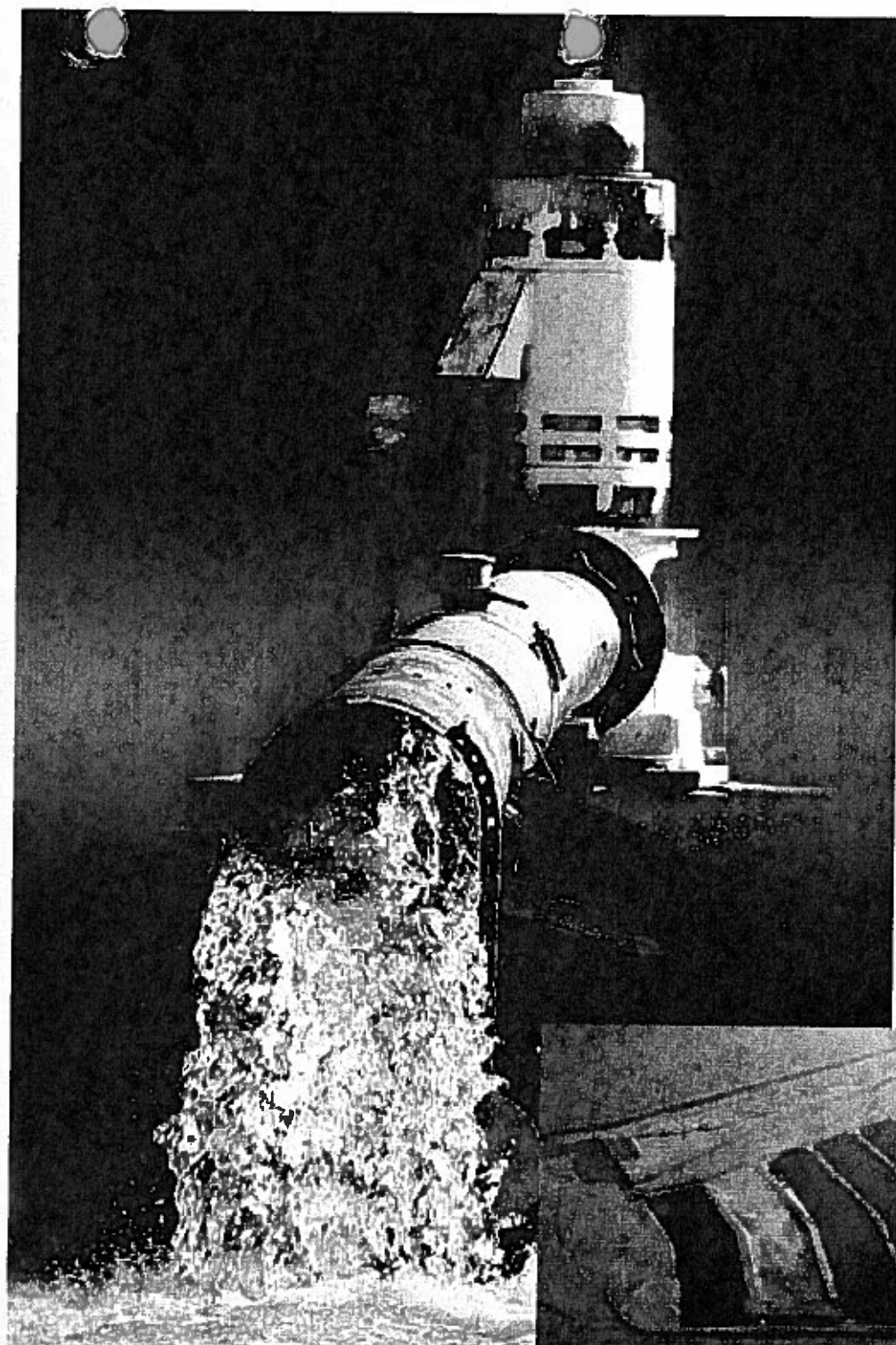


DEPARTMENT OF WATER RESOURCES



BULLETIN 118 · UPDATE 2003

CALIFORNIA'S GROUNDWATER

Cover photograph:

A typical agricultural well with the water discharge pipe and the electric motor that drives the pump.

Inset photograph:

Groundwater recharge ponds in the Upper Coachella Valley near the Whitewater River that use local and imported water. Recharge ponds are also called spreading basins or recharge basins.



State of California
The Resources Agency
Department of Water Resources

CALIFORNIA'S GROUNDWATER

BULLETIN 118 *Update 2003*

October 2003

GRAY DAVIS
Governor
State of California

MARY D. NICHOLS
Secretary of Resources
The Resources Agency

MICHAEL J. SPEAR
Interim Director
Department of Water Resources

If you need this publication in an alternate form, contact the Department's Office of Water Education at 1-800-272-8869.

Foreword

Groundwater is one of California's greatest natural resources. In an average year, groundwater meets about 30 percent of California's urban and agricultural water demands. In drought years, this percentage increases to more than 40 percent. In 1995, an estimated 13 million Californians, nearly 43 percent of the State's population, were served by groundwater. The demand on groundwater will increase significantly as California's population grows to a projected 46 million by the year 2020. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality impacts, or limited by a lack of data, management, and coordination between agencies.

Over the last few years, California voters and the Legislature have provided significant funding to local agencies for conjunctive use projects, groundwater recharge facilities, groundwater monitoring, and groundwater basin management activities under Proposition 13 and the Local Groundwater Management Assistance Act of 2000. Most recently, the 2002 passage of Proposition 50 will result in additional resources to continue recent progress toward sustaining our groundwater resources through local agency efforts. We are beginning to see significant benefits from these investments.

The State Legislature recognizes the need for groundwater data in making sound local management decisions. In 1999, the Legislature approved funding and directed the Department of Water Resources (DWR) to update the inventory of groundwater basins contained in Bulletin 118 (1975), *California's Ground Water* and Bulletin 118-80 (1980), *Ground Water Basins in California*. In 2001, the Legislature passed AB 599, requiring the State Water Resources Control Board to establish a comprehensive monitoring program to assess groundwater quality in each groundwater basin in the State and to increase coordination among agencies that collect groundwater contamination information. In 2002, the Legislature passed SB 1938, which contains new requirements for local agency groundwater management plans to be eligible for public funds for groundwater projects.

Effective management of groundwater basins is essential because groundwater will play a key role in meeting California's water needs. DWR is committed to assisting local agencies statewide in developing and implementing effective, locally planned and controlled groundwater management programs. DWR is also committed to federal and State interagency efforts and to partnerships with local agencies to coordinate and expand data monitoring activities that will provide necessary information for more effective groundwater management. Coordinated data collection at all levels of government and local planning and management will help to ensure that groundwater continues to serve the needs of Californians.



Michael J. Spear
Interim Director

State of California
Gray Davis, Governor

The Resources Agency
Mary D. Nichols, Secretary for Resources

Department of Water Resources
Michael J. Spear, Interim Director

L. Lucinda Chipponeri
Deputy Director

Peggy Bernardy
Chief Counsel

Stephen Verigin
Acting Chief Deputy Director

Jonas Minton
Deputy Director

Peter Garris
Deputy Director

Vernon T. Glover
Deputy Director

Division of Planning and Local Assistance
Mark Cowin, Chief

Statewide Water Planning Branch
Kamyar Guivetchi, Chief

Conjunctive Water Management Branch
John Woodling, Chief

This Bulletin was prepared under direction of
Doug Osugi

by

Robert Swartz, Senior Engineering Geologist
and

Carl Hauge, Chief Hydrogeologist

Final coordination by
Mary Scruggs and Joe Yun
with assistance from

Tom Hawkins Derick Louie
Tom Lutterman Darby Vickery Ilene Wellman-Barbree Judy Colvin

Data collection, regional information, and basin descriptions provided by Department district offices

Northern District

Dwight Russell, District Chief

William Mendenhall, Chief, Resources Assessment Branch

Toccoy Dudley, Chief, Groundwater Section

Mike Ward, Engineer WR, technical lead

Todd Hillaire Noel Eaves Dan McManus Bill Ehorn Debbie Spangler

Kelley Staton Doti Watkins Charlene Sundermann Bruce Ross

Central District

Karl Winkler, District Chief

Emil Calzascia, Chief, Water Management

Bob Niblack, Chief, Geology and Groundwater Section

Chris Bonds, Engineering Geologist, technical lead

Sandra Maxwell Mark Souverville Tanya Meeth Bill Waggoner Solomon Mesghina

Bill Brewster Anne Roth

San Joaquin District

Paula J. Landis, District Chief

Brian Smith, Chief, Resource Assessment

Ben Igawa, Chief, Groundwater Section

Al Steele, Engineering Geologist, technical lead

Bruce Myers Anna Mancillas Ken Winden Amanda Mayes Noemi Baca

Southern District

Mark Stuart, District Chief

Bob Pierotti, Chief, Groundwater Section

Tim Ross, Engineering Geologist, technical lead

Gary Guacci Richard Lewy Dan Gamon Brian Moniz Randall Davis Jen Wong

Nuna Tersibahian Monica Lee Jeremy Lancaster Tammy Surco Mark Stuhlman

Editorial, design, and production services were provided by

Brenda Main, Supervisor of Technical Publications

Linda Sinnwell, Art Director

Marilee Talley Alice Dyer Xiaojun Li Gretchen Goettl Joanne Pierce

Acknowledgments

Successful completion of this update and continued implementation of this program would not be possible without the dedicated efforts of the Central, Northern, San Joaquin, and Southern District Offices of the California Department of Water Resources. The information in this report is the result of contributions from many local, state, and federal agencies outside DWR. We would like to acknowledge the contributions of the following agencies.

California Department of Pesticide Regulation
California Department of Toxic Substances Control
California Department of Health Services
California State Water Resources Control Board
California Regional Water Quality Control Boards
United States Geological Survey
United States Bureau of Reclamation

We also wish to thank numerous reviewers who provided valuable comments on the April 2003 public review draft of this bulletin.

Acronyms and abbreviations

AB Assembly Bill
BMO Basin management objective
CAS California Aquifer Susceptibility
CVP Central Valley Project
DBCP Dibromochloropropane
DCE Dichloroethylene
DHS California Department of Health Services
DPR California Department of Pesticide Regulation
DTSC California Department of Toxic Substances Control
DWR California Department of Water Resources
DWSAP Drinking Water Source Assessment Program
EDB Ethylene dibromide
EC Electrical conductivity
EMWD Eastern Municipal Water District
EWMP Efficient water management
EPA U.S. Environmental Protection Agency
ESA Federal Endangered Species Act
ET Evapotranspiration
ETAW Evapotranspiration of applied water
EWA Environmental Water Account
GAMA Groundwater Ambient Monitoring and Assessment
GIS Geographic information system
GMA Groundwater Management Agency
gpm Gallons per minute
GRID Groundwater Resources Information Database
GRIST Groundwater Resources Information Sharing Team
H & S Health and Safety Code
HR Hydrologic region
ISI Integrated Storage Investigations
ITF Interagency Task Force
JPA Joint powers agreement
maf Million acre-feet
MCL Maximum contaminant level
mg/L Milligrams per liter
MOU Memorandum of understanding
MTBE Methyl tertiary-butyl ether
OCWD Orange County Water District
PAC Public Advisory Committee
PCE Tetrachloroethylene
PCA Possible contaminating activity
PPIC Public Policy Institute of California
ROD Record of Decision
RWQCB Regional Water Quality Control Board
SB Senate Bill
SGA Sacramento Groundwater Authority
SVOC Semi-volatile organic compound
SVWD Scotts Valley Water District
SWRCB State Water Resources Control Board

taf Thousand acre-feet
TCE Trichloroethylene
TDS Total dissolved solids
UWMP Urban water management plan
USACE U.S. Army Corps of Engineers
USBR U.S. Bureau of Reclamation
USC United States Code
USGS U.S. Geological Survey
VOC Volatile organic compound
WQCP Water Quality Control Plan



Contents

Contents

Findings	1
Recommendations	7
 Introduction	 13
History of Bulletin 118	15
The Need for Bulletin 118 Update 2003	16
Report Organization	17
 Chapter 1 Groundwater—California’s Hidden Resource	 19
California’s Hydrology	20
California’s Water Supply System	24
Recent Groundwater Development Trends	27
The Need for Groundwater Monitoring and Evaluation	28
 Chapter 2 Groundwater Management in California	 31
How Groundwater is Managed in California	33
Groundwater Management through Authority Granted to Local Water Agencies	33
Local Groundwater Ordinances	36
Adjudicated Groundwater Basins	40
How Successful Have Groundwater Management Efforts Been?	44
Future Groundwater Management in California	49
 Chapter 3 Groundwater Management Planning and Implementation	 53
Criteria for Evaluating Groundwater Management Plans—Required and Recommended Components ...	54
Required Components of Local Groundwater Management Plans	54
Recommended Components of Groundwater Management Plans	55
Model Groundwater Management Ordinance	62
 Chapter 4 Recent Actions Related to Groundwater Management	 65
Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13)	66
California Bay-Delta Record of Decision	66
Local Groundwater Management Assistance Act of 2000 (AB 303, Water Code Section 10795 et seq.) .	67
Groundwater Quality Monitoring Act of 2001 (AB 599, Water Code Section 10780 et seq.)	67
Water Supply Planning	68
Emergency Assistance to the Klamath Basin	68
Governor’s Drought Panel	68
Sacramento Valley Water Management Agreement	69
Groundwater Management Water Code Amendments	69
Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50)	69
 Chapter 5 The Roles of State and Federal Agencies in California Groundwater Management	 71
Local Groundwater Management Assistance from DWR	72
Conjunctive Water Management Program	72

Assistance from Other State and Federal Agencies	75
State Water Resources Control Board and Regional Water Quality Control Boards	75
California Department of Health Services	76
California Department of Pesticide Regulation	76
California Department of Toxic Substances Control	77
California Bay-Delta Authority	78
U.S. Environmental Protection Agency	78
U.S. Geological Survey	78
U.S. Bureau of Reclamation	78
Chapter 6 Basic Groundwater Concepts	79
Origin of Groundwater	80
Occurrence of Groundwater	80
Groundwater and Surface Water Interconnection	81
Physical Properties That Affect Groundwater	83
Aquifer	85
Aquitard	85
Unconfined and Confined Aquifers	87
Groundwater Basin	88
Groundwater Subbasin	90
Groundwater Source Areas	90
Movement of Groundwater	92
Quantity of Groundwater	93
Groundwater Storage Capacity	93
Usable Groundwater Storage Capacity	95
Available Groundwater Storage Capacity	95
Groundwater Budget	95
Change in Groundwater Storage	96
Overdraft	96
Safe Yield	99
Subsidence	100
Conjunctive Management	100
Quality of Groundwater	101
Beneficial Uses	101
Public Drinking Water Supply	101
Agricultural Supply	101
Contaminant Groups	103
Chapter 7 Inventory of California's Groundwater Information	105
<i>Statewide Groundwater Information</i>	106
Groundwater Basins	106
Groundwater Budgets	106
Active Monitoring	111
Groundwater Quality	112
<i>Regional Groundwater Use</i>	113

North Coast Hydrologic Region	119
Description of the Region	122
Groundwater Development	122
Groundwater Quality	124
Changes from Bulletin 118-80	125
San Francisco Bay Hydrologic Region	129
Description of the Region	131
Groundwater Development	131
Groundwater Quality	132
Changes from Bulletin 118-80	134
Central Coast Hydrologic Region	137
Description of the Region	140
Groundwater Development	140
Groundwater Quality	140
Changes from Bulletin 118-80	142
South Coast Hydrologic Region	145
Description of the Region	148
Groundwater Development	149
Conjunctive Use	149
Groundwater Quality	149
Changes from Bulletin 118 - 80	150
Sacramento River Hydrologic Region	155
Description of the Region	158
Groundwater Development	159
Groundwater Quality	160
Changes from Bulletin 118-80	161
San Joaquin River Hydrologic Region	167
Description of the Region	169
Groundwater Development	169
Conjunctive Use	170
Groundwater Quality	170
Changes from Bulletin 118-80	170
Tulare Lake Hydrologic Region	175
Description of the Region	177
Groundwater Development	177
Groundwater Quality	178
Changes from Bulletin 118-80	180
North Lahontan Hydrologic Region	183
Description of the Region	185
Groundwater Development	186
Groundwater Quality	187
Changes from Bulletin 118-80	188
South Lahontan Hydrologic Region	191
Description of the Region	194
Groundwater Development	194
Groundwater Quality	194
Changes from Bulletin 118-80	196

Colorado River Hydrologic Region	201
Description of the Region	204
Groundwater Development	204
Groundwater Quality	204
Changes from Bulletin 118-80	206
References	209
Glossary	213

Appendices

Appendix A Obtaining Copies of Supplemental Material	224
Appendix B The Right to Use Groundwater in California	225
Appendix C Required and Recommended Components of Local Groundwater Management Plans	230
Appendix D Groundwater Management Model Ordinance	232
Appendix E SWRCB Beneficial Use Designations	239
Appendix F Federal and State MCLs and Regulation Dates for Drinking Water Contaminants	241
Appendix G Development of Current Groundwater Basin/Subbasin Map	245

Tables

Table 1 Groundwater management methods	33
Table 2 Local agencies with authority to deliver water for beneficial uses, which may have authority to institute groundwater management	34
Table 3 Special act districts with groundwater management authority in California	35
Table 4 Counties with ordinances addressing groundwater management	39
Table 5 List of adjudicated basins.....	42
Table 6 Scotts Valley Water District's Groundwater Monitoring Plan	58
Table 7 Porosity (in percent) of soil and rock types	85
Table 8 Types and boundary characteristics of groundwater basins	88
Table 9 Examples of factors that limit development of a groundwater basin	94
Table 10 Range of TDS values with estimated suitability for agricultural uses	102
Table 11 Range of boron concentrations with estimated suitability on various crops	102
Table 12 Annual agricultural and municipal water demands met by groundwater	113
Table 13 Most frequently occurring contaminants by contaminant group in the North Coast Hydrologic Region	125
Table 14 Modifications since Bulletin 118-80 of groundwater basins in North Coast Hydrologic Region	125
Table 15 North Coast Hydrologic Region groundwater data	127
Table 16 Most frequently occurring contaminants by contaminant group in the San Francisco Bay Hydrologic Region	133
Table 17 Modifications since Bulletin 118-80 of groundwater basins and subbasins in San Francisco Bay Hydrologic Region	134
Table 18 San Francisco Bay Hydrologic Region groundwater data	135
Table 19 Most frequently occurring contaminants by contaminant group in the Central Coast Hydrologic Region	141

Table 20	Modifications since Bulletin 118-80 of groundwater basins and subbasins in Central Coast Hydrologic Region	142
Table 21	Central Coast Hydrologic Region groundwater data	143
Table 22	Most frequently occurring contaminants by contaminant group in the South Coast Hydrologic Region	151
Table 23	Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Coast Hydrologic Region	152
Table 24	South Coast Hydrologic Region groundwater data	153
Table 25	Most frequently occurring contaminants by contaminant group in the Sacramento River Hydrologic Region	161
Table 26	Modifications since Bulletin 118-80 of groundwater basins and subbasins in Sacramento River Hydrologic Region	161
Table 27	Sacramento River Hydrologic Region groundwater data	163
Table 28	Most frequently occurring contaminants by contaminant group in the San Joaquin River Hydrologic Region	171
Table 29	Modifications since Bulletin 118-80 of groundwater basins and subbasins in San Joaquin River Hydrologic Region	172
Table 30	San Joaquin River Hydrologic Region groundwater data	173
Table 31	Most frequently occurring contaminants by contaminant group in the Tulare Lake Hydrologic Region	179
Table 32	Modifications since Bulletin 118-80 of groundwater basins and subbasins in Tulare Lake Hydrologic Region	180
Table 33	Tulare Lake Hydrologic Region groundwater data	181
Table 34	Most frequently occurring contaminants by contaminant group in the North Lahontan Hydrologic Region	188
Table 35	North Lahontan Hydrologic Region groundwater data	189
Table 36	Most frequently occurring contaminants by contaminant group in the South Lahontan Hydrologic Region	196
Table 37	Modifications since Bulletin 118-80 of groundwater basins and subbasins in South Lahontan Hydrologic Region	196
Table 38	South Lahontan Hydrologic Region groundwater data	198
Table 39	Most frequently occurring contaminants by contaminant group in the Colorado River Hydrologic Region	205
Table 40	Modifications since Bulletin 118-80 of groundwater basins in Colorado River Hydrologic Region	206
Table 41	Colorado River Hydrologic Region groundwater data	207

Figures

Figure 1	Shaded relief map of California	21
Figure 2	Mean annual precipitation in California, 1961 to 1990	22
Figure 3	Groundwater basins, subbasins, and hydrologic regions.....	23
Figure 4	Water projects in California	25
Figure 5	Well completion reports filed with DWR from 1987 through 2000.....	27
Figure 6	Well completion reports filed annually from 1987 through 2000	28
Figure 7	Process of addressing groundwater management needs in California	32
Figure 8	Counties with groundwater ordinances.....	37
Figure 9	Scotts Valley Water District's Groundwater Management Plan monitoring locations.....	60

Figure 10	Broad distribution of grant and loan awardees for 2001 through 2003	74
Figure 11	The Hydrologic Cycle	81
Figure 12	Examples of porosity in sediments and rocks	84
Figure 13	Hydraulic conductivity ranges of selected rocks and sediments	86
Figure 14	Interbedded aquifers with confined and unconfined conditions	87
Figure 15	Groundwater basin near the coast with the aquifer extending beyond the surface basin boundary	89
Figure 16	Significant volcanic groundwater source areas	91
Figure 17	Schematic of total, usable, and available groundwater storage capacity	94
Figure 18	Hydrograph indicating overdraft	97
Figure 19	Photograph of extensometer	100
Figure 20	Groundwater basins and subbasins	108
Figure 21	Basin and subbasin groundwater budget types	109
Figure 22	California's 10 hydrologic regions	114
Figure 23	Agricultural and urban demand supplied by groundwater in each hydrologic region	115
Figure 24	Regional Water Quality Control Board regions and Department of Water Resources hydrologic regions	117
Figure 25	North Coast Hydrologic Region	120
Figure 26	MCL exceedances in public supply wells in the North Coast Hydrologic Region	124
Figure 27	San Francisco Bay Hydrologic Region	130
Figure 28	MCL exceedances in public supply wells in the San Francisco Bay Hydrologic Region	133
Figure 29	Central Coast Hydrologic Region	138
Figure 30	MCL exceedances in public supply wells in the Central Coast Hydrologic Region	141
Figure 31	South Coast Hydrologic Region	146
Figure 32	MCL exceedances in public supply wells in the South Coast Hydrologic Region	150
Figure 33	Sacramento River Hydrologic Region	156
Figure 34	MCL exceedances in public supply wells in the Sacramento River Hydrologic Region	160
Figure 35	San Joaquin River Hydrologic Region	168
Figure 36	MCL exceedances in public supply wells in the San Joaquin River Hydrologic Region	171
Figure 37	Tulare Lake Hydrologic Region	176
Figure 38	MCL exceedances by contaminant group in public supply wells in the Tulare Lake Hydrologic Region	179
Figure 39	North Lahontan Hydrologic Region	184
Figure 40	MCL exceedances in public supply wells in the North Lahontan Hydrologic Region	187
Figure 41	South Lahontan Hydrologic Region	192
Figure 42	MCL exceedances in public supply wells in the South Lahontan Hydrologic Region	195
Figure 43	Colorado River Hydrologic Region	202
Figure 44	MCL exceedances in public supply wells in the Colorado River Hydrologic Region	205

Sidebars

Box A	Which Bulletin 118 Do You Mean?	16
Box B	Will Climate Change Affect California's Groundwater?	26
Box C	What About Overdraft?	29
Box D	Basin Management Objectives for Groundwater Management	38
Box E	Adjudication of Groundwater Rights in the Raymond Basin	41
Box F	Managing through a Joint Powers Agreement	45
Box G	Managing a Basin through Integrated Water Management	46

Box H Managing Groundwater Using both Physical and Institutional Solutions	47
Box I Impediments to Conjunctive Management Programs in California	48
Box J Managing Groundwater Quantity and Quality	50
Box K What are Management Objectives?	61
Box L Providing Data: The Internet Makes Groundwater Elevation Data Readily Accessible to the Public	73
Box M Improving Coordination of Groundwater Information	77
Box N One Resource, Two Systems of Law	82
Box O Critical Conditions of Overdraft	98
Box P Focused on Nitrates: Detailed Study of a Contaminant	103
Box Q How Does the Information in This Report Relate to the Recently Enacted Laws Senate Bill 221 and Senate Bill 610 (2002)?	107
Box R Explanation of Groundwater Data Tables	110
Box S What Happens When an MCL Exceedance Occurs?	112



Findings

Major Findings

1. **Groundwater provides about 30% of the State's water supply in an average year, yet in many basins the amount of groundwater extracted annually is not accurately known.**
 - In some regions, groundwater provides 60% or more of the supply during dry years.
 - Many small- to moderate-sized towns and cities are entirely dependent on groundwater for drinking water supplies.
 - 40% to 50% of Californians rely on groundwater for part of their water supply.
 - In many basins, groundwater use is indirectly estimated by assuming crop evapotranspiration demands and surveying the acreage of each crop type.
2. **Opportunities for local agencies to manage their groundwater resources have increased significantly since the passage of Assembly Bill 3030 in 1992. (Water Code § 10750 et seq.). In the past several years more agencies have developed management programs to facilitate conjunctive use, determine the extent of the resource, and protect water quality.**
 - The act provides the authority for many local agencies to manage groundwater.
 - The act has resulted in more than 200 local agencies adopting groundwater management plans to date.
 - The act encourages regional cooperation in basins and allows private water purveyors to participate in groundwater management through memoranda of understanding with public agencies.
 - Many local agencies are recognizing their responsibility and authority to better manage groundwater resources.
3. **Agencies in some areas have not yet developed groundwater management plans.**
 - Concerns about cooperative management, governance, and potential liabilities have kept some agencies from developing management plans.
 - Development of management programs to maintain a sustainable groundwater supply for local use has not been accomplished throughout the State.
4. **A comprehensive assessment of overdraft in the State's groundwater basins has not been conducted since Bulletin 118-80, but it is estimated that overdraft is between 1 million and 2 million acre-feet annually.**
 - Historical overdraft in many basins is evident in hydrographs that show a steady decline in groundwater levels for a number of years.
 - Other basins may be subject to overdraft in the future if current water management practices are continued.
 - Overdraft can result in increased water production costs, land subsidence, water quality impairment, and environmental degradation.
 - Few basins have detailed water budgets by which to estimate overdraft.
 - While the most extensively developed basins tend to have information, many basins have insufficient data for effective management or the data have not been evaluated.
 - The extent and impacts of overdraft must be fully evaluated to determine whether groundwater will provide a sustainable water supply.
 - Modern computer hardware and software enable rapid manipulation of data to determine basin conditions such as groundwater storage changes or groundwater extraction, but a lack of essential data limits the ability to make such calculations.
 - Adequate statewide land use data for making groundwater extraction estimates are not available in electronic format.

5. **Surface water and groundwater are connected and can be effectively managed as integrated resources.**
 - Groundwater originates as surface water.
 - Groundwater extraction can affect flow in streams.
 - Changes in surface water flow can affect groundwater levels.
 - Legal systems for surface water and groundwater rights can make coordinated management complex.
6. **Groundwater quality and groundwater quantity are interdependent and are increasingly being considered in an integrated manner.**
 - Groundwater quantity and groundwater quality are inseparable.
 - Groundwater in some aquifers may not be usable because of contamination with chemicals, either from natural or human sources.
 - Unmanaged groundwater extraction may cause migration of poor quality water.
 - Monitoring and evaluating groundwater quality provides managers with the necessary data to make sound decisions regarding storage of water in the groundwater basin.
 - State agencies conduct several legislatively mandated programs to monitor different aspects of groundwater quality.
 - California Department of Water Resources (DWR) monitors general groundwater quality in many basins throughout the State for regional evaluation.
7. **Land use decisions affecting recharge areas can reduce the amount of groundwater in storage and degrade the quality of that groundwater.**
 - In many basins, little is known about the location of recharge areas and their effectiveness.
 - Protection and preservation of recharge areas are seldom considered in land use decisions.
 - If recharge areas are altered by paving, channel lining, or other land use changes, available groundwater will be reduced.
 - Potentially contaminating activities can degrade the quality of groundwater and require wellhead treatment or aquifer remediation before use.
 - There is no coordinated effort to inform the public that recharge areas should be protected against contamination and preserved so that they function effectively.

Additional Important Findings

8. **Funding to assist local groundwater management has recently been available in unprecedented amounts.**
 - Proposition 13 (Water Code, § 79000 et seq.) authorized \$230 million in loans and grants for local groundwater programs and projects, almost all of which has been allocated.
 - The Local Groundwater Management Assistance Act of 2000 (Water Code, § 10795) has resulted in more than \$15 million in grants to local agencies in fiscal years 2001, 2002, and 2003.
 - Proposition 50 (Water Code, § 79500 et seq) will provide funding for many aspects of water management, including groundwater management and groundwater recharge projects.
 - Funding for the California Bay-Delta program has provided technical and facilitation assistance to numerous local groundwater planning efforts.

9. **Local governments are increasingly involved in groundwater management.**
 - Twenty-four of the 27 existing county groundwater management ordinances have been adopted since 1990.
 - Most ordinances require the proponents of groundwater export to demonstrate that a proposed project will not cause subsidence, degrade groundwater quality, or deplete the water supply before the county will issue an export permit.
 - While the ordinances generally require a permit for export of groundwater, most do not require a comprehensive groundwater management plan designed to ensure a sustainable water resource for local use.
 - Some local governments are coordinating closely with local water agencies that have adopted groundwater management plans.
 - Many local governments are monitoring and conducting studies in an effort to better understand groundwater resources.
10. **Despite the increased groundwater management opportunities and activities, the extent of local efforts is not well known.**
 - There is no general requirement that groundwater management plans be submitted to DWR, so the number of adopted plans and status of groundwater management throughout the State are not currently known.
 - There are no requirements for evaluating the effectiveness of adopted plans, other than during grant proposal review.
 - No agency is responsible for tracking implementation of adopted plans.
 - Unlike urban water management plans, groundwater management plans are not required to be submitted to DWR, making the information unavailable for preparing the California Water Plan.
11. **Despite the fact that several agencies often overlies each groundwater basin, there are few mechanisms in place to support and encourage agencies to manage the basin cooperatively.**
 - Some local agencies have recognized the benefits of initiating basinwide and regional planning for groundwater management and have recorded many successes.
 - Regional cooperation and coordination depends on the ability of local agencies to fund such efforts.
 - There is no specific State or federal program to fund and support coordination efforts that would benefit all water users in a region and statewide.
12. **The State Legislature has recognized the need to consider water supplies as part of the local land use planning process.**
 - Three bills—Senate Bill 221¹, SB 610², and AB 901³—were enacted in 2001 to improve the assessment of water supplies. The new laws require the verification of sufficient water supply as a condition for approving certain developments and compel urban water suppliers to provide more information on the reliability of groundwater as an element of supply.
 - The Government Code does not specifically require local governments to include a water resources element in their general plans.

¹ Business and Professions Code Section 11010, Government Code Sections 65867.5, 66455.3, and 66473.7.

² Public Resources Code Section 21151.9, Water Code Sections 10631, 10656, 10657, 10910-10912, 10915.

³ Water Code Sections 10610.2, 10631, 10634.

13. **The need to monitor groundwater quality and contamination of groundwater continues to grow.**
 - As opportunities for developing additional surface water supplies become more limited, subsequent growth will increasingly rely on groundwater.
 - Human activities are likely the cause of more than half the exceedances of maximum contaminant levels in public water supply wells.
 - New contaminants are being regulated and standards are becoming more stringent for others, requiring increased monitoring and better management of water quality.
14. **Monitoring networks for groundwater levels and groundwater quality have not been evaluated in all basins to ensure that the data accurately represent conditions in the aquifer(s).**
 - Groundwater levels are monitored in about 10,000 active wells including those basins where most of the groundwater is used.
 - Groundwater levels are not monitored in approximately 200 basins, where population is sparse and groundwater use is generally low.
 - Groundwater quality monitoring networks are most dense near population centers and may not be representative of the basin as a whole.
 - Many of the wells being monitored are not ideally constructed to provide water level or water quality information that is representative of a specific aquifer.
 - Many wells are too deep to monitor changes in the unconfined (water table) portion of basins.
15. **The coordination of groundwater data collection and evaluation by local, State, and federal agencies is improving.**
 - The State Water Resources Control Board (SWRCB) recently formed the Groundwater Resources Information Sharing Team (GRIST) consisting of several State and federal agencies with groundwater-related programs.
 - DWR established a website in 1996 that has provided water-level data and hydrographs for more than 35,000 active and inactive wells monitored by DWR and cooperating agencies.
 - DWR collects and maintains water level data in part through partnerships with local agency cooperators.
 - DWR staff collaborated with many local, State, and federal agencies in developing this update of Bulletin 118.
 - SWRCB recently formed an interagency task force to develop a comprehensive groundwater quality monitoring program for assessing every groundwater basin in the State as required by the Groundwater Quality Monitoring Act of 2001 (AB 599; Water Code, § 10780 et seq.).
 - Water purveyors have concerns about balancing public access to data with water supply security.

16. **Boundaries of groundwater basins have been determined using the best available geologic and hydrologic information. These boundaries are important in determining the availability of local water supplies.**
 - Basin boundaries were derived primarily by identifying alluvial sediments on geologic maps using the best available information, but are subject to change when new information becomes available.
 - The Water Code requires the use of basin boundaries defined in Bulletin 118 in groundwater management plans and urban water management plans.
 - The location of basin boundaries will become more critical as the demand for water continues to increase.
 - Subbasin boundaries may be delineated for management convenience rather than based on hydrogeologic conditions.
17. **Little is known about the stream-aquifer interaction in many groundwater basins.**
 - Groundwater and surface water are closely linked in the hydrologic cycle.
 - The relationship between streamflow and extraction of groundwater is not fully understood in most basins and is generally not monitored.
 - Groundwater extraction in many basins may affect streamflow.
 - Interaction of groundwater flow and surface water may affect environmental resources in the hyporheic zone.
 - An understanding of stream-aquifer interaction will be essential to evaluating water transfers in many areas of the State.
18. **Although many new wells are built in fractured rock areas, insufficient hydrogeologic information is available to ensure the reliability of groundwater supplies.**
 - Population is increasing rapidly in foothill and mountain areas in which groundwater occurs in fractured rock.
 - The cumulative effect of groundwater development may reduce the yield of individual wells, lower the flow of mountain streams, and impact local habitat.
 - Characterization of groundwater resources in fractured rock areas can be very expensive and complex.
 - Many groundwater users in these areas have no other water supply alternatives.
 - Recent dry years have seen many wells go dry in fractured rock areas throughout the State.
 - Groundwater management in these areas is beginning, but there is insufficient data to support quantitative conclusions about the long-term sustainable yield.
19. **When new wells are built, drillers are required to file a Well Completion Report with DWR. That report contains a lithologic log, the usability of which varies considerably from driller to driller.**
 - The Well Completion Reports are confidential and not available to the public, as stipulated by the Water Code, unless the owner's permission is obtained.
 - The usefulness of the information in Well Completion Reports varies but is not fully realized.
 - Public access to Well Completion Reports would increase understanding of groundwater conditions and issues.
 - There is no provision in the Water Code that requires submission of geophysical logs, which would provide an accurate log of the geologic materials within the aquifer.
 - Geophysical logs would provide a greatly improved database for characterization of aquifers.



Recommendations

Major Recommendations

1. **Local or regional agencies should develop groundwater management plans if groundwater constitutes part of their water supply. Management objectives should be developed to maintain a sustainable long-term supply for multiple beneficial uses. Management should integrate water quantity and quality, groundwater and surface water, and recharge area protection.**
 - Groundwater management in California is a local agency responsibility.
 - In basins where there is more than one management agency, those agencies should coordinate their management objectives and program activities.
 - A water budget should be completed that includes recharge, extraction and change in storage in the aquifer(s).
 - Changes in groundwater quality should be monitored and evaluated.
 - Stakeholders should be identified and included in development of groundwater management plans.
2. **The State of California should continue programs to provide technical and financial assistance to local agencies to develop monitoring programs, management plans, and groundwater storage projects to more efficiently use groundwater resources and provide a sustainable supply for multiple beneficial uses. DWR should:**
 - Post information about projects that have successfully obtained funding through various grant and loan programs.
 - Provide additional technical assistance to local agencies in the preparation of grant and loan applications.
 - Continue outreach efforts to inform the public and water managers of grant and loan opportunities.
 - Participate, when requested, in local efforts to develop and implement groundwater management plans.
 - Continue to assess, develop, and modify its groundwater programs to provide the greatest benefit to local agencies.
 - Develop grant criteria to ensure funding supports local benefits as well as Statewide priorities, such as development of the California Water Plan and meeting Bay-Delta objectives.
3. **DWR should continue to work with local agencies to more accurately define historical overdraft and to more accurately predict future water shortages that could result in overdraft.**
 - A water budget should be developed for each basin.
 - The annual change in storage should be determined for each basin.
 - The amount of annual recharge and discharge, including pumping, should be determined.
 - Changes in groundwater quality that make groundwater unusable or could allow additional groundwater to be used should be included in any evaluation of overdraft.
4. **Groundwater management agencies should work with land use agencies to inform them of the potential impacts various land use decisions may have on groundwater, and to identify, prioritize, and protect recharge areas.**
 - Local planners should consider recharge areas when making land use decisions that could reduce recharge or pose a risk to groundwater quality.
 - Recharge areas should be identified and protected from land uses that limit recharge rates, such as paving or lining of channels.

- Both local water agencies and local governments should pursue education and outreach to inform the public of the location and importance of recharge areas.
 - DWR should inform local agencies of the availability of grant funding and technical assistance that could support these efforts.
5. **DWR should publish a report by December 31, 2004 that identifies those groundwater basins or subbasins that are being managed by local or regional agencies and those that are not, and should identify how local agencies are using groundwater resources and protecting groundwater quality.**
 - Such information will be necessary to confirm whether agencies are meeting the requirements of SB 1938 (Water Code Section 10753.7).
 - Collection and summary of existing groundwater management plans will provide a better understanding of the distribution and coordination of groundwater management programs throughout the State.
 - Successful strategies employed by specific local agencies should be highlighted to assist others in groundwater management efforts.
 - Similarly, the impact of groundwater management ordinances throughout the State should be evaluated to provide a better understanding of the effect of ordinances on groundwater management.
 6. **Water managers should include an evaluation of water quality in a groundwater management plan, recognizing that water quantity and water quality are inseparable.**
 - Local water managers should obtain groundwater quality data from federal, state, and local agencies that have collected such data in their basin.
 - Local agencies should evaluate long-term trends in groundwater quality.
 - Local agencies should work closely with the SWRCB and DWR in evaluating their groundwater basins.
 - Local agencies should establish management objectives and monitoring programs that will maintain a sustainable supply of good quality groundwater.
 7. **Water transfers that involve groundwater (or surface water that will be replaced with groundwater) should be consistent with groundwater management in the source area that will assure the long term sustainability of the groundwater resource.**
 8. **Continue to support coordinated management of groundwater and surface water supplies and integrated management of groundwater quality and groundwater quantity.**
 - Future bond funding should be provided for conjunctive use facilities to improve water supply reliability.
 - Funding for feasibility and pilot studies, in addition to construction of projects will help maximize the potential for conjunctive use.
 - DWR should continue and expand its efforts to form partnerships with local agencies to investigate and develop locally controlled conjunctive use programs.
 9. **Local, State, and federal agencies should improve data collection and analysis to better estimate groundwater basin conditions used in Statewide and local water supply reliability planning. DWR should:**
 - Assist local agencies in the implementation of SB 221, SB 610, and AB 901 to help determine water supply reliability during the local land use planning process.
 - Provide and continue to update information on groundwater basins, including basin boundaries, groundwater levels, monitoring data, aquifer yield, and other aquifer characteristics.

- Identify areas of rapid development that are heavily reliant on groundwater and prioritize monitoring activities in these areas to identify potential impacts on these basins.
 - Evaluate the existing network of wells monitored for groundwater elevations, eliminate wells of questionable value from the network, and add wells where data are needed.
 - Work cooperatively with local groundwater managers to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts, beginning with the most heavily used basins.
 - Expand DWR and local agency monitoring programs to provide a better understanding of the interaction between groundwater and surface water.
 - Work with SWRCB to investigate temporal trends in water quality to identify areas of water quality degradation that should receive additional attention.
 - Estimate groundwater extraction using a land use based method for over 200 basins with little or no groundwater budget information.
 - Integrate groundwater budgets into the California Water Plan Update process.
10. **Increase coordination and sharing of groundwater data among local, State, and federal agencies and improve data dissemination to the public. DWR should:**
- Use the established website to continually update new groundwater basin data collected after the publication of California's Groundwater (Bulletin 118-Update 2003).
 - Publish a summary update of Bulletin 118 every five years coincident with the California Water Plan (Bulletin 160).
 - Publish, in cooperation with SWRCB, a biennial groundwater report that addresses current groundwater quantity and quality conditions.
 - Coordinate the collection and storage of its groundwater quality monitoring data with programs of SWRCB and other agencies to ensure maximum coverage statewide and reduce duplication of effort.
 - Make groundwater basin information more compatible with other Geographic Information System-based resource data to improve local integrated resources planning efforts.
 - Compile data collected by projects funded under grant and loan programs and make data available to the public on the DWR website.
 - Encourage local agency cooperators to submit data to the DWR database.
 - Maximize the accuracy and usefulness of data and develop guidelines for quality assurance and quality control, consistency, and format compatibility.
 - Expand accessibility of groundwater data by the public after considering appropriate security measures.
 - State, federal and local agencies should expand accessibility of groundwater data by the public after considering appropriate security measures.
 - Local agencies should submit copies of adopted groundwater management plans to DWR.

Additional Important Recommendations

11. **Local water agencies and local governments should be encouraged to develop cooperative working relationships at basinwide or regional levels to effectively manage groundwater. DWR should:**
- Provide technical and financial assistance to local agencies in the development of basinwide groundwater management plans.
 - Provide a preference in grant funding for groundwater projects for agencies that are part of a regional or basinwide planning effort.
 - Provide Proposition 50 funding preferences for projects that are part of an integrated regional water management plan.

12. **Groundwater basin boundaries identified in Bulletin 118 should be updated as new information becomes available and the basin becomes better defined. DWR should:**
 - Identify basin boundaries that are based on limited data.
 - List the kind of information that is necessary to better define basin boundaries.
 - Develop a systematic procedure to obtain and evaluate stakeholder input on groundwater basin boundaries.
13. **Improve the understanding of groundwater resources in fractured rock areas of the State.**
 - DWR, in cooperation with local and federal agencies, should conduct studies to determine the amount of groundwater that is available in fractured rock areas, including water quality assessment, identification of recharge areas and amounts, and a water budget when feasible.
 - Local agencies and local governments should conduct studies in their areas to quantify the local demands on groundwater and project future demands.
 - The Legislature should consider expanding the groundwater management authority in the Water Code to include areas outside of alluvial groundwater basins
 - DWR should include information on the most significant fractured rock groundwater sources in future updates of Bulletin 118.
14. **Develop a program to obtain geophysical logs in areas where additional data are needed.**
 - DWR should encourage submission of geophysical logs, when they are conducted, as a part of the Well Completion Report.
 - The geophysical logs would be available for use by public agencies to better understand the aquifer, but would be confidential as stipulated by the Water Code.
 - DWR should seek funding to work with agencies and property owners to obtain geophysical logs of new wells in areas where additional data are needed.
 - Geophysical logs would be used to better characterize the aquifers within each groundwater basin.
15. **Educate the public on the significance of groundwater resources and on methods of groundwater management.**
 - DWR should continue to educate the public on statewide groundwater issues and assist local agencies in their public education efforts.
 - Local agencies should expand their outreach efforts during development of groundwater management plans under AB 3030 and other authority.
 - DWR should develop educational materials to explain how they quantify groundwater throughout the State, as well as the utility and limitations of the information.
 - DWR should continue its efforts to educate individual well owners and small water systems that are entirely dependent on groundwater.



Introduction

Introduction

Groundwater is one of California's greatest natural resources. In an average water supply year, groundwater meets about 30 percent of California's urban and agricultural demand. In drought years, this percentage increases to 40 percent or even higher (DWR 1998). Some cities, such as Fresno, Davis, and Lodi, rely solely on groundwater for their drinking water supply. In 1995, an estimated 13 million Californians (nearly 43 percent of the State's population) used groundwater for at least a portion of their public supply needs (Solley and others 1998). With a projected population of nearly 46 million by the year 2020, California's demand on groundwater will increase significantly. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality, or limited by a lack of data, lack of management, and coordination between agencies.

In the last few years, California has provided substantial funds to local agencies for groundwater management. For example, the nearly \$2 billion Water Bond 2000 (Proposition 13) approved by California voters in March 2000 specifically authorizes funds for two groundwater programs: \$200 million for grants for feasibility studies, project design, and the construction of conjunctive use facilities; and \$30 million for loans for local agency acquisition and construction of groundwater recharge facilities and grants for feasibility studies for recharge projects. Additionally, the Local Groundwater Management Assistance Act of 2000 (AB 303) resulted in \$15 million in fiscal years 2001, 2002, and 2003 for groundwater studies and data collection intended to improve basin and subbasin groundwater management. These projects focus on improving groundwater monitoring, coordinating groundwater basin management, and conducting groundwater studies.

The State Legislature has increasingly recognized the importance of groundwater and the need for monitoring in making sound groundwater management decisions. Significant legislation was passed in 2000, 2001 and 2002. AB 303 authorizes grants to help local agencies develop better groundwater management strategies. AB 599 (2001) requires, for the first time, that the State Water Resources Control Board (SWRCB), in cooperation with other agencies, develop a comprehensive monitoring program capable of assessing groundwater quality in every basin in the State with the intent of maintaining a safe groundwater supply. SB 610 (2001) and SB 901 (2001) together require urban water suppliers, in their urban water management plans, to determine the adequacy of current and future supplies to meet demands. Detailed groundwater information is required for those suppliers that use groundwater. SB 221 (2001) prohibits approval of certain developments without verification of an available water supply. These bills are significant with respect to groundwater because much of California's new development will rely on groundwater for its supply.

Finally, SB 1938 (2002) was enacted to provide incentives to local agencies for improved groundwater management. The legislation modified the Water Code to require that specific elements be included in a groundwater management plan for an agency to be eligible for certain State funding administered by the Department of Water Resources for groundwater projects. AB 303 is exempt from that requirement.

History of 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. An example of this is DWR's Bulletin 118 series. Bulletin 118 presents the results of groundwater basin evaluations in California. The Bulletin 118 series was preceded by Water Quality Investigations Report No. 3, *Ground Water Basins in California* (referred to in this bulletin as Report No. 3), published in 1952 by the Department of Public Works, Division of Water Resources (the predecessor of DWR). The purpose of Report No. 3 was to create a base index map of the "more important ground water basins" for carrying out DWR's mandate in Section 229 of the Water Code. Section 229 directed Public Works to:

...investigate conditions of the quality of all waters within the State, including saline waters, coastal and inland, as related to all sources of pollution of whatever nature and shall report thereon to the Legislature and to the appropriate regional water pollution control board annually, and may recommend any steps which might be taken to improve or protect the quality of such waters.

Report No. 3 identified 223 alluvium-filled valleys that were believed to be basins with usable groundwater in storage. A statewide numbering system was created in cooperation with the State Water Pollution Control Board (now the State Water Resources Control Board) based on the boundaries of the nine Regional Water Quality Control Boards. In 1992, Water Code Section 229 was amended, resulting in the elimination of the annual reporting requirements.

In 1975, DWR published Bulletin 118, *California's Ground Water*, (referred to in this report as Bulletin 118-75). Bulletin 118-75 summarized available information from DWR, U.S. Geological Survey, and other agencies for individual groundwater basins to "help those who must make decisions affecting the protection, additional use, and management of the State's ground water resources."

Bulletin 118-75 contains a summary of technical information for 248 of the 461 identified groundwater basins, subbasins, and what were referred to as "areas of potential ground water storage" in California as well as maps showing their location and extent. The Bulletin 118-75 basin boundaries were based on geologic and hydrogeologic conditions except where basins were defined by a court decision.

In 1978, Section 12924 was added to the California Water Code:

The Department shall, in conjunction with other public agencies, conduct an investigation of the State's groundwater basins. The Department shall identify the State's groundwater basins on the basis of geologic and hydrogeologic conditions and consideration of political boundary lines whenever practical. The Department shall also investigate existing general patterns of groundwater pumping and groundwater recharge within such basins to the extent necessary to identify basins which are subject to critical conditions of overdraft.

DWR published the report in 1980 as *Ground Water Basins in California: A Report to the Legislature in Response to Water Code Section 12924* (referred to in this report as Bulletin 118-80). The bulletin included 36 groundwater basins with boundaries different from Bulletin 118-75. The changed boundaries resulted by combining several basins based on geologic or political considerations and by dividing the San Joaquin Valley groundwater basin into many smaller subbasins based primarily on political boundaries. These changes resulted in the identification of 447 groundwater basins, subbasins, and areas of potential groundwater storage. Bulletin 118-80 also identified 11 basins as subject to critical conditions of overdraft.

Box A Which Bulletin 118 Do You Mean?

Mention of an update to Bulletin 118 causes some confusion about which Bulletin 118 the California Department of Water Resources (DWR) has updated. In addition to the statewide Bulletin 118 series (Bulletin 118-75, Bulletin 118-80, and Bulletin 118-03), DWR released several other publications in the 118 series that evaluate groundwater basins in specific areas of the State. Region-specific Bulletin 118 reports are listed below.

- Bulletin 118-1. Evaluation of Ground Water Resources: South San Francisco Bay
Appendix A. Geology, 1967
Volume 1. Fremont Study Area, 1968
Volume 2. Additional Fremont Study Area, 1973
Volume 3. Northern Santa Clara County, 1975
Volume 4. South Santa Clara County, 1981
- Bulletin 118-2. Evaluation of Ground Water Resources: Livermore and Sunol Valleys, 1974
Appendix A. Geology, 1966
- Bulletin 118-3. Evaluation of Ground Water Resources: Sacramento County, 1974
- Bulletin 118-4. Evaluation of Ground Water Resources: Sonoma County
Volume 1. Geologic and Hydrologic Data, 1975
Volume 2. Santa Rosa Plain, 1982
Volume 3. Petaluma Valley, 1982
Volume 4. Sonoma Valley, 1982
Volume 5. Alexander Valley and Healdsburg Area, 1983
- Bulletin 118-5. Bulletin planned but never completed.
- Bulletin 118-6. Evaluation of Ground Water Resources: Sacramento Valley, 1978

The Need for Bulletin 118 Update 2003

Despite California's heavy reliance on groundwater, basic information for many of the groundwater basins is lacking. Particular essential data necessary to provide for both the protection and optimal use of this resource is not available. To this end, the California Legislature mandated in the Budget Act of 1999 that DWR prepare:

...the statewide update of the inventory of groundwater basins contained in Bulletin 118-80, which includes, but is not limited to, the following: the review and summary of boundaries and hydrographic features, hydrogeologic units, yield data, water budgets, well production characteristics, and water quality and active monitoring data; development of a water budget for each groundwater basin; development of a format and procedures for publication of water budgets on the Internet; development of the model groundwater management ordinance; and development of guidelines for evaluating local groundwater management plans.

The information on groundwater basins presented in Bulletin 118 Update 2003 is mostly limited to the acquisition and compilation of existing data previously developed by federal, State, and local water agencies. While this bulletin is a good starting reference for basic data on a groundwater basin, more recent data and more information about the basin may be available in recent studies conducted by local water management agencies. Those agencies should be contacted to obtain the most recent data.

Report Organization

Bulletin 118 Update 2003 includes this report and supplemental material consisting of individual descriptions and a Geographic Information System-compatible map of each of the delineated groundwater basins in California. The basin descriptions will be updated as new information becomes available, and can be viewed or downloaded at <http://www.waterplan.water.ca.gov/groundwater/118index.htm> (Appendix A). Basin descriptions will not be published in hard copy.

This report is organized into the following topics:

- Groundwater is one of California's most important natural resources, and our reliance on it has continued to grow (Chapter 1).
- Groundwater has a complex legal and institutional framework in California that has shaped the groundwater management system in place today (Chapter 2).
- Groundwater management occurs primarily at the local water agency level, but may also be instituted at the local government level. At the request of the Legislature, DWR has developed some recommendations for a model groundwater management ordinance and components for inclusion in a groundwater management plan (Chapter 3).
- Groundwater has had a flurry of activity in the Legislature and at the ballot box in recent years that will affect the way groundwater is managed in California (Chapter 4).
- Groundwater programs with a variety of objectives exist in many State and federal agencies (Chapter 5).
- Groundwater concepts and definitions should be made available to a wide audience (Chapter 6).
- Groundwater basins with a wide range of characteristics and concerns exist in each of California's 10 hydrologic regions (Chapter 7).

Introduction

Chapter 1

Groundwater – California's Hidden Resource

Chapter 1

Groundwater – California's Hidden Resource

In 1975, *California's Ground Water – Bulletin 118* described groundwater as “California’s hidden resource.” Today, those words ring as true as ever. Because groundwater cannot be directly observed, except under a relatively few conditions such as at a spring or a wellhead, most Californians do not give much thought to the value that California’s vast groundwater supply has added to the State. It is unlikely that California could have achieved its present status as the largest food and agricultural economy in the nation and fifth largest overall economy in the world without groundwater resources. Consider that about 43 percent of all Californians obtain drinking water from groundwater. California is not only the single largest user of groundwater in the nation, but the estimated 14.5 million acre-feet (maf) of groundwater extracted in California in 1995 represents nearly 20 percent of all groundwater extracted in the entire United States (Solley and others 1998).

California's Hydrology

California’s climate is dominated by the Pacific storm track. Numerous mountain ranges cause orographic lifting of clouds, producing precipitation mostly on the western slopes and leaving a rain shadow on most eastern slopes (Figure 1 and Figure 2). These storms also leave tremendous accumulations of snow in the Sierra Nevada during the winter months. While the average annual precipitation in California is about 23 inches (DWR 1998), 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 of the State.

Snowmelt and rain falling in the mountains flow into creeks, streams, and rivers. The average annual runoff in California is approximately 71 maf (DWR 1998). As these flows make their way into the valleys, much of the water percolates into the ground. The vast majority of California’s groundwater that is accessible in significant amounts is stored in alluvial groundwater basins. These alluvial basins, which are the subject of this report, cover nearly 40 percent of the geographic area of the State (Figure 3).

This bulletin focuses on groundwater resources, but in reality groundwater and surface water are inextricably linked in the hydrologic cycle. As an example, groundwater may be recharged by spring runoff in streams, but later in the year the base flow of a stream may be provided by groundwater. So, although the land surface is a convenient division for categorizing water resources, it is a somewhat arbitrary one. It is essential that water managers recognize and account for the relationship between groundwater and surface water in their planning and operations.

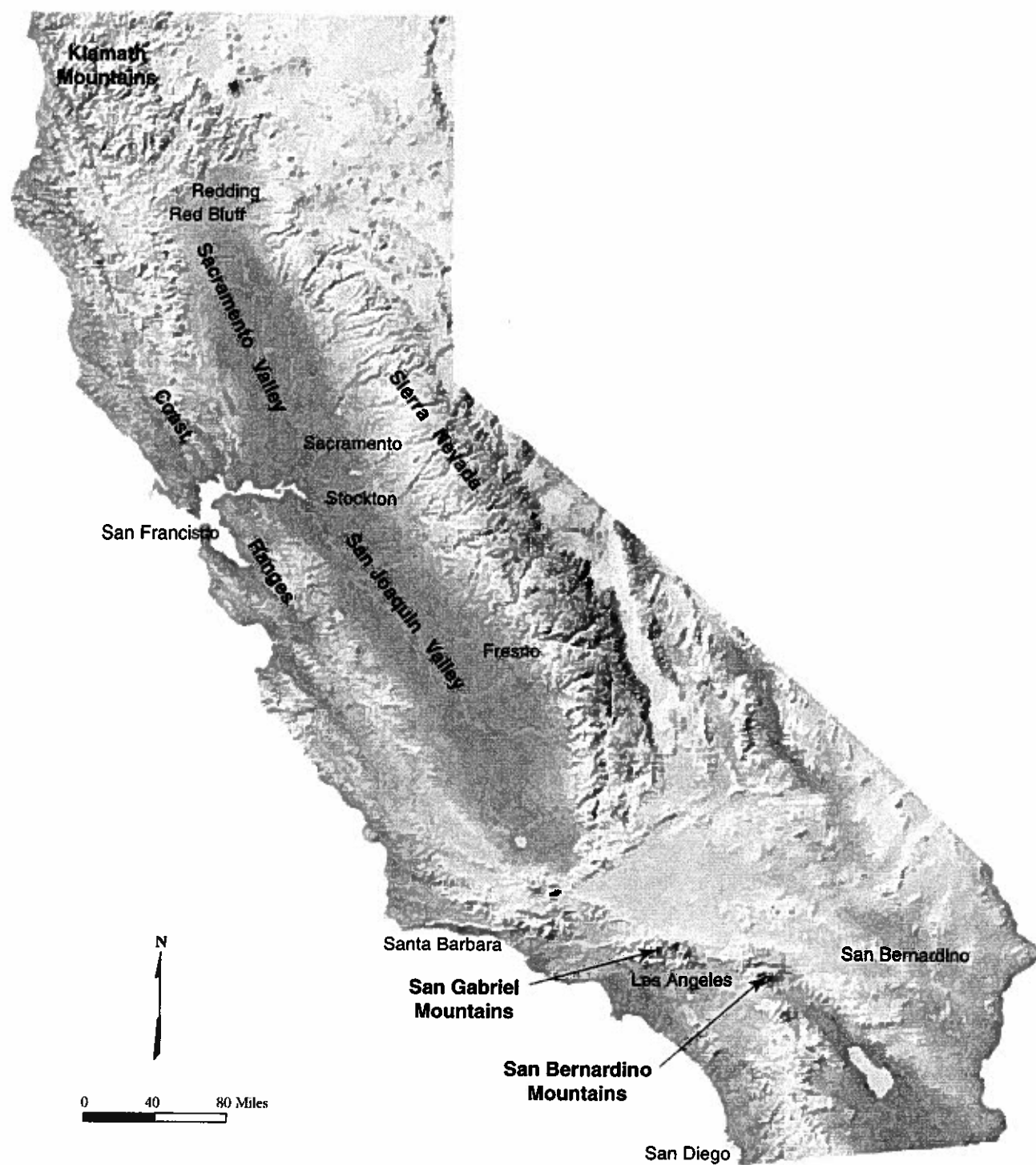


Figure 1 Shaded relief map of California

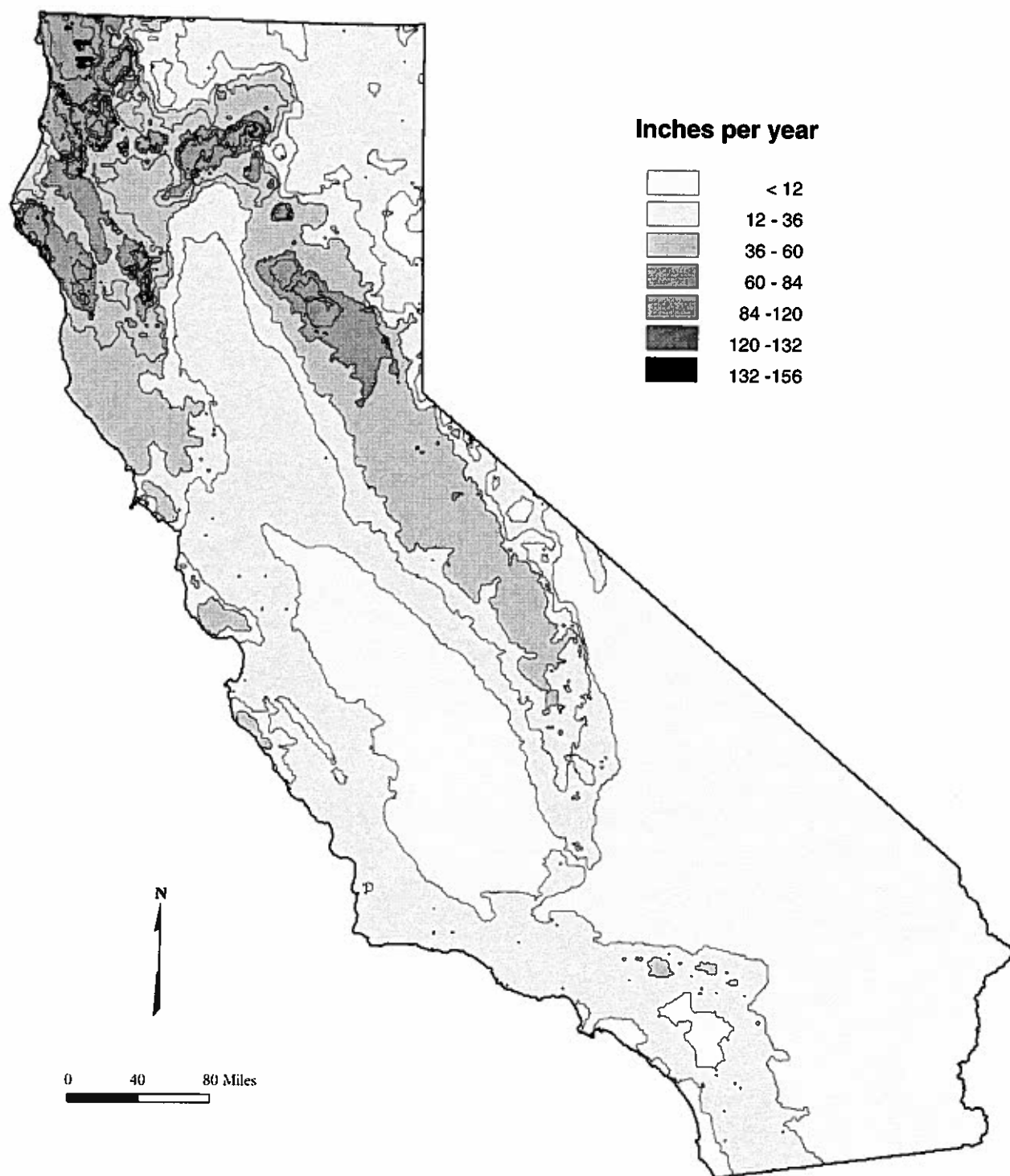


Figure 2 Mean annual precipitation in California, 1961 to 1990

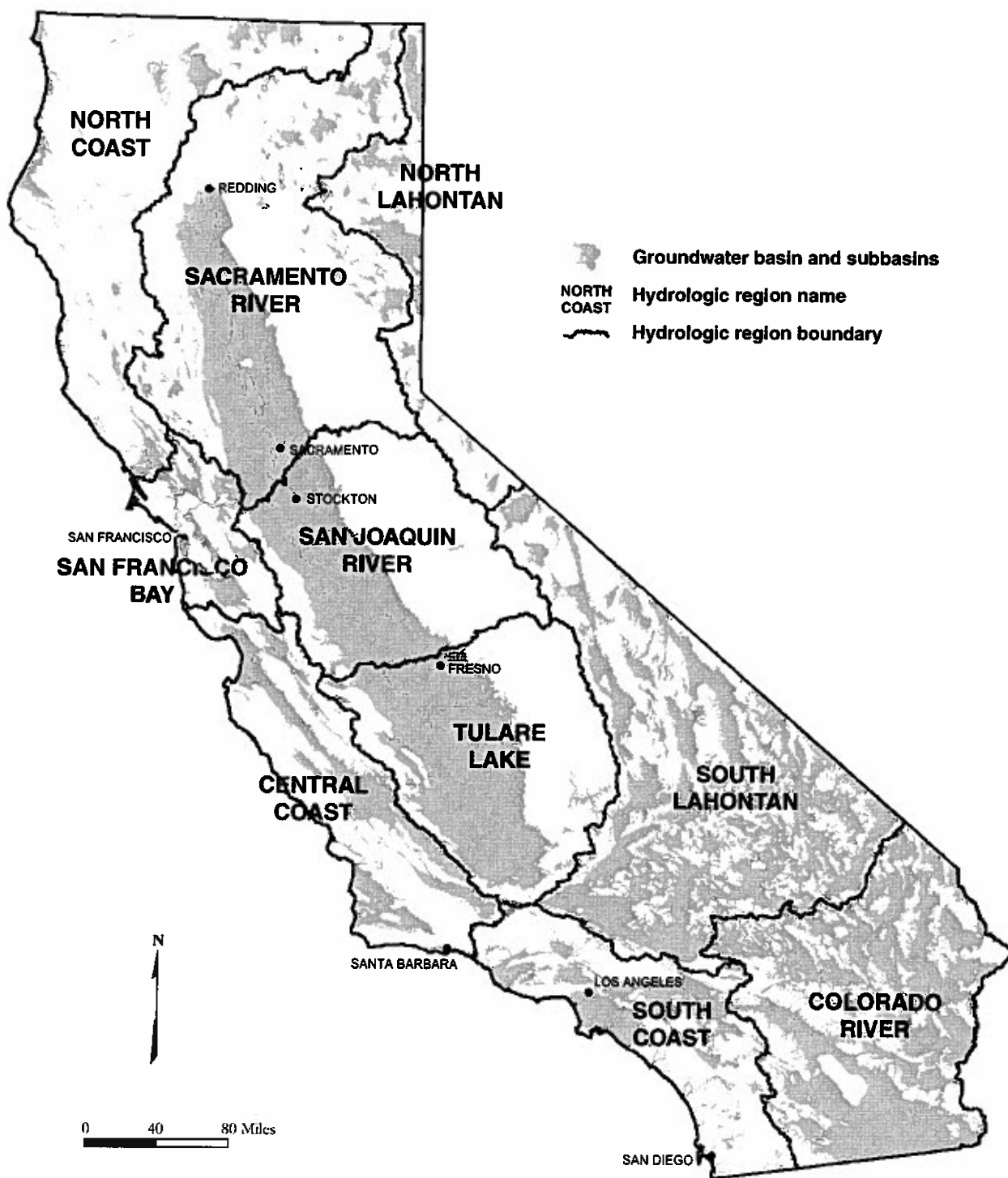


Figure 3 Groundwater basins, subbasins and hydrologic regions

California's Water Supply System

The economic success achieved in California could not have been foreseen a century ago. California's natural hydrologic system appeared too limited to support significant growth in population, industry, and agriculture. The limitations revolved around not only the relative aridity of the State, but the geographic, seasonal, and climatic variability that influence California's water supply. Approximately 70 percent of the State's average annual runoff occurs north of Sacramento, while about 75 percent of the State's urban and agricultural water needs are to the south. Most of the State's precipitation falls between October and April with half of it occurring December through February in average years. Yet, the peak demand for this water occurs in the summer months. Climatic variability includes dramatic deviations from average supply conditions by way of either droughts or flooding. In the 20th century alone, California experienced multiyear droughts in 1912–1913, 1918–1920, 1922–1924, 1929–1934, 1947–1950, 1959–1961, 1976–1977, and 1987–1992 (DWR 1998).

California has dealt with the limitations resulting from its natural hydrology and achieved its improbable growth by developing an intricate system of reservoirs, canals, and pipelines under federal, State and local projects (Figure 4). However, a significant portion of California's water supply needs is also met by groundwater. Typically, groundwater supplies about 30 percent of California's urban and agricultural uses. In dry years, groundwater use increases to about 40 percent statewide and 60% or more in some regions.

The importance of groundwater to the State's development may have been underestimated at the beginning of the 20th century. At that time, groundwater was seen largely as just a convenient resource that allowed for settlement in nearly any part of the State, given groundwater's widespread occurrence. Significant artesian flow from confined aquifers in the Central Valley allowed the early development of agriculture. When the Water Commission Act defined the allocation of surface water rights in 1914, it did not address allocation of the groundwater resource. In the 1920s, the development of the deep-well turbine pump and the increased availability of electricity led to a tremendous expansion of agriculture, which used these high-volume pumps and increased forever the significance of groundwater as a component of water supply in California.

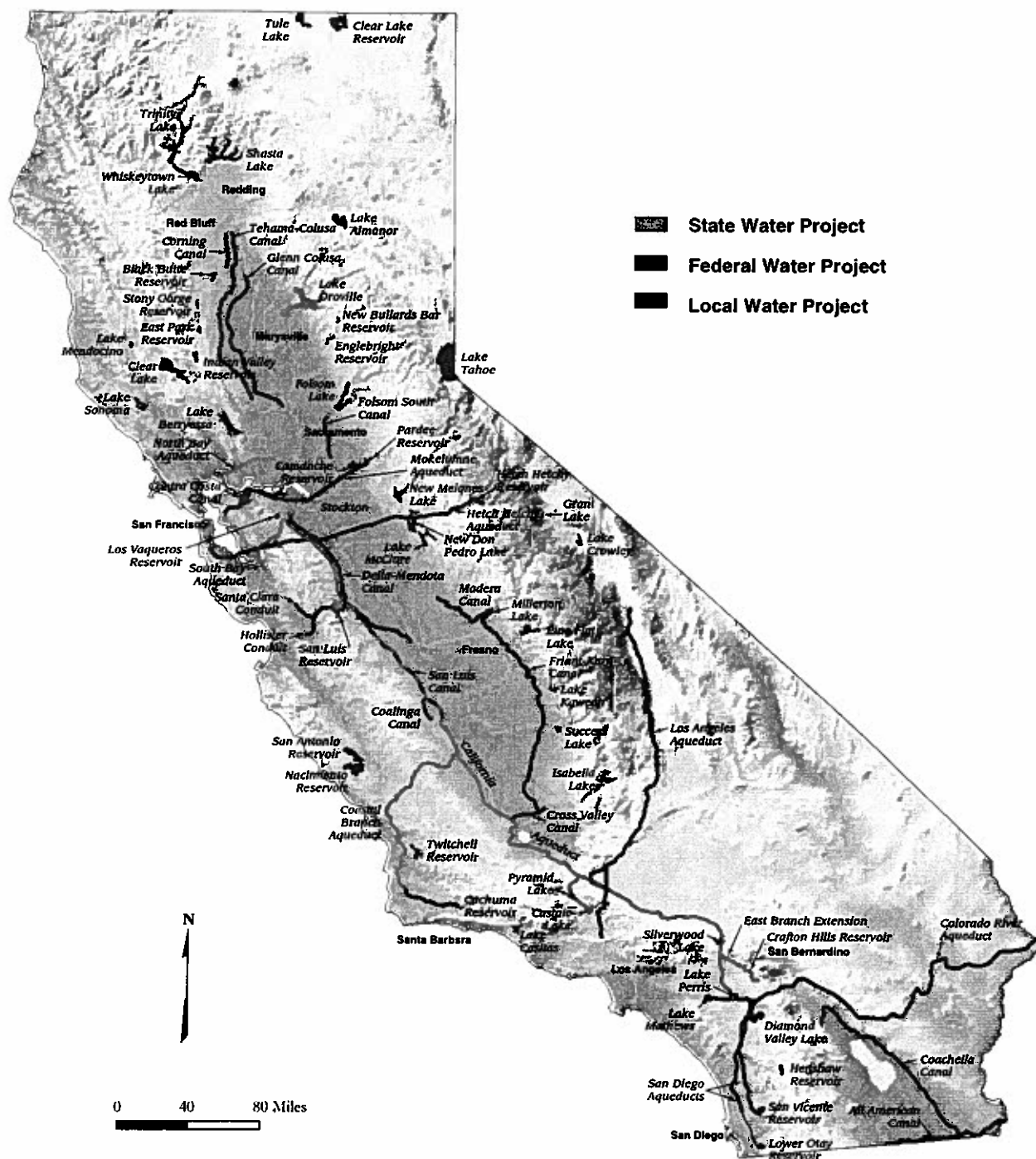


Figure 4 Water projects in California

Box B Will Climate Change Affect California's Groundwater?

California's water storage and delivery system can be thought of as including three reservoir systems—the snowpack of the Sierra Nevada, an extensive system of dams, lakes, and conveyance systems for surface water, and finally the aquifers that store groundwater. Precipitation in the form of snow is stored in the Sierra in winter and early spring and under ideal conditions melts in a manner that allows dams to capture the water for use during California's dry season. When snow melts faster, the dams act as flood control structures to prevent high runoff from flooding lowland areas. Water storage and delivery infrastructure—dams and canals—has been designed largely around the historical snowpack, while aquifers have played a less formal and less recognized role.

What will be the effect of climate change on California's water storage system? How will groundwater basins and aquifers be affected?

The latest report of the Intergovernmental Panel on Climate Change (2001) reaffirms that climate is changing in ways that cannot be accounted for by natural variability and that "global warming" is occurring. Studies by the National Water Assessment Team for the U.S. Global Change Research Program's National Assessment of the Potential Consequences of Climate Variability and Change identify potential changes that could affect water resources systems. For California, these include higher snow levels leading to more precipitation in the form of rain, earlier runoff, a rise in sea level, and possibly larger floods. In addition to affecting the balance between storage and flood control of our reservoirs, such changes in hydrology would affect wildlands, resulting in faunal and floral displacement and resulting in changes in vegetative water consumption. These changes would also affect patterns of both irrigated and dryland farming.

A warmer, wetter winter would increase the amount of runoff available for groundwater recharge; however, this additional runoff in the winter would be occurring at a time when some basins, particularly in Northern California, are either being recharged at their maximum capacity or are already full. Conversely, reductions in spring runoff and higher evapotranspiration because of warmer temperatures could reduce the amount of water available for recharge and surface storage.

The extent to which climate will change and the impact of that change are both unknown. A reduced snowpack, coupled with increased seasonal rainfall and earlier snowmelt may require a change in the operating procedures for existing dams and conveyance facilities. Furthermore, these changes may require more active development of successful conjunctive management programs in which the aquifers are more effectively used as storage facilities. Water managers might want to evaluate their systems to better understand the existing snowpack-surface water-groundwater relationship, and identify opportunities that may exist to optimize groundwater and other storage capability under a new hydrologic regime that may result from climate change. If more water was stored in aquifers or in new or reoperated surface storage, the additional water could be used to meet water demands when the surface water supply was not adequate because of reduced snowmelt.

Recent Groundwater Development Trends

While development of California's surface water storage system has slowed significantly, groundwater development continues at a strong pace. A review of well completion reports submitted to the California Department of Water Resources (DWR) provides data on the number and type of water wells drilled in California since 1987. For the 14-year period, DWR received 127,616 well completion reports for water supply wells that were newly constructed, reconditioned, or deepened—an average of 9,115 annually¹. Of these, 82 percent were drilled for individual domestic uses; 14 percent for irrigation; and about 4 percent for a combined group of municipal and industrial uses (Figure 5). Although domestic wells predominate, individual domestic use makes up a small proportion of total groundwater use in the State.

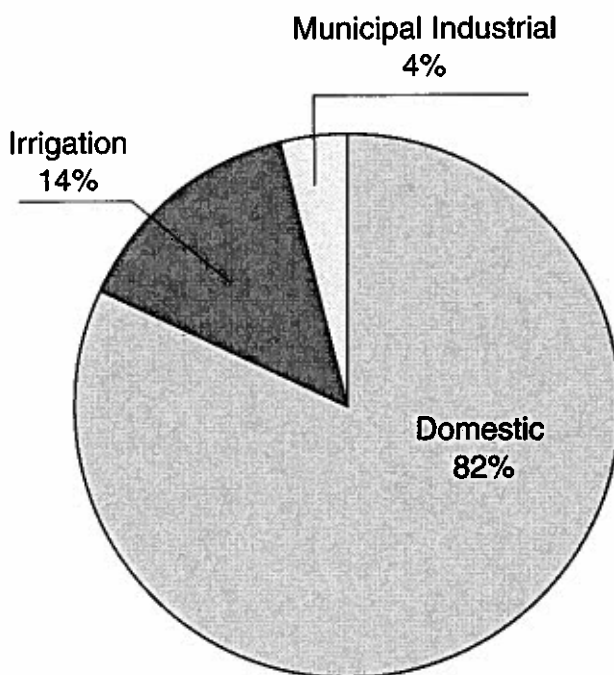


Figure 5 Well completion reports filed with DWR from 1987 through 2000

The most evident influence on the number of wells constructed is hydrologic conditions. The number of wells constructed and modified increases dramatically with drought conditions (Figure 6). The number of wells constructed and modified annually from 1987 through 1992 is more than double the annual totals for 1995 through 2000. Each year from 1987 through 1992 was classified as either dry or critically dry; water years 1995 through 2000 were either above normal or wet, based on measured unimpaired runoff in the Sacramento and San Joaquin valleys. In addition to providing an indication of the growth of groundwater development, well completion reports are a valuable source of information on groundwater basin conditions.

¹ DWR also received an average of 4,225 well completion reports for monitoring, which were not included above because they do not extract groundwater for supply purposes.

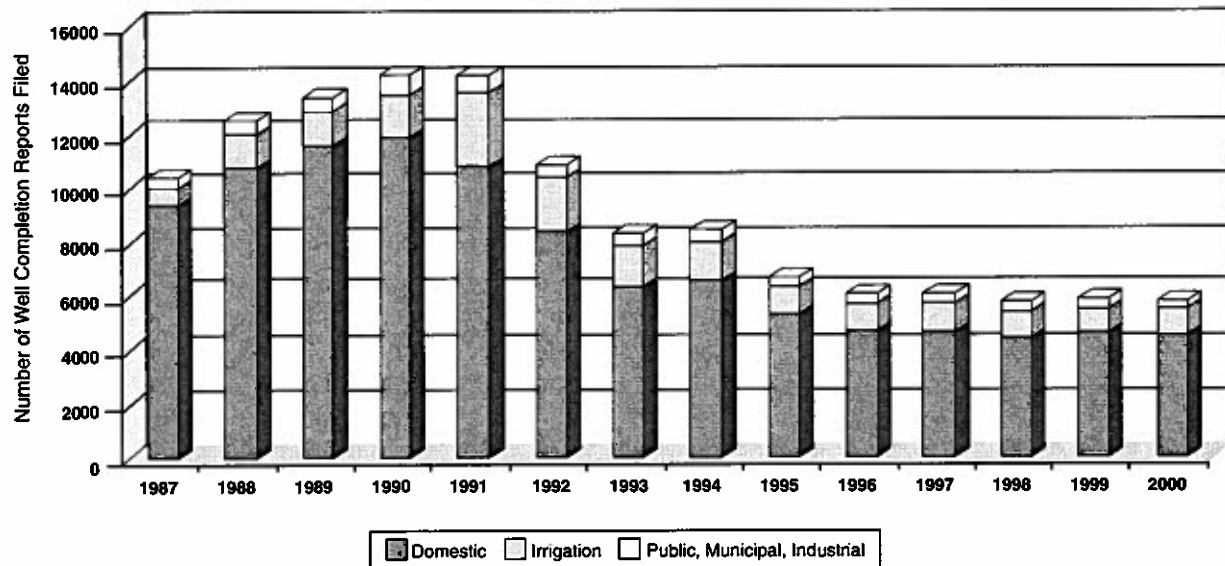


Figure 6 Well completion reports filed annually from 1987 through 2000

The Need for Groundwater Monitoring and Evaluation

Some 34 million people called California their home in the year 2000, and a population of nearly 46 million is expected by 2020. The increased population and associated commercial, industrial, and institutional growth will bring a substantially greater need for water. This need will be met in part by improved water use efficiency, opportunities to reoperate or expand California's surface water system, and increased desalination and recycling of water sources not currently considered usable. This need will also be met by storing and extracting additional groundwater. However, the sustainability of the groundwater resource, both in terms of what is currently used and future increased demand, cannot be achieved without effective groundwater management. In turn, effective groundwater management cannot be achieved without a program of groundwater data collection and evaluation.

Perhaps surprising to many, California does not have a comprehensive monitoring network for evaluating the health of its groundwater resource, including quantity and quality of groundwater. The reasons for this are many with the greatest one being that information on groundwater levels and groundwater quality is primarily obtained by drilling underground, which is relatively expensive. Given that delineated groundwater basins cover about 40 percent of the State's vast area, the cost of a dedicated monitoring network would be prohibitive. The other important reason for the lack of a comprehensive network is that, as will be discussed later in this report, groundwater is a locally controlled resource. State and federal agencies become involved only when a groundwater issue is directly related to the mission of a particular agency or if a local agency requests assistance. For these and other reasons, California lacks a cohesive, dedicated monitoring network.

Box C What about 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 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.

The California Water Plan Update, Bulletin 160-98 (DWR 1998) estimated that groundwater overdraft in California in 1995 was nearly 1.5 million acre-feet annually, with most of the overdraft occurring in the Tulare Lake, San Joaquin River, and Central Coast hydrologic regions. The regional and statewide estimates of overdraft are currently being revised for the 2003 update of Bulletin 160. While these estimates are useful from a regional and statewide planning perspective, the basin water budgets calculated for this update of Bulletin 118 clearly indicate that information is insufficient in many basins to quantify overdraft that has occurred, project future impacts on groundwater in storage, and effectively manage groundwater. Further technical discussion of overdraft is provided in Chapter 6 of this bulletin.

When DWR and other agencies involved in groundwater began to collect data in the first half of the 20th century, it quickly became evident that there were insufficient funds to install an adequate number of monitoring wells to accurately determine changes in the condition of groundwater basins. Consequently, to create a serviceable monitoring network, the agencies asked owners of irrigation or domestic wells for permission to measure water levels and to a lesser extent to monitor water quality. These have been called “wells of opportunity.” In many areas, this approach has led to a network of wells that provide adequate information to gain a general understanding of conditions in the subsurface and to track changes through time. In some areas, groundwater studies were conducted and often included the construction of a monitoring well network. These studies have gradually contributed to a more detailed understanding of some of California’s groundwater basins, particularly the most heavily developed basins.

Given the combination of monitoring wells of opportunity and dedicated monitoring wells, it might be assumed that an adequate monitoring network in California will eventually accumulate. However, several factors contribute to reducing the effectiveness of the monitoring network for data collection and evaluation: (1) The funding for data programs in many agencies, which was generally insufficient in the first place, has been reduced significantly. (2) When private properties change ownership, some new owners rescind permission for agency personnel to enter the property and measure the well. (3) The appropriateness of using these private wells is questionable because they are often screened over long intervals encompassing multiple aquifers in the subsurface, and in some cases construction details for the well are unknown. (4) Some wells with long-term records actually reach the end of their usefulness because the casing collapses or something falls into the well, making it unusable. In some cases, groundwater levels may drop below the well depth. (5) As water quality or water quantity conditions change, the monitoring networks may no longer be adequate to provide necessary data to manage groundwater.

The importance of long-term monitoring networks cannot be overstated. Sound groundwater management decisions require observation of trends in groundwater levels and groundwater quality. Only through these long-term evaluations can the question of sustainability of groundwater be answered. For example, this report contains a summary of groundwater contamination in public water supply wells throughout the State collected from 1994 through 2000. While this provides a “snapshot” of the suitability of the groundwater currently developed for public supply needs, it does not address sustainability of groundwater for public uses. Sustainability can only be determined by observing groundwater quality over time. If conditions worsen, local managers will need to take steps to prevent further harm to groundwater quality. Long-term groundwater records require adequate funding and staff to develop groundwater monitoring networks and to collect, summarize, and evaluate the data.

Chapter 2

Groundwater Management in California

Chapter 2

Groundwater Management in California

Groundwater management, as defined in this report, is the planned and coordinated monitoring, operation, and administration of a groundwater basin or portion of a groundwater basin with the goal of long-term sustainability of the resource. Throughout the history of water management in California, local agencies have practiced an informal type of groundwater management. For example, since the early 20th century, when excess surface water was available, some agencies intentionally recharged groundwater to augment their total water supply. In 1947, the amount of groundwater used was estimated at 9 million to 10 million acre-feet. By the beginning of the 21st century, the amount of groundwater used had increased to an estimated 15 million acre-feet. Better monitoring would provide more accurate information. This increased demand on California's groundwater resources, when coupled with estimates of population growth, has resulted in a need for more intensive groundwater management.

In 1914, California created a system of appropriating surface water rights through a permitting process (Stats 1913, ch. 586), but groundwater use has never been regulated by the State. Though the regulation of groundwater has been considered on several occasions, the California Legislature has repeatedly held that groundwater management should remain a local responsibility (Sax 2002). Although they are treated differently legally, groundwater and surface water are closely interconnected in the hydrologic cycle. Use of one resource will often affect the other, so that effective groundwater management must consider surface water supplies and uses.

Figure 7 depicts the general process by which groundwater management needs are addressed under existing law. Groundwater management needs are identified at the local water agency level and may be directly resolved at the local level. If groundwater management needs cannot be directly resolved at the local agency level, additional actions such as enactment of ordinances by local governments, passage of laws by the Legislature, or decisions by the courts may be necessary to resolve the issues. Upon implementation, local agencies evaluate program success and identify additional management needs. The State's role is to provide technical and financial assistance to local agencies for their groundwater management efforts, such as through the Local Groundwater Assistance grant program (see Chapter 4, AB 303).

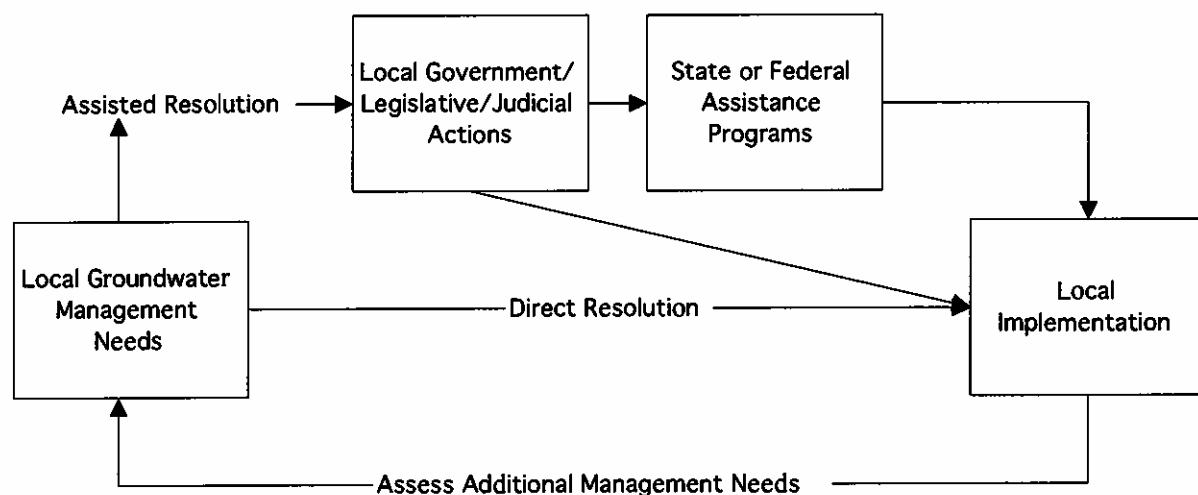


Figure 7 Process of addressing groundwater management needs in California

How Groundwater is Managed in California

There are three basic methods available for managing groundwater resources in California: (1) management by local agencies under authority granted in the California Water Code or other applicable State statutes, (2) local government groundwater ordinances or joint powers agreements, and (3) court adjudications. Table 1 shows how often each of these methods has been used, and each method is discussed briefly below. No law requires that any of these forms of management be applied in a basin. Management is often instituted after local agencies or landowners recognize a specific groundwater problem. The level of groundwater management in any basin or subbasin is often dependent on water availability and demand.

Table 1 Groundwater management methods

Method	Frequency of use ^a
Local water agencies	<p>Undetermined number of agencies with authority to manage some aspect of groundwater under general powers associated with a particular type of district.</p> <p>Thirteen agencies with specially legislated authority to limit or regulate extraction.</p> <p>Seven agencies with adopted plans under authority from Water Code Section 10750 et seq.^b (AB 255 of 1991).</p> <p>More than 200 agencies with adopted plans under authority from Water Code Section 10750 et seq. (AB 3030 of 1992).</p>
Local groundwater management ordinances	Currently adopted in 27 counties.
Court adjudication	<p>Currently decided in 19 groundwater basins, mostly in Southern California.</p> <p>Three more basins are in court.</p>

a. The numbers for some methods are unknown because reporting to the California Department of Water Resources is not required.

b. Section 10750 et seq. was amended in 1992.

Groundwater Management through Authority Granted to Local Water Agencies

More than 20 types of local agencies are authorized by statute to provide water for various beneficial uses. Many of these agencies also have statutory authority to institute some form of groundwater management. For example, a Water Replenishment District (Water Code, § 60000 et seq.) is authorized to establish groundwater replenishment programs and collect fees for that service. A Water Conservation District (Water Code, § 75500 et seq.) can levy groundwater extraction fees. Table 2 lists these and other types of local agencies that deliver water and may have authority to institute some form of groundwater management. Most of these agencies are identified in the Water Code, but their specific authority related to groundwater management varies. The Water Code does not require that the agencies report their activities to the California Department of Water Resources (DWR).

Table 2 Local agencies with authority to deliver water for beneficial uses, which may have authority to institute groundwater management

Local agency	Authority	Number of agencies ^a
Community Services District	Gov. Code § 61000 et seq.	313
County Sanitation District	Health and Safety Code § 4700 et seq.	91
County Service Area	Gov. Code § 25210.1 et seq.	897
County Water Authority	Water Code App. 45.	30
County Water District	Water Code § 30000 et seq.	174
County Waterworks District	Water Code § 55000 et seq.	34
Flood Control and Water Conservation District	Water Code App. 38.	39
Irrigation District	Water Code § 20500 et seq.	97
Metropolitan Water District	Water Code App 109.	1
Municipal Utility District	Pub. Util. Code § 11501 et seq.	5
Municipal Water District	Water Code § 71000 et seq.	40
Public Utility District	Pub. Util. Code § 15501 et seq.	54
Reclamation District	Water Code § 50000 et seq.	152
Recreation and Park District	Pub. Resources Code § 5780 et seq.	110
Resort Improvement District	Pub. Resources Code § 13000 et seq.	-
Resource Conservation District	Pub. Resources Code § 9001 et seq.	99
Water Conservation District	Water Code App. 34; Wat. Code § 74000 et seq.	13
Water District	Water Code § 34000 et seq.	141
Water Replenishment District	Water Code § 60000 et seq.	1
Water Storage District	Water Code § 39000 et seq.	8

a. From State Controller's Office Special Districts Annual Report, 49th Edition.

Greater authority to manage groundwater has been granted to a small number of local agencies or districts created through special acts of the Legislature. For example, the Sierra Valley Groundwater Basin Act of 1980 (Water Code, App. 119) created the first two groundwater management districts in California. Currently, 13 local agencies have specific groundwater management authority as a result of being special act districts. The specific authority of each agency varies, but they can generally be grouped into two categories. Most of the agencies formed since 1980 have the authority to limit export and even control some in-basin extraction upon evidence of overdraft or the threat of overdraft. These agencies can also generally levy fees for groundwater management activities and for water supply replenishment. Agencies formed prior to 1980 do not have authority to limit extraction from a basin. However, the groundwater users in these areas are generally required to report extractions to the agency, and the agency can levy fees for groundwater management or water supply replenishment. Some of these agencies have effectively used a tiered fee

structure to discourage excessive groundwater extraction in the basin. Table 3 lists the names of special act districts with legislative authority to manage groundwater.

Table 3 Special act districts with groundwater management authority in California

District or agency	Water Code citation ^a	Year agency established in Code ^b
Desert Water Agency	App. 100	1961
Fox Canyon Groundwater Management Agency	App. 121.	1982
Honey Lake Groundwater Management District	App. 129.	1989
Long Valley Groundwater Management District	App. 119.	1980
Mendocino City Community Services District	Section 10700 et seq.	1987
Mono County Tri-Valley Groundwater Management District	App. 128.	1989
Monterey Peninsula Water Management District	App. 118.	1977
Ojai Groundwater Management Agency	App. 131.	1991
Orange County Water District	App. 40.	1933
Pajaro Valley Water Management Agency	App. 124.	1984
Santa Clara Valley Water District	App. 60.	1951
Sierra Valley Groundwater Management District	App. 119.	1980
Willow Creek Groundwater Management Agency	App. 135.	1993

a. From West's Annotated California Codes (1999 update)

b. This represents the year the agency was established in the Water Code. Specific authorities, such as those for groundwater management activities, may have been granted through later amendments.

In 1991, AB 255 (Stats. 1991, Ch. 903) was enacted authorizing local agencies overlying basins subject to critical conditions of overdraft, as defined in DWR's Bulletin 118-80, to establish programs for groundwater management within their service areas. Water Code section 10750 et seq. provided these agencies with the powers of a water replenishment district to raise revenue for facilities to manage the basin for the purposes of extraction, recharge, conveyance, and water quality. Seven local agencies adopted plans under this authority.

The provisions of AB 255 were repealed in 1992 with the passage of AB 3030 (Stats. 1992, Ch. 947). This legislation was significant in that it greatly increased the number of local agencies authorized to develop a groundwater management plan and set forth a common framework for management by local agencies throughout California. AB 3030, which is codified in Water Code section 10750 et seq., provides a systematic procedure to develop a groundwater management plan by local agencies overlying the groundwater basins defined by Bulletin 118-75 (DWR 1975) and updates. Upon adoption of a plan, these agencies could possess the same authority as a water replenishment district to "fix and collect fees and assessments for groundwater management" (Water Code, § 10754). However, the authority to fix and collect these fees and assessments is contingent on receiving a majority of votes in favor of the proposal in a local election (Water Code, § 10754.3). More than 200 agencies have adopted an AB 3030 groundwater management plan. None of these agencies is known to have exercised the authority of a Water Replenishment District.

Water Code section 10755.2 expands groundwater management opportunities by encouraging coordinated plans and by authorizing public agencies to enter into a joint powers agreement or memorandum of understanding with public or private entities that provide water service. At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.

Local Groundwater Ordinances

A second general method of managing groundwater in California is through ordinances adopted by local governments such as cities or counties. Twenty-seven counties have adopted groundwater ordinances, and others are being considered (Figure 8). The authority of counties to regulate groundwater has been challenged, but in 1995 the California Supreme Court declined to review an appeal of a lower court decision *Baldwin v. County of Tehama* (1994) that holds that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. However, the precise nature and extent of the police power of cities and counties to regulate groundwater is uncertain.

The Public Policy Institute of California recently performed a study of California's water transfer market, which included a detailed investigation of the nature of groundwater ordinances by counties in California. The report found that 22 counties had adopted ordinances requiring a permit to export groundwater. In all but three cases, restricting out-of-county uses appears to be the only purpose (Hanak 2003). One ordinance, adopted recently in Glenn County (Box D, "Basin Management Objectives for Groundwater Management"), takes a comprehensive approach by establishing management objectives for the county's groundwater basins. Several other counties in Northern California are considering adopting similar management objective based ordinances.

Ordinances are mostly a recent trend in groundwater management, with 24 of the 27 ordinances enacted since 1990. Local ordinances passed during the 1990s have significantly increased the potential role of local governments in groundwater management. The intent of most ordinances has been to hold project proponents accountable for impacts that may occur as a result of proposed export projects. Because adoption of most of these ordinances is recent, their effect on local and regional groundwater management planning efforts is not yet fully known. However, it is likely that future groundwater development will take place within the constraints of local groundwater management ordinances. Table 4 lists counties with groundwater management ordinances and their key elements.

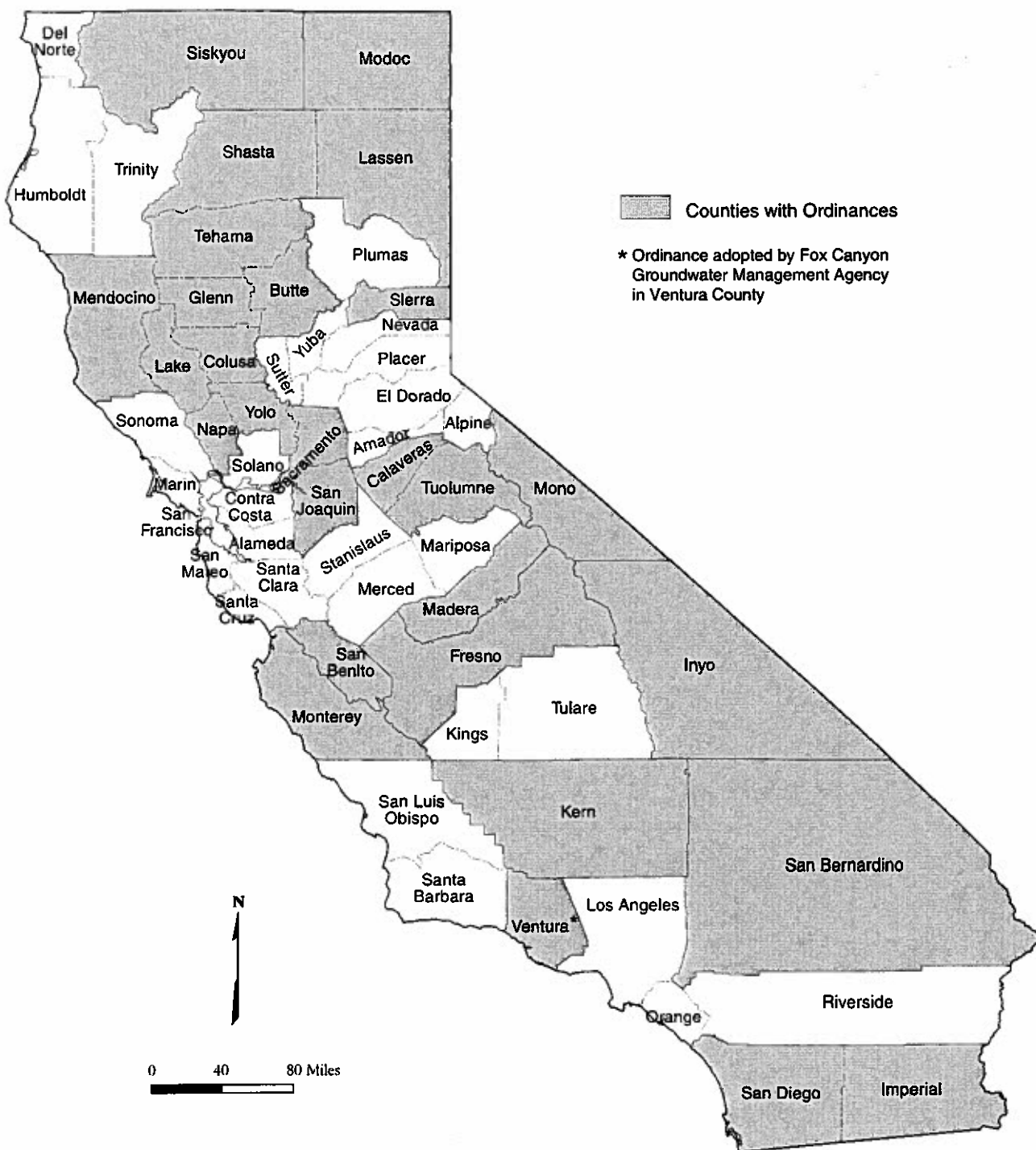


Figure 8 Counties with groundwater ordinances

Box D Basin Management Objectives for Groundwater Management

Most county groundwater management ordinances require that an export proponent prove the project will not deplete groundwater, cause groundwater quality degradation, or result in land subsidence. Although these factors could be part of any groundwater management plan, these ordinances do not require that a groundwater management plan be developed and implemented.

The only ordinance requiring development and adoption of objectives to be accomplished by management of the basin was adopted by the Glenn County Board of Supervisors in 2000. The action came after a citizens committee spent five years working with stakeholders. The process of developing a groundwater management ordinance for Glenn County began in 1995 when local landowners and county residents became concerned about plans to export groundwater or substitute groundwater for exported surface water. Control of exports was the focus of early ordinance discussions.

After long discussions and technical advice from groundwater specialists, the committee realized that goals and objectives must be identified for effective management of groundwater in the county. What did the county want to accomplish by managing groundwater within the county? What did groundwater management really mean?

The concept of establishing basin management objectives emerged (BMOs). BMOs would establish threshold values for groundwater levels, groundwater quality, and land surface subsidence. When a threshold level is reached, the rules and regulations require that groundwater extraction be adjusted or stopped to prevent exceeding the threshold.

The Glenn County Board of Supervisors has adopted BMOs, which were developed by an advisory committee, for groundwater levels throughout the county. While currently there are 17 BMOs representing the 17 management areas in the county, the goal is to begin managing the entire county in a manner that benefits each of the local agencies and their landowners, as well as landowners outside of an agency boundary. The committee is now developing BMOs for groundwater quality and land surface subsidence.

There is no single set of management objectives that will be successful in all areas. Groundwater management must be adapted to an area's political, institutional, legal, and technical constraints and opportunities. Groundwater management must be tailored to each basin or subbasin's conditions and needs. Even within a single basin, the management objectives may change as more is learned about managing the resource within that basin. Flexibility is the key, but that flexibility must operate within a framework that ensures public participation, monitoring, evaluation, feedback on management alternatives, rules and regulations, and enforcement.

Table 4 Counties with ordinances addressing groundwater management

County	Year enacted	Key elements (refer to ordinances for exemptions and other details)
Butte	1996	Export permit required (extraction & substitute pumping), Water Commission and Technical Advisory Committee, groundwater planning reports (county-wide monitoring program)
Calaveras	2002	Export permit required (extraction & substitute pumping)
Colusa	1998	Export permit required (extraction & substitute pumping)
Fresno	2000	Export permit required (extraction & substitute pumping)
Glenn	1990 rev. 2000	Water Advisory Committee and Technical Advisory Committee, basin management objectives and monitoring network, export permit required (1990)
Imperial	1996	Commission established to manage groundwater, including controlling exports (permit required), overdraft, artificial recharge, and development projects
Inyo	1998	Regulates (1) water transfers pursuant to Water Code Section 1810, (2) sales of water to the City of Los Angeles from within Inyo Co., (3) transfer or transport of water from basins within Inyo County to another basin with the County, and (4) transfers of water from basins within Inyo Co. to any area outside the County.
Kern	1998	Conditional use permit for export to areas both outside county and within watershed area of underlying aquifer in county. Only applies to southeastern drainage of Sierra Nevada and Tehachapi mountains.
Lake	1999	Export permit required (extraction & substitute pumping)
Lassen	1999	Export permit required (extraction & substitute pumping)
Madera	1999	Permit required for export, groundwater banking, and import for groundwater banking purposes to areas outside local water agencies
Mendocino	1995	Mining of groundwater regulated for new developments in Town of Mendocino
Modoc	2000	Export permit required for transfers out of basin
Mono	1988	Permit required for transfers out of basin
Monterey	1993	Water Resources Agency strictly regulates extraction facilities in zones with groundwater problems
Napa	1996	Permits for local groundwater extractions; exemptions for single parcels and agricultural use
Sacramento	1952 rev. 1985	Water Agency established to manage and protect groundwater management zones; replenishment charges
San Benito	1995	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use, injecting imported water; influence of well pumping restrictions
San Bernardino	2002	Permit required for any new groundwater well within the desert region of the county
San Diego	1991	Provides for mapping of groundwater impacted basins (defined); projects within impacted basins require groundwater investigations
San Joaquin	1996	Export permit required (extraction & substitute pumping)
Shasta	1997	Export permit required (extraction & substitute pumping)
Sierra	1998	Export permit required or for off-parcel use
Siskiyou	1998	Permit required for transfers out of basin
Tehama	1992	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use; influence of well pumping restrictions
Tuolumne	2001	Export permit required (extraction & substitute pumping)
Yolo	1996	Export permit required (extraction & substitute pumping)

Adjudicated Groundwater Basins

A third general form of groundwater management in California is court adjudication. In some California groundwater basins, as the demand for groundwater exceeded supply, landowners and other parties turned to the courts to determine how much groundwater can rightfully be extracted by each user. The courts study available data to arrive at a distribution of the groundwater that is available each year, usually based on the California law of overlying use and appropriation. This court-directed process can be lengthy and costly. As noted in Table 5, the longest adjudication took 24 years. Many of these cases have been resolved with a court-approved negotiated settlement, called a stipulated judgment. Unlike overlying and non-overlying rights to groundwater, such decisions guarantee to each party a proportionate share of the groundwater that is available each year. The intense technical focus on the groundwater supply and restrictions on groundwater extraction for all parties make adjudications one of the strongest forms of groundwater management in California.

There are 19 court adjudications for groundwater basins in California, mostly in Southern California (see Table 5). Eighteen of the adjudications were undertaken in State Superior Court and one in federal court. For each adjudicated groundwater basin, the court usually appoints a watermaster to oversee the court judgment. In 15 of these adjudications, the court judgment limits the amount of groundwater that can be extracted by all parties based on a court-determined safe yield of the basin. The basin boundaries are also defined by the court. The Santa Margarita Basin was adjudicated in federal court. That decision requires water users to report the amount of surface water and groundwater they use, but groundwater extraction is not restricted.

Most basin adjudications have resulted in either a reduction or no increase in the amount of groundwater extracted. As a result, agencies often import surface water to meet increased demand. The original court decisions provided watermasters with the authority to regulate extraction of the quantity of groundwater; however, they omitted authority to regulate extraction to protect water quality or to prevent the spread of contaminants in the groundwater. Because water quantity and water quality are inseparable, watermasters are recognizing that they must also manage groundwater quality.

Box E Adjudication of Groundwater Rights in the Raymond Basin

The first basin-wide adjudication of groundwater rights in California was in the Raymond Basin in Los Angeles County in 1949 (*Pasadena v. Alhambra*). The first water well in Raymond Basin was drilled in 1881; 20 years later, the number of operating wells grew to about 140. Because of this pumping, the City of Pasadena began spreading water in 1914 to replenish the groundwater, and during the next 10 years the city spread more than 20,000 acre-feet.

Pumping during 1930 through 1937 caused water levels to fall 30 to 50 feet in wells in Pasadena. After attempting to negotiate a reduction of pumping on a cooperative basis, the City of Pasadena, on September 23, 1937, filed a complaint in Superior Court against the City of Alhambra and 29 other pumpers to quiet title to the water rights within Raymond Basin. The court ruled that the city must amend its complaint, making defendants of all entities pumping more than 100 acre-feet per year, and that it was not a simple quiet title suit but, a general adjudication of the water rights in the basin.

In February 1939, a court used the reference procedure under the State Water Code to direct the State Division of Water Resources, Department of Public Works (predecessor to the Department of Water Resources) as referee to review all physical facts pertaining to the basin, determine the safe yield, and ascertain whether there was a surplus or an overdraft. The study took 2-1/2 years to complete and cost more than \$53,000, which was paid by the parties. The resulting Report of Referee submitted to the court in July 1943 found that the annual safe yield of the basin was 21,900 acre-feet but that the actual pumping and claimed rights were 29,400 acre-feet per year.

Most parties agreed to appoint a committee of seven attorneys and engineers to work out a stipulated agreement. In 1944, the court designated the Division of Water Resources to serve as watermaster for the stipulated agreement, which all but one of the parties supported. On December 23, 1944, the judge signed the judgment that adopted the stipulation.

The stipulation provided that (1) the water was taken by each party openly, notoriously, and under a claim of right, which was asserted to be, and was adverse to each and all other parties; (2) the safe yield would be divided proportionally among the parties; and (3) each party's right to a specified proportion of the safe yield would be declared and protected. It also established an arrangement for the exchange of pumping rights among parties.

Based on the stipulation, the court adopted a program of proportionate reductions. In so doing, the court developed the doctrine of mutual prescription, whereby the rights were essentially based on the highest continual amount of pumping during the five years following the beginning of the overdraft, and under conditions of overdraft, all of the overlying and appropriative water users had acquired prescriptive rights against each other, that is, mutual prescription.*

In 1945, one party appealed the judgment, and in 1947, the District Court of Appeals reversed and remanded *Pasadena v. Alhambra*. However, on June 3, 1949, the State Supreme Court overturned the appellate court's decision and affirmed the original judgment. In 1950, the court granted a motion by the City of Pasadena that there be a review of the determination of safe yield, and in 1955, the safe yield and the total decreed rights were increased to 30,622 acre-feet per year. In 1984, watermaster responsibilities were assigned to the Raymond Basin Management Board.

*In *City of Los Angeles v. City of San Fernando* (1975) the California Supreme Court rejected the doctrine of mutual prescription and held that a groundwater basin should be adjudicated based on the correlative rights of overlying users and prior appropriation among non-overlying users. For further discussion, see Appendix B.

Table 5 List of adjudicated basins

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
1—Scott River Stream System	Scott River Valley; Siskiyou	1-5	1970	1980	Two local irrigation districts
2—Santa Paula Basin	Subbasin of Santa Clara River; Ventura	4-4	1991	1996	Three-person technical advisory committee from United Water CD, City of Ventura, and Santa Paula Basin Pumpers Association; www.unitedwater.org
3—Central Basin	Northeast part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1962	1965	DWR—Southern District; www.dpla.water.ca.gov/sd/watermaster/watermaster.html
4—West Coast Basin	Southwest part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1946	1961	DWR—Southern District; www.dpla.water.ca.gov/sd/watermaster/watermaster.html
5—Upper Los Angeles River Area	San Fernando Valley Basin (entire watershed); Los Angeles	4-12	1955	1979	Superior Court appointee
6—Raymond Basin	Northwest part of San Gabriel Valley Basin; Los Angeles	4-13	1937	1944	Raymond Basin Management Board
7—Main San Gabriel Basin	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1968	1973	Water purveyors and water districts elect a nine-member board; www.watermaster.org/
Puente Narrows, Addendum to Main San Gabriel Basin decision	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1972	1972	Two consulting engineers
			1985	1985	Three consultants
8—Puente	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1985	1985	Three consultants
9—Cummings Basin	Cummings Valley Basin; Kern	5-2	1966	1972	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
10—Tehachapi Basin	Tehachapi Valley West Basin and Tehachapi Valley East Basin; Kern	5-28 6-45	1966	1973	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
11—Brite Basin	Brite Valley; Kern	5-80	1966	1970	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm

Table 5 List of adjudicated basins (continued)

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
12—Mojave Basin Area Adjudication	Lower, Middle & Upper Mojave River Valley Basins; El Mirage & Lucerne valleys; San Bernardino	6-40, 6-41, 6-42	1990	1996	Mojave Water Agency; www.mojavewater.org/inwa700.htm
13—Warren Valley Basin	Part of Warren Valley Basin; San Bernardino	7-12	1976	1977	Hi-Desert Water District; www.mojavewater.org
14—Chino Basin	Northwest part of Upper Santa Ana Valley Basin; San Bernardino and Riverside	8-2	1978	1978	Nine people, recommended by producers and appointed by the court; www.cbwm.org/
15—Cucamonga Basin	North central part of Upper Santa Ana Valley Basin; San Bernardino	8-2	1975	1978	Not yet appointed, operated as part of Chino Basin
16—San Bernardino Basin Area	Northeast part of Upper Santa Ana Basin; San Bernardino and Riverside	8-2	1963	1969	One representative each from Western Municipal Water District of Riverside County & San Bernardino Valley Municipal Water District
17—Six Basins	Six subbasins in northwest upper Santa Ana Valley; Upper & Lower Claremont Heights, Canyon, Pomona, Live Oak & Ganesha; Los Angeles. Small portions of Upper Claremont Heights and Canyon are in San Bernardino County	4-14, 8-2	1998	1998	Nine-member board representing all parties to the judgment
18—Santa Margarita River watershed	The Santa Margarita River watershed, including 3 groundwater basins: Santa Margarita Valley, Temecula Valley and Cahuilla Valley Basins; San Diego and Riverside.	9-4, 9-5, 9-6	1951	1966	U.S. District Court appointee
19—Goleta	Goleta Central Basin; judgment includes North Basin; Santa Barbara	3-16	1973	1989	No watermaster appointed; the court retains jurisdiction

How Successful Have Groundwater Management Efforts Been?

This chapter describes the opportunities for local agencies to manage their groundwater resources. Many have questioned whether these opportunities have led to an overall successful system of groundwater management throughout California. How successful groundwater management has been throughout the State is a difficult question and cannot be answered at present. While there are many examples of local agency successes (see Box F, “Managing through a Joint Powers Agreement,” Box G, “Managing a Basin through Integrated Water Management,” and Box H, “Managing Groundwater Using both Physical and Institutional Solutions”), there are neither mandates to prepare groundwater management plans nor reporting requirements when plans are implemented, so a comprehensive assessment of local planning efforts is not possible. Additionally, many plans have been adopted only recently, during a period of several consecutive wet years, so many of the plan components are either untested or not implemented.

At a minimum, successful groundwater management should be defined as maintaining and maximizing long-term reliability of the groundwater resource, focused on preventing significant depletion of groundwater in storage over the long term and preventing significant degradation of groundwater quality. A review of some of the groundwater management plans prepared under AB 3030 reveals that some plans are simply brief recitations about continuing the agency’s existing programs. Not all agencies that enacted groundwater management plans under AB 3030 are actively implementing the plan.

Despite this apparent lack of implementation of groundwater management plans prepared under AB 3030, the bill has certainly increased interest in more effective groundwater management. With more than 200 agencies participating in plans and more than 120 of those involved in coordinated plans with other agencies, AB 3030 has resulted in a heightened awareness of groundwater management. Additionally, annual reports published by a few water agencies indicate that they are indeed moving toward better coordination throughout the basin and more effective management of all water supplies. Given the history of groundwater management in California, these seemingly small steps toward better management may actually represent giant strides forward.

More recently, financial incentives have played a large role in driving groundwater management activities. For example, under grant and loan programs resulting from Proposition 13 of 2000 (see description in Chapter 4), local agencies submitted applications proposing a total increase in annual water yield of more than 300,000 acre-feet through groundwater storage projects. Additional projects and programs would be developed with sufficient funding for feasibility and pilot studies. Unfortunately, not enough funding exists for all of the proposed projects, and many other legal and institutional barriers remain (see Box I, “Impediments to Conjunctive Management Programs in California”). It is clear, however, that further incentives would help agencies move ahead more aggressively in their groundwater management planning efforts.

Additional progress in groundwater management is reflected by passage of amendments to the Water Code (§§ 10753.4 and 10795.4 as amended, §§ 10753.7, 10753.8, and 10753.9 as amended and renumbered, and §§ 10753.1 and 10753.7 as added) through SB 1938 of 2002. The amendments require that groundwater management plans include specific components for agencies to be eligible for some public funds for groundwater projects. The provisions of SB 1938 (2001) are fully described in Chapters 3 and 4.

This evaluation of groundwater management success has not really considered ordinances and adjudications. Adjudications have been successful at maintaining the groundwater basin conditions, often restricting pumping for all basin users. In some cases, adjudication provides the necessary framework for more proactive management as well. Ordinances have successfully restricted exports from basins, but have not

Box F Managing through a Joint Powers Agreement

In 1993, representatives from business, environmental, public, and water purveyor interests formed the Sacramento Area Water Forum to develop a plan to protect the region's water resources from the effects of prolonged drought as the demand for water continues to grow. The Water Forum was founded on two co-equal objectives: (1) to provide a reliable and safe water supply for the region's economic health and planned development to the year 2030 and (2) to preserve the fishery, wildlife, recreational and aesthetic values of the lower American River.

After a six-year consensus-based process of education, analysis and negotiation, the participants signed a Water Forum agreement to meet these objectives. The agreement provides a framework for avoiding future water shortages, environmental degradation, groundwater contamination, threats to groundwater reliability, and limits to economic prosperity.

The Sacramento Groundwater Authority (SGA) was formed to fulfill a key Water Forum goal of protecting and managing the north-area groundwater basin. The SGA is a joint powers authority formed for the purpose of collectively managing the region's groundwater resources. This authority permits SGA to make contractual arrangements required to implement a conjunctive use program, and also provides potential partners with the legal and political certainty for entering into long-term agreements.

SGA's regional banking and exchange program is designed to provide long-term supply benefits for local needs, but also will have the potential to provide broader statewide benefits consistent with American River environmental needs. Water stored in Folsom Lake would be conjunctively used with groundwater in order to reduce surface water diversions in dry years and to achieve in-lieu recharge of the basin in wet years. The conjunctive use program participants include 16 water providers in northern Sacramento and southern Placer counties that serve water to more than half a million people.

Two of three implementation phases of the program are complete. In the first phase, program participants identified long-term water supply needs and conducted an inventory of existing infrastructure that could be used to implement the program. In the second phase, SGA completed two pilot banking and exchange projects, demonstrating the technical, legal, and institutional viability of a regional conjunctive use program. In the first pilot study, water agencies worked with the U.S. Bureau of Reclamation and the Sacramento Area Flood Control Agency to bank 2,100 acre-feet of groundwater, providing additional flood storage capacity in Folsom Lake. In the second pilot study, Citrus Heights and Fair Oaks water districts and the city of Sacramento extracted and used 7,143 acre-feet of groundwater, forgoing a portion of their rights to surface water, making this water available to the Environmental Water Account. The third phase of the SGA program is to further solidify the institutional framework and construct facilities to implement a full-scale regional conjunctive use program. These facilities, that will result in an average annual yield of 21,400 acre-feet, are currently under construction, funded in part by a \$21.6 million grant under Proposition 13 of 2000.

Box G Managing a Basin through Integrated Water Management

Orange County Water District (OCWD) was established in 1933 by an uncoded Act (Water Code App. 40) to manage Orange County's groundwater basin and protect the Santa Ana River rights of water users of north-central Orange County. The district manages the groundwater basin, which provides as much as 75 percent of the water supply for its service area. The district strives for a groundwater-based water supply with enough reserves to provide a water supply through drought conditions. An integrated set of water management practices helps achieve this, including the use of recharge, alternative sources, and conservation.

Recharge

The Santa Ana River provides the main natural recharge source for the county's groundwater basin. Increased groundwater use and lower-than-average rainfall during the late 1980s and early 1990s forced the district to rely on an aggressive program to enhance recharge of the groundwater basin. Programs used today to optimize water use and availability include:

- Construction of levees in the river channel to increase infiltration.
- Construction of artificial recharge basins within the forebay.
- Development of an underwater basin cleaning vehicle that removes a clogging layer at the bottom of the recharge basin and extends the time between draining the basin for cleaning by a bulldozer.
- Use of storm water captured behind Prado Dam that would otherwise flow to the ocean.
- Use of imported water from the State Water Project and Colorado River.
- Injection of treated recycled water to form a seawater intrusion barrier.

Alternative Water Use and Conservation

OCWD has successfully used nontraditional sources of water to help satisfy the growing need for water in Orange County. Projects that have added to the effective supply of groundwater are:

- Use of treated recycled water for irrigation and industrial use.
- In-lieu use to reduce groundwater pumping.
- Change to low-flow toilets and showerheads.
- Participation of 70 percent of Orange County hotels and motels in water conservation programs.
- Change to more efficient computerized irrigation.

Since 1975, Water Factory 21 has provided recycled water that meets all primary and secondary drinking water standards set by the California Department of Health Services. OCWD has proposed a larger, more efficient membrane purification project called the Groundwater Replenishment System (GWRS), which is scheduled to begin operating at 70,000 acre-feet per year in 2007. By 2020 the system will annually supply 121,000 acre-feet of high quality water for recharge, for injection into the seawater intrusion barrier, and for direct industrial uses.

This facility will use a lower cost microfiltration and reverse osmosis treatment process that produces water of near distilled quality, which will help reverse the trend of rising total dissolved solids (TDS) in groundwater caused by the recharge of higher TDS-content Santa Ana River and Colorado River waters. The facility will use about half the energy required to import an equivalent amount of water to Orange County from Northern California. The GWRS will be funded, in part, by a \$30 million grant under Proposition 13 of 2000.

Source: Orange County Water District

Box H Managing Groundwater using both Physical and Institutional Solutions

Four agencies share responsibility for groundwater management in Ventura County. Coordination and cooperation between these agencies focus on regular meetings, attendance at each other's board meetings, joint projects, watershed committees, and ongoing personal contacts to discuss water-related issues. The agencies and their areas of responsibility are:

- United Water Conservation District – physical solutions, monitoring, modeling, reporting, administering management plans and adjudication;
- Fox Canyon Groundwater Management Agency – pumping allocations, credits and penalties, abandoned well destruction, data for irrigation efficiency;
- County of Ventura – well permits, well construction regulations, tracking abandoned wells; and
- Calleguas Municipal Water District – groundwater storage of imported water.

In Ventura County 75% to 80% of the extracted groundwater is for agriculture; the remainder is for municipal and industrial use. Seawater intrusion into the aquifers was recognized in the 1940s and was the driving force behind a number of groundwater management projects and policies in the county's groundwater basins. As groundwater issues became more complicated at the end of the 20th century, these groundwater management projects and policies were useful in solving a number of problems.

Physical Solutions

Physical solutions substitute supplemental surface water for groundwater pumping near coastal areas, increase basin recharge, and increase the reliability of imported water. Projects include:

- Winter flood-flow storage for dry season release
- Wells and pipelines to move pumping for drinking water away from the coast
- Diversion structures to supply surface water to spreading grounds and irrigation
- Pipelines to convey surface water to coastal areas
- Las Posas Basin Aquifer Storage and Recovery project

Institutional Solutions

Institutional solutions focus on developing and implementing effective groundwater management programs, reducing pumping demands, tracking groundwater levels and water quality, managing groundwater pumping patterns, and destroying abandoned wells to prevent cross-contamination of aquifers. Solutions include:

- Creation of Fox Canyon Groundwater Management Agency (GMA), which represents each major pumping constituency
- Use of irrigation efficiency (agriculture), water conservation, and alternative sources of water (urban) to reduce pumping by 25%
- Manage outside the GMA area through an AB 3030 plan and a court adjudication
- Limit new permits for wells in specific aquifers to avoid seawater intrusion
- Creation of a program to destroy abandoned wells
- Creation of a database of historical groundwater levels and quality information collected since the 1920s
- Development of a regional groundwater flow model and a regional master plan for groundwater projects
- Creation of an irrigation weather station to assist in irrigation efficiency

Implementation of these physical and institutional management tools has resulted in the reversal of seawater intrusion in key coastal monitoring wells. These same tools are being used to mitigate saline intrusion (not seawater) in two inland basins and to reduce seasonal nitrate problems in the recharge area. Work is being expanded to help reduce loading of agricultural pesticides and nutrients. Without close coordination and cooperation of the county's water-related agencies, municipalities, and landowners, it would have been very difficult to implement most of these solutions. Although such coordination takes time, the investment has paid off in solutions that help provide a sustainable water supply for all water users in Ventura County.

Source: United Water Conservation District

necessarily improved groundwater management. The primary intent of most ordinances is to ensure that proponents of projects are held accountable for potential impacts of the proposed export projects. As studies lead to a better understanding of local water resources, development of pilot export and transfer projects, with appropriate monitoring, may lead to greater certainty in managing groundwater resources. Areas managed under adjudications and ordinances will continue to develop more active management approaches. Population growth and its accompanying increased demand on the resources is a certainty. Most geographic areas in California are not immune to this growth, so strategies for more than just maintaining existing groundwater supply through extraction or export restrictions need to be implemented.

Box I Impediments to Conjunctive Management Programs in California

In 1998 the National Water Research Institute, in cooperation with the Association of Ground Water Agencies and the Metropolitan Water District of Southern California, conducted a workshop to determine the biggest impediments to implementing a cost-effective conjunctive water management program in California.

Since that time, some steps have been taken to overcome those impediments, but several important barriers remain. Workshop participants identified the 10 most significant obstacles:

- 1) Inability of local and regional water management governance entities to build trust, resolve differences (internally and externally), and share control.
- 2) Inability to match benefits and funding burdens in ways that are acceptable to all parties, including third parties.
- 3) Lack of sufficient federal, State, and regional financial incentives to encourage groundwater conjunctive use to meet statewide water needs.
- 4) Legal constraints that impede conjunctive use, regarding storage rights, basin judgments, area of origin, water rights, and indemnification.
- 5) Lack of statewide leadership in the planning and development of conjunctive use programs as part of comprehensive water resources plans, which recognize local, regional, and other stakeholders' interests.
- 6) Inability to address quality difference in "put" versus "take"; standards for injection, export, and reclaimed water; and unforeseeable future groundwater degradation.
- 7) Risk that water stored cannot be extracted when needed because of infrastructure, water quality or water level, politics, and institutional or contractual provisions.
- 8) Lack of assurances to prevent third-party impacts and assurances to increase willingness of local citizens to participate.
- 9) Lack of creativity in developing lasting "win-win" conjunctive use projects, agreements, and programs.
- 10) Supplemental suppliers and basin managers have different roles and expectations in relation to conjunctive use.

[Editor's note: The California Department of Water Resources' Conjunctive Water Management program has taken significant steps to overcome several of these impediments, using a combination of California Bay-Delta Authority, DWR, Proposition 13, and AB 303 funds to promote locally planned and controlled conjunctive use programs.]

Future Groundwater Management in California

Trying to predict what will happen with groundwater management in California is difficult given that actions by all of the involved groups—landowners, local governments, local, State, and federal agencies, and the courts—will continue to shape groundwater management in the future. However, the increasing population and its demands on California’s water supply will accelerate the rate at which groundwater management issues become critical and require resolution. Some general conclusions are:

- Groundwater management will continue to be a local responsibility with increasing emphasis on how actions in one part of a basin impact groundwater resources throughout the basin. Regional cooperation and coordination of groundwater management activities will increase.
- As the State’s population continues to grow, the increased reliance on groundwater will keep the topic of groundwater management at the forefront of legislative interest.
- Coordinated management of groundwater and surface water resources, through further development of conjunctive water management programs and projects, will become increasingly important.
- The increased reliance on groundwater in the future will necessitate a more direct link between land use planning, watershed management, floodplain management, and groundwater management plans.
- Current trends indicate that financial incentives in the form of loans and grants are increasing groundwater management planning and implementation at the local level. These successes will only continue at the current pace with increased funding to local agencies.
- Management of groundwater will increasingly include consideration of groundwater quality and groundwater quantity.
- Groundwater will be an important element in the trend toward an integrated water management approach that considers the full range of demand management and supply alternatives.
- Understanding of the relationship of groundwater and surface water and the role of groundwater in the environment will continue to grow.

Box J Managing Groundwater Quantity and Quality

When people hear the words “groundwater monitoring” they may think either of measuring groundwater levels or of analyzing for groundwater quality. In reality, monitoring and management of groundwater quantity and groundwater quality are inseparable components of a management plan.

Although the primary focus of the California Department of Water Resources (DWR) is on groundwater quantity and the measures taken by local agencies to manage supply, management must also consider groundwater quality. Natural or anthropogenic contamination and pumping patterns that are not managed to protect groundwater quality may limit the quantity of groundwater that is available for use in a basin.

Several State programs provide useful data as well as regulatory direction on groundwater quality that managers can use in managing their groundwater supply. One program is the Drinking Water Source Assessment and Protection Program prepared by the California Department of Health Services in response to 1996 amendments to the federal Safe Drinking Water Act. The DWSAP requires water purveyors to assess sources of drinking water, develop zones indicating time of travel of groundwater, and identify potentially contaminating activities around supply wells. The goal is to ensure that the quality of drinking water sources is maintained and protected. Other useful water quality data for groundwater managers is collected by the agencies within the California Environmental Protection Agency, including the State Water Resources Control Board, Department of Pesticide Regulation and the Department of Toxic Substances Control, which are discussed in more detail in Chapter 5. Each of these agencies has a specific statutory responsibility to collect groundwater quality information and protect water quality.

Protection of Recharge Areas

Groundwater recharge areas, and the human activities that can render them unusable, are an example of the need to coordinate land use activities to protect both groundwater quality and quantity. Protection of recharge areas, whether natural or man-made, is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. Existing and potential recharge areas must be protected so that they remain functional, that is they continue to provide recharge to the aquifer and they are not contaminated with chemical or microbial constituents. Land-use practices should be implemented so that neither the quantity nor quality of groundwater is reduced. A lack of protection of recharge areas could decrease the availability of usable groundwater and require the substitution of a more expensive water supply.

Many potentially contaminating activities have routinely been practiced in recharge areas, leading to the presence of contaminants in groundwater. In many areas, groundwater obtained from aquifers now requires remediation. Recent studies in some areas show that recharge areas are contaminated, but down-gradient wells are not, indicating that it is only a matter of time before contaminants in wells reach concentrations that require treatment of the groundwater.

In addition to quality impacts, urban development, consisting of pavement and buildings on former agricultural land, lining of flood control channels, and other land use changes have reduced the capacity of recharge areas to replenish groundwater, effectively reducing the safe yield of some basins.

Box J Managing Groundwater Quantity and Quality (continued)

To ensure that recharge areas continue to replenish high quality groundwater, water managers and land use planners should work together to:

- Identify recharge areas so the public and local zoning agencies are aware of the areas that need protection from paving and from contamination;
- Include recharge areas in zoning categories that eliminate the possibility of contaminants entering the subsurface;
- Standardize guidelines for pre-treatment of the recharge water, including recycled water;
- Build monitoring wells to collect data on changes in groundwater quality that may be caused by recharge; and
- Consider the functions of recharge areas in land use and development decisions.



Chapter 3

Groundwater Management Planning and Implementation

Chapter 3

Groundwater Management Planning and Implementation

The 1990s were a very important decade in the history of groundwater management in California. In 1992, the State Legislature provided an opportunity for more formal groundwater management with the passage of AB 3030 (Water Code § 10750 et seq.). More than 200 agencies have adopted an AB 3030 groundwater management plan. Additionally, 24 of the 27 counties with ordinances related to groundwater management adopted those laws during the 1990s. Plans prepared under AB 3030 certainly brought unprecedented numbers of water agencies into the groundwater management arena, and counties are now heavily involved in groundwater management, primarily through ordinances. However, many plans prepared under AB 3030 have had little or no implementation, and many counties focus primarily on limiting exports rather than on a comprehensive management program. As a result, the California Budget Act of 1999 (Stats. 1999, ch. 50), which authorized this update to Bulletin 118, directed the California Department of Water Resources (DWR) to complete several tasks, including developing criteria for evaluating groundwater management plans and developing a model groundwater management ordinance. This chapter presents the results of these directives. The intent is to provide a framework that will assist local agencies in proactively planning and implementing effective groundwater management programs.

Criteria for Evaluating Groundwater Management Plans—Required and Recommended Components

In 2002, the Legislature passed SB 1938 (Stats 2002, ch 603), which amended Water Code section 10750 et seq to require that groundwater management plans adopted by local agencies include certain components to be eligible for public funds administered by DWR for construction of groundwater projects; the statute applies to funds authorized or appropriated after September 1, 2002. In addition to the required components, DWR worked with representatives from local water agencies to develop a list of additional recommended components that are common to effective groundwater management.

Both the “required” and the “recommended” components are tools that local agencies can use either to institute a groundwater management plan for the first time or to update existing groundwater management plans. These components are discussed below and listed in Appendix C, which can be used as a checklist by local agencies to assess whether their groundwater management plans are addressing these issues.

Required Components of Local Groundwater Management Plans

As of January 1, 2003, amendments to Water Code Section 10750 et seq., resulting from the passage of SB 1938, require new groundwater management plans prepared under section 10750, commonly referred to as AB 3030 plans, to include the first component listed below.

Groundwater management plans prepared under any statutory authority must include components 2 through 7 to be eligible for the award of public funds administered by DWR for the construction of groundwater projects or groundwater quality projects. These requirements apply to funds authorized or appropriated after September 1, 2002. Funds appropriated under Water Code section 10795 et seq. (AB 303 – Local Groundwater Assistance Fund) are specifically excluded.

- 1) Documentation that a written statement was provided to the public “describing the manner in which interested parties may participate in developing the groundwater management plan” (Water Code, § 10753.4 (b)).

- 2) Basin management objectives (BMOs) for the groundwater basin that is subject to the plan (Water Code, § 10753.7 (a)(1)).
- 3) Components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping (Water Code, § 10753.7 (a)(1)).
- 4) A plan by the managing entity to “involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin” (Water Code, § 10753.7 (a)(2)). A local agency includes “any local public agency that provides water service to all or a portion of its service area” (Water Code, § 10752 (g)).
- 5) Adoption of monitoring protocols (Water Code, § 10753.7 (a)(4)) for the components in Water Code section 10753.7 (a)(1). Monitoring protocols are not defined in the Water Code, but the section is interpreted to mean developing a monitoring program capable of tracking changes in conditions for the purpose of meeting BMOs.
- 6) A map showing the area of the groundwater basin as defined by DWR Bulletin 118 with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan (Water Code, § 10753.7 (a)(3)).
- 7) For local agencies not overlying groundwater basins, plans shall be prepared including the above listed components and using geologic and hydrologic principles appropriate to those areas (Water Code, § 10753.7 (a)(5)).

Recommended Components of Groundwater Management Plans

Although the seven components listed above are required only under certain conditions, they should always be considered for inclusion in any groundwater management planning process. In addition to the required components of a groundwater management plan resulting from the passage of SB 1938, it is recommended that the components listed below be included in any groundwater management plan adopted and implemented by a local managing entity. These additional components were developed in accord with the Budget Act of 1999 and with the assistance of stakeholder groups. The components should be considered and developed for specific application within the basin, subbasin, or agency service area covered by the plan. Additional components will likely be needed in specific areas. The level of detail for each component will vary from agency to agency. None of the suggested data reporting in the components should be construed to require disclosure of information that is confidential under State law. Local agencies should consider both the benefits of public dissemination of information and water supply security in developing reporting requirements.

Manage with the Guidance of an Advisory Committee

The managing entity should establish an advisory committee of interested parties that will help guide the development and implementation of the plan. The committee can benefit management in several ways. First, the committee can bring a variety of perspectives to the management team. As the intent of local groundwater management is to maintain and expand local benefits from the availability of the resource, it makes sense that the intended beneficiaries are a part of the management process. Second, the committee is free to focus on the specifics of groundwater management without being distracted by the many operational activities that the managing entity (such as a water district) must complete. Third, some parties could be negatively impacted by certain groundwater management decisions, and these actions and potential adverse impacts should be a part of the decision-making process to help reduce future conflicts. Finally, the advisory committee helps the managing entity gain the confidence of the local constituency by providing the opportunity for interested parties to participate in the management process.

Many managing entities have already elected to use advisory committees for implementation of their groundwater management plans. The composition of these committees varies widely. Some groups consist entirely of stakeholders, others add local or State government representatives or academic members as impartial third parties, and some have included consultants as technical advisers. Some plans use multiple advisory committees to manage unique subareas. Some plans appoint advisory committees with different objectives, such as one that deals with technical issues and another that deals with policy issues. There is no formula for the composition of an advisory committee because it should ultimately be based on local management needs and should include representation of diverse local interests.

The Tulare Lake Bed Coordinated Management Plan provides an example of the benefit of an advisory committee. The plan includes nine groups of participants, making coordination and communication a complicated issue. To allow for greater communication, an executive committee was established consisting of one voting member from each public agency participating in the plan and one voting member representing a combined group of private landowner plan participants. The committee administers groundwater management activities and programs for the plan (TLBWSD 2002).

Describe the Area to Be Managed under the Plan

The plan should include a description of the physical setting and characteristics of the aquifer system underlying the plan area in the context of the overall basin. The summary should also include a description of historical data, including data related to groundwater levels, groundwater quality, subsidence, and groundwater-surface water interaction; known issues of concern with respect to the above data; and a general discussion of historical and projected water demands and supplies. All of these data are critical to effective groundwater management because they demonstrate the current understanding of the system to be managed and serve as a point of departure for monitoring activities as part of plan implementation.

Create a Link Between Management Objectives and Goals and Actions of the Plan

The major goal of any groundwater management plan is to maintain a reliable supply of groundwater for long-term beneficial uses of groundwater in the area covered by the plan. The plan should clearly describe how each of the adopted management objectives helps attain that goal. Further, the plan should clearly describe how current and planned actions by the managing entity help meet the adopted management objectives. The plan will have a greater chance of success by developing an understanding of the relationship between each action, management objectives, and the goal of the groundwater management plan.

For example, prevention of contamination of groundwater from the land surface is a management objective that clearly supports the goal of groundwater sustainability. Management actions that could help support this objective include (1) educating the public through outreach programs that explain how activities at the surface ultimately impact groundwater, (2) developing wellhead protection programs or re-evaluating existing programs, (3) working with the local responsible agency to ensure that permitted wells are constructed, abandoned, and destroyed according to State well standards, (4) investigating whether local conditions necessitate higher standards than those adopted by the local permitting agency for the construction, abandonment, or destruction of wells, and (5) working with businesses engaged in practices that might impact groundwater to reduce the risks of contamination.

The concept of having a management objective is certainly not new. While many existing plans do not clearly include management objectives nor specifically identify actions to achieve objectives, some plans indirectly include these components. As an example, Eastern Municipal Water District's (EMWD) Groundwater Management Plan states that its goal includes maximizing "the use of groundwater for all beneficial uses in such a way as to lower the cost of water supply and to improve the reliability of the total

water supply for all users.” To achieve this goal, EMWD has listed several issues to be addressed. One is the prevention of long-term depletion of groundwater. This can be defined as a management objective even though it is not labeled as such. Where this management objective is currently unmet in the North San Jacinto watershed portion of the plan area, EMWD has identified specific actions to achieve that objective including the reduction of groundwater extraction coupled with pursuing the construction of a pipeline to act as an alternative source of surface water for the impacted area (EMWD 2002).

Describe the Plan Monitoring Program

The groundwater management plan should include a map indicating the locations of any applicable monitoring sites for groundwater levels, groundwater quality, subsidence, stream gaging, and other applicable monitoring. The groundwater management plan should summarize the type of monitoring (for example, groundwater level, groundwater quality, subsidence, streamflow, precipitation, evaporation, tidal influence), type of measurements, and the frequency of monitoring for each location. Site specific monitoring information should be included in each groundwater management plan. The plan should include the well depth, screened interval(s) and aquifer zone(s) monitored and the type of well (public, irrigation, domestic, industrial, monitoring). These components will serve as a tool for the local managing entity to assess the adequacy of the existing monitoring network in tracking the progress of plan activities.

The groundwater management plan developed for the Scotts Valley Water District (SVWD) provides a detailed description of the monitoring program in Santa Cruz County (Todd Engineers 1994) Table 6 is SVWD’s monitoring table, which serves as an example of the level of detail that is useful in a plan (Todd Engineers 2003a). Figure 9 shows the locations and types of monitoring points for each monitoring site. The monitoring table specifies in detail the data available and the planned monitoring. These serve as useful tools for SVWD to visualize the types and distribution of data available for their groundwater management activities. In addition to the minimum types of monitoring, SVWD summarizes other types of data that are relevant to their groundwater management effort.

Describe Integrated Water Management Planning Efforts

Water law in California treats groundwater and surface water as two separate resources with the result that they have largely been managed separately. Such management does not represent hydrologic reality. Recently, managers of a number of resources are becoming increasingly aware of how their planning activities could impact or be impacted by the groundwater system. Because of this, the local managing entity should describe any current or planned actions to coordinate with other land use, zoning, or water management planning entities.

Integrated management is addressed in existing groundwater management plans in several ways, including conjunctively managing groundwater with surface water supplies, recharging water from municipal sewage treatment plants, and working with local planning agencies to provide comments when a project is proposed that could impact the groundwater system.

Examples of planning efforts that should be integrated with groundwater management may include watershed management, protection of recharge areas, agricultural water management, urban water management, flood management, drinking water source assessment and protection, public water system emergency and disaster response, general plans, urban development, agricultural land preservation, and environmental habitat protection or restoration. Another example that may appear insignificant is transportation infrastructure. However, local impacts on smaller aquifers could be significant when landscaping of medians and interchanges requires groundwater pumping for irrigation or when paved areas are constructed over highly permeable sediments that act as recharge zones for the underlying aquifer.

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Precipitation	El Pueblo Yard	15-minute recording	Feb-85	Daily/District, Monthly/City	Other historic gages: (1) Blair site on Granite Ck. Rd. (Jan. 1975 - Dec. 1980)
	WWTP	5-minute recording	1990	Daily/City	(2) Hacienda Dr. (Jul. 1974 - Mar. 1979) (3) El Pueblo Yard bucket gage (Jan. 1981 - Jan. 1985)
Evaporation	El Pueblo Yard	Pan	Jan-86	Daily/District	Evaporation pan raw data not compiled after July 1990
Evapotranspiration	De Laveaga Park, Santa Cruz	Automated active weather station	Sep-90	California Irrigation Management Information System/Monthly	Data available on-line through CIMIS
Streamflow	Carbonera Ck at Scotts Valley @ Cabonera Way Bridge (#111613000)	15-minute recording	Jan-85	USGS/ Daily	Other historic gages: (1) Carbonera Ck @ Santa Cruz (#11161400) 150 feet upstream from mouth (1974-1976 partial data)
	Bean Ck near Scotts Valley @ Hermon Crossing (#11160430)	15-minute recording	Dec-88	USGS/ Daily	(2) Bean Ck near Felton (#11160320) (1973-1978 partial data), low flows at same location (1983-1988)
Well Inventory	Eagle Creek In Henry Cowell Redwoods State Park	Bucket-Fall, Flow Meter-Spring	Mar-01	Semi-annually/ Todd Engineers	(3) Carbonera Creek @ Glen Canyon (1990-1994?)
	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36	Over 400 wells: location, log, type, capacity, etc. stored in GIS, and Access database	1950s	Logs from DWR maintained by Todd Engineers	
Groundwater Levels	~34 Santa Margarita aquifer and ~14 Lompico formation wells	Depth to water	1968	Quarterly/ District and cooperators	Data from over 75 wells, as early as 1968, bi-monthly 1983-1989
Pumpage	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36 District wells in production and on standby	Metered	1975	Monthly/ Scotts Valley Water District, Mt. Hermon Association, Hanson Aggregates West, San Lorenzo Valley Water District	Other historic pumpage data: Manana Woods (1988-1996 partial data)

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan (continued)

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Groundwater Quality	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1, 11-14, 23-26, 36 District wells in production	Title 22 constituents	1963	At least semi-annual/ District and others	Data from over 80 wells, as early as 1963, monitoring frequency similar to groundwater level program
	North Scotts Valley 3 shallow monitoring wells	Metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Surface Water Quality	4 sites on Carbonera and 3 sites on Bean Creek	Grab samples - metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Wastewater Outflows	City of Scotts Valley WWTP @ Lundy Lane	Wastewater outflow volume and effluent quality	1965	Daily/City of Scotts Valley	Plant operational in 1965 (septic systems pre-1965)
Recycled Water Production	Scotts Valley WWTP	Recycled water quantity and quality	2002	At least quarterly/ WWTP	

Source: Todd Engineering 2003a

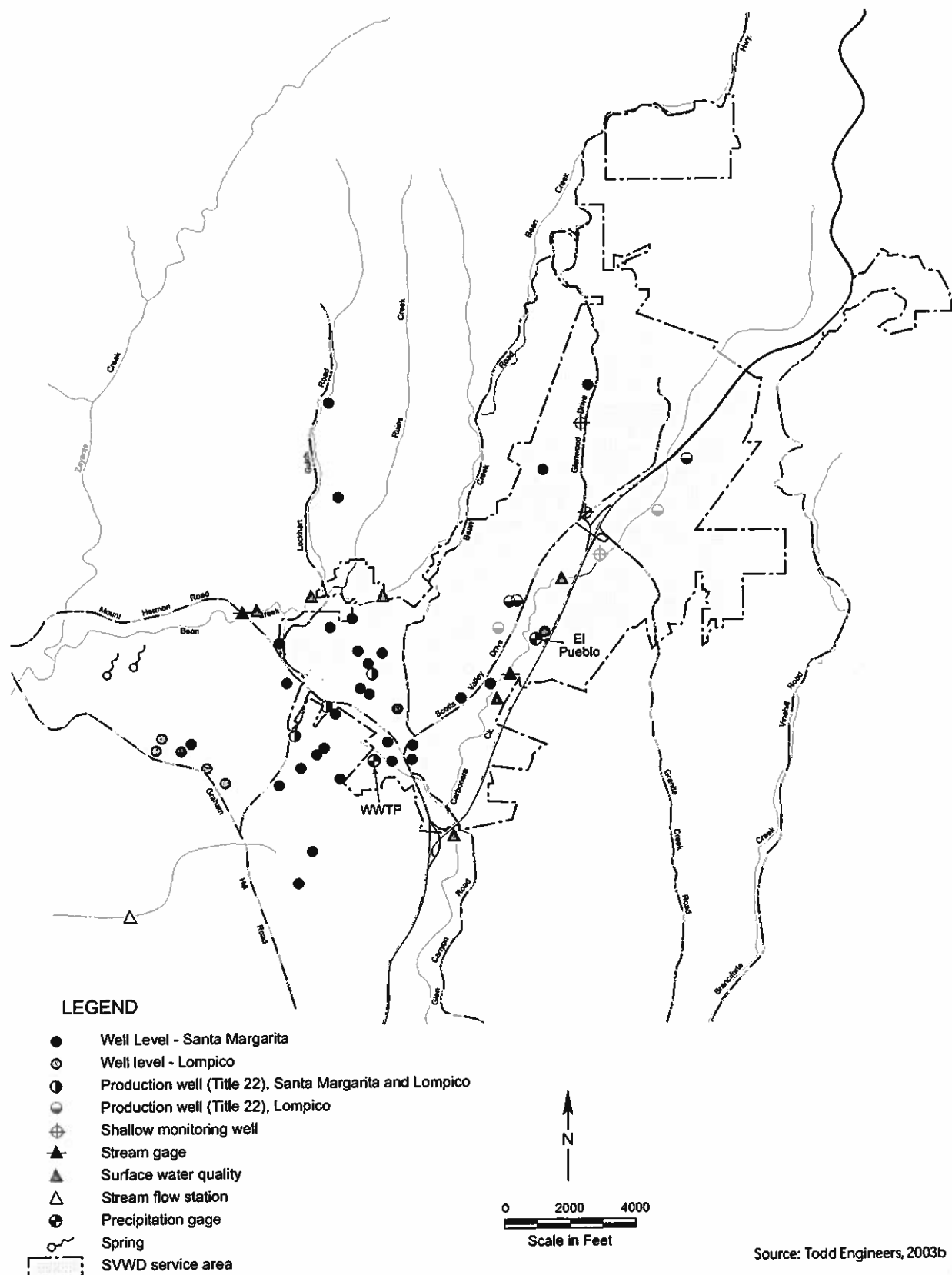


Figure 9 Scotts Valley Water District's Groundwater Management Plan monitoring locations

Box K What are Management Objectives?

Management objectives are the local managing entity's way of identifying the most important issues in meeting local resource needs; they can be seen as establishing a "value system" for the plan area. There is no fixed set of management objectives for any given plan area. Some of the more commonly recognized management objectives include the monitoring and managing of groundwater levels, groundwater quality, inelastic land subsidence, and changes in streamflow and surface water quality where they impact or are impacted by groundwater pumping. Management objectives may range from being entirely qualitative to strictly quantified.

Each management objective would have a locally determined threshold value associated with it, which can vary greatly. For example, in establishing a management objective for groundwater quality, one area may simply choose to establish an average value of total dissolved solids as the indicator of whether a management objective is met, while another agency may choose to have no constituents exceeding the maximum contaminant level for public drinking water standards. While there is great latitude in establishing management objectives, local managers should remember that the objectives should serve to support the goal of a sustainable supply for the beneficial use of the water in their particular area.

An example of an alternative management objective is Orange County Water District's (OCWD) objective of maintaining available storage space in its management area at 200,000 acre-feet. The objective does not require that groundwater elevations be fixed at any particular location, although managing to this objective would likely have the net benefit of stabilizing water levels. Groundwater storage is a dynamic value, so attempting to meet this management objective is an ongoing challenge. OCWD has implemented many management actions directly aimed at managing the basin to meet this objective.

The Deer Creek and Tule River Authority provides an excellent example of how groundwater management activities can be coordinated with other resources. The authority, in conjunction with the U.S. Bureau of Reclamation, has constructed more than 200 acres of recharge basins as part of its Deer Creek Recharge-Wildlife Enhancement Project. When available, the project takes surplus water during winter months and delivers it to the basins, which serve as winter habitat for migrating waterfowl, creating a significant environmental benefit. Most of the water also recharges into the underlying aquifer, thereby benefiting the local groundwater system.

Report on Implementation of the Plan

The managing entity should produce periodic reports—annually or at other frequencies determined by the local managing entity—summarizing groundwater basin conditions and groundwater management activities. For the period since the previous update, the reports should include:

- A summary of monitoring results, including historical trends,
- A summary of actual management actions,
- A summary, supported by monitoring results, of whether management actions are achieving progress in meeting management objectives,
- A summary of proposed management actions, and
- A summary of any plan component changes, including addition or modification of management objectives.

Unfortunately, many plans were prepared in the mid-1990s with little or no follow-up documentation of whether the plan is actually being implemented. This makes it difficult to determine what progress has been achieved in managing the groundwater resource. Periodic reports will serve as a tool for the managing entity to organize its many activities to implement the plan, act as a driving force for plan implementation, and help interested parties understand the progress made by local entities in managing their groundwater resource.

Progress reports on SVWD (Todd Engineers 2002) and EMWD (2002) groundwater management plans serve as excellent examples of the value of such an exercise. Both reports effectively portray the results of management actions: progress toward achieving objectives and specific recommendations for future management actions. An example of reporting on the modification of a management objective for water quality can be found in EMWD's 2000 Annual Report (EMWD 2001). A task force of more than 20 water suppliers and wastewater agencies, including EMWD, worked to update the Regional Water Quality Control Board's Region 5 Basin Plan objectives for nitrogen and total dissolved solids in water, effectively changing EMWD's management objectives for those constituents.

Evaluate the Plan Periodically

The managing entity and advisory committee should re-evaluate the entire plan. Periodic evaluation of the entire management plan is essential to define successes and failures under the plan and identify changes that may be needed. Additionally, re-evaluation of the plan should include assessment of changing conditions in the basin that may warrant modification of the plan or management objectives. Adjustment of components in the plan should occur on an ongoing basis if necessary. The re-evaluation of the plan should focus on determining whether the actions under the plan are meeting the management objectives and whether the management objectives are meeting the goal of sustaining the resource.

While there are several examples of existing groundwater management plans that demonstrate ongoing changes to plan activities, there are no known examples of such an approach to entirely re-evaluate an existing plan. This is likely due in part to the occurrence of several consecutive wet years in the mid- and late-1990s. The abundant surface water supplies reduced the need to actively manage groundwater supplies in many cases. More recent dry conditions and the recent passage of SB 1938 will create an excellent opportunity for managing entities to begin a re-evaluation of existing plans.

Model Groundwater Management Ordinance

As discussed in the previous chapter, ordinances are groundwater management mechanisms enacted by local governments through exercise of their police powers to protect the health and safety of their citizens. In *Baldwin v. Tehama County* (1994), the appellate court declared that State law does not preempt the field of groundwater management.

In the mid- to late-1990s, many counties adopted ordinances that effectively prevented export of groundwater from the county, even though none specifically prohibited export. The intent of each of these ordinances is to sustain groundwater as a viable local resource. To ensure that goal, an export project proponent is required by most of the ordinances to show that the proposed project will not cause depletion of the groundwater, degradation of groundwater quality, or subsidence before a permit to export groundwater can be issued. Although these ordinances do not specifically require threshold limits for each of these potential negative impacts, a project proponent can really only show that these negative effects will not occur if the proponent develops a groundwater management plan.

Many of these ordinances were developed in response to the plans of some agencies or landowners to export groundwater or develop a groundwater substitution project where surface water is exported and groundwater is substituted for local use. In some cases, short-term export actually took place, leading to a number of claims of negative third party impacts. Residents of some counties became concerned because no one knew how much groundwater was available for local use and how much groundwater was available for export. In short, details of the hydrology of the basin, including surface water and groundwater availability, water quality, and the interaction of surface water and groundwater were not known. This lack of detailed knowledge about the operating potential of their groundwater resources led counties to take what they viewed as protective action, which consisted of requiring a permit before anyone could export groundwater from the county.

From the perspective of DWR, groundwater should be managed in a manner that ensures long-term sustainability of the resource for beneficial uses. Those beneficial uses are to be decided by the local stakeholders within the basin. In some areas, there may be an ample supply of water, so groundwater exports or substitution projects are feasible while local beneficial uses of the water supply are maintained. In other areas, limiting exports may be necessary to maintain local beneficial uses. Such determinations can be made only after the data are collected and evaluated and the results are used to develop management objectives for the basin.

While developing both the criteria for evaluating groundwater management plans and the model groundwater management ordinance, DWR staff has borne two principles in mind. First, the goal of groundwater management, whether accomplished by a plan or by an ordinance, is to sustain and often expand a groundwater resource. Second, groundwater management, whether accomplished by a plan or by an ordinance, requires that local agencies address and resolve the same or similar issues within the boundaries of the agencies. To say it in different words, whether it is a plan or an ordinance, good groundwater management should address the same issues and problems and arrive at the same conclusions and solutions to satisfy the needs of the local area. While some areas may allow or promote exports, others may not.

As stated above, the Legislature required a model ordinance as one of the elements of this update of Bulletin 118. The model ordinance is included as Appendix D and can be used by local governments that have identified a need to adopt a groundwater management ordinance. The model is an example of what a local ordinance might include. Local conditions will require some additions, modifications, or deletions. The variety of political, institutional, legal, technical, and economic opportunities and constraints throughout California guarantees that there will be differences to which the model will have to be adapted. Local governments interested in adopting a groundwater management ordinance are encouraged to consider all components included in the model.

Water Code section 10753.7(b)(1)(A) allows an agency to participate in or consent to be subject to a groundwater management plan, a basin-wide management plan, or other integrated regional water management plan in order to meet the funding eligibility requirements that resulted from passage of SB 1938 (2001). A local government that adopts an ordinance should consider whether or not it will have local agencies that do not have their own groundwater management plan, but consent to be managed under the ordinance. If this situation is anticipated, the ordinance should include the required components described in the Water Code so State funding can be pursued.



Chapter 4

Recent Actions Related to Groundwater Management

Chapter 4

Recent Actions Related to Groundwater Management

The past few years have seen significant actions that impact groundwater management in California. Below are several examples of recent actions including legislation, ballot measures, and executive orders that show the State Legislature and the citizens of California clearly recognize the importance of groundwater and its appropriate management in meeting the present and future water supply needs of the State.

Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13)

On March 7, 2000, California voters approved a \$1.97-billion general obligation bond known as the Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act (Proposition 13). Of the nearly \$2 billion, \$230 million was earmarked for groundwater programs. The act authorizes \$200 million for grants for feasibility studies, project design, and construction of conjunctive use facilities (Water Code, § 79170 et seq.) and \$30 million in loans for local agency acquisition and construction of groundwater recharge facilities and feasibility study grants for projects potentially eligible for the loan program (Water Code, § 79161 et seq.). More than \$120 million have been awarded in grants and loans to local agencies in the first two years of implementation of these programs.

California Bay-Delta Record of Decision

The goal of the California Bay-Delta (formerly CALFED) program is to restore ecosystem health and improve water management in the Bay-Delta system. The program has four primary objectives:

- 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
- 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 Record of Decision (ROD), released in August 2000, sets forth a 30-year plan to address ecosystem health and water supply reliability problems in the Bay-Delta system. The ROD lays out specific actions and investments over the first seven years to meet program goals. Most important, with respect to groundwater is the California Bay-Delta program's commitment to local groundwater management. The ROD states, "CALFED will work with local governments and affected stakeholders to develop legislation to strengthen AB 3030 and provide technical and financial incentives to encourage more effective basin-wide groundwater management plans..." (CALFED 2000). The ROD encourages basin management that is developed at the subbasin level so that it addresses local needs, but is coordinated at the basin-wide level so that it considers impacts to other users in the basin. The ROD also commits Bay-Delta agencies to "facilitate and fund locally supported, managed, and controlled groundwater and conjunctive use projects with a total of 500,000 acre-feet to 1 million acre-feet (maf) of additional storage capacity by 2007" (CALFED 2000).

Local Groundwater Management Assistance Act of 2000 (AB 303, Water Code Section 10795 et seq.)

The goal of the Local Groundwater Management Assistance Act is to help local agencies better understand how to manage groundwater resources effectively to ensure the safe production, quality, and proper storage of groundwater in the State. The act created the Local Groundwater Assistance Fund, which must be appropriated annually. In three years, more than \$15 million in grants were awarded for 71 projects. Grants went to local agencies for groundwater studies and projects that contribute to basin and subbasin management objectives, including but not limited to groundwater monitoring and groundwater basin management. Grants are available to all geographic areas of the State. This act serves to emphasize that groundwater is recognized as an important local resource and, to the extent that groundwater is properly managed at the local level, serves to benefit all Californians.

Groundwater Quality Monitoring Act of 2001 (AB 599, Water Code Section 10780 et seq.)

Assembly Bill 599, known as the Groundwater Quality Monitoring Act of 2001, set a goal to establish comprehensive groundwater monitoring and increase the availability of information about groundwater quality to the public. The objective of the program is to highlight those basins in which contamination has occurred or is likely to occur and provide information that will allow local managers to develop programs to curtail, treat, or avoid additional contamination. The act required the State Water Resources Control Board (SWRCB), in coordination with an Interagency Task Force (ITF) and a Public Advisory Committee (PAC), to integrate existing monitoring programs and design new program elements, as necessary, to establish a comprehensive statewide groundwater quality monitoring program.

Through the ITF and PAC, the Comprehensive Groundwater Quality Monitoring Program was developed. The program will seek to:

- Accelerate the monitoring and assessment program already established by the SWRCB,
- Implement monitoring and assessment in accordance with a prioritization of basins/subbasins,
- Increase coordination and data sharing among groundwater agencies, and
- Maintain groundwater data in a single repository to provide useful access by the public while maintaining appropriate security measures.

The Comprehensive Groundwater Quality Monitoring Program is expected to provide the following key benefits:

- A common base communications medium for agencies to utilize and supply groundwater quality data at multiple levels,
- A mechanism to unite local, regional and statewide groundwater programs in a common effort,
- Better understanding of local, regional and statewide water quality issues and concerns that in turn can provide agencies at all levels with better information to deal with the concerns of consumers and consumer advocate groups,
- Groundwater agencies with trend and long-term forecasting information, essential for groundwater management plan preparation and implementation, and
- The motivation for small- and medium-sized agencies to begin or improve their own groundwater monitoring and management programs.

Water Supply Planning

Three bills enacted by the Legislature to improve water supply planning processes at the local level became effective January 1, 2002. In general, the new laws are intended to improve the assessment of water supplies during the local planning process before land use projects that depend on water are approved. The new laws require the verification of sufficient water supplies as a condition for approving developments, and they compel urban water suppliers to provide more information on the reliability of groundwater if used as a supply.

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 (UWMP) 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 DWR 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 subject to the California Environmental Quality Act supplied with water from a public water system be provided a water supply assessment, except as specified in the law. 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.

Emergency Assistance to the Klamath Basin

On May 4, 2001, the Governor proclaimed a State of Emergency in the Klamath Basin in Siskiyou and Modoc counties. The proclamation included disaster assistance of up to \$5 million under authority of the State Natural Disaster Assistance Act. This assistance went directly into constructing wells to extract groundwater for use on cover crops to avoid loss of critical topsoil. The Governor’s proclamation also included \$1 million for a study of the Klamath River Basin to determine the long-term water supply in the California portion of the basin.

Governor’s Drought Panel

The Governor’s Advisory Drought Planning Panel was formed in 2000 to develop a contingency plan to address the impacts of critical water shortages in California. The panel formed with the recognition that critical water shortages may severely impact the health, welfare, and economy of California. Panel recommendations included securing funding for the Local Groundwater Management Assistance Act (described above), continued support of critical groundwater monitoring in basins with inadequate data, and the formation of a technical assistance and education program for “rural homeowners and small domestic water systems relying on self-supplied groundwater” (GADPP 2000).

Sacramento Valley Water Management Agreement

On May 22, 1995, SWRCB adopted the “Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary” (the 1995 WQCP). Following this action, SWRCB initiated a water rights hearing process with the intent of allocating responsibility for meeting the standards of the 1995 WQCP among water right holders in areas tributary to the Delta. The water rights hearing was conducted in phases with all phases being resolved with the exception of Phase 8, which involved water rights holders in the Sacramento Valley.

Proceeding with Phase 8 may have involved litigation and judicial review for years. That extended process could have resulted in adverse impacts to the environment and undermined progress on other statewide water management initiatives. To avoid the consequences of delay, the Sacramento Valley Water Users, DWR, the U.S. Bureau of Reclamation (USBR), and export water users developed the Sacramento Valley Water Management Agreement. The agreement became effective April 20, 2001. At that time SWRCB issued an order staying the Phase 8 hearing for 18 months. The parties negotiated a short-term settlement agreement that obligated DWR and USBR to continue to fully meet the Bay-Delta water quality standards while providing for the development of conjunctive use and system improvement projects by participating upstream water rights holders that would make water available to help meet water quality standards while improving the reliability of local water supplies. SWRCB has subsequently dismissed the Phase 8 proceedings, and work is being undertaken on both short-term and long-term activities included in the Sacramento Valley Water Management Agreement.

Groundwater Management Water Code Amendments

In September 2002, SB 1938 (Water Code, § 10753.4 and § 10795.4 as amended; Water Code, § 10753.7, § 10753.8 and § 10753.9 as amended and renumbered; Water Code, § 10753.1 and § 10753.7 as added) was signed into law. The act amends existing law related to groundwater management by local agencies. The law requires any public agency seeking State funds administered through DWR for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan with certain specified components. Prior to this, there were no required plan components. New requirements include establishing basin management objectives, preparing a plan to involve other local agencies in a cooperative planning effort, and adopting monitoring protocols that promote efficient and effective groundwater management. The requirements apply to agencies that have already adopted groundwater management plans as well as agencies that do not overlie groundwater basins identified in Bulletin 118 and its updates when these agencies apply for state funds. The requirements do not apply to funds administered through the AB 303-Local Groundwater Management Assistance Act (Water Code, § 10795 et seq.) or to funds authorized or appropriated prior to September 1, 2002. Further discussion of the requirements is included in Chapter 3 and Appendix C.

Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50)

California voters approved the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50; Water Code, § 79500 et seq.) in the November 2002 elections. The initiative provides for more than \$3.4 billion of funding, subject to appropriation by the Legislature, for a number of land protection and water management activities.

Several chapters of Proposition 50 allocate funds for specified water supply and water quality projects, including:

- Chapter 3 Water Security. Provides \$50 million to protect State, local, and regional drinking water systems from terrorist attack or deliberate acts of destruction or degradation.

- **Chapter 4 Safe Drinking Water.** Provides \$435 million for grants and loans for infrastructure improvements to meet safe drinking water standards.
- **Chapter 5 Clean Water and Water Quality.** Provides \$390 million for a number of water quality and environmental improvements.
- **Chapter 6 Contaminant and Salt Removal Technologies.** Provides \$100 million for desalination of ocean or brackish waters as well as treatment and removal of contaminants.
- **Chapter 7 California Bay-Delta program.** Provides \$825 million for continuing implementation of all elements of the program.
- **Chapter 8 Integrated Regional Water Management.** Provides \$500 million for many categories of water management projects that will protect communities from drought, protect and improve water quality, and reduce dependence on imported water supplies.
- **Chapter 9 Colorado River.** Provides \$70 million for canal-lining projects necessary to reduce water use and to meet commitments related to California's allocation of water from the Colorado River.



Chapter 5

The Roles of State and Federal Agencies in California Groundwater Management

Chapter 5

The Roles of State and Federal Agencies in California Groundwater Management

Even though groundwater management is a local responsibility and mostly voluntary, several State and federal agencies have key roles in California groundwater management. Some of these roles may not be immediately recognized, but because they work toward the goal of maintaining a reliable groundwater supply, they are closely related to groundwater management. Some of the programs available through the California Department of Water Resources (DWR) and other agencies that assist local agencies in managing groundwater resources are described below.

Local Groundwater Management Assistance from DWR

DWR's role in groundwater management begins with the fundamental understanding that groundwater management is locally driven and management programs should respond to local needs and concerns. DWR recognizes that when groundwater is effectively managed at the local level, benefits are realized at a statewide level.

DWR has historically maintained many programs that directly benefit local groundwater management efforts including:

- Providing assistance to local agencies to assess basin hydrogeologic characteristics,
- Assisting local agencies to identify opportunities to develop additional groundwater supply,
- Monitoring groundwater levels and quality,
- Providing watermaster services for court-adjudicated basins,
- Providing standards for well construction and destruction,
- Managing the State's extensive collection of well completion reports, and
- Reviewing proposals and distributing grant funds and low-interest loans for conjunctive use projects, as well as local groundwater management and monitoring programs.

Conjunctive Water Management Program

DWR's Conjunctive Water Management Program consists of a number of integrated efforts to assist local agencies in improving groundwater management and increasing water supply reliability.

One goal of the Integrated Storage Investigations (ISI) Program, an element of the Bay-Delta program, is to increase water supply reliability statewide through the planned, coordinated management and use of groundwater and surface water resources. The effort emphasizes forming working partnerships with local agencies and stakeholders to share technical data and costs for planning and developing locally controlled and managed conjunctive water management projects.

Toward that end, the Conjunctive Water Management Program has:

- Developed a vision in which DWR would assist local agencies throughout the State so that these agencies can effectively manage groundwater resources,
- Adopted a set of working principles to ensure local planning; local control, operation, and management of conjunctive use projects; voluntary implementation of projects; and local benefits from the proposed projects,
- Executed memoranda of understanding with 30 local agency partners and provided technical and financial assistance to study groundwater basins and assess opportunities for conjunctive water management,

- Provided technical assistance in the form of groundwater monitoring, groundwater modeling, and local water management planning, as well as a review of numerous regional and statewide planning efforts on a variety of water issues, and
- Provided facilitation assistance to promote broad stakeholder involvement in regional water management planning processes.

DWR staff review proposals and distribute grants pursuant to the Local Groundwater Management Assistance Act of 2000 (AB 303). To date, DWR has awarded more than \$15 million to local agencies to fund 71 projects dealing with groundwater investigation, monitoring, or management.

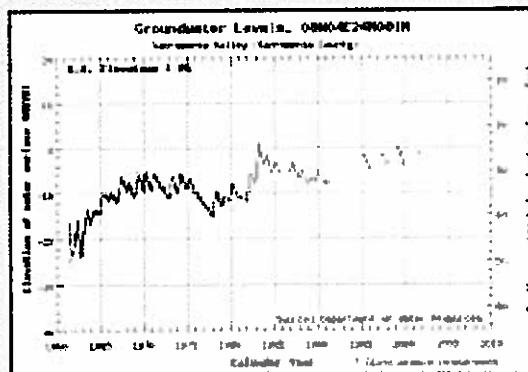
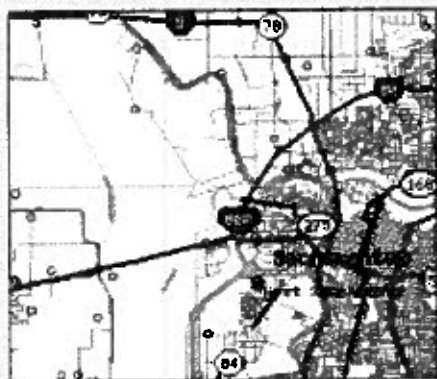
With funds provided under Proposition 13, DWR has awarded more than \$170 million in loans and grants for groundwater recharge and storage studies and projects to local agencies throughout the State. Applicant estimates of the water supply reliability increases that will be realized from these projects exceeds 150 thousand acre-feet annually. Recipients of loans and grants must provide progress reports to allow an evaluation of the successes of the various programs. Figure 10 shows the distribution of loan and grant awardees throughout the State.

Both grant programs have active outreach efforts to inform and to assist agencies in preparation of applications. Selection of projects for funding relies in part on input from advisory committees composed of stakeholders from throughout the State.

Box L Providing Data:

The Internet Makes Groundwater Elevation Data Readily Accessible to the Public

In 1996, the California Department of Water Resources (DWR) began providing Internet access to groundwater level data and hydrographs for wells in groundwater basins throughout California. The website, which distributes historical data for more than 35,000 wells monitored by DWR and its many cooperators, has proven very popular, with more than 60,000 visits to date. Options include a form or map interface to locate wells with water level data and the ability to download long-term water levels for specific wells or seasonal measurements for specific areas to create groundwater contour maps. The accessibility of this data makes it a significant resource for local agencies in making sound groundwater management decisions. The address of the site is <http://wdl.water.ca.gov/>.



Wells can be located with a map interface. By clicking on a well, a hydrograph with the latest data available is automatically generated.

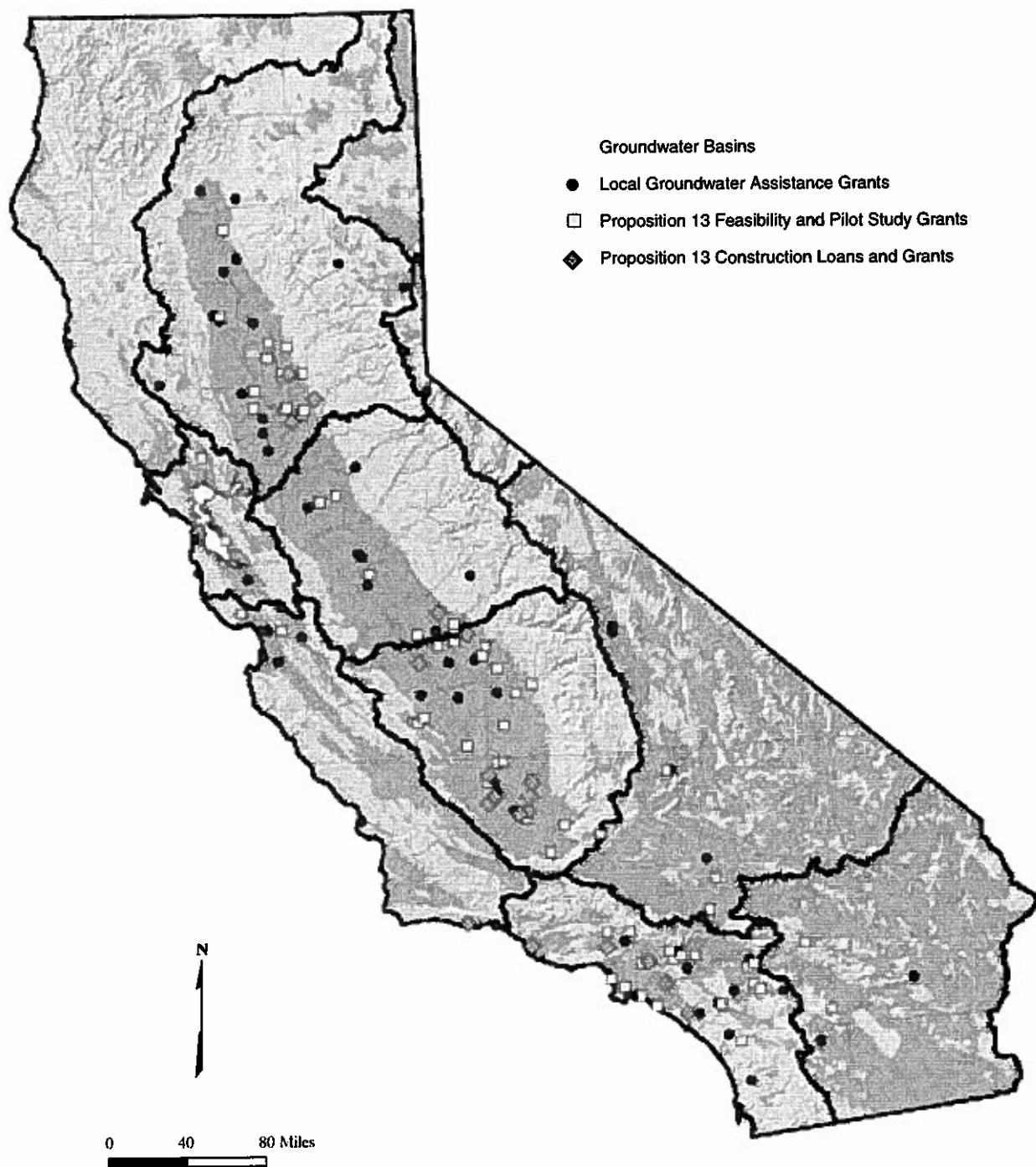


Figure 10 Broad distribution of grant and loan awardees for 2001 through 2003

Assistance from Other State and Federal Agencies

Many other State and federal agencies provide groundwater management assistance to local agencies. Some of those roles are described below. For more information on the roles of various agencies in protecting the groundwater resource, see the California Department of Health Services' Drinking Water Source Assessment and Protection Program Document (DHS 2000), California Groundwater Management (Bachman and others 1997), or the individual agency websites.

State Water Resources Control Board and Regional Water Quality Control Boards

<http://www.swrcb.ca.gov> The mission of the State Water Resources Control Board (SWRCB) is to ensure the highest reasonable quality of waters of the State, while allocating those waters to achieve the optimum balance of beneficial uses. In turn, the nine Regional Water Quality Control Boards (RWQCB) develop and enforce water quality objectives and implement plans to protect the beneficial uses of the State's waters, recognizing differences in climate, topography, geology, and hydrology.

SWRCB has many responsibilities regarding the protection of the groundwater resource. One of the more notable is the Groundwater Ambient Monitoring and Assessment (GAMA) Program. GAMA is a recently enacted program that will provide a comprehensive assessment of water quality in water wells throughout the state. GAMA has two main components: the California Aquifer Susceptibility (CAS) Assessment and the Voluntary Domestic Well Assessment Project.

The CAS combines age dating of water and sampling for low-level volatile organic compounds (VOCs), such as methyl tertiary-butyl ether (MTBE), to assess the relative susceptibility of all of approximately 16,000 public supply wells throughout the State. Age dating provides a general assessment of how quickly groundwater is moving through the system, while the sampling of low-level VOCs allows greater reaction time for potential remediation strategies before contaminants reach action levels. Sampling is being conducted by staff from the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The CAS Assessment was developed cooperatively with DHS and DWR.

The Voluntary Domestic Well Assessment Project will provide a previously unavailable sampling of water quality in domestic wells, which will assist in assessing the relative susceptibility of California's groundwater. Because water quality in individual domestic wells is unregulated, the program is voluntary and will focus, as resources permit, on specific areas of the state. Constituents to be analyzed include nitrate, total and fecal coliform bacteria, MTBE, and minerals. Additional constituents will be added in areas with known water quality problems.

Other SWRCB/RWQCB activities related to groundwater protection include developing basin plans that identify existing and potential beneficial uses of marine water, groundwater, and surface waters; regulating the discharge of waste that may affect water quality in California; monitoring of landfills and hazardous waste facilities; establishing standards for the construction and monitoring of underground storage tanks; establishing management plans for control of nonpoint source pollutants; and issuing cleanup and abatement orders that require corrective actions by the responsible party for a surface water or groundwater pollution problem or nuisance.

The Groundwater Quality Monitoring Act of 2001 (AB599, Water Code, § 10780 et seq.) required the SWRCB to develop a comprehensive monitoring program in a report to the Legislature. See Chapter 4 for details.

California Department of Health Services

<http://www.dhs.ca.gov/ps/ddwem> The DHS Drinking Water Program, part of the Division of Drinking Water and Environmental Management, is responsible for DHS implementation of the federal Safe Drinking Water Act, as well as California statutes and regulations related to drinking water. As part of this responsibility, DHS inspects and provides regulatory oversight of approximately 8,500 public water systems (and approximately 16,000 drinking water wells) to assure delivery of safe drinking water to all California consumers.

Public water system operators are required to regularly monitor their drinking water sources for microbiological, chemical and radiological contaminants to show that drinking water supplies meet regulatory requirements (called primary maximum contaminant levels—MCLs). Among these contaminants are approximately 80 specific inorganic and organic chemical contaminants and six radiological contaminants that reflect the natural environment as well as human activities.

Public water system operators also monitor their water for a number of other contaminants and characteristics that deal with the aesthetic properties of drinking water (known as secondary MCLs). They are also required by regulation to analyze for certain unregulated contaminants (to allow DHS to collect information on emerging contaminants, for example), and to report findings of other contaminants that may be detected during routine monitoring. The DHS water quality monitoring database contains the results of analyses since 1984. These data, collected for purposes of regulatory compliance with drinking water laws, also provide an extensive body of information on the quality of groundwater throughout the State.

California Department of Pesticide Regulation

<http://www.cdpr.ca.gov/dprprograms.htm> The California Department of Pesticide Regulation (DPR) protects human health and the environment by regulating pesticide sales and use and by promoting reduced-risk pest management. DPR plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the groundwater resource.

DPR conducts six types of groundwater monitoring:

- 1) Monitoring for pesticides on a DPR-determined Ground Water Protection List, which lists pesticides with the potential to pollute groundwater;
- 2) Four-section survey monitoring to verify a reported detection and to help determine if a detected pesticide resulted from legal agricultural use;
- 3) Areal extent monitoring to identify the extent of contaminated wells;
- 4) Adjacent section monitoring to identify additional areas sensitive to pesticide movement to groundwater;
- 5) Monitoring to repeatedly sample a network of wells to determine whether pesticide residues are declining; and
- 6) Special project monitoring.

When pesticides are found in groundwater, they are normally regulated in one-square mile areas identified in regulation as sensitive to groundwater pollution. These pesticides are subject to permitting by the county agricultural commissioner and to use restrictions specified in regulation. DPR maintains an extensive database of pesticide sampling in groundwater and reports a summary of annual sampling and detections to the State Legislature.

California Department of Toxic Substances Control

<http://www.dtsc.ca.gov> The California Department of Toxic Substances Control (DTSC) has two programs related to groundwater resources protection: the Hazardous Waste Management Program and the Site Mitigation Program. These programs are authorized under Division 20 of the California Health and Safety Code, and implementing regulations are codified in Title 22 of the California Code of Regulations.

A critical element of both programs is maintaining environmental quality and economic vitality through the protection of groundwater resources. This is accomplished through hazardous waste facility permitting and design; oversight of hazardous waste handling, removal, and disposal; oversight of remediation of hazardous substances releases; funding of emergency removal actions involving hazardous substances, including the cleanup of illegal drug labs; cleanup of abandoned hazardous waste sites; oversight of the closure of military bases; and pollution prevention.

If groundwater is threatened or impacted by a hazardous substance release, DTSC provides technical oversight for the characterization and remediation of soil and groundwater contamination. DTSC and the nine RWQCBs coordinate regulatory oversight of groundwater remediation. To ensure site-specific groundwater quality objectives are met, DTSC consults with RWQCB staff and appropriate groundwater basin plans.

Box M Improving Coordination of Groundwater Information

California's groundwater resources are addressed by an array of different State and federal agencies. Each agency approaches groundwater from a unique perspective, based on its individual statutory mandate. As a result, each agency collects different types of groundwater data and information. To facilitate the effective and efficient exchange of groundwater resource information, the State Water Resources Control Board (SWRCB) is coordinating the Groundwater Resources Information Sharing Team (GRIST), which is composed of representatives from various groundwater agencies. Agencies currently participating in GRIST are:

- State Water Resources Control Board
- Department of Health Services
- Department of Water Resources
- Department of Pesticide Regulation
- Lawrence Livermore National Laboratory
- U.S. Geological Survey

One of the tasks of the GRIST is to identify data relevant to California groundwater resources. A listing of the data, along with the appropriate agency contacts and Internet links, will be maintained by SWRCB on the Groundwater Resources Information Database. In addition, to facilitate effective information sharing and communication among stakeholders, groundwater data will be made available on the SWRCB GeoTracker system. GeoTracker is a geographic information system that provides Internet access to environmental data. The centralization of environmental data through GeoTracker will enable more in-depth geospatial and statistical analyses of groundwater data in the future. For more information about GeoTracker, visit the GeoTracker Internet site at <http://geotracker.arsenautlegg.com>.

California Bay-Delta Authority

<http://calwater.ca.gov> The California Bay-Delta program was initiated in 1994 to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Sacramento-San Joaquin Bay-Delta System. The partnership currently consists of more than 20 State and federal agencies. An important element of the program is to increase storage by developing an additional 500,000 acre-feet to 1.0 million acre-feet of groundwater storage capacity by the year 2007 (CALFED 2000).

Effective January 1, 2003, a newly formed State agency assumed responsibility for overseeing implementation of the Bay-Delta program. The California Bay-Delta Authority provides a permanent governance structure for the collaborative state-federal effort. The authority was established by enactment of Senate Bill 1653 in 2002. The legislation calls for the authority to sunset on January 1, 2006, unless federal legislation has been enacted authorizing the participation of appropriate federal agencies in the authority.

U.S. Environmental Protection Agency

<http://www.epa.gov/safewater> The U.S. Environmental Protection Agency (EPA) Office of Ground Water and Drinking Water, together with states, tribes, and many partners, protects public health by ensuring safe drinking water and protecting groundwater. The EPA's role in California groundwater is primarily related to protection of the resource and comes in the form of administering several federal programs in close coordination with State agencies such as SWRCB, DHS, and DTSC.

U.S. Geological Survey

<http://ca.water.usgs.gov> USGS has published results of many studies of California groundwater basins. USGS maintains an extensive groundwater level and groundwater quality monitoring network and has compiled this data in a database. The California District is working on cooperative programs with local, State, and other federal agencies. The most notable programs include three regional studies of the San Joaquin-Tulare Basin, the Sacramento River Basin, and the Santa Ana River basin under the National Water Quality Assessment Program. Results were published for the San Joaquin-Tulare Basin in 1995 and the Sacramento River Basin in 2000. The Santa Ana River basin study is in progress.

U.S. Bureau of Reclamation

<http://www.usbr.gov> The U.S. Bureau of Reclamation (USBR) operates the Central Valley Project (CVP), an extensive network of dams, canals, and related facilities that delivers about 7 maf during normal years for agricultural, urban, and wildlife use. USBR's role with respect to groundwater is generally limited to monitoring for impacts to the groundwater systems adjacent to its CVP facilities. Through the cooperative efforts of USBR, DWR, irrigation districts, farmers, and other local entities, groundwater level data have been collected continuously since project conception in the 1930s and 1940s.

In addition to CVP monitoring, USBR monitors groundwater levels to identify potential impacts as a result of two other projects in California. That monitoring includes the Santa Ynez basin as part of the Cachuma Project on the central coast, and the Putah Creek Cone as part of the Solano Project in the southwest Sacramento Valley. Both monitoring efforts are required as part of permitting for the projects.

USBR is planning to implement a groundwater information system to collect and distribute to the public the large volume of historical groundwater level data associated with its projects.