pursuing implementation of CALFED storage projects that have regional support and viable finance plan.
- Long-term finance plan with funding solutions for implementation of the different program elements of the CALFED Bay-Delta Program.

Resource Assumptions

- Existing resources can complete the inventory of tasks being conducted under the CALFED Bay-Delta Program and a work plan for completing the tasks.
- Additional resources or a redirection of existing resources will be required to complete the feasibility studies associated with the CALFED Bay-Delta Program. Significant additional resources will be required to fully implement the CALFED Bay-Delta Program Record of Decision.
- Additional resources will be required for the development of the Delta Risk Management Strategy.

Implementation Challenges

- Resistance to implementing new water user fees or general taxes to fund the work.
- Difficulty in defining beneficiaries that could help fund the work.

[3] For information about CALFED program, visit the CALFED Web site: www.calwater.ca.gov

Performance Measures

- Level, sources, and continuity of annual funding dedicated for CALFED Bay-Delta Program.
- Progress in completing the actions in the CALFED Bay-Delta Program Record of Decision.
- Measured improvements in statewide water management objectives using criteria in Table 5-2 (Evaluation criteria for achieving water management objectives).

Recommendation 6 – Provide Effective State Government Leadership, Assistance, and Oversight

State government must lead water planning and management activities that: (a) regions cannot accomplish on their own, (b) the State can do more efficiently, (c) involve interregional, interstate, or international issues, or (d) have broad public benefits.

These activities include, but are not limited to: (1) preparing California Water Plan updates as a public forum to integrate State, federal, regional, and local plans to meet the state's future agricultural, urban, and environmental water demands and water management objectives; (2) operating and maintaining the State Water Project; (3) providing regulatory oversight to protect public health and safety and public trust values, including water quality, environmental protection, flood management, and dam safety; (4) participating in major regional initiatives, such as the CALFED Bay-Delta Program, and (5) forming public-private partnerships to implement regional programs like the Colorado River Quantification Settlement Agreement. Other State activities are included in the recommendations that follow.

Action Plan

- ⌛ State government should continue to provide a leadership role in the protection of public health and safety, especially with regard to drinking water quality, dam safety, and flood management.
- ⌛ State government should provide technical assistance for efforts involving interregional, interstate, and international issues or for efforts creating broad public benefits and for at-risk low-income communities with drinking water and other infrastructure challenges.
- ⌛ DWR will develop and administer a Dry Year Water Transfer Program when needed to meet critical water needs during shortages while protecting regions with available supplies.
- ⌛ DWR and State agencies should advance water planning and management that restore and protect watersheds and assess instream flow demands needed to protect and restore aquatic ecosystems.
- ⌛ DWR will complete the next phases of this water plan update, use the water plan update process as a forum to identify and resolve conflicts between regional plans, and integrate the water plan into a future State strategic planning process.
- State government will provide timely regulatory approvals and prevent conflicting rules or guidelines.
- DWR will use a collaborative process to work with local, regional, State, and federal agencies and stakeholders to conduct regular updates of key reports on California's water resources including the California Water Plan (Bulletin 160), California's Groundwater (Bulletin 118), California Water Atlas, and California's Water Resources (Bulletin No. 1).
- DWR will continue to expand its public education programs to raise public awareness of California's water system, supplies and uses and various water management strategies.

Intended Outcomes

- Improve statewide and local water supply reliability and water quality.
- Establish a Dry Year Water Transfer Program.
- Successful resolution of interregional, interstate and international water negotiations.
- Updates of *California Water Plan* (Bulletin 160), *California's Groundwater* (Bulletin 118), *California Water Atlas, and California's Water Resources* (Bulletin No. 1).
- Develop a statewide database of instream flow demands that can be used by regional and State planning efforts to identify and prioritize ecosystem restoration projects for integrated water management plans.

Resource Assumptions

- Many tasks in this recommendation can be accomplished with existing resources.
- Future updates of the *California Water Plan* (Bulletin 160) will require annual funding to include professional facilitation, outreach to the public, and better coordination with local, State and federal water and resource agencies. Additional resources needed for analytical tools and data are included under Recommendation 11.
- Future updates of *California's Groundwater* (Bulletin 118), *California Water Atlas* (OPR and DWR 1979), and *California's Water Resources* (Bulletin No. 1) cannot be accomplished with existing resources unless resources are redirected from other programs.

Implementation Challenges

- Developing the institutional relationships with other agencies necessary for integrating information between different planning efforts.
- Uncertainty in continuity of State and local funding to maintain participation.

Performance Measures

- Measured improvements in statewide water management objectives using criteria in Table 5-2 (Evaluation categories for achieving water management objectives).
- Operational efficiency and effectiveness of the State Water Project.
- Annual funding dedicated for CALFED Bay-Delta Program and updates for California Water Plan (Bulletin 160), California's Groundwater (Bulletin 118), California Water Atlas (OPR and DWR 1979), and California's Water Resources (Bulletin No. 1).
- Frequency and quality of updates of *California Water Plan* (Bulletin 160), California's Groundwater (Bulletin 118), California Water Atlas, and California's Water Resources (Bulletin No. 1).
- Number and implementation of interregional, interstate, and international water agreements.

Recommendation 7 – Clarify State, Federal, and Local Role and Responsibilities

California must define and articulate the respective roles, authorities, and responsibilities of State, federal, and local agencies and governments responsible for water.

In light of the growing role of local agencies and governments in regional water planning and management, State government should redefine how to empower and assist them to implement their regional water plans and programs. State government also needs an internal review of how State resource agencies do business and identify ways to make these agencies more efficient, effective, and responsive to Californians. Establishing an interagency water forum would strengthen coordination among State agencies responsible for water, water quality, and for ocean water desalination and would ensure that State agency strategic plans and activities are consistent with the Governor's and State water policies.

Action Plan

- ⌛ State government should lead an effort to examine where the mandates and jurisdictions of State, federal, and local governments and agencies conflict with or complement each other to streamline and coordinate the roles and jurisdictions governing California water management.
- ⌛ State agencies must integrate their expertise and resources to support integrated regional water management.
- DWR will work with the Governor and Legislature to improve DWR's mission, functions and organization in relation to other State and local agencies and governments with water management responsibilities.

Intended Outcomes

- State develops a proposal to redefine the respective roles, authorities, and responsibilities of State agencies and local agencies and governments responsible for water.
- DWR responds more effectively and efficiently to today's water problems and supports integrated regional water resource planning and management.
- Development and implementation of a framework through which local, State, and federal water agencies and governments can coordinate their activities and work plans.

Resource Assumptions

- Additional resources or a redirection of existing resources will be required to conduct a thorough review of DWR's mission and organization and to participate in a larger review of all State water management agencies

Implementation Challenges

- Getting the needed direction and resources from the Governor and Legislature to undertake a comprehensive review of existing programs and evaluate alternatives.
- Difficulty in maintaining staff morale during any significant reorganization.

Performance Measures

- Progress in implementing changes to DWR's mission and organization to respond to today's water problems.
- Level of consistency among the strategic and capital improvement plans of State water agencies.
- Level of participation of local, State, and federal water agencies and governments in the effort to redefine the respective roles, authorities, and responsibilities of State agencies and local agencies and governments responsible for water.

Recommendation 8 – Develop Funding Strategies and Clarify Role of Public Investments

California must develop broad, realistic, and stable funding strategies that define the role of public investments for water and other water-related resource needs over the next quarter century.

State government needs to lead an effort to identify and prioritize funding strategies to finance regional and statewide water planning, programs, and infrastructure. State government needs to clearly articulate when, and for what actions, to use public investments from State and federal sources. California's water finance plan must also recognize the critical role of local public and private funding based on the principle of beneficiary pays and the need for user fees.

Action Plan

- ⌛ State government should use a benefit-based approach to develop long-term, reliable funding sources for water projects in a way that accurately characterizes benefits, uses public funds responsibly, and follows the principles of equity and environmental justice.
- ⌛ State leads an effort to develop broad and realistic funding strategies that define the role of public investments for water and other water-related resource needs over the next quarter century.
- ⌛ State agencies work with the Governor and the Legislature to develop policy and a work plan for implementing the finance plan of the CBDA, recommendations of the Commission on Building for the 21st Century and other efforts for financing water management and related activities, and develop policy regarding investment of public funds in private water utilities.
- State government help implement regional programs by developing funding processes that are clear, consistent, and streamline.
- State agencies ensure consistency and coordination with the Capital Budget Planning Process, a five-year strategic planning process for capital budget planning across State agencies pursuant to AB 1473 and the three planning priorities in AB 857 (Stats. 2002; ch. 1016).

Intended Outcomes

- Greater linkage of State investments in water infrastructure and projects with the mandated capital budget planning process to ensure greater consistency in State policies used as the basis for investment decisions across State agencies.
- Implement the finance plan of the CBDA and the recommendations of the Commission on Building for the 21st Century.
- State's water finance plan with funding strategies and criteria.

Resource Assumptions

- Developing the work plan can be accomplished with existing resources.
- Implementing the work plan will likely require additional resources or the redirection of existing resources.

Implementation Challenges

- Resistance to funding methods like new water user fees or general taxes to fund the work.
- Difficulty in defining and allocating benefits and costs among diverse sets of water users.

Performance Measures

- Level of implementation of the finance plan of the CBDA.
- Level of implementation of the recommendations of the Commission on Building for the 21st Century.
- Level and continuity of funding and variety of local, State, and federal funding sources for water management activities.

Recommendation 9 – Invest in New Water Technology

State government must invest in research and development to help local agencies and governments implement promising water technologies more cost effectively.

State government should work with California research and academic institutions, like the California Academy of Science, California Council on Science and Technology, the University of California, and other universities and colleges, to identify and prioritize applied research projects leading to the commercialization of new water technologies and better scientific understanding of California's water-related systems.

Action Plan

- DWR will work with California research and academic institutions to identify and prioritize applied research projects. State government should also encourage pilot projects and focused research incorporating knowledge and experience specific to each region.
- DWR will work with other State agencies and in coordination with the Interagency Ecological Program and CALFED Science Program to invest in a broad and diverse scientific agenda that will fill the gaps of knowledge about California's water resources.
- DWR will work with State agencies to help in the collection of data and analysis of instream flows.

Intended Outcomes

- Initiate and support research and development studies on promising water technologies.
- Enhanced Science Program modeled upon and, integrated with, the existing Science Program of the CBDA.

Resource Assumptions

- For ongoing research and development, the State would need to invest annually to commercialize promising water technologies.
- Consistent with CALFED Bay-Delta Program goals for science funding, investments in water science should be established within a range of 3 percent to 5 percent of total public funds (cost share) expended to help implement local and regional resource management strategies.

Implementation Challenges

- Uncertainty in continuity of State and local funding to maintain participation.
- Participation and cooperation of local, State, and federal agencies on science and research efforts.

Performance Measures

- Number of initiated research and development projects.
- Application of results of research and development studies in integrated regional water management plans.

Recommendation 10 – Adapt for Global Climate Change Impacts

State government must help predict and prepare for the effects of global climate change on our water resources and water management systems.

State government should work with and assist researchers to monitor, predict and prepare for the effects of global climate change on California's water systems and the environment. DWR should develop alternative flow data to help State, federal, and regional planners test the potential effects of global climate change on different resource management strategies; and to help water facility operators test alternative reoperation strategies, including the State Water Project.

Action Plan

- DWR will work with other State agencies to develop biannual reports on the impacts of global climate change, including impacts to water supply and will prepare and report on mitigation and adaptation plans in accordance with Executive Order S-3-05 signed by the Governor of California June 1, 2005.
- DWR will work with other State agencies to develop and help implement strategies to reduce greenhouse gas emissions in the State in accordance with the goals established by Executive Order S-03-05. DWR will provide expertise to help identify means of energy savings for the storage, conveyance, distribution, and use of water. DWR will describe the energy use characteristics of various resource management strategies in the next California Water Plan.
- DWR will evaluate management responses to potential impacts of global climate change on the State Water Project and California's hydrology.
- DWR will work with climate change experts to develop alternative flow data to help State and regional planners test potential effects of global climate change on different management strategies.
- DWR will seek funding to establish a position to participate with ongoing global climate change studies and manage staff work related to global climate change research. Alternatively, existing resources may be redirected from other programs to establish the position.

Intended Outcomes

- Developing plans to mitigate and adapt to the impacts of global climate change, especially on California water supply and agriculture.
- Developing plans to help reduce the emission of green house gases related to the storage, conveyance, distribution and use of water.
- Establishing a position to coordinate DWR's participation in global climate change studies.
- Beginning implementation of the plan responding to the impact of global climate change on the management of the State Water Project.
- Alternative flow data characterizing potential climate change impacts.

Resource Assumptions

- Establishing positions to coordinate DWR's participation in global climate change studies would require additional resources or redirection of existing staff and annual funding to improve data and analytical tools to more accurately predict impacts of global climate change.
- Evaluating impacts of global climate change on the management of the State Water Project can be done with existing resources.

Implementation Challenges

- Uncertainty in continuity of State and local funding to maintain participation.
- Participation and cooperation of local, State, and federal agencies on science and research efforts.

Performance Measures

- Funding provided to California's universities and local, regional, and State agencies for ongoing global climate change studies and manage staff work related to global climate change research.
- Progress in implementing of the plan responding to the impact of global climate change on the management of the State Water Project.
- Number of planning studies that evaluate the potential impacts of climate change on the alternative management strategies and infrastructure they consider and select.

Recommendation 11 – Improve Water Data Management and Scientific Understanding

DWR and other State agencies must improve data, analytical tools, and information management and exhange needed to prepare, evaluate, and implement regional integrated resource plans and programs in cooperation with other federal, tribal, local, and research entities.

California needs better data and analytical tools to produce useful and more integrated information on water quality, environmental objectives, economic and equity issues, and surface water and groundwater interaction. A consortium of public and private entities, with State leadership and stakeholder input, should prepare a long-term plan to improve and peer review data and analytical tools, as well as to develop presentation and decision-support tools to make complex technical information more accessible to decision-makers and resource managers. DWR should build and maintain the Water Plan Information Exchange (Water PIE), an online information management system to assist regional and local agencies and governments, which would include information from locally-developed urban and agricultural water management plans and local general plans.

Action Plan

- DWR with regional input will develop a general checklist of issues, resources, data, and analytical tools as well as guidelines to aid regional integrated resource planning.
- DWR will select and/or develop the analytical tools and data in support of the next water plan update.
- DWR will develop the Water Plan Information Exchange (Water PIE) for collecting and sharing data, and networking existing databases and Web sites, among State, federal, regional, and local agencies and governments and citizen monitoring efforts, to improve analytical capabilities and developing timely surveys of statewide land use, water use, and estimates of future implementation of resource management strategies.
- DWR will participate in efforts by the California Water and Environmental Model Forum to develop and carry out a plan for long-term improvement of analytical tools and data for statewide planning.

Intended Outcomes

- Strategic plan for the long-term improvement of analytical tools and data for statewide planning.
- Inventory of existing data and tools, resulting in identification of key data and tool gaps.
- A conceptual analytical framework and analytical work plan for the next water plan update that is accepted by water stakeholders.
- Begin implementation of elements of the Water Plan Information Exchange.

Resource Assumptions

- Developing the long-term plan for analytical tools and data and the work plan for the Water Plan Information Exchange could be accomplished with existing resources.
- Limited implementation could be accomplished with existing resources, but full implementation would require additional resources or redirection of existing staff.

Implementation Challenges

- Developing the institutional relationships with other local, State, and federal agencies necessary for integrating information between different planning efforts.
- Adoption of data and data management guidelines, principles and standards by local, State, and federal agencies and programs needed to promote data and information sharing.
- Inadequate resources to develop Water Plan Information Exchange database.

Performance Measures

- Progress in completing and implementing plan for the long-term improvement of analytical tools and data for statewide planning.
- Progress in completing and implementing the work plan for the creation of the Water Plan Information Exchange.
- Progress in evaluating the performance of alternative mixes of management strategies using multiple future scenarios and the evaluation categories in Table 5-2 (Evaluation categories for achieving water management objectives).

Recommendation 12 – Protect Public Trust Resources

DWR and other State agencies must explicitly consider public trust values in the planning and allocation of water resources and protect public trust uses whenever feasible.

State government should exercise continuous supervision over its navigable waters, the lands beneath them, and the flows of their tributary streams and protect the public's rights to commerce, navigation, fisheries, recreation, ecological preservation, and related beneficial uses.

Action Plan

- DWR will protect the public trust when carrying out its role in water planning, including the preparation of this water plan.
- DWR will protect the public trust in connection with the planning, design, construction, and operation of SWP facilities and other projects in which DWR is a participant.
- Where DWR is the owner of a dam, it will make releases in compliance with Fish and Game Code section 5937. The State will assist all dam owners in meeting this code.
- DWR will take the public trust into account when acting as a party to a transfer, or when approving use of SWP facilities by others. Where approval of the State Water Resources Control Board is not required, as in the case of transfers of pre-1914 rights, DWR will consider all available information and protect public trust uses whenever feasible and reasonable.
- DWR will develop consistent, department-wide guidelines and methodology for how it will evaluate its public trust responsibilities.
- DWR will participate in efforts to coordinate implementation of public trust responsibilities with other State agencies.
- DWR will assist the State Water Resources Control Board by conducting and presenting studies and investigations regarding the needs of trust resources.
- DWR will protect the public trust when it represents the State on interstate river compacts such as the Klamath River Compact.
- DWR will protect the public trust in connection with water master duties on adjudicated streams.

Intended Outcomes

- DWR guidelines and methodology for how DWR will evaluate its public trust responsibilities.
- Institutional mechanism for coordinating public trust responsibilities with other agencies.
- Complete and balanced evaluation and environmental review and documentation for planning, projects and operations.

Resource Assumptions

- A portion of the necessary work could be accomplished with existing resources.
- Full implementation would require additional resources and/or redirection of existing resources.

Implementation Challenges

- Difficulty in quantifying public trust responsibilities.
- Developing the institutional relationships with other agencies necessary for coordinating implementation of public trust responsibilities.

Performance Measures

- Progress in completing department-wide guidelines and methodology for how DWR will evaluate its public trust responsibilities.
- Progress in implementing an institutional mechanism for coordinating public trust responsibilities with other agencies.
- Explicit evaluation of public trust resources and values in DWR and other State environmental review documents and reports.

Recommendation 13 – Increase Tribal Participation and Access to Funding

DWR and other State agencies must invite, encourage, and assist tribal government representatives to participate in statewide, regional, and local water planning processes and to access State funding for water projects.

State agencies should include tribal water concerns and water uses in future water plan updates and should engage appropriate local, State, and federal agencies to resolve tribal water issues that are identified.

Action Plan

- State government engages tribes at all stages of State's water planning processes and provides assistance for meeting participation.
- DWR will conduct outreach to tribal associations and California tribes seeking their participation in the California water plan updates, particularly for identifying and evaluating tribal water concerns and water uses. Some of the potential areas of interest identified through tribal outreach conducted in 2003 follow.
- Tribal, State, and federal governments work cooperatively to ensure safe and piped potable water for all Californians, including its tribes.
- Tribal, State, and federal governments jointly assess sur face water and groundwater quantity and quality needed to support tribal fishing rights and cultural practices.
- California Water Plan Update 2005 addresses tribal water rights in California and considers needed changes.
- Tribal, State, and federal governments cooperatively engage in sourcing funds for projects to improve tribal water supplies and quality and ecosystem restoration.
- Reinstate question for "Source of Water" and "Sewage Disposal" in the U.S. Census questionnaire.

Intended Outcomes

- Incorporate tribal water concerns and water uses in the next update of the California Water Plan.
- Identify responsibilities of State agencies to address tribal water rights and other tribal water issues.
- Safer and piped potable water for tribes.
- Assessment of surface water and groundwater quantity and quality needed to support tribal fishing rights and cultural practices.
- Fund sources for projects to improve tribal water supplies and quality and ecosystem restoration.
- Reinstated question for "Source of Water" and "Sewage Disposal" in the U.S. Census questionnaire.

Resource Assumptions

- Limited outreach could be accomplished with existing resources. Greatly expanded outreach would require additional resources or redirection of existing resources.

Implementation Challenges

- Developing the institutional relationships with California tribes and appropriate federal, State, and local agencies and programs necessary for integrating information into the California Water Plan Update.

Performance Measures

- Number and geographic representation of California tribes participating in statewide, regional, and local water planning processes.
- Level of support among California tribes of the findings and recommendations of the California Water Plan update.
- Successful implementation of tribal-related water policies, programs, and projects.

Recommendation 14 – Ensure Environmental Justice across All Communities

DWR and other State agencies must encourage and assist representatives from disadvantaged communities and vulnerable populations, and the local agencies and private utilities serving them, to participate in statewide, regional, and local water planning processes and to get equal access to State funding for water projects.

Recent State policy establishes social equity and environmental justice as a State planning priority to ensure the fair treatment of people of all races, cultures, and income, in particular those having experienced significant disproportionate adverse health and environmental impacts.

Action Plan

- DWR will incorporate environmental justice issues of precautionary applications, cumulative health impact reductions, public participation, community capacity building and communication, and meaningful participation into current and future California Water Plan Update processes and other DWR programs.
- DWR will conduct outreach to disadvantaged communities and vulnerable populations and their advocates seeking their participation in the California Water Plan Update, particularly for evaluating how they might be affected by different water management strategies.
- DWR will monitor or participate in activities of other federal, State, regional, and local governmental programs and processes which may have environmental justice interests relevant to the California Water Plan update.
- DWR, in coordination with the appropriate State and federal agencies, will review its current monitoring and regulatory programs to identify and address gaps in available data and monitoring programs that impact disadvantaged communities and vulnerable populations.

Intended Outcomes

- Reporting the results of outreach to disadvantaged communities and vulnerable populations in the next California Water Plan Update, particularly the evaluation of how they might be affected by different water management strategies.
- Increased awareness of EJ issues by DWR Program Managers and other local and regional planning efforts.
- Identification of Environmental Justice communities and their specific needs.

Resource Assumptions

- Limited outreach could be accomplished with existing resources. Greatly expanded outreach would require additional resources or redirection of existing resources.

Implementation Challenges

- Developing the institutional relationships with local, State, and federal agencies serving, and advocates for disadvantaged communities and vulnerable populations to conduct outreach and integrate information into the California Water Plan update.

Performance Measures

- Number and geographic representation of representatives from disadvantaged communities and vulnerable populations participating in statewide, regional, and local water planning processes.
- Level of support among representatives from disadvantaged communities and vulnerable populations of the findings and recommendations of the California Water Plan update.

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Glossary

A

acre-foot (af) – The volume of water that would cover one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons.

adjudication –The act of judging or deciding by law. In the context of an adjudicated groundwater basin, landowners or other parties have turned to the courts to settle disputes over how much groundwater can be extracted by each party to the decision.

agricultural discharge standards – State and federal water quality regulations regarding discharge of water used for agricultural production to streams, rivers, groundwater aquifers, or evaporation ponds. Context: Scenario Factor.

agricultural lands stewardship – Conserving natural resources and protecting the environment by compensating owners of private farms and ranches for implementing stewardship practices. Context: Resource Management Strategy.

agriculture water reliability (average) – A measure of a water system's ability to sustain the social, environmental, and economic agricultural systems that it serves during a year of average precipitation

agricultural water use efficiency – The ratio of applied water to the amount of water required to sustain agricultural productivity. Efficiency is increased through the application of less water to achieve the same beneficial productivity or by achieving more productivity while applying the same amount of water. Context: Scenario Factor, Resource Management Strategy.

allocation of long-term contractual imports – Interregional allocation of water for periods of time more than one year through mechanisms such as the State and federal water projects. Context: Scenario Factor.

alluvial – Of or pertaining to or composed of alluvium.

alluvium – A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water, as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, as a cone or fan at the base of a mountain slope.

anthropogenic – Of human origin or resulting from human activity.

applied water – The amount of water from any source needed to meet the demand for beneficial use by the user. It includes consumptive use, reuse, and outflows.

applied water reduction – A decrease in the amount of water needed to meet the demand for beneficial use; can be a supply for both new (real) water and reused water. Context: Resource Management Strategy. See also new water.

appropriative right – The right to use water that is diverted or extracted by a nonriparian or nonoverlying party for nonriparian or nonoverlying beneficial uses. In California, surface water appropriative rights are subject to a statutory permitting process while groundwater appropriation is not.

aquifer – A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant (i.e. economic) quantities of groundwater to wells and springs.

aquifer remediation – See groundwater remediation/aquifer remediation

aquitard – A confining bed or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores groundwater.

artesian aquifer – A body of rock or sediment containing groundwater that is under greater than hydrostatic pressure; that is, a confined aquifer. When an artesian aquifer is penetrated by a well, the water level will rise above the top of the aquifer.

artesian pressure – Hydrostatic pressure of artesian water, often expressed in terms of pounds per square inch; or the height, in feet above the land surface, of a column of water that would be supported by the pressure.

artificial recharge – The (intentional) addition of water to a groundwater reservoir by human activity, such as putting surface water into dug or constructed spreading basins or injecting water through wells.

available groundwater storage capacity – The volume of a groundwater basin that is unsaturated and capable of storing groundwater.

available soil water – The amount of water held in the soil that can be extracted by a crop; often expressed in inches per foot of soil depth. It is the amount of water released between in situ field capacity and the permanent wilting point.

average annual cost of implementing option – Annualized total monetary cost of option required for "turn key" implementation including environmental and third party impact mitigation, storage, conveyance, energy, capitalized operations and maintenance, administrative, planning, legal and engineering costs. Context: Evaluation Criteria; Planning Concept/Consideration.

average annual runoff – The average value of total annual runoff volume calculated for a selected period of record, at a specified location, such as a dam or stream gage.

average year water demand – Demand for water under average hydrologic conditions for a specific level of development.

B

basin irrigation – Irrigation by flooding areas of level land surrounded by dikes. Used interchangeably with level border irrigation, but usually refers to smaller areas.

basin management objectives (BMOs) – See management objectives

beneficial use – Use of water either directly by people or for their overall benefit. There are 24 categories of beneficial uses identified by the State Water Resources Control Board.

border irrigation – Irrigation by flooding strips of land, rectangular in shape and cross leveled, bordered by dikes. Water is applied at a rate sufficient to move it down the strip in a uniform sheet. Border strips having no downfield slope are referred to as level border systems. Border systems constructed on terraced lands are commonly referred to as benched borders.

C

catastrophic vulnerability – The probability and magnitude of potential negative economic, public health, and environmental impacts associated with water management actions. Context: Scenario Factor, Evaluation Criteria..

Central Valley Project deliveries – The volume of water imported to a given area through the Central Valley Project. Context: Scenario Factor.

check irrigation – Modification of a border strip with small earth ridges or restrictions (checks) constructed or inserted at intervals to retain water as it flows down the strip.

CIMIS – California Irrigation Management Information System- A network of automated weather stations that are owned and operated cooperatively between the DWR and local agencies. The stations are installed in most of the agricultural and urban areas in the State and provide farm and large landscape irrigation managers and researchers with "real-time" weather data to estimate crop and landscape ET rates and make irrigation management decisions.

climate change – Changes in average annual temperature and precipitation and their monthly patterns in 2050 compared to today.

Colorado River supply – The volume of water California has the right to import from the Colorado River. California's allocation is 4.4 million acre-feet per year plus 50% of any declared surplus. Context: Scenario Factor.

commercial activity mix – The mix of high- and low-water using commercial activity. Note that commercial activity is broken into two factors: total commercial activity and commercial activity mix. The latter factor allows designation of the type of commercial activity that is occurring. See also total commercial activity. Context: Scenario Factor.

community water system – A public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25 yearlong residents. See also public water system.

consumed fraction – the portion of agricultural applied irrigation water that satisfies evapotranspiration.

conveyance – Provides for the movement of water and includes the use of natural and constructed facilities including open channels, pipelines, diversions, fish screens distribution systems and pump lifts.

conveyance facilities – Canals, pipelines, pump lifts, ditches, etc. used to move water from one area to another. Context: Study Plan Building Block, Resource Management Strategy.

confined aquifer – An aquifer that is bounded above and below by formations of distinctly lower permeability than that of the aquifer itself. An aquifer containing confined groundwater. See also artesian aquifer.

conjunctive management and groundwater storage – Coordinated operation of surface water storage and use, ground water storage and use, and conveyance facilities. Context: Resource Management Strategy.

conjunctive use – Application of surface and groundwater to meet the demand for a beneficial use. Coordinated and planned management of both surface and groundwater resources in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average surface water supply.

conservation tillage – A tillage practice that leaves plant residues on the soil surface for erosion control and moisture conservation

consumptive use – A quantity of applied water that is not available for immediate or economical reuse. It includes water that evaporates, transpires, or is incorporated into products, plant tissue, or animal tissue. Consumptively used water is removed from available supplies without return to a water resource system (uses such as manufacturing, agriculture, landscaping, food preparation, and in the case of Colorado River water, water that is not returned to the river.)

contaminant – Any substance or property preventing the use or reducing the usability of the water for ordinary purposes such as drinking, preparing food, bathing washing, recreation, and cooling. Any solute or cause of change in physical properties that renders water unfit for a given use. (Generally considered synonymous with pollutant.)

cost recovery – Designates who (marginal or existing users) pays the marginal and existing water costs. Also specifies circumstances where other revenue sources are used to recover costs. Costs can include capital, O&M, financing, environmental compliance (documentation, permitting and mitigation), etc. Context: Scenario Factor

cost of reliability enhancement – The total cost required to add an increment of reliability. Context: Evaluation Criteria.

cost of unreliability – The sum of the forgone long-term value and short-term costs incurred to the users. Context: Evaluation Criteria

critical conditions of overdraft – A groundwater basin in which continuation of present practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts. The definition was created after an extensive public input process during the development of the Bulletin 118-80 report.

cover crop – Close growing crop, that provides soil protection, seeding protection, and soil improvement between periods of normal crop production, or between trees in orchards and vines in vineyards. When plowed under and incorporated into the soil, cover crops may be referred to as green manure crops.

crop coefficient – A numerical factor (normally identified as Kp or Kc) that relates the evapotranspiration (ET) of the individual crop (ETc) to reference evaporation or some other index.

crop idling – The temporary or permanent fallowing of land previously under irrigation that results in a reduction in stresses to a water system (e.g., alternate land use must result in a reduction in water use and/or enhancement of water quality, etc.). Context: Scenario Factor.

crop rotation – A system of farming in which a succession of different crops are planted on the same land area, as opposed to growing the same crop time after time (monoculture).

crop unit water use –The volume of irrigation water used per unit area of land, commonly expressed in acre feet per acre. As used in scenario evaluation, a change in unit water use can be a function of evapotranspiration rates and cultural practices, but NOT use efficiency. Agricultural use efficiency is captured under its own distinct factor. Context: Scenario Factor.

D

deep percolation – Percolation of water through the ground and beyond the lower limit of the root zone of plants into groundwater

deep percolation of surface and groundwater – Water that is applied for agricultural, urban, and managed wetlands in excess of the net use requirements. Water either is applied for groundwater recharge or percolates naturally to the water table. This does not include reuse, evaporation, evapotranspiration of applied water, or flows/percolation to a salt sink. Context: Water Portfolio

depletion – Water consumed through evapotranspiration, flows to salt sinks or is otherwise no longer available as a source supply.

desalination – Water treatment process for the removal of salt from water for beneficial use. Source water can be brackish (low salinity) or seawater. Context: Study Plan Building Block.

dewvaporation (Atmospheric Pressure Desalination) – Desalination through humidification and subsequent dehumidification (collection of evaporated water). Context: Resource Management strategy.

distribution system – System of ditches or conduits and their controls that conveys water from the supply canal to the farm points of delivery domestic well – A water well used to supply water for the domestic needs of an individual residence or systems of four or fewer service connections.

drinking water standards – State and federal regulations regarding water delivered by water purveyors that is used as a potable supply. Context: Scenario Factor.

drinking water system – see public water system

drinking water treatment and distribution – Treatment is the physical, biological and chemical processes that make water suitable for potable use. Distribution includes storage, pumping, and pipe systems to protect and deliver the treated water to customers. Context: Study Plan Building Block.

drip irrigation – A method of micro irrigation wherein water is applied to the soil surface as drops or small streams through emitters. Discharge rates are generally less than 8 L/h (2 gal/h) for a single-outlet emitters and 12 L/h (3 gal/h) per meter for line-source emitters.

drought preparedness– The magnitude and probability of economic, social or environmental consequences that would occur as a result of a sustained drought under a given study plan. Evaluation criteria measure the "drought tolerance" of study plans. Context: Water Management Objective

drought condition – Hydrologic conditions during a defined period, greater than one dry year, when precipitation and runoff are much less than average.

drought year supply – The average annual supply of a water development system during a defined drought period.

duty of water – The total volume of irrigation water required to mature a particular type of crop. It includes consumptive use, evaporation, and seepage as well as the water returned to streams by percolation and surface water.

E

earthquake vulnerability – see seismic vulnerability

economic incentives – Financial assistance and pricing policies intended to influence water management including, for example, amount of use, time of use wastewater volume, and source of supply. Context: Resource Management Strategy.

ecosystem restoration – The activity of improving the condition of natural landscapes and biotic communities. Context: Study Plan Building Block.

effective precipitation – That portion of precipitation that supplies crop evapotranspiration. It includes precipitation stored in the soil before and during the growing season

effective porosity – The volume of voids or open spaces in alluvium and rocks that is interconnected and can transmit fluids.

effective rooting depth – The depth from which soil moisture is extracted; it is determined by the crop rooting characteristics and soil depth limitations.

electrical conductivity (EC) – The measure of the ability of water to conduct an electrical current, the magnitude of which depends on the dissolved mineral content of the water.

energy availability – The energy consumption to facilitate water management-related actions such as desalting, pump-storage, groundwater extraction, conveyance or treatment. This criterion pertains to the economic feasibility of a proposed water management action in terms of O&M costs. Context: Evaluation Criteria.

energy costs – Refers to the cost of energy use related to producing, conveying and applying water. It also refers to the cost of energy use for processes and inputs not directly related to water, but which can affect the demand for water (e.g., the cost of nitrogen fertilizer, tractor manufacturing, etc.). Context: Scenario Factor.

energy production – Both instantaneous capacity (megawatt) and energy produced (kilowatt hours). Context: Evaluation Criteria.

environmental justice – The fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. (Section 65040.12. (c) Government code)

environmental water (flow based) – The amount of water dedicated to instream fishery uses, Wild and Scenic rivers, Bay-Delta outflow and aquatic habitat.

environmental water (land based) – The amount of water used for fresh-water managed wetlands and native vegetation.

environmental water quality – Water quality in terms of ecosystem health, recreation, salinity intrusion, usability per sector, treatment costs, etc. Aquatic species and water bodies are vulnerable to changes to water quality.

ETo (Reference Evapotranspiration) – The evapotranspiration rate from an extended surface of 3 to 6 inch (8–15 cm) tall green grass cover of uniform height, actively growing, completely shading the ground, and not short on water (the reference ET reported by CIMIS).

evaluation criteria – The technical information that will be used to compare the favorability of different response packages of resource management strategies against future scenarios in California Water Plan Update 2010. They are designed to identify and measure potential effects on water supply, the environment, energy use or production, recreational opportunities, groundwater overdraft, and many more.

evaporation – The physical process by which a liquid or solid is transformed to a gaseous state.

evaporative demand – The collective influence of all climatic factors on the rate of evaporation of water.

evapotranspiration (ET) – The quantity of water transpired by plants, retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces

evapotranspiration of applied water (ETAW) – The portion of ET satisfied by applied irrigation water.

F

flood irrigation – Method of irrigation where water is applied to the soil surface without flow controls, such as furrows, borders, or corrugations

floodplain management – Actions designed to reduce risks to life, property, and the environment due to flooding. Actions can include watershed management, infrastructure construction and operation, variations in land use practices, floodway designations, etc. Context: Study Plan Building Block.

flood risk – The magnitude and probability of consequences that would occur as a result of flood-induced infrastructure damage under a given study plan. Context: Evaluation Criteria.

flow diagram – Diagram that characterizes a region's hydrologic cycle by documenting sources of water such as precipitation and inflows and tracks the water as it flows (through many different uses) to its ultimate destinations.

flow diagram table – An itemized listing of all the categories contained in the Flow Diagram including more detailed information, organized by "inputs" and "withdrawals."

full cost – (1) all monetary costs associated with project planning, implementation, financing, or impact mitigation plus any recurring costs required to sustain benefits; PLUS (2) all nonmonetary costs that are incurred either at implementation or on a recurring basis such as unmitigable environmental or cultural impacts, public trust, environmental justice, or other nonmarket-based societal values. (Coincides with CEQA/NEPA study and other permitting requirements.) Context: Planning Concept/Consideration.

furrow irrigation – Method of surface irrigation where the water is supplied to small ditches or furrows for guiding across the field.

G

groundwater – Water that occurs beneath the land surface and fills the pore spaces of the alluvium, soil, or rock formation in which it is situated. It excludes soil moisture, which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

groundwater basin – An alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and having a definable bottom.

groundwater budget – A numerical accounting, the groundwater equation, of the recharge, discharge and changes in storage of an aquifer, part of an aquifer, or a system of aquifers.

groundwater in storage – The quantity of water in the zone of saturation.

groundwater management – The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a goal of long-term sustainability of the resource.

groundwater management plan – A comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal or statutory authority.

groundwater mining – The process, deliberate or inadvertent, of extracting groundwater from a source at a rate in excess of the replenishment rate such that the groundwater level declines persistently, threatening exhaustion of the supply or at least a decline of pumping levels to uneconomic depths.

groundwater monitoring network – A series of monitoring wells at appropriate locations and depths to effectively cover the area of interest. Scale and density of monitoring wells is dependent on the size and complexity of the area of interest, and the objective of monitoring.

groundwater overdraft – The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions.

groundwater quality – See water quality

groundwater recharge facility – A structure that serves to conduct surface water into the ground for the purpose of replenishing groundwater. The facility may consist of dug or constructed spreading basins, pits, ditches, furrows, streambed modifications, or injection wells.

groundwater recharge – The natural or intentional infiltration of surface water into the zone of saturation.

groundwater remediation/aquifer remediation – Groundwater Remediation involves extracting contaminated groundwater from an aquifer, treating it, and then either putting it back in the aquifer or using it for agricultural or municipal purposes. Aquifer Remediation is usually accomplished by treating groundwater while it is still in the aquifer, using in-situ methods involving biological, physical, or chemical treatment or electrokinetics. Context: Study Plan Building Block, Resource Management Strategy.

groundwater source area – An area where groundwater may be found in economically retrievable quantities outside of normally defined groundwater basins, generally referring to areas of fractured bedrock in foothill and mountainous terrain where groundwater development is based on successful well penetration through interconnecting fracture systems. Well yields are generally lower in fractured bedrock than wells within groundwater basins.

groundwater storage capacity – Volume of void space that can be occupied by water in a given volume of a formation, aquifer, or groundwater basin.

groundwater subbasin – A subdivision of a groundwater basin created by dividing the basin using geologic and hydrologic conditions or institutional boundaries.

groundwater table – The upper surface of the zone of saturation in an unconfined aquifer.

groundwater quality – Water quality can affect supply integrity. Many pollutants are hydrophilic and not easily filtered by soil. Treated groundwater can be added to water supply. Context: Evaluation Criteria.

H

hazardous waste – Waste that poses a present or potential danger to human beings or other organisms because it is toxic, flammable, radioactive, explosive, or has some other property that produces substantial risk to life.

hydraulic barrier – A barrier created by injecting fresh water to control seawater intrusion in an aquifer, or created by water injection to control migration of contaminants in an aquifer.

hydraulic conductivity – A measure of the capacity for a rock or soil to transmit water; generally has the units of feet/day or cm/sec.

hydrograph – A graph that shows some property of groundwater or surface water as a function of time at a given point.

hydrology – A science related to the occurrence and distribution of natural water on the earth including the annual volume and the monthly timing of runoff.

hydrologic cycle – The circulation of water from the ocean through the atmosphere to the land and ultimately back to the ocean.

hydrologic region – A study area consisting of multiple planning subareas. California is divided into 10 hydrologic regions.

hydrostratigraphy – A geologic framework consisting of a body of rock having considerable lateral extent and composing a reasonably distinct hydrologic system.

hyporheic zone – The region of saturated sediments beneath and beside the active channel and that contain some proportion of surface water that was part of the flow in the surface channel and went back underground and can mix with groundwater.

I

in-lieu recharge – The practice of providing surplus surface water to historic groundwater users, thereby leaving groundwater in storage for later use.

industrial activity mix – The mix of high and low water using industrial activity. Note that Industrial Activity is broken into two factors: Total Industrial Activity and Industrial Activity Mix. The latter factor allows designation of the type of industry that is occurring. This is necessary to account for the large variation in water demands by industry type. See also total industrial activity. Context: Scenario Factor.

infiltration – The flow of water downward from the land surface into and through the upper soil layers.

infiltration capacity – The maximum rate at which infiltration can occur under specific conditions of soil moisture.

infrastructure – the underlying foundation or basic framework of a system

integrated regional water management – A comprehensive, systems approach for determining the appropriate mix of demand and supply management options that provide long-term, reliable water supply at lowest reasonable cost and with highest possible benefits to customers, economic development, environmental quality, and other social objectives.

intercropping – The simultaneous planting of two or more crops in the same field. The practice is used to help control pest populations that can occur on monoculture crops, sometimes called "polycropping" or "plant stratification."

interregional import projects – Movement of water between regions through mechanisms such as the State and federal water projects. Context: Scenario Factor.

irrecoverable water – the amount of applied water that is not available for supply or reuse, including discharge to saline sinks, evaporation, and evapotranspiration. See recoverable water

irrigation efficiency (IE) – The efficiency of water application and use, calculated by dividing a portion of applied water that is beneficially used by the total applied water, expressed as a percentage The two main beneficial uses are crop water use (evapotranspiration, ETc) and leaching to maintain a salt balance.

irrigation water requirements – The quantity of water exclusive of precipitation that is required from various uses.

J

joint powers agreement (JPA) – An agreement entered into by two or more public agencies that allows them to jointly exercise any power common to the contracting parties. The JPA is defined in Ch. 5 (commencing with Section 6500) of Division 7 of Title 1 of the California Government Code.

L

land subsidence – The lowering of the natural land surface due to groundwater (or oil and gas) extraction.

leaching requirements – The fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specific value.

leaching efficiency – The ratio of the average salt concentration in drainage water to an average salt concentration in the soil water of the root zone when near field capacity.

leaky confining layer – A low-permeability layer that can transmit water at sufficient rates to furnish some recharge from an adjacent aquifer to a well.

lithologic log – A record of the lithology of the soils, sediments and/or rock encountered in a borehole from the surface to the bottom.

lithology – The description of rocks, especially in hand specimen and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

M

management objectives – Objectives that set forth the priorities and measurable criteria of water management. Examples include improve water quality, augment water supplies, improve use efficiency, etc.

matching water quality to use – a resource management strategy that recognizes not all water uses require the same quality water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water, and lesser quality water can be desirable for some uses, such as riparian streams with plant materials benefiting fish. Context: Resource Management Strategy.

maximum contaminant level (MCL) – The highest drinking water contaminant concentration allowed under federal and State Safe Drinking Water Act regulations.

microirrigation – The frequent application of small quantities of water as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line. Microirrigation encompasses a number of methods or concepts such as bubbler, drip, trickle, mist, or spray.

multicropping – The practice of consecutively producing two crops (double cropping) or more of either like or unlike com modities on the same land within the same year. An example of double cropping might be to harvest a wheat crop by early summer and then plant corn or beans on that acreage for harvest in the fall. Suitable climates and reliable water supplies are important factors with this practice.

N

naturally occurring conservation – The amount of background conservation occurring independent of the BMP and EWMP programs (e.g., plumbing codes, etc.). Context: Scenario Factor.

natural recharge – Natural replenishment of an aquifer generally from snowmelt and runoff; through seepage from the surface.

net groundwater withdrawal - groundwater extraction in excess of percolation into a groundwater basin. Context: Water Portfolio net water use (demand) – the amount of water needed in a water service area to meet all requirements or demands. It is the sum of several components including evapotranspiration of applied water in an area, the irrecoverable water from the distribution system, and the outflow leaving the service area; does not include reuse of water within a service area.

new water – Water that is legally and empirically available for a beneficial use; can be developed through many strategies such as capturing surplus water, desalination of ocean water and reductions in depletions. (Same meaning as real water) Context: Planning Concept/Consideration.

nonpoint source – Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, etc., carried to lakes and streams by surface runoff. See also point source

O

operational flexibility – The temporal or spatial operational efficiency of existing and proposed infrastructure to maximize benefits. Context: Evaluation Criteria.

operational yield – An optimal amount of groundwater that should be withdrawn from an aquifer system or a groundwater basin each year. It is a dynamic quantity that must be determined from a set of alternative groundwater management decisions subject to goals, objectives, and constraints of the management plan.

ordinance – A law set forth by a governmental authority.

other interregional import deliveries – This factor is intended to capture the interregional movement of water for "projects" such as Russian River, Trinity River Exports or Putah South Canal. Note that the project name must be specified in the study plan narrative. Context: Scenario Factor.

overdraft – See groundwater overdraft

overlying right – Property owners above a common aquifer possess a mutual right to the reasonable and beneficial use of a groundwater resource on land overlying the aquifer from which the water is taken. Overlying rights are correlative (related to each other) and overlying users of a common water source must share the resource on a pro rata basis in times of shortage. A proper overlying use takes precedence over all non-overlying uses.

P

pelagic fish – fish that spawn in open water, often near the surface. Many river-dwelling anadromous fishes, such as shad are also pelagic spawners

perched groundwater – Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater.

percolation – Process in which water moves through a porous material, usually surface water migrating through soil toward a groundwater aquifer.

perennial yield – The maximum quantity of water that can be annually withdrawn from a groundwater basin over a long period of time (during which water supply conditions approximate average conditions) without developing an overdraft condition.

permeability – The capability of soil or other geologic formations to transmit water.

pesticide – Any of a class of chemicals used for killing insects, weeds, or other undesirable entities. Most commonly associated with agricultural activities, but has significant domestic use in California.

point source – A specific site from which wastewater or polluted water is discharged into a water body. See also nonpoint source

pollution (of water) – The alteration of the physical, chemical, or biological properties of water by the introduction of any substance into water that adversely affects any beneficial use of water.

pollution prevention – Improving water quality for all beneficial uses by protecting water at its source, reducing the need and cost for other water management actions and treatment. Context: Resource Management Strategy.

population density – The average number of people per square mile for a planning area. Context: Scenario Factor.

population distribution – The geographic location within California of the population projection. Context: Scenario Factor.

population projection – The 2030 forecast of population made by the California Department of Finance or other agencies. Context: Scenario Factor.

porosity – The ratio of the voids or open spaces in alluvium and rocks to the total volume of the alluvium or rock mass.

possible contaminating activity (PCA) – Human activities that are actual or potential origins of contamination for a drinking water source. PCAs include sources of both microbiological and chemical contaminants that could have an adverse effect upon human health.

precipitation enhancement – The action of artificially stimulating clouds "cloud seeding" to produce more rainfall/snowfall than would naturally occur. Context: Resource Management Strategy.

prescriptive right – Rights obtained through the open and notorious adverse use of another's water rights. By definition, adverse use is not use of a surplus, but the use of non surplus water to the direct detriment of the original rights holder.

public trust doctrine–A legal doctrine recognizing public rights in the beds, banks, and waters of navigable waterways, and the State's power and duty to exercise continued supervision over them as trustee for the benefit of the people.

public water system – A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year.

pueblo right – A water right possessed by a municipality which, as a successor of a Spanish or Mexican pueblo, entitled to the beneficial use of all needed, naturally occurring surface and groundwater of the original pueblo watershed Pueblo rights are paramount to all other claims.

R

rate structure – Designates the rate basis for cost recovery (e.g., flat, uniform, tiered, etc.). Block/Tiered rates are assumed to provide cost signals to consumers. Costs can include capital, O&M, financing, environmental compliance (documentation, permitting and mitigation), etc. Context: Scenario Factor.

real water – See new water. Context: Planning Concept/Consideration.

recharge – Water added to an aquifer or the process of adding water to an aquifer. Groundwater recharge occurs either naturally as the net gain from precipitation or artificially as the result of human influence. See also artificial recharge.

recharge area protection – The action of keeping recharge areas from being paved over or otherwise developed and guarding the recharge areas so they don't become contaminated Context: Resource Management Strategy.

recharge basin – A surface facility constructed to infiltrate surface water into a groundwater basin.

recoverable water – the amount of applied water that is available for supply or reuse; including surface runoff to non-saline bodies of water and deep percolation that becomes groundwater.
See irrecoverable water

recreation – Water-dependent recreation activities that are consumptive (e.g., parks), flat-water (e.g., boating), or flow-based (e.g., whitewater rafting). Context: Scenario Factor.

recreation (reservoir-based) – Flat water recreation, such as boating and skiing, in the form of future storage facilities as well as operation of existing surfaces storage facilities. Context:

recreation sport-fish populations – Populations of fish species that support recreational fishing.

recreation (watercourse-based) – Activities that are dependent on instream flows such as whitewater rafting. Context:

recycled water – Treated municipal, industrial, or agricultural wastewater to produce water that can be reused. Context: Resource Management Strategy

regional self-sufficiency – The degree to which a study plan involves implementation of regional water management options. Context: Evaluation Criteria.

reliability planning – Water reliability management planning is done by comparing the costs of taking actions to maintain or increase reliability to the costs of accepting less reliability. On this basis, accepting of the costs of adverse effects of less than 100 percent reliability could be a legitimate planning decision. Providing full water supply to meet 100 percent of projected future water demand is not the planning goal, rather, the goal is to find the justified level of reliability. Context: Planning Concept/Consideration.

resource management strategy – A project, program, or policy that helps federal, State or local agencies manage water and related resources. Resource Management Strategies can reduce water demand, improve operational flexibility, increase water supply, improve water quality, or practice resource stewardship.

response packages – Additional sets of resource management strategies to be tested against future scenario conditions for performance comparison. This analysis will take place in California Water Plan Update 2010. Comparing the performance of different response packages will provide useful information to decision-makers and water managers as they choose actions to achieve a desirable future water condition.

return-flow system – A system of pipelines or ditches to collect and convey surface or subsurface runoff from an irrigated field for reuse.

reused agricultural water – Water that is used by more than one grower and is, therefore, not available for reallocation should one grower become increasingly efficient (i.e., applied water reductions minus real water equal zero). Context: Planning Concept/Consideration.

riparian right – A right to use surface water, such right derived from the fact that the land in question abuts the banks of streams.

root zone – The portion of the soil profile through which plant roots readily penetrate to obtain water and plant nutrients, expressed in inches or feet of depth.

runoff – The volume of surface flow from an area.

S

safe yield – The maximum quantity of water that can be continuously withdrawn from a groundwater basin without adverse effect

saline soil – A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most plants.

saline intrusion – The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater bodies.

salinity – Generally, the concentration of mineral salts dissolved in water. Salinity may be expressed in terms of a concentration or as electrical conductivity. When describing salinity influenced by seawater, salinity often refers to the concentration of chlorides in the water.

saturated zone – The zone in which all interconnected openings are filled with water, usually underlying the unsaturated zone.

scenarios – Sets of plausible future conditions based on different assumptions of factors such as population size, density, and distribution, per capita income, commercial and industrial activity, and crop area and water use. In California Water Plan Update 2005, the three scenarios for 2030 are strictly narrative and are "no action" (i.e., they do not reflect any additional resource management strategies in the form of response packages beyond those currently planned, such as new water efficiency programs).

seasonal vs. permanent crop mix – Shifts in crop type between seasonal and permanent. This factor depicts the diminished ability to reduce water use during times of increased water scarcity (due to shifting from seasonal to permanent crops). In other words, shortage losses increase when shifting from season to permanent. Context: Scenario Factor.

seawater intrusion barrier – A system designed to retard, cease or repel the advancement of seawater intrusion into potable groundwater supplies along coastal portions of California. The system may be a series of specifically placed injection wells where water is injected to form a hydraulic barrier.

secondary porosity – Voids in a rock formed after the rock has been deposited; not formed with the genesis of the rock, but later due to other processes. Fractures in granite and caverns in limestone are examples of secondary openings.

seepage – The gradual movement of water into, through, or from a porous medium. Also, the infiltration of water into the soil from canals, ditches, laterals, watercourse, reservoir, storage facilities, or other body of water, or from a field.

semi-confined aquifer – A semi-confined aquifer or leaky confined aquifer is an aquifer that has aquitards either above or below that allow water to leak into or out of the aquifer depending on the direction of the hydraulic gradient.

service area – The geographic area served by a water agency.

soil moisture – The water in soils. Usually expressed as a percentage of the dry weight of the soil. Can also be expressed on a wet weight or a volume basis.

soil texture – Soil texture refers to the percentage of sand, silt, and clay particles in a soil. Sand, silt, and clay particles are defined by their size. Soil texture has important effects on soil properties. Water-holding capacity, drainage class, consistence, and chemical properties are just a few examples of properties that are affected by soil texture.

specific retention – The ratio of the volume of water a rock or sediment will retain against the pull of gravity to the total volume of the rock or sediment.

specific yield – the ratio of the volume of water a rock or soil will yield by gravity drainage to the total volume of the rock or soil.

spring – a location where groundwater flows naturally to the land surface or a surface water body.

sprinkler irrigation – Method of irrigation in which the water is sprayed, or sprinkled, through the air to the ground surface.

stakeholder – individuals or groups who can affect or be affected by an organization's activities. or: Individuals or groups with an interest or "stake" in what happens as a result of any decision or action. Stakeholders do not necessarily use the products or receive the services of a program.

State Water Project deliveries – The volume of water imported to a given study area from the State Water Project. Context: Scenario Factor.

statewide water management systems – These include physical facilities (more than 1,200 State, federal, and local reservoirs, as well as canals, treatment plants, and levees), which make up the backbone of water management in California, and statewide water management programs, which include water-quality standards, monitoring programs, economic incentives, water pricing policies, and statewide water-efficiency programs such as appliance standards, labeling, and education.

strategic plan – The long-term goals of an organization or program and an outline of how they will be achieved (e.g., adopting specific strategies, approaches, and methodologies).

stratigraphy – The science of rocks. It is concerned with the original succession and age relations of rock strata and their form, distribution, lithologic composition, fossil content, geophysical and geochemical properties—all characters and attributes of rocks as strata—and their interpretation in terms of environment and mode of origin and geologic history.

stress irrigation – Management of irrigation water to apply less than enough water to satisfy the soil water deficiency in the entire root zone. (Preferred term is limited irrigation.)

subirrigation – Application of irrigation water below the ground surface by raising the water table to within or near the root zone.

subsurface drip irrigation – Application of water below the soil surface through emitters, with discharge rates generally in the same range as drip irrigation. This method of water application is different from and not to be confused with subirrigation where the root zone is irrigated by water table control.

surface irrigation – Irrigation in which the soil surface is used as the conduit, as in furrow and border irrigation, and as opposed to sprinkler, drip, and subirrigation.

surface storage facilities – The volume and yield of usable reservoir storage in a given area. Context: Resource Management Strategy.

surge irrigation – A surface irrigation technique wherein flow is applied to furrows (or less commonly, borders) intermittently during a single irrigation set.

subsidence – See land subsidence

subterranean stream – Subterranean streams "flowing through known and definite channels" are regulated by California's surface water rights system.

surface supply – Water supply obtained from streams, lakes, and reservoirs.

surplus water – Water that is not being used directly or indirectly to benefit the environmental, agricultural or urban use sectors. Context: Planning Concept/Consideration.

sustainability – A specific resource that avoids complete depletion over a specified time horizon. The continued feasibility of a specified economic activity over a specified time horizon, usually influenced by management and policy actions t Context: Economic Activity.

system reoperation – Changing existing water system operation and management procedures or priorities to either meet competing beneficial uses or derive more total benefits from the water system by operating more efficiently. Context: Resource Management Strategy.

T

third party impacts – The occurrence of incidental economic impacts to parties not directly related to (impact-causing) water management actions. For example, agricultural land retirement can impact local tax revenues and/or labor conditions, etc. Context: Evaluation Criteria.

total capital cost – Total monetary cost of option required for "turn key" implementation including environmental and third party impact mitigation, storage, conveyance, energy, capitalized O&M, administrative, planning, legal and engineering costs. Context: Planning Concept/Consideration.

total commercial activity – The amount of commercial activity (e.g., employment, productivity, commercial land use, etc) that occurs in a given study area. This factor is a driver of (and indicator for) commercial water use and includes institutional water use (government offices, schools, etc.) as well. See also commercial activity mix. Context: Scenario Factor.

total industrial activity – The total amount of industrial activity (e.g., employment, productivity, industrial land use, etc) that occurs in a given study area. This factor is a driver of (and indicator for) industrial water use. Context: Scenario Factor.

total irrigated crop area – The total area of irrigated crops (by type) planted in a planning area during a given year. This number includes multiple cropping. Context: Scenario Factor.

total population – The statewide total population projection regardless of geographical distribution. Context: Scenario Factor.

transpiration – An essential physiological process in which plant tissues give off water vapor to the atmosphere.

U

unconfined aquifer – An aquifer which is not bounded on top by an aquitard. The upper surface of an unconfined aquifer is the water table.

underground stream – Body of water flowing as a definite current in a distinct channel below the surface of the ground, usually in an area characterized by joints or fissures. Application of the term to ordinary aquifers is incorrect.

unit applied water – The quantity of water applied to a specific crop per unit area (sometimes expressed in inches of depth).

unsaturated zone – The zone below the land surface in which pore space contains both water and air.

urban land use management – Planning for the housing and economic development needs of the growing population while providing for the efficient use of water and other resources.

urban runoff management – A broad series of activities to manage both storm water and dry weather runoff.

Urban Water Management Planning Act – Sections 10610 through 10657 of the California Water Code. The Act requires urban water suppliers to prepare urban water management plans which describe and evaluate sources of water supplies, efficient uses of water, demand management measures, implementation strategies and schedules, and other relevant information and programs within their water service areas. Urban water suppliers (CWC Section 10617) are either publicly or privately owned and provide water for municipal purposes, either directly or indirectly, to more than 3,000 customers or supply more than 3,000 acre-feet of water annually.

[urban] water reliability (average) – A measure of a system's ability to sustain the social, environmental and economic systems that it serves during a year of average participation. Context: Evaluation Criteria.

[urban] water reliability (dry) – A measure of a system's ability to sustain the social, environmental and economic systems that it serves during a dry year. Context: Evaluation Criteria.

[urban] water reliability (wet) – A measure of a system's ability to sustain the social, environmental and economic systems that it serves during a wet year. Context: Evaluation Criteria.

urban water use efficiency – Methods or technologies resulting in the same beneficial residential, commercial, industrial, and institutional uses with less water or increased beneficial uses from existing water quantities. Context: Scenario Factor, Resource Management Strategy.

usable storage capacity – The quantity of groundwater of acceptable quality that can be economically withdrawn from storage.

V

volatile organic compound (VOC) – A manmade organic compound that readily vaporizes in the atmosphere. These com pounds are often highly mobile in the groundwater system and are generally associated with industrial activities.

W

water bag transport/storage technology – Water diverted in areas that have unallocated fresh water supplies, storing the water in large inflatable bladders, and towing to an alternate coastal region. Context: Resource Management Strategy.

water balance – An analysis of the total developed/dedicated supplies, uses, and operational characteristics for a region.

water demand – The desired quantity of water that would be used if the water is available and a number of other factors such as price do not change. Demand is not static.

water demand elasticity – The desire to use water is based on a number of factors such as the intended use for the water, the price of water, and the cost of alternative ways to meet the intended use.

water portfolio – A picture of the water supply and use for a given year statewide or by region, subject to availability of data; includes the flow diagram, flow diagram table, water balances, and summary table.

water quality – Description of the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.

water reliability (dry) – A measure of a system's ability to sustain the social, environmental, and economic systems that it serves during a dry year.

water reliability (wet) – A measure of a system's ability to sustain the social, environmental, and economic systems which it serves during a wet year.

water supply exports – The amount of water that a region transfers to another to meet needs. Context: Regional Reports.

water supply imports – The amount of water that needs to be brought in from other regions to meet needs. Context: Regional Reports.

water table – See groundwater table

water transfers – 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. 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. Context: Scenario Factor, Resource Management Strategy.

water year – A continuous 12-month period for which hydrologic records are compiled and summarized. Different agencies may use different calendar periods for their water years.

watershed – The land area from which water drains into a stream, river, or reservoir.

watershed management – The process of evaluating, planning, managing, restoring, and organizing land and other resource use within an area that has a single common drainage point. Context: Resource Management strategy.

Metric Conversion Factors				
Quantity	**To Convert from Metric Unit**	**To Customary Unit**	**Multiply Metric Unit By**	**To Convert to Metric Unit Multiply Customary Unit By**
Length	millimeters (mm)	inches (in)	0.03937	25.4
	centimeters (cm) for snow depth	inches (in)	0.3937	2.54
	meters (m)	feet (ft)	3.2808	0.3048
	kilometers (km)	miles (mi)	0.62139	1.6093
Area	square millimeters (mm^2)	square inches (in^2)	0.00155	645.16
	square meters (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometers (km^2)	square miles (mi^2)	0.3861	2.590
Volume	liters (L)	gallons (gal)	0.26417	3.7854
	megaliters (ML)	million gallons (10*)	0.26417	3.7854
	cubic meters (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic meters (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekameters (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic meters per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	liters per minute (L/mn)	gallons per minute (gal/mn)	0.26417	3.7854
	liters per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megaliters per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekameters per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lbs)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb.)	1.1023	0.90718
Velocity	meters per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.32456	2.989
Specific capacity	liters per minute per meter drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per liter (mg/L)	parts per million (ppm)	1.0	1.0
Electrical conductivity	microsiemens per centimeter (µS/cm)	micromhos per centimeter (µmhos/cm)	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8X°C)+32	0.56(°F-32)

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