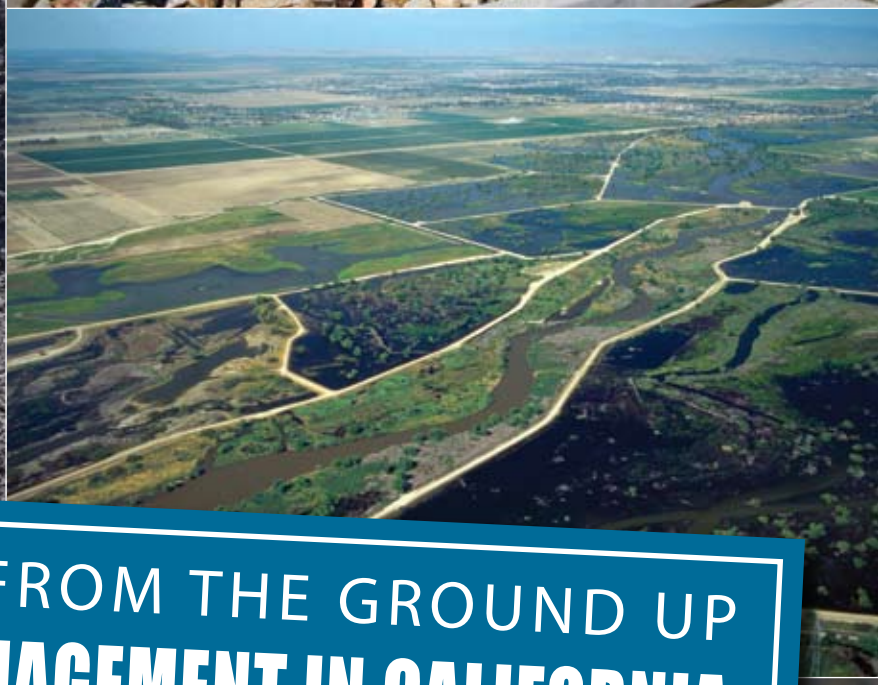
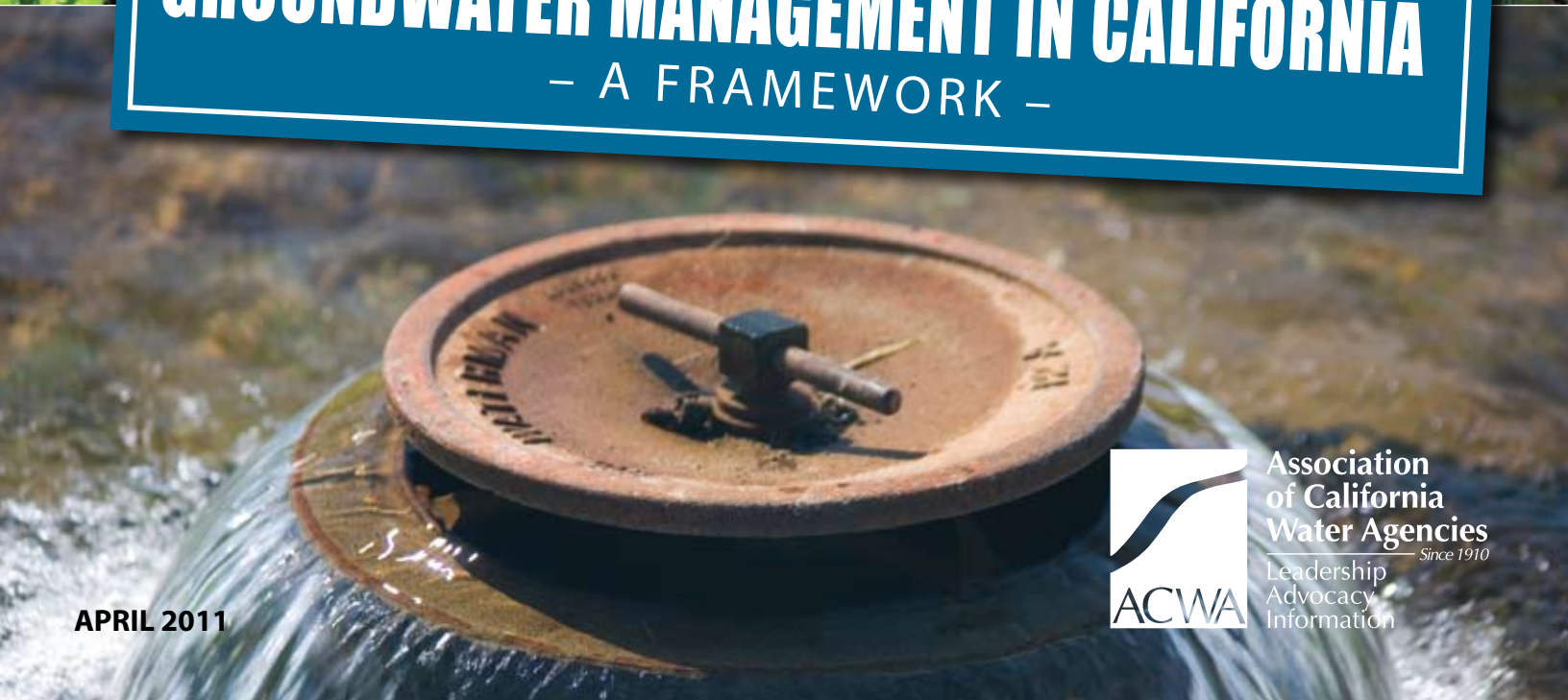


SUSTAINABILITY FROM THE GROUND UP

# GROUNDWATER MANAGEMENT IN CALIFORNIA

– A FRAMEWORK –



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# Acknowledgements

**Principal writers**
Danielle Blacet, ACWA Senior Regulatory Advocate
Tim Parker, Parker Groundwater
David Aladjem, Downey Brand LLP

**Core Review Group**
Greg Zlotnick, Chair, ACWA Groundwater Committee*, San Luis & Delta-Mendota Water Authority
John Rossi, Vice Chair, ACWA Groundwater Committee, Western Municipal Water District
Dave Orth, Kings River Conservation District
Kirby Brill, Mojave Water Agency
John Woodling, Sacramento Groundwater Authority
Jill Duerig, Zone 7 Water Agency
Thad Bettner, Glenn-Colusa Irrigation District
Timothy Quinn, ACWA Executive Director

**Regions Review Group**
Region 1: Jay Jasperse, Sonoma County Water Agency
Region 2: Thad Bettner, Glenn-Colusa Irrigation District
Region 3: Bob Dean, Calaveras County Water District
Region 4: Robert Roscoe, Sacramento Suburban Water District*
Region 5: Derrik Williams, HydroMetrics WRI (Soquel Creek Water District)
Region 6: Chris Kapheim, Alta Irrigation District*
Region 7: Paul Hendrix, Tulare Irrigation District*
Region 8: Dee Zinke, Metropolitan Water District
Region 9: Ken Manning, Chino Basin Watermaster
Region 10: Mike Markus, Orange County Water District

**Editorial Assistance and Production**
Jennifer Persike, ACWA Director of Strategic Coordination and Public Affairs
Lisa Lien-Mager, ACWA Communications Supervisor
Katherine Causland, ACWA Graphic Designer

** Member of ACWA's Board of Directors*

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# Foreword

In 2009, California lawmakers passed historic legislation that marked an important step toward improving the state's water supply reliability and restoring the Sacramento-San Joaquin Delta ecosystem. A critical challenge to achieving the goals of the legislative package is providing more effective management of groundwater resources at a time when California's reliance on its groundwater basins is growing due to a variety of short- and long-term factors.

The Association of California Water Agencies (ACWA) developed this Framework to describe current groundwater management efforts and identify proactive steps to advance sustainable groundwater management as part of the state's overall water management portfolio. ACWA believes the challenge of providing sustainable groundwater management must be met by local and regional agencies and not by centralized state regulation. Locally controlled groundwater management is effective because it is best able to respond to the particular circumstances of, and significant differences in, groundwater basins throughout the state. Local expertise and direct reliance on the resource ensures immediate response to problems and trends, and provides the strongest basis for collaborative regional approaches.

But as this Framework emphasizes, the job is far from done. While there are numerous case studies in successful management, efforts must be expanded in many parts of the state to achieve sustainable outcomes.

ACWA members are not daunted by the challenge. The actions and policy recommendations outlined in this document reflect the on-the-ground experience of experts involved in managing groundwater in every region of California and in a variety of geographic and hydrologic settings. Implementing these actions will help empower local agencies to strengthen their management efforts and contribute to the state's overall need for sustainable groundwater management, today and into the future.

To be successful, sustainable groundwater management must be accomplished in the context of a comprehensive solution that includes conveyance improvements in the Delta, investments in additional surface storage and groundwater storage to meet the co-equal goals, and massive investments in local water resources development.

ACWA members are prepared to step up to the challenge of providing sustainable groundwater management. We stand ready to work with policy makers and water managers to carry out actions and initiatives to promote more effective local groundwater management as part of a comprehensive solution.

Paul Kelley
ACWA President

Greg Zlotnick
ACWA Groundwater
Committee Chair

Timothy Quinn
ACWA Executive Director

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# Overview

## Groundwater has long been an integral part of California's water supply. Today, it has an even more critical role to play as the state grapples with significant water supply challenges.

California's water management system is arguably among the most complex and innovative in the world. Massive amounts of water are captured, stored and delivered through a combination of man-made and natural features to serve urban, agricultural and environmental needs.

Groundwater was widespread and abundant at the beginning of the 20th century. Its extensive availability contributed to large-scale agricultural and urban growth, which in turn steadily increased demand for and dependence on the resource. Effective management quickly became critical to protecting the future availability and quality of California's groundwater supplies. While many strategies have been implemented over the years to address groundwater management challenges, some are falling short today and require modernization.

Though California does not have a formal state-administered system of regulating and permitting groundwater use, it does have a long history of managing groundwater resources through locally controlled programs developed and refined over the past century.

Many of these programs have been very effective in addressing the state's most difficult groundwater management problems over the years. However, the array of challenges on the horizon will demand even more of local agencies and require a greater commitment to ensuring that local decisions and management contribute to statewide water policy goals.

The current state of California's groundwater should not be considered in isolation since it is largely reflective of broader water management concerns in the state. It has become increasingly clear in recent years that California's aging water supply and management infrastructure can no longer reliably meet the economic and environmental needs of the state. This is readily apparent in the Sacramento-San Joaquin Delta and elsewhere where challenges associated with population growth, drought, climate change, unmanaged groundwater overdraft and environmental concerns await resolution. The growing uncertainty of surface water supplies due to these and other factors has triggered greater reliance on groundwater as a principal or supplemental supply for urban, agricultural and environmental uses (e.g. wildlife refuges). It has also focused attention on groundwater basins as a potential storage solution.

The shift toward greater reliance on groundwater has magnified long-term risks to the quality and quantity of water available from California's groundwater basins. While Californians have relied on groundwater resources to varying degrees over the years, ACWA strongly believes today's growing dependence – intensified by both cyclical and long-term factors – will continue to stress California's groundwater basins unless proactive steps are taken at the local and regional level.

The California Legislature took an important step toward addressing the state's water challenges with passage of comprehensive water legislation in 2009. In addition to an $11.14 billion water bond now targeted for the November 2012 ballot and policy bills addressing Delta governance, water conservation, and water diversion and use, the package included new requirements for groundwater elevation monitoring to help track seasonal and long-term trends in groundwater basins.

ACWA developed this Framework to complement that legislation and advance the dialog on sustainable groundwater management. Produced by a task force of local groundwater managers from throughout the state, the Framework has four main purposes:

1. To define "sustainability" in terms that promote effective groundwater basin management;
2. To describe the current state of groundwater management in California, including an increasing number of successful local and regional management and conjunctive use programs, to provide an accurate and comprehensive foundation on which the public, policy makers and other stakeholders may make informed decisions;
3. To articulate groundwater management practices to address current and future challenges in California groundwater management; and
4. To identify specific policy development needs and recommend ways to enhance accountability, transparency, and the efficacy of sustainable groundwater management in California and its appropriate integration as a critical part of California's overall water management planning portfolio.

As evidenced by effective local and regional programs highlighted in this Framework, (see map, page 22), existing mechanisms for managing groundwater basins are providing an excellent foundation for sustainable management now and into the future. These examples, along with many other programs throughout the state, have generated impressive results and should be utilized as models for other agencies to help achieve the goal of sustainable groundwater management in California.

Locally controlled groundwater management is effective because local and regional entities are the most knowledgeable about their local basins and tend to be the first to notice changes or problems. They are also best suited to address issues unique to their region, including the implementation of proactive plans and actions to meet current and future groundwater needs.

Groundwater management plans developed under AB 3030, SB 1938 and the Integrated Regional Water Management Planning Act offer prime opportunities to enhance effective management and incorporate strategies that can help address the potential consequences of a large-scale shift to groundwater, whether cyclical or permanent. Doing so will also improve coordination and collaboration with state agencies as elevation data is collected pursuant to the new requirements of SBX7 6, enacted as part of the 2009 comprehensive legislative water package.

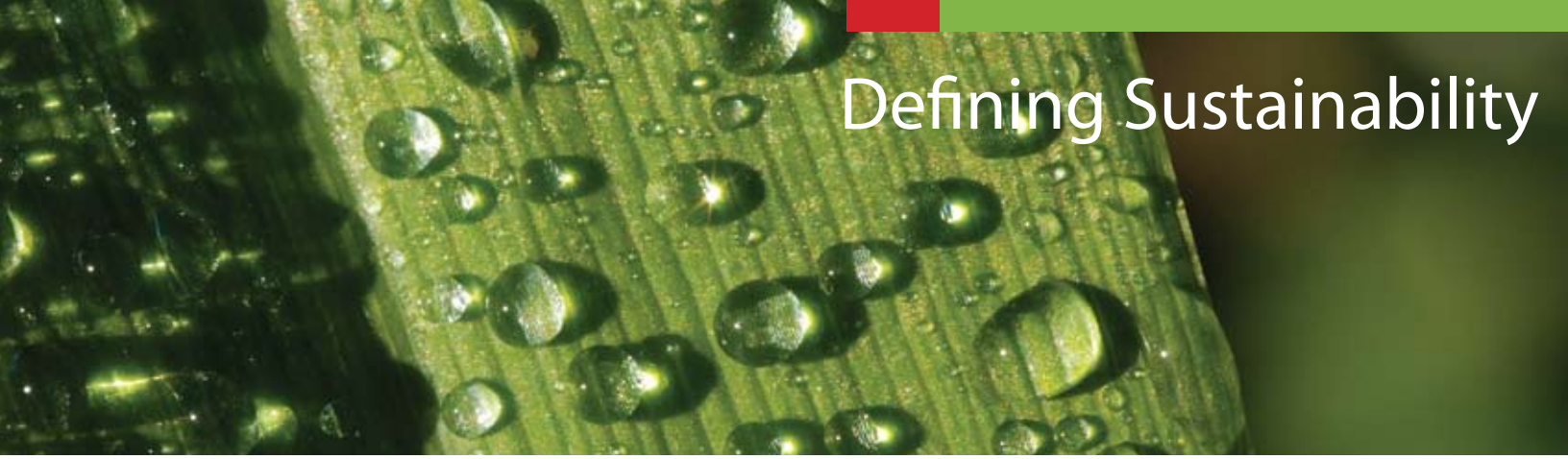
ACWA believes the state Legislature should encourage and support local management policies that appropriately reflect California's geographic and hydrologic diversity rather than institute a state-administered centralized control structure for regulating or permitting the use of groundwater. Statewide permitting and regulation would undermine the effectiveness of existing and planned local investments and would be counterproductive because it would not account for the significant differences in California groundwater basins throughout the state.

The Legislature should focus instead on incentivizing the development and implementation of the best practices outlined in this Framework. Recommendations for doing so are outlined beginning on page 29.

Ultimately, for sustainable groundwater management to succeed, California must invest in improvements to its water storage and conveyance infrastructure to optimize both surface and groundwater supplies. Such investments are critical if conjunctive use and groundwater banking are to realize their full potential as effective strategies to meet California's future demands, both economic and environmental. These investments must complement an ongoing commitment to expanded water use efficiency and water reuse.

ACWA believes that with the actions and policy modifications recommended in this Framework, local agencies can provide sustainable groundwater management, to the benefit of California, without the addition of new layers of state bureaucracy or regulation.

In addition to this Framework, ACWA has adopted Groundwater Management Policy Principles to provide further guidance and recommendations for sustainable management of the state's groundwater resources. The principles can be found on page 32. The Framework and the principles together provide a solid foundation for achieving groundwater management goals in California, and an effective basis for collaboration among the water and environmental communities, agriculture, business and labor leaders, and state and local governments.



# Defining Sustainability

## Sustainability has emerged as an important principle in natural resources management in recent years. ACWA has adopted policy principles that identify environmental and economic sustainability as co-equal priorities for water management in California.

In the context of groundwater, ACWA defines sustainability as actively managing the resource at the local level in a way that satisfies the needs of both the environment and the economy while ensuring the continued health of the basin. Given the importance of groundwater to California's water supply, sustainable management of the state's groundwater resources is essential to ensuring a reliable water supply and a healthy environment – both today and for generations of Californians to come.

The United States Geological Survey characterizes groundwater sustainability as the "development and use of groundwater in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences."[1]

Inherent in that definition as applied is the long-term protection and maintenance of both groundwater quantity and quality. As evidenced by effective local and regional programs throughout the state, managing groundwater basins to achieve sustainability has many benefits, including:

- More reliable surface and groundwater resources
- Increased opportunities for conjunctive use and recharge projects
- Environmental health / stability
- Drought mitigation
- Water quality improvements
- More effective land use planning and management
- Reduced energy costs associated with pumping

On the other hand, the lack of effective groundwater management contributes no such benefits and has led to the further decline of groundwater resources in certain areas of California. Unacceptable consequences include depletion of existing groundwater supplies, land subsidence, water quality degradation and environmental damage.

1 Alley, W.M., Reilly, T.E., and Franke, O.L. (1999). *Sustainability of Ground-Water Resources:* U.S. Geological Survey Circular 1186.

# Groundwater Management Today

In California, groundwater management generally refers to a locally developed and controlled program that integrates groundwater protection, recharge, extraction and monitoring to achieve the long-term sustainability of the resource. Since groundwater basins vary greatly around the state, local control and supervision allow for the most effective and careful management of the resource. One size does not fit all when it comes to groundwater management.

California is known for its diverse ecosystems, topography and geology and for its highly variable water resources. With more than 38 million people and a land area of 100 million acres, California is the most populous state and the third-largest geographically in the country. It is also the most productive agricultural state, producing over half the fruits, nuts and vegetables in the nation.

In 2000, an average water year, California cities and suburbs used about 8.9 million acre-feet (MAF) of water. California agriculture irrigated 9.6 million acres of cropland (includes multi-cropping) using roughly 34 MAF of applied water. Dedicated environmental uses of water, including in-stream flows, wild and scenic flows, required Delta outflow, and managed wetlands, exceeded 39 MAF.[2]

In an average year (based on 1998-2005 data), groundwater resources supply about 35 percent of California's urban, agricultural and managed wetlands water demands (about 15 million acre-feet per year).[3] In dry years, this percentage increases to 40 percent or higher statewide and as high as 60 percent or more in some regions. Nearly half of California's drinking water supply comes from groundwater.

In addition to contributing essential water supplies, the state's groundwater basins provide significant water storage capacity. This storage capability is important in and of itself, but when used in conjunction with surface water storage it can go a long way toward meeting local and regional needs for greater flexibility, increased water supply reliability and improved water quality. This potential is limited, however, by current regulatory and infrastructure constraints on groundwater recharge and extractions. Optimizing large-scale conjunctive use programs will require investments in both surface and groundwater storage.

2 California Department of Water Resources. *California Water Plan Update 2009:* v1c4, pp 4-12, 4-21.
3 California Department of Water Resources. *California Water Plan Update 2009:* v2c8, p 8-10.

## APPLIED WATER VS. CONSUMPTIVE USE

According to the California Department of Water Resources, applied water is the amount of water from any source needed to meet the demand for beneficial use by the user. It includes consumptive use, reuse, and outflows. Consumptive use is a quantity of applied water that is not available for immediate or economical reuse. It includes water that evaporates, transpires, or is incorporated into products, plant tissue, or animal tissue. Consumptively used water is removed from available supplies without return to a water resource system (uses such as manufacturing, agriculture, landscaping, food preparation, and in the case of Colorado River water, water that is not returned to the river.)*

*DWR California Water Plan Update 2005 http://www.waterplan.water.ca.gov/docs/cwpu2005/vol2/v2glossary.pdf

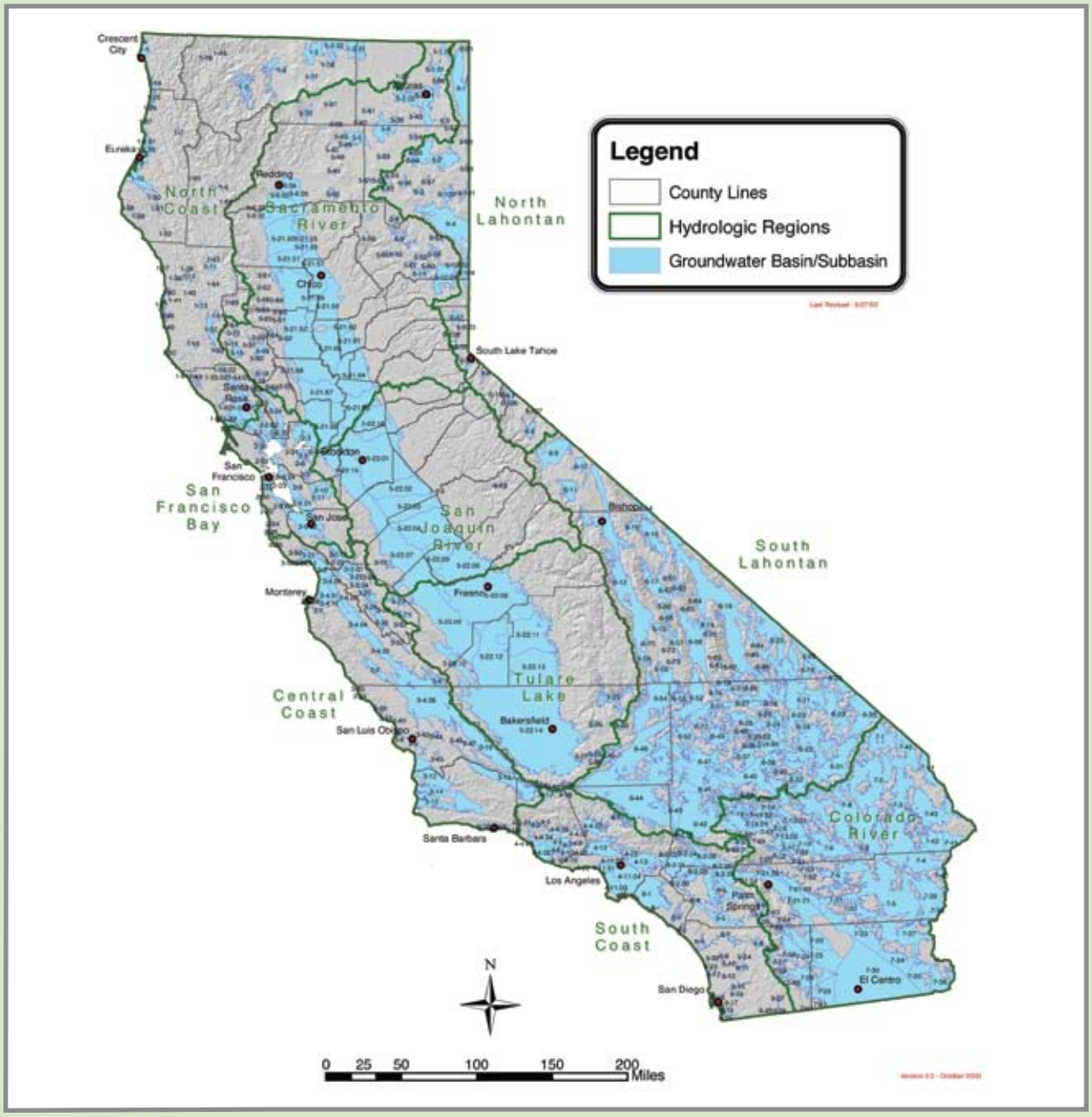
# WHERE DOES GROUNDWATER COME FROM?

**Much of the water from snowmelt and rain that flows into surface water formations (e.g. creeks, streams, rivers, ponds) percolates into the ground and becomes groundwater.** Groundwater can be thousands of years old, but most of the groundwater typically used in California today is extracted a few years to a few decades after its original percolation.

Groundwater is found in two main types of geologic settings in California. The vast majority of groundwater in the state is stored in alluvial basins, which are composed of sediments such as gravel, sand, silt or clay and cover nearly 40 percent of the geographic area of the state. Alluvial basins account for all 515 basins and sub-basins identified in DWR's Bulletin 118. (http://www.water.ca.gov/pubs/groundwater/bulletin_118)

However, groundwater is also stored and extracted from fractured bedrock or sandstone. About 20 percent of the state's municipal supply wells are located in this type of formation, with prime examples found in the Sierra Nevada and the Coast Ranges.

## Groundwater Basins in California



## Water Supply Infrastructure: Key to Meeting Needs

Precipitation in California varies widely—from place to place, from season to season, and from year to year. Wet years can bring the threat of floods, while dry years can reduce available water supplies and require the temporary drawdown of stored water. This unpredictable hydrology affects not only the amount of surface water available in a given year but also the amount of groundwater available for extraction and use.

The state's water storage and delivery infrastructure was designed to address that unpredictability, protecting communities from floods and capturing winter precipitation and spring snowmelt for strategic delivery in the drier summer and fall months. The system also contributes to effective groundwater management by providing surface water to augment local supply sources and alleviate pressure on groundwater basins.

California's two largest water delivery systems are the State Water Project (SWP) and the federal Central Valley Project (CVP). The SWP, operated by the California Department of Water Resources, delivers water to 25 million Californians and 755,000 acres of irrigated farmland. The CVP, operated by the United States Bureau of Reclamation, provides water for more than 3 million acres of farmland and drinking water to nearly 2 million consumers.

All told, California has nearly 200 surface storage reservoirs with a capacity of 10,000 acre-feet or more, for a combined storage capacity of more than 41 MAF. In addition, there are many other reservoirs smaller than 10,000 acre-feet that are used to manage water for a wide range of uses.

Given the state's highly variable hydrology, surface and groundwater storage facilities are critical to supplying cities, farms, businesses and the environment with adequate water year-round. They are particularly effective when used in concert with each other to make maximum use of water when it's available and store it for use in dry times.

## Conjunctive Use: A Critical Part of Sustainable Management

Conjunctive use or management refers to the coordinated and planned use of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Since surface water and groundwater resources can differ significantly in their availability, quality, cost and other characteristics, managing both resources together, rather than in isolation from each other, allows water managers to use the advantages of each for maximum benefit.

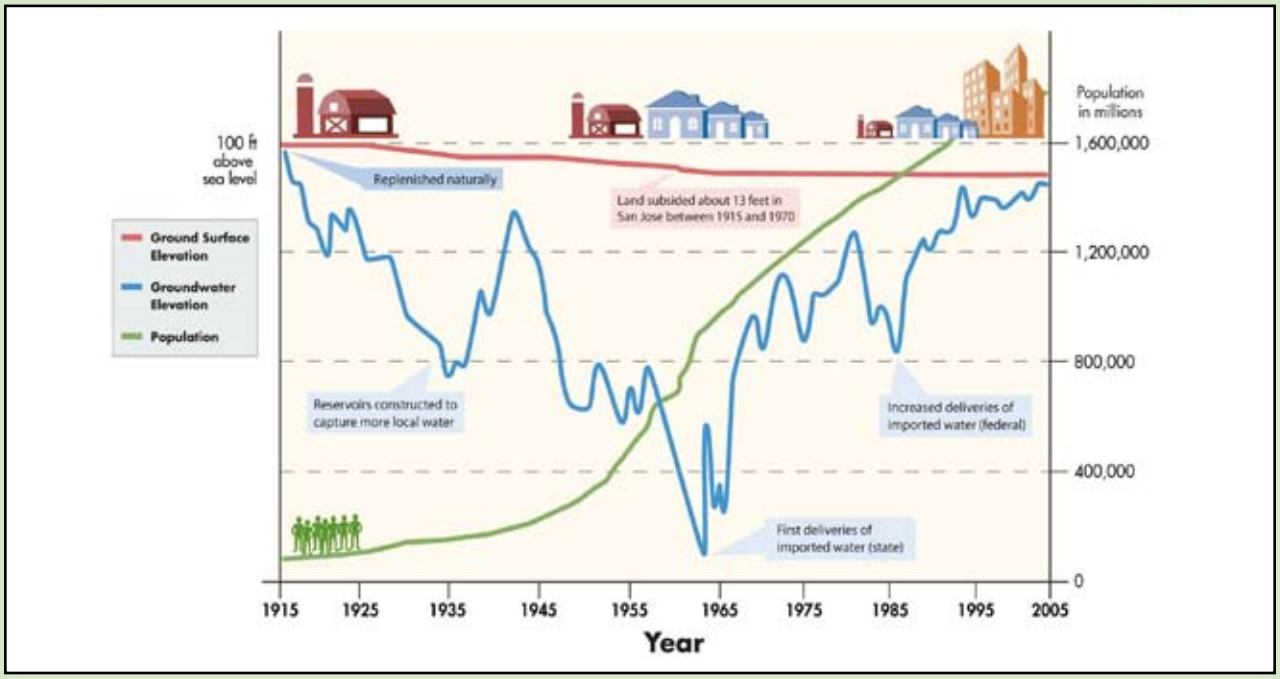
### WHAT IS GROUNDWATER BANKING?

Groundwater banking is a water management tool designed to increase water supply reliability. By using dewatered aquifer space to store water during wet years (when there is abundant rainfall and surplus water available), water can be pumped and used during dry years (when there is little rainfall and no surplus water).

Groundwater banking is accomplished two ways: through in-lieu and direct recharge. In-lieu recharge is storing water by utilizing surface water "in-lieu" of pumping groundwater, thereby storing an equal amount in the groundwater basin. Direct recharge is storing water by allowing it to percolate directly to storage in the groundwater basin.*

*Definition courtesy of Semitropic Water Storage District

# CONJUNCTIVE MANAGEMENT OF LOCAL AND IMPORTED WATER SUPPLIES: THE KEY TO A SUSTAINABLE SILICON VALLEY




*Graphic courtesy of Santa Clara Valley Water District*

The Santa Clara Valley Water District has a long record of conjunctive water management. Established in the late 1920s to address groundwater overdraft and subsidence, the district constructed seven dams by 1935 to impound surface water for recharge into percolation facilities. As the graphic illustrates, the post-war boom brought increased demands for water and the return of unsustainable declines in groundwater elevation. Surface reservoir capacity was quadrupled by constructing four additional reservoirs in the 1950s. In 1965, the district began importing surface water from the State Water Project. Groundwater levels began to recover and the rate of subsidence slowed significantly. The rise of Silicon Valley brought increased demands again, and the district added Central Valley Project deliveries to its supply portfolio in the late 1980s. By the mid-1990s groundwater elevations had returned to levels seen at the turn of the 20th century.

Conjunctive use has been practiced for decades in California. In general, conjunctive use programs take advantage of available groundwater storage capacity to "bank" or store surface water through natural and / or artificial recharge for later extraction and use. In many areas, there is tremendous potential to enhance local supplies even further by utilizing storm flows and recycled water with appropriate safeguards to augment groundwater recharge.

Well-planned conjunctive use programs not only enhance local and regional water supply reliability, but can also provide other benefits such as enhanced flood management, improved environmental water management, reduced reliance on the Delta to meet future water supply needs, and water quality improvements.

Conjunctive use projects require investments in surface storage, conveyance systems, recharge and extraction facilities, and management of groundwater basins. Conveyance systems may include lined and / or unlined canals, pipelines, and streams. Recharge options include direct spreading and infiltration in artificial ponds, injection via wells, and induced natural recharge in natural systems. In the strategy known as in-lieu recharge, surface water can be provided to users who normally use groundwater to allow supplies to stay in groundwater basins.

Groundwater may be extracted later for direct use, for pumping back to conveyance systems, or for surface water exchange.

# KEY WATER PROJECTS IN CALIFORNIA

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## WHAT ARE SOME OF THE SOURCES FOR CONJUNCTIVE USE PROJECTS?

**Imported water** – Water that is transferred across hydrologic region boundaries from one agency to another. Many parts of the state receive imported water from the State Water Project and Central Valley Project.

**Local surface water** – Direct deliveries of water from stream flows, as well as water supplies from local storage facilities.

**Recycled water** – Municipal, industrial, or agricultural wastewater that is treated to produce water that can be reused.

**Reclaimed water** – Treated water where the inflow water supply is polluted, contaminated, or otherwise tainted.

**Desalinated water** – Water that has been treated to remove salt for beneficial use. Source water can be brackish (low salinity) or seawater.

**Stormwater (runoff)** – Water that collects during a precipitation event and may carry pollutants to water courses, causing degradation.*

*For more information, please see Bulletin 160 Water Plan Update 2009 Glossary (http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v4c01ag_cwp2009.pdf)

# The Current Regulatory Landscape

California is often criticized for being one of the only Western states without a formal state-administered system of regulating and permitting groundwater use. But while it is true there is no *centralized* system to regulate the use of groundwater, California has developed and refined an effective system of locally controlled groundwater management over the past century.

As noted by the California Legislative Analyst's Office[4], the current system has been successful in addressing the state's most difficult groundwater management problems over the years. The growing list of challenges on the horizon, however, will demand more of local agencies and require a greater commitment to ensuring that local decisions and management contribute to achieving statewide water policy goals.

To that end, ACWA is confident that, with certain modifications recommended in this Framework, local agencies can provide sustainable groundwater management for the benefit of California without the addition of new layers of state bureaucracy or regulation.

## Basic Legal Principles Set Foundation

As a general rule, landowners in California are entitled to pump and use a reasonable amount of groundwater from a basin underlying their land. Under the doctrine known as "correlative rights," landowners overlying a common source of groundwater are limited to using a reasonable share, typically based on the amount of overlying land owned by each and the physical condition of the basin. When there is insufficient water to meet the demands of overlying landowners, those users are expected to reduce their demands correlatively to bring their groundwater extractions within the safe yield of the basin and prevent overdraft.

Entities other than overlying users, such as cities, may be entitled to "appropriate" water from the basin for use as a municipal supply when water surplus to the needs of overlying users is available. Unless otherwise prescribed, appropriators must curtail their use when there is no surplus.

As the above paragraphs suggest, the interrelated concepts of "safe yield," "surplus" and "overdraft" are central elements in the legal landscape addressing California groundwater. As defined by the California Supreme Court in the landmark *Los Angeles v. San Fernando* case in 1975, "safe yield" refers to "the maximum quantity of water which can be withdrawn annually from a groundwater supply under a given set of conditions without causing an undesirable result." The phrase "undesirable result" is understood to refer to "a gradual lowering of the groundwater levels resulting eventually in depletion of the supply." "Surplus" refers to "the amount of water in a groundwater basin in excess of safe yield." *City of Los Angeles v. City of San Fernando* (1975) 14 Cal.3d at 278.

The *San Fernando* court also clarified that an overdraft occurs only when extractions exceed safe yield plus "temporary surplus," the latter term defined as the amount of water that can be pumped from a basin to provide storage space for surface water that would otherwise be lost during wet years if it could not be stored in the basin. *Id.* at 279.

4 California Legislative Analyst's Office. 2010. *Liquid Assets: Improving Management of the State's Groundwater Resources.* (http://www.lao.ca.gov/laoapp/PubDetails.aspx?id=2242)

## Recognizing Interplay Between Surface Water and Groundwater

Though surface water and groundwater are often interconnected from a hydrologic perspective, they are generally managed and regulated through separate legal regimes in California. The Legislative Analyst's Office and others have called for California's groundwater law to be "modernized" to better reflect the well-established physical connection between groundwater and surface water in many areas.

That recommendation fails to consider, however, that California has a long and reasonably well-developed history of successfully integrating the use of surface water and groundwater, despite the existence of two different legal regimes. Though this "dual system" may not always appear neat and orderly, case law is sufficiently well-developed to suggest that California courts are fully aware of the interplay between surface water and groundwater in specific instances and have crafted legal doctrines to address those hydrologic realities.

## A LOOK AT LEGAL CASES OVER THE YEARS

Under California law, water is characterized as being surface water or groundwater. Groundwater is further classified as either a subterranean stream or as percolating groundwater. Surface water and groundwater classified as a subterranean stream are subject to the permitting authority of the State Water Resources Control Board, while groundwater classified as percolating groundwater is not subject to that authority.

In areas where there is a hydrologic connection between groundwater and surface water resources, a number of early cases established the legal rules for interconnected surface water and groundwater systems. These rules form the foundation of groundwater management today.

**Potential Interference by Groundwater Pumpers with Surface Water Rights**

| Case Information | Result |
|---|---|
| *City of Los Angeles v. Hunter* (1909) 156 Cal. 603, 607; *McClintock v. Hudson* (1903) 141 Cal. 275, 278; *Los Angeles v. Pomeroy* (1899) 124 Cal. 597, 624. | Found that a user of percolating groundwater may diminish flows in a surface stream only if the groundwater is put to reasonable use on lands overlying the groundwater basin. |
| *Hudson v. Dailey* (1909) 156 Cal. 617, 624-627. | Virtually ignores the distinction between riparian rights to surface water and correlative rights to groundwater in finding a right to extract groundwater for use on overlying lands despite impacts on downstream riparians and downgradient overlying pumpers. |
| *Barton Land & Water Co. v. Crafton Water Co.* (1915) 171 Cal. 89, 94-95. | Owner of lands overlying a subterranean stream cannot extract water from that stream so as to have an adverse impact on surface water diverters. |

**Potential Interference by Surface Water Diverters with Groundwater Rights**

| Case Information | Result |
|---|---|
| *Miller v. Bay Cities Water Co.* (1910) 157 Cal. 256, 276-279 (overruled on other grounds in *City of Lodi v. East Bay Municipal District* (1936) 7 Cal.2d 316, 338-339). | California Supreme Court decision that articulated a broad standard protecting the owner of percolating groundwater from surface appropriations of water on non-riparian lands |
| *United States v. Fallbrook Pub. Util. Dist.* (S.D. Cal. 1958) 165 F.Supp. 806, 847 (citing *McClintock,* 141 Cal. at 281; *Hudson,* 156 Cal. at 628). | Federal district court decision that found riparian and overlying rights are treated as extracting water from one common source and so have joint rights to reasonable shares of the resource. |

# Challenges to Sustainable Groundwater Management

**To advance sustainable groundwater management, it is essential to understand the growing list of challenges related to California's groundwater basins.**

Addressing these challenges will require comprehensive efforts by local agencies individually and within regional partnerships to develop and implement sustainable groundwater management practices. This brief overview describes a number of factors confounding the management of California's groundwater resources.

## Declining Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta is the hub of California's two main water delivery systems – the State Water Project and the federal Central Valley Project. Court-ordered restrictions to protect species have significantly reduced deliveries from these projects in recent years. This reduction in surface water supplies has hampered conjunctive use projects in some parts of the state and highlighted the need for more sustainable groundwater management as urban, agricultural and environmental users have turned to local groundwater resources as a substitute for increasingly unreliable SWP and CVP deliveries.

## Periodic, Inevitable Droughts

The southwestern United States, including California, is prone to periodic droughts. Most recently, three consecutive dry years from 2006-2009 resulted in some of the driest conditions in decades and reduced water storage in key reservoirs to record lows. Regulatory restrictions on SWP and CVP deliveries magnified the impacts of this natural drought.

Prolonged drought has multiple effects on groundwater resources and management. The lack of available surface water can place additional demands on groundwater basins. Less surface water also means less water available for groundwater recharge. If groundwater levels drop as a result of increased demand or reduced recharge, there are additional energy costs to pump groundwater and greater potential for overdraft conditions. Further, the strategic value of conjunctive use projects that rely on surface water reliability can be undermined.

## Changing Climate

Climate change will exacerbate the existing water management challenges facing California, including those affecting groundwater resources. Possible consequences include more frequent drought periods, reduced snowpack in the Sierra Nevada, increased flooding intensity as well as impacts to the operation of the state's surface storage facilities.[5] Higher temperatures, particularly in inland areas, could lead to increased demands on water supplies for urban, agricultural and environmental uses.

Changes in rainfall patterns could also result in faster local runoff and reduced natural groundwater recharge. Collectively, these impacts could result in less reliable water supplies and an overall increase in the demand for groundwater supplies.

5 ACWA Policy Principles on Climate Change. March 2010.

## "HIGHER HIGHS, LOWER LOWS"

Based upon historical data and modeling, DWR projects that the Sierra snowpack will decline by 25 percent to 40 percent from its historic average by 2050. Climate change is also anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing the total snowpack.* These storm events will, however, increase peak flows and affect the length of the recharge and recovery cycle of reservoirs that is critical to effective conjunctive use projects.

* California Department of Water Resources. *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water.* October 2008.

## Unmanaged Overdraft and Subsidence

Overdraft is defined as the condition of a groundwater basin when the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin, either through natural or artificial methods. A basin in overdraft tends to not fully recover, even in wet years. While the occasional extraction of groundwater in amounts greater than annual recharge can be part of an effective groundwater management plan, unmanaged or excessive extractions can result in land subsidence, water quality degradation, and environmental impacts.

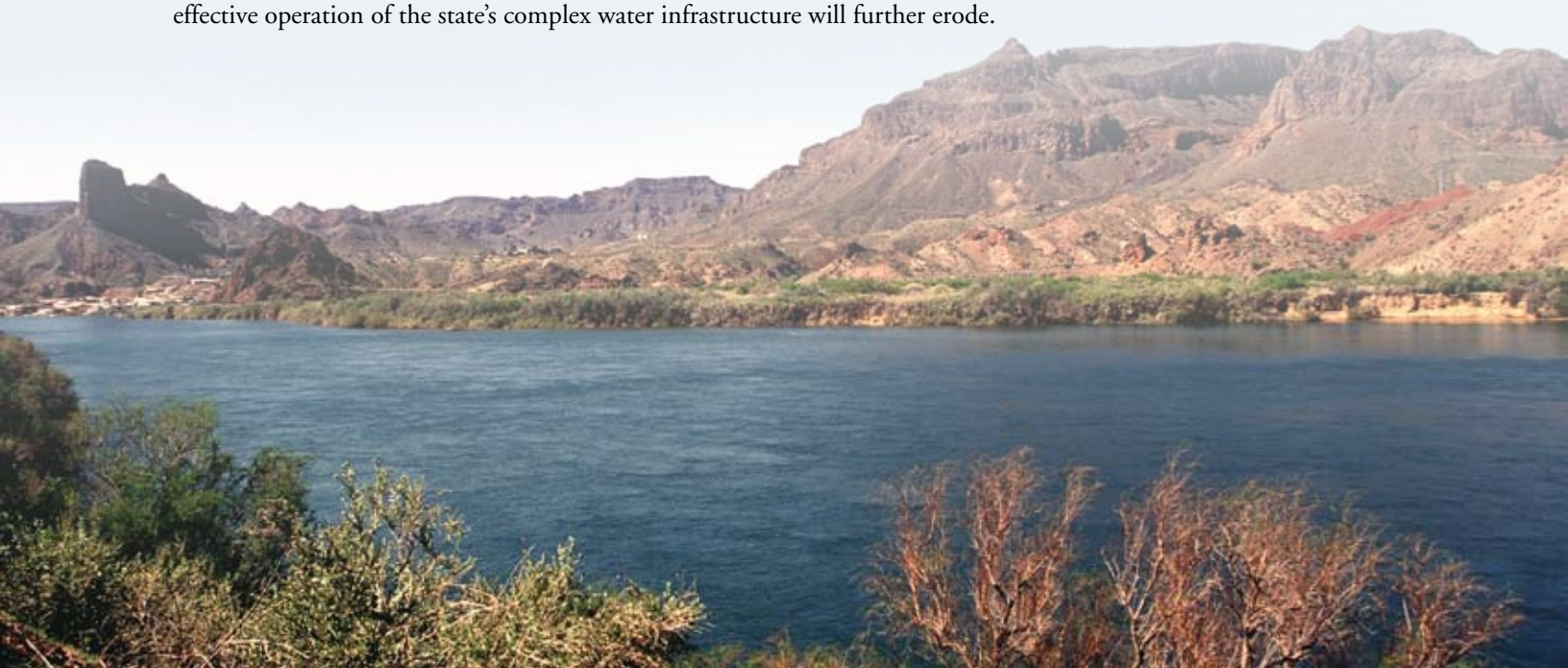
## Protracted Drought on the Colorado River

The Colorado River is a key source of water for seven states and Mexico, providing water for some 30 million people to drink and meet household needs, irrigate crops and urban landscapes, operate businesses and replenish groundwater basins. California's annual allocation is 4.4 MAF for irrigation and domestic uses. The Colorado River Basin is in the midst of a multi-year drought that has reduced reservoir storage to record-low levels. These conditions are affecting the reliability of Colorado River supplies for conjunctive use projects and other beneficial uses throughout Southern California. Climate change is expected to further diminish the reliability of deliveries to California.

## Aging System and Maintenance Backlog

California has not made significant investments in its backbone water storage and delivery systems, the SWP and CVP, in more than 40 years. In addition, several key components of the projects as originally planned were never built. Constructed when the state's population was just 18 million, the projects are struggling to meet the needs of 38 million Californians today. They also lack the flexibility to meet 21st century demands for both ecosystem health and water supply reliability. These aging facilities also suffer from a backlog of maintenance and repair needs arising from budget and contracting constraints.

Further complicating the effective maintenance of the state's water infrastructure is the growing number of issues related to an aging workforce. It is becoming increasingly difficult to secure professionals for policy and technical positions (such as engineers and water treatment operators), particularly those with extensive experience in California's water industry. As those individuals with expertise begin to retire en masse or find employment elsewhere, effective operation of the state's complex water infrastructure will further erode.



As a result of the increasing physical and workforce limitations, contractual and historic water delivery expectations are not being met and the existing facilities have neither the capacity nor flexibility to adapt to the approaching challenges presented by climate change. The deterioration of the delivery capabilities and reliability of this surface water infrastructure has resulted in, and will continue to contribute to, reductions in the amount of supply available for effective recharge and increasing demands for already-stressed groundwater resources.

At the local and regional level, efforts to maintain and upgrade facilities can be constrained by factors such as Propositions 218, which limits the ability of local agencies to raise rates and fees for a variety of projects and purposes. In addition, the practice of restricting bond funds solely for new construction and not for retrofitting and major maintenance needs can undermine past investments by allowing the foundation upon which they rely to crumble.

## Groundwater Quality Degradation

Groundwater quality degradation has become a significant challenge for agencies that manage groundwater. Though groundwater quality can be affected by many factors, some of the most significant threats include chemical contaminants, both naturally occurring and man-made, salinity (including seawater intrusion), landfills and other hazardous waste sites. When groundwater quality is compromised, it may become unsafe for consumption or other uses and it can, without remediation, render the basin unfit for conjunctive use and artificial recharge projects.

Efforts to remediate groundwater contamination can be complicated by a number of issues. Under current law, local agencies that wish to initiate a remediation effort can face numerous disincentives that can hinder or even prevent a proactive approach. Difficulties related to liability, water quality standards, anti-degradation versus non-degradation concerns, assignment of costs and other factors are impediments to clean-up efforts.

## Limited Data Collection, Interpretation and Use

In many areas, the lack of a comprehensive approach to systematically managing data on California's groundwater resources is a considerable challenge to sustainable groundwater development. Due to inadequate funding, a comprehensive assessment of groundwater level trends in California's groundwater basins has not been conducted since 1980. While some data is collected through ongoing efforts such as the Groundwater Level and Quality Monitoring Program (DWR), the Groundwater Ambient Monitoring and Assessment (GAMA) Program (administered by the U.S. Geological Survey under contract to the State Water Resources Control Board), and the U.S. Geological Survey Groundwater Information Program, these initiatives are weakened by their limited geographic scope. DWR and the

### HOW DOES LAND SUBSIDENCE OCCUR?

Land subsidence is the gradual settling or sudden sinking of the Earth's surface due to changes that take place underground. This movement of earth can be the result of many factors, including groundwater extraction. In some types of groundwater basins, water that is pumped to the surface is drawn from spaces between sand and gravel. In addition, layers of clay can contain large amounts of water, and water pressure in the surrounding aquifer keeps the clay particles slightly apart from each other. When the water pressure in such a basin drops due to extensive pumping, the clay particles are pushed together by the weight of the overlying sediments, which is no longer in equilibrium with the (now lower) water pressure. As clay particles are pressed together for lack of water pressure, water drains out of the clay and the clay layers become compressed (thinner).

The effect of thinner clay layers is seen as a lowering of the land surface – sometimes as much as 20 or 30 feet over the course of a few decades. The lowering of land surface elevation from this process is permanent. Effective groundwater management utilizes the storage capabilities of groundwater basins while preventing significant subsidence from occurring. More information can be found at http://www.water.ca.gov/groundwater/well_info_and_other/land_subsidence.cfm, http://geochange.er.usgs.gov/sw/changes/anthropogenic/subside/.

## CONJUNCTIVE USE OPERATIONS AND "OVERDRAFT"

An increasingly common practice in California is to operate a groundwater basin in conjunction with available surface water supplies on a local or regional level. The practice involves exercising the basin, a process that causes the groundwater level to go up and down with wet and dry annual and periodic cycles. During the wet season and during wetter years, surface water is relied on more and the groundwater basin is recharged with surplus surface water, from local and / or imported sources, resulting in groundwater level increases. Such recharge occurs through direct means via spreading basins or in-lieu via surface deliveries that otherwise offset groundwater pumping. During dry years, when less surface water is available, groundwater is relied on more, drawing the groundwater levels down.

In the event of a periodic drought lasting several years, when less surface water is available and groundwater is used more extensively to meet demands, groundwater level trends can sometimes decline quite dramatically without any notable recovery for a longer period of time. The groundwater level trend in a conjunctively managed basin over a period of several years during a drought may appear as long-term overdraft; however, some would refer to this as "managed overdraft" as the downward trend will be offset by recovery cycles in wetter periods utilizing the direct or in-lieu groundwater recharge methods.

SWRCB do not adequately coordinate their statewide monitoring efforts. This lack of comprehensive data management will continue to hinder the ability of local and regional agencies to optimize the use of California's groundwater resources.

### Small System Vulnerability

Small community water systems, including many that serve disadvantaged populations, can face unique management challenges not shared by their larger counterparts. Such systems that are dependent on groundwater and / or private wells are especially vulnerable to drought and the effects of climate change because they are typically located in isolated areas with few opportunities for interconnections with other systems, water transfers, or emergency relief. This can also make it more challenging to develop successful conjunctive use programs or implement costly water quality treatment technologies.

### Fragmented Regulations

California has a multifaceted and complex regulatory structure. Numerous agencies have jurisdiction over various aspects of groundwater recharge and banking projects, particularly those involving underground storage supplements (USS) and aquifer storage and recovery (ASR). Regulations governing these projects tend to be fragmented, duplicative or unnecessarily complicated. Often-conflicting regulatory requirements affecting the same basin or water supply can also slow or even stall progress on critical projects.

### Mounting Environmental Requirements

In addition to a complicated regulatory landscape, local water agencies must adhere to an array of environmental statutes as they plan, develop and operate projects. The California Environmental Quality Act (CEQA), for example, adds numerous layers and requirements that can be a hurdle to moving projects forward. Depending on how they are implemented, the state and federal Endangered Species Acts can also affect development and operation of projects, sometimes at great cost to water supplies. Loss of surface water supplies as a result of environmental regulations can result in greater short-term reliance on groundwater, often with long-term ramifications.

### Land Use Decisions and Population Growth

Population growth and commercial development continue to put pressure on resources throughout California. As competition increases for a limited amount of developable land, the need to retain adequate groundwater recharge capability is often overlooked in decisions affecting land use. Activities such as paving and development change the absorption capacity of land, thereby reducing opportunities for natural recharge. In some watershed areas, forestry practices affect in-stream recharge by contributing to siltation, which blocks the absorption capability of creek and river bottoms.

Land use policies and regulations that fail to consider and protect natural and artificial recharge and extraction capabilities create long-term challenges for successful sustainable groundwater management, including permanent reductions in permeable acreage, water quality degradation and land subsidence. Such policies can also exacerbate problems associated with management of stormwater runoff.

# Existing Local Management Strategies

California relies on a variety of mechanisms to promote the local control and management of groundwater resources. Since the earliest efforts to manage California's groundwater, the effectiveness and complexity of these strategies has continued to evolve with changing urban and environmental needs and conditions.

As previously noted, every groundwater basin in California presents unique physical and hydrogeological characteristics. In addition, each basin has unique beneficial uses dependent upon water quality, water rights, number and breadth of stakeholders, institutional type and complexity, and other features.[6]

Locally-controlled groundwater management is effective because local and regional entities are the most knowledgeable about their local basins and tend to be the first to notice changes or problems. They are also best suited to address issues unique to their region, including the implementation of proactive plans and actions to meet current and future groundwater needs.

Since local stakeholders and management agencies receive the direct benefits of sustainable management, they are more inclined to support investments in local infrastructure and water quality projects, which in turn leads to more consistent implementation of improvements. Local agencies are also in the best position to identify and assess the consequences of over-reliance on groundwater resources and to evaluate options for improved management. While a certain degree of coordination with the state is important, particularly with regard to data management and funding, one-size-fits-all mandates and uniform statewide protocols tend to be counterproductive because they do not recognize the significant differences in California groundwater basins.

## Basic Management Mechanisms

As noted in the Department of Water Resources' California Groundwater Bulletin 118[7], there are three basic mechanisms available for managing groundwater resources in California. These mechanisms include: 1) management by local agencies under authority granted by state statute; 2) coordinated agreements and ordinances; and 3) court adjudications.

Local and regional agencies employ a variety of successful management strategies under these mechanisms, reflecting the diversity of the state's groundwater basins and the diverse beneficial uses of water from those basins. Examples can be found on pages 22 and 23. Financial support and incentives at the state and local levels have also contributed to the success of local and regional groundwater management plans. State policy makers can play a key role in promoting these efforts by providing consistent support and assistance through legislation and funding. Propositions 204, 13, 50 and 84 are examples of this constructive support.

### Local Management under Authority Granted by State Statute

Many local water agencies are authorized by statute to institute and conduct some form of groundwater management. Agencies formed under the Water Replenishment District Act and the Water Conservation District Act, for example, are authorized to carry out groundwater replenishment programs and assess fees to pay for groundwater management programs.

6 California Department of Water Resources. *California's Groundwater, Bulletin 118 - Update 2003.* (http://www.water.ca.gov/groundwater/bulletin118/bulletin118update2003.cfm)

7 California Department of Water Resources. *California's Groundwater, Bulletin 118 - Update 2003: Ch. 2.* (http://www.water.ca.gov/pubs/groundwater/bulletin_118/california%27s_groundwater__bulletin_118_-_update_2003_/bulletin118-chapter2.pdf)

## FINANCIAL SUPPORT FOR LOCAL GROUNDWATER MANAGEMENT

The California Legislature and voters have approved several propositions that included funding for groundwater quality remediation or local and regional management. The following are the most recent and largest allocations:

**The Safe, Clean, Reliable Water Supply Act of 1996 (Proposition 204)**

This measure authorized the state to sell $995 million in general obligation bonds for the purposes of restoration and improvement of the Bay-Delta; wastewater treatment, water supply and conservation; and local flood control and prevention. Funds were included in Proposition 204 for a water conservation and groundwater recharge loan program ($30 million) and local water supply development and environmental mitigation ($25 million).

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

Proposition 13 was a $1.97 billion general obligation bond with $230 million earmarked for groundwater programs. The act authorized $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.).

**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.), which provided for more than $3.4 billion in funding, subject to appropriation by the Legislature, for a number of land protection, water quality and water management activities. Proposition 50 provided $500 million for integrated regional water management, water management projects that will protect communities from drought, protect and improve water quality, and reduce dependence on imported water supplies.

**The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 (Proposition 84)**

Proposition 84 authorized $5.488 billion in general obligation bonds to fund safe drinking water, water quality and supply, flood control, waterway and natural resource protection, water pollution and contamination control, state and local park improvements, public access to natural resources, and water conservation efforts. Within Proposition 84 is $60 million for projects that prevent or reduce groundwater contamination, and $1 billion for integrated regional water management (IRWM) planning and implementation.

*Note: The 2009 legislative package included an $11.14 billion water bond (set for the November 2012 ballot) with additional funding for groundwater activities. See page 28 for more on the package.

Currently, 13 local agencies throughout California have specific authority under special legislation to limit or regulate groundwater extraction.

### AB 3030 Plans

The Groundwater Management Planning Act, commonly known as AB 3030, greatly expanded the number of local agencies with authority and responsibility over groundwater resources. The act, which became effective in January 1993, was aimed at encouraging more effective local management as an alternative to establishing a state-administered groundwater management structure. AB 3030 was developed by ACWA and its Groundwater Committee, partially in response to the U.S. Environmental Protection Agency's Comprehensive State Ground Water Protection Program (CSGWPP), which promoted comprehensive groundwater quality management on the state level with EPA providing proposed oversight and coordinated funding.

After the passage of AB 3030, many water agencies developed voluntary "3030" plans and significantly increased their involvement in groundwater management. As of 2003, more than 200 agencies have adopted an AB 3030 groundwater management plan.[8] This legislation was a big step forward in formalizing and supporting the local management of groundwater in California. Some plans prepared under its provisions, however, have suffered from little or no implementation, while others have focused primarily on limiting exports of groundwater to other regions, rather than incorporating all elements of a comprehensive management program.

8 California Department of Water Resources. *California's Groundwater, Bulletin 118 - Update 2003: Ch. 2.* (http://www.water.ca.gov/pubs/groundwater/bulletin_118/california%27s_groundwater__bulletin_118_-_update_2003_/bulletin118-chapter2.pdf)

### SB 1938 Groundwater Management Programs

In 2002, the Legislature passed SB 1938. This statute provides additional direction and technical guidance to local agencies for developing groundwater management plans and requires the inclusion of basin management objectives relative to groundwater quantity and quality, subsidence and monitoring programs. SB 1938 also requires agencies to have a groundwater management plan that meets certain requirements in order to be eligible for any state grant or loan programs for groundwater projects.

Building upon the positive elements of AB 3030, SB 1938's passage strengthened the effectiveness of groundwater management plans in California. Many agencies have supplemented their existing plans by incorporating the bill's new provisions or are developing entirely new SB 1938 plans to not only sustain the resource but also to ensure eligibility for state grants or loans.

AB 3030 and SB 1938 plans have provided the basis for action and progress. Under the Local Groundwater Assistance Program (AB 303), DWR awarded nearly $28 million in grants between 2000 and 2005 to local agencies to conduct 128 projects involving groundwater management plans or related activities.[9]

DWR also distributed $205 million in funds from Proposition 13 to groundwater recharge and storage feasibility studies, pilot projects and construction projects between 2000 and 2004, with the total value of those efforts (when combined with leveraged local dollars) totaling over $1 billion. Primary benefits from these activities were enhanced groundwater management and improved water supply reliability, but there have been other benefits as well, including improved drinking water quality, groundwater protection, reduced wastewater discharges, dedicated environmental water and improved habitat / wetlands restoration. It is estimated that these projects provide an additional 300,000 acre-feet per year to local California water supplies.[10]

More recent water bond measures have also included funding to support local groundwater management programs. When distributed, that funding will assist local management entities to ensure further progress in the implementation of their plans.

Groundwater management plans developed under AB 3030 and SB 1938 are among the most effective and widely used management techniques in California. As noted, more than 200 plans have been implemented throughout the state. Entities implementing this type of management are also best prepared to work with state agencies as elevation data is collected pursuant to the new requirements of SBX7 6, enacted as part of the 2009 comprehensive legislative package on water. The comprehensive structure of AB 3030 and SB 1938 plans provides a vehicle to simultaneously provide effective management now and into the future while remaining focused on local hydrologic and economic conditions.

### Integrated Regional Water Management Plans (IRWMPs)

Proposition 50's passage in 2002 provided additional grants and matching funding for local projects consistent with the new integrated regional water management plan (IRWMP) initiative. IRWMPs require various local entities to

9 California Department of Water Resources. *Local Groundwater Assistance Program Five-Year Report, 2000-2005.* (http://www.water.ca.gov/groundwater/docs/AB303_Finalized_050206.pdf)

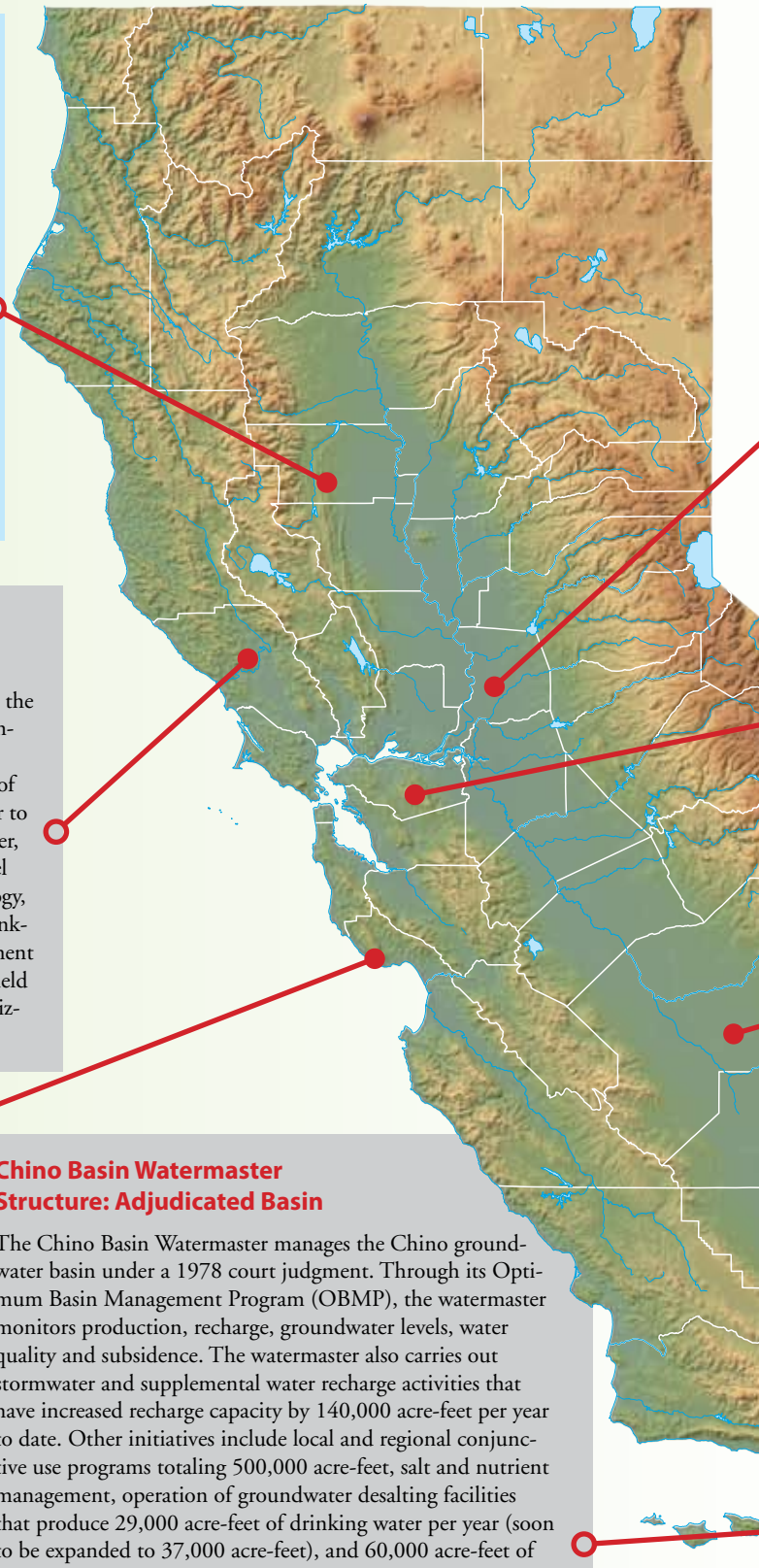
10 California Department of Water Resources. *2000-2004 Proposition 13 Groundwater Grants and Loans Program Summary.* (http://www.grantsloans.water.ca.gov/docs/prop13/Prop_13_Final_Report.pdf)

## COMMON CHARACTERISTICS OF SUCCESSFUL GROUNDWATER MANAGEMENT

Elinor Ostrom, who recently won the Nobel Prize in Economics for her work on local governments' management of natural resources, identified a number of characteristics shared by successful efforts to manage groundwater resources. These characteristics include: (i) clearly defined boundaries, both in area and in participants; (ii) rules that are tailored to the local circumstances; (iii) local governance; (iv) active monitoring for compliance with adopted rules; (v) graduated sanctions for violations of those rules; (vi) conflict resolution mechanism within the institution; and (vii) support for local institutions by external governments.*

* Ostrom, Elinor (1990). *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge University Press. ISBN 0-521-40599-8.

# Case Studies in Effective Local Groundwater Man



### Glenn County Groundwater Management Plan
### Structure: Groundwater Ordinance

Utilizing a mission and goals statement and a memorandum of understanding (MOU) among local stakeholders, the Glenn County Board of Supervisors adopted a groundwater ordinance in 2000. The ordinance builds on earlier work by a water advisory committee and identifies basin management objectives in key areas to help overcome challenges associated with defining safe yield and overdraft in the Sacramento Valley. Instead of a "one-size-fits-all" approach, the ordinance calls for management objectives to be set for minimum groundwater levels, minimum water quality and maximum subsidence for each of 17 sub-areas in the basin. The creation of the advisory committee, adoption of the ordinance and the subsequent adoption of a Four County MOU in 2006 have led to increased coordination and improved water resources understanding at the county and regional level. An Integrated Regional Water Management Planning process is also under way. (www.glenncountywater.org/management_plan.aspx)

### Sonoma Valley Groundwater Management Program
### Structure: AB 3030 / SB 1938 Plan

With a primary goal of sustaining groundwater resources for future generations, the Sonoma Valley Groundwater Management Program centers on an SB 1938-compliant plan adopted in 2007. The program includes four main management strategies: conservation, recycled water use to offset groundwater pumping, use of stormwater to recharge groundwater, and banking of winter Russian River water to recharge the basin. Cooperative efforts have helped to bring stakeholders together, while information gathered from the expansion of a voluntary groundwater-level monitoring program has led to increased understanding of the basin hydrogeology, improved public awareness, and better planning. Initiation of a groundwater banking feasibility study, a flood control / groundwater recharge study, and development of a guidebook for homeowners to better manage stormwater are expected to yield broader benefits such as reducing localized groundwater depressions and minimizing or eliminating seawater intrusion. (www.scwa.ca.gov)

### Soquel-Aptos Area Groundwater Management Plan
### Structure: AB 3030 / SB 1938 Plan

Soquel Creek Water District, Central Water District, the City of Santa Cruz Water Department and the County of Santa Cruz are working cooperatively to manage resources and prevent seawater intrusion. The program centers on activities to limit water demand, maintain groundwater extractions within sustainable quantities, and closely monitor changes in all or part of four groundwater basins. Efforts include aggressive conservation, conjunctive use, and development of a seawater desalination project that will provide water for in-lieu recharge. Cooperative groundwater management has slowed the decline of coastal water levels by collectively reducing demand and reducing pumping toward sustainable levels. Opportunities for interagency projects are identified through regular communications and a collaborative approach. Projects that could not have been undertaken by any one agency are being jointly funded through cost-sharing agreements and / or Integrated Regional Water Management grant funding. (www.soquelcreekwater.org/content/groundwater-management-plan)

### Chino Basin Watermaster
### Structure: Adjudicated Basin

The Chino Basin Watermaster manages the Chino groundwater basin under a 1978 court judgment. Through its Optimum Basin Management Program (OBMP), the watermaster monitors production, recharge, groundwater levels, water quality and subsidence. The watermaster also carries out stormwater and supplemental water recharge activities that have increased recharge capacity by 140,000 acre-feet per year to date. Other initiatives include local and regional conjunctive use programs totaling 500,000 acre-feet, salt and nutrient management, operation of groundwater desalting facilities that produce 29,000 acre-feet of drinking water per year (soon to be expanded to 37,000 acre-feet), and 60,000 acre-feet of recycled water reuse. The OBMP has enhanced the sustainable yield of the basin, improved water supply reliability as well as water quality, reduced subsidence, and expanded the direct use and recharge of recycled water. It has also reduced demand for imported water from the State Water Project and the Colorado River. (www.cbwm.org)

# nagement in California

### Sacramento Groundwater Authority
### Structure: Joint Powers Authority

SGA draws its authority from a 1998 agreement between the cities of Sacramento, Citrus Heights, Folsom, and the County of Sacramento to utilize their common police powers to protect the basin. Through its SB1938-compliant groundwater management plan and a comprehensive update completed in 2008, SGA has developed a dedicated monitoring well network, a regional groundwater model, a comprehensive groundwater database, and a biennial basin management report to assess the basin's health. Prior to SGA's formation, much of the basin suffered from decades of continually declining groundwater levels. Collaboration through SGA has improved the basin to the point that banked water could be transferred to state and federal programs during recent drought conditions. SGA's efforts also have led to the accelerated cleanup of regional contaminant plumes. The region is now poised to further expand banking and exchange operations, while ensuring a sustainable basin. (www.sgah2o.org)

### Zone 7 Water Agency
### Structure: AB 3030 Plan

Zone 7 Water Agency has actively managed the Livermore Valley Groundwater Basin for more than 40 years for municipal water supply. It began importing State Water Project water into the watershed in 1962 to reduce groundwater extractions that had left the basin in overdraft. Soon after, the district began artificially recharging the basin by using local "losing" streams to convey and percolate imported water. It continues to manage the basin conjunctively through a comprehensive Groundwater Management Plan that incorporates salinity management to offset the addition of salts from imported and recycled water. Plans are being developed to augment the district's artificial recharge capacity by adding nine aggregate quarry pits that will be used as water storage and aquifer recharge basins. Through its efforts, Zone 7 has curbed groundwater pumping and replenished basin aquifers to levels that can be managed sustainably. (www.zone7water.com)

### Upper Kings Basin Integrated Regional Water Management Authority
### Structure: Integrated Regional Water Management Plan

Local water agencies in the Kings Groundwater Basin have created a coalition of water districts, private water companies, cities, counties, environmental interests, and other stakeholders to deal with the most pressing local water issues—groundwater depletion, supply reliability and quality. The Upper Kings Basin Integrated Regional Water Management Authority was formed in 2009 to create a sustainable supply of the Kings Basin's finite surface and groundwater resources through balanced regional planning. The IRWMP features an array of projects, including groundwater banking facilities to capture available surface water to enhance local groundwater levels and water quality. A second-phase plan includes surface water exchanges and a groundwater treatment plant to serve disadvantaged communities currently using water of lesser quality. Regional planning and projects will improve supply reliability in dry years and mitigate the Kings Basin's groundwater overdraft. (www.krcd.org/water/ukbirwma)

### Orange County Water District
### Structure: Special District Act

OCWD was the first agency in California to adopt a groundwater management plan. Originally adopted in 1989, the plan was updated most recently in 2009. In addition to operating one of the most advanced groundwater recharge and monitoring systems in the nation, OCWD manages the largest constructed wetlands in Southern California to naturally filter and clean Santa Ana River flows before entering the recharge area. The district has an active groundwater conjunctive use storage agreement with Metropolitan Water District of Southern California and has constructed the largest planned indirect potable reuse project in the world, the Groundwater Replenishment System, which provides 72,000 acre-feet per year of highly purified water for an expanded seawater barrier and recharge to the aquifer. Successful management of the basin has helped reduce the region's reliance on imported water from Northern California and the Colorado River. (www.ocwd.com)

work collaboratively within a region to develop common water resources management goals and objectives through a transparent process including public involvement. These standards include a list of water management strategies and objectives, including surface and groundwater management, water quality protection and improvement, recycled water and desalination (where appropriate).

The intent of the IRWMP program is to encourage integrated regional strategies for management of water resources and to provide funding, through competitive grants, for projects that protect communities from drought and other extreme weather events, ensure sustainable water uses and environmental stewardship, protect and improve water quality, and improve local water security by reducing dependence on imported water.

Similar to the AB 3030 and SB 1938 processes, local and regional stakeholders have collaborated to develop common water resources management goals and objectives. Multiple plans have emerged since 2002, bolstered by over $1 billion in funding from Propositions 50, 84 and 1E for those agencies with groundwater management plans and / or an urban water management plan. It is anticipated the comprehensive approach outlined through the IRWMP process will continue to play a vital role in sustaining California's overall water supply, particularly if the considerable financial support for the program is maintained in the future.

### Coordinated Agreements and Ordinances

Some agencies have entered into coordinated agreements over the years in which multiple water purveyors commit to participate in mutually beneficial management activities, including the analysis of a jointly used basin and the development of joint capital projects and joint operational policies. Enforcement of the agreement and the collection of any fees or levies may be jointly shared among the parties.

In addition, groundwater ordinances have been adopted by some cities and counties. These ordinances may include controls intended to limit or prohibit exports of groundwater to protect the area's groundwater basins. The more general intent is to better coordinate management of water supply and land development. Local governments implementing this type of groundwater management utilize their police power, land use authority and general plan provisions to regulate the use of groundwater in their jurisdiction. These governmental entities are often faced with unique, internal management issues, such as planning department goals that must be coordinated with water or public works department goals and objectives. These ordinances have been most successful when coordinated with an AB 3030 / SB 1938 groundwater management plan.

Other voluntary management strategies are less common, but they can also be successful when implemented proactively and in cooperation with other local and regional stakeholders. Coordinated agreements such as the Sacramento Area Water Forum (including the Sacramento Groundwater Authority) have produced positive results in some regions.

### Adjudication

Adjudication is a management method for groundwater basins that have typically exhibited a condition of sustained overdraft for a period of at least five consecutive years. Adjudication is the product of a judicial process involving parties in a groundwater basin to determine the nature and quantity of each producer's share of the basin's safe yield. The process includes the appointment of a watermaster to oversee the court judgment that specifies how much each of the parties to the decision can extract from the basin. There are 22 settled court adjudications of groundwater basins in California, mostly in Southern California.[11] The first basin-wide adjudication of groundwater rights in California was in the Raymond Basin in Los Angeles County in 1949 (*Pasadena v. Alhambra*)[12]and the majority of adjudications were initiated or completed prior to the passage of AB 3030 in 1992.

Adjudicated groundwater basins in California can help to provide certainty by defining and quantifying specific rights for individual producers in the basin. However, application of this strategy indicates significant challenges exist in the affected basin, and parties entering into adjudication should understand the process is time consuming, expensive and complex for the involved parties.

11 California Department of Water Resources. Groundwater Information Center – Court Adjudications. 2011. (http://www.water.ca.gov/groundwater/gwmanagement/court_adjudications.cfm)

12 California Department of Water Resources. *California's Groundwater, Bulletin 118 - Update 2003: Ch. 2.* (http://www.water.ca.gov/pubs/groundwater/bulletin_118/california%27s_groundwater__bulletin_118_-_update_2003_/bulletin118-chapter2.pdf)

# Advancing Sustainable Groundwater Management

It is increasingly clear that California's reliance on groundwater is growing. Local groundwater management plans must reflect that reality and incorporate strategies that consider the potential consequences of a large-scale shift to groundwater, whether cyclical or permanent.

The components of AB 3030 and SB 1938, along with the Integrated Regional Water Management Plan approach, provide an excellent foundation for this type of management and their use should be encouraged and incentivized. Engaging stakeholders in the process is a key way to promote broad participation in the development of such plans. As experience shows, cooperation and participation by a wide spectrum of stakeholders — including surface water users — can be extremely beneficial to the development and implementation of sustainable groundwater management programs.

The ideal groundwater management plan addresses the resource on a local level, provides for operational flexibility, and satisfies the needs of both the environment and the economy while ensuring the continued health of the basin.

The following management objectives reflect best practices that will maximize the effectiveness and sustainability of local groundwater management plans.

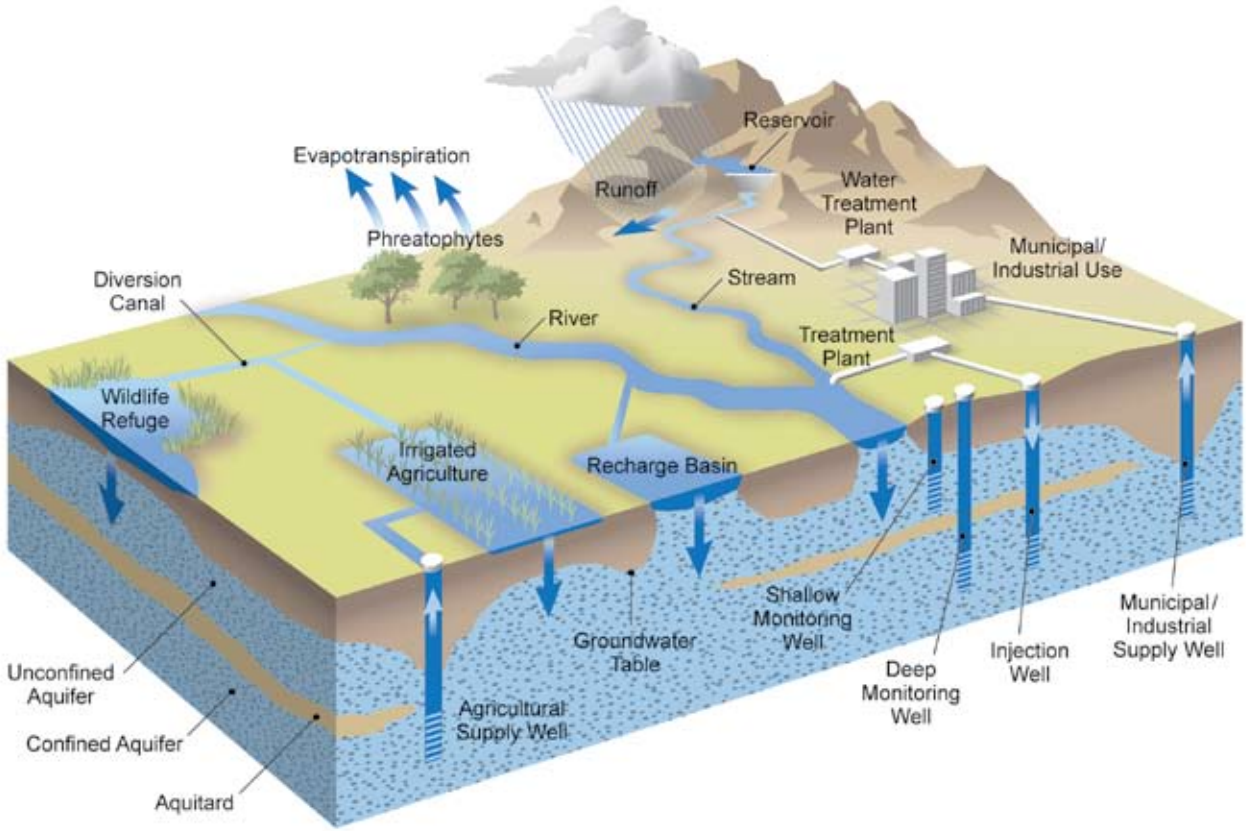
**Optimize conjunctive management of surface and groundwater resources.** California must invest in surface storage and conveyance improvements as part of a comprehensive plan to restore the Delta ecosystem, ensure a reliable statewide water supply and help recover, improve and sustain the state's economy. Because surface water and groundwater resources are most effective when used in concert with each other, significant investments in surface water storage and conveyance facilities are critical to the success of conjunctive use projects and sustainable groundwater management throughout California.

One of the most effective methods to do this is to ensure that grant programs and regulatory policies reflect the critical link between local and regional groundwater management programs and investments in new storage and conveyance infrastructure. This link is integral to maximizing California's overall water management flexibility.

Groundwater management agencies must also prepare for the effects of future surface water shortages and develop strategies to augment natural and artificial recharge. These strategies should include the increased use of alternative water sources such as stormwater, recycled and desalinated water, as well as additional conservation / water use efficiency efforts, to expand the portfolio of options for groundwater recharge.

**Integrate conservation and water use efficiency.** Many of the challenges facing groundwater management agencies are driven by the general availability of water for beneficial uses. A continued and intensified commitment to conservation and water use efficiency is critical to addressing these issues. In the context of California water management, water use efficiency means "using water more efficiently to reduce water demand for a given set of beneficial uses."

As with groundwater management efforts, water conservation and water use efficiency programs will only be successful if local water agencies are responsible for their design and implementation. Local water agencies are accountable to their customers for making locally cost-effective decisions that will provide reliable water supplies while balancing other factors, consistent with applicable regulatory requirements. Water conservation and water use efficiency programs are indispensable tools in any agency's portfolio as it develops a sustainable water management plan.




Conceptual model of a typical water management system. Courtesy of the Department of Water Resources.

**Undertake comprehensive data collection and analysis.** While large amounts of groundwater information are currently being collected and used by multiple local, regional, state and federal agencies and organizations, there are data gaps that can prevent the optimal beneficial use of a groundwater basin. These gaps may also affect relationships among agencies and limit opportunities for regional efforts to sustainably manage a basin's resources. Filling data gaps, ensuring adequate and sustained local groundwater monitoring and making periodic evaluations of the data are the most effective ways to gauge the long-term management risks to groundwater basins (both from a quality and quantity perspective) resulting from increased reliance on groundwater resources. Such fundamental data gathering and assessment are prerequisites to successful, sustainable groundwater management.

Sustainable groundwater management has the best chance of being achieved and maintained if a proper and frequent assessment of the state's groundwater resources is completed, including groundwater level trends, average quantities of groundwater available, and unused storage capacity. Efforts should also focus on groundwater quality data, the effects of current and future contamination and management options for better protecting basins over the long term. This assessment of the groundwater basins' level trends, availability, capacity and quality should be completed and reported by DWR and the appropriate federal agencies (e.g. USGS, NASA), working cooperatively with local groundwater management agencies and optimizing local agency data, evaluations and reports. ACWA was encouraged by the inclusion of a provision requiring such a document in the SBX7 6 legislation and has been working with DWR to develop appropriate, effective and efficient protocols for engaging with local groundwater management agencies.

Most of the groundwater served in California is well managed by local agencies utilizing the appropriate scale of monitoring, data evaluation and reporting through a well-designed groundwater management program. Those areas without, but in need of, active groundwater management programs should be identified, and local agencies should be engaged to implement strategies to move toward sustainability. However, at this time there is limited large-scale groundwater data and information available to systematically assess and accurately describe the status of groundwater basins throughout the state. In addition to developing such information, it is important that representative groundwater level and quality information already collected be made transparent and accessible to interested stakeholders, including adjacent local groundwater managers.

Local and regional entities should share appropriate information and collaborate with other pertinent agencies and the state in developing and implementing sustainable groundwater management programs. Additional efforts may be required to engage individual landowners on a case-by-case basis because sustainable local management of groundwater resources requires accountability, stewardship and transparency by all users. This data collection and transparency of information will not only provide a means for communication and education about the resource, but ultimately will help provide protection to all groundwater users, ensuring a high quality, reliable water supply in each basin. Appropriate local monitoring, measurement and reporting of groundwater basin activity are the only ways to assess whether groundwater basin objectives are being achieved.

**Consider the implications of land use decisions.** Land use policies that maximize conjunctive use projects and minimize subsidence and groundwater contamination often conflict with common practices of agricultural and urban development throughout California. The constant pressure of residential and commercial development can result in the loss of critical acreage that could be utilized to recharge groundwater basins or ensure storage for areas with unreliable surface supplies. Ironically, areas developed in a way that prevents adequate recharge have the potential to suffer subsidence and a loss of the infrastructure built over the basin. IRWMPs can be an important tool in minimizing such impacts, but it is necessary to collaborate with the developer community to ensure effective communication and reduce potential conflict.

Local agencies should be proactive in identifying and including in a sustainable groundwater management plan the most appropriate areas to serve as dedicated recharge or conjunctive use locations. In addition, land use practices to protect indirect recharge should be promoted to land use jurisdictions for their consideration and implementation, through ordinance where necessary. One example of an indirect approach to conjunctive use is promoting low-impact development (LID), a strategy increasingly used to improve the effectiveness of groundwater recharge and extraction options by minimizing the loss of recharge areas and requiring certain construction practices that increase or maintain the absorption capability of lands overlying groundwater basins. Such efforts, when developed and implemented in coordination with other actions such as enhanced water use efficiency and / or water recycling, present an important opportunity for coordination with local governments and collaboration with stakeholders.

**Make public communication and education a priority.** Many local and regional groundwater management agencies continue to improve and implement plans that effectively maintain or enhance the health of their basins and provide the foundation for future sustainable management activities. Efforts to educate the public (including policy makers, other local agencies and regulators) about groundwater and successful management approaches can be significantly improved and should be a higher priority for agencies already implementing or working to craft a sustainable groundwater management plan. Information should be made available in a variety of formats and regular workshops should be designed to appeal to all audiences.

## WHAT IS LOW-IMPACT DEVELOPMENT?

Low-impact development (LID) is a sustainable practice that benefits water supply and contributes to water quality protection. Unlike traditional stormwater management, which collects and conveys stormwater runoff through storm drains, pipes, or other conveyances to a centralized stormwater facility, LID takes a different approach by using site design and stormwater management to maintain the site's pre-development runoff rates and volumes. The goal of LID is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall.*

* State Water Resources Control Board. *Low Impact Development – Sustainable Storm Water Management*. 2011. (http://www.swrcb.ca.gov/water_issues/programs/low_impact_development/index.shtml)

# THE 2009 LEGISLATIVE WATER PACKAGE

The comprehensive water package enacted in November 2009 marked a new era for California water. At its core, the new law formalized the co-equal goals of water supply reliability and ecosystem health as state water management policy. The package includes four policy bills and an $11.14 billion water bond measure now targeted to go before California voters on the November 2012 ballot. The policy bills address the Delta ecosystem and its governance, statewide conservation policies applicable to urban, industrial and agricultural water suppliers, development of updated in-stream flow criteria, and groundwater elevation monitoring requirements in every basin and sub-basin in California.

While all of the bills include policies or actions that will directly or indirectly impact groundwater resources, the groundwater monitoring bill, SBX7 6, requires the most of groundwater managers and users. This legislation requires groundwater elevation monitoring for all basins and sub-basins by January 1, 2012 to demonstrate seasonal and long-term elevation trends in groundwater basins. The monitoring provisions are designed to help better manage the resource during both normal water years and drought conditions.

Under the legislation, a local agency or other eligible organization in each basin or sub-basin interested in assuming responsibility for monitoring and reporting groundwater elevations for its respective area was to notify DWR by January 1, 2011. If no entity volunteers for a particular area, DWR will assume the responsibility for monitoring and the affected county and entities will become ineligible for state grants or loans.

This legislation supports local groundwater management by appropriately looking to local and regional agencies as the authorities for monitoring groundwater elevations. ACWA has been an active partner with DWR as the monitoring program protocols have been developed. The state's commitment to supporting the local management approach will help ensure effective implementation.

In addition to the groundwater provisions in SBX7 6, accomplishing the goals included in the Delta package will be a critical part of securing a healthy Delta ecosystem and improvements in water supply reliability for the entire state. It will allow for a more reliable surface supply for users who may otherwise shift to groundwater to satisfy part or all of their water needs.

Implementing activities to reach conservation targets outlined in SBX7 7 will also be important as local agencies seek to reduce long-term stress on groundwater resources, particularly during periods when access to surface water supplies is reduced or eliminated.

While this historic package of water legislation includes much that will contribute to improved water management in California, it alone will not lead to sustainable groundwater management. Though it reflects recognition that the state is facing a multi-faceted water crisis and provides policy and financial support for many projects, much work remains to be done to ensure groundwater resources can be sustained through active management on a local or regional scale.

# Recommendations

Throughout this Framework ACWA has described key elements of groundwater management and the growing number of challenges facing local water managers today. Examples of successful, locally coordinated approaches to groundwater management have been provided to highlight best practices that may enhance the effectiveness of management plans. Plans such as these should be developed and expanded at the local or regional level, understanding that sometimes there is a need to engage beyond an individual agency's jurisdictional boundaries.

ACWA firmly believes the state Legislature should encourage and support local management policies that appropriately reflect California's geographic and hydrologic diversity rather than institute a state-administered centralized control structure for regulating or permitting the use of groundwater. Statewide permitting and regulation would undermine the effectiveness of existing and planned local investments and would be counterproductive. The Legislature should focus instead on incentivizing the development and implementation of the best practices outlined in this Framework.

In addition, ACWA stands ready to collaborate in the development of appropriate regulatory and policy-related actions and initiatives that will further promote more effective and comprehensive local groundwater management. To that end, we make the following management and policy recommendations to help ensure the sustainability of California's groundwater resources.

## ACWA Groundwater Framework Recommendations

**Local Agency Level**

1. Excluding small or undeveloped basins, groundwater basins in California that are identified in DWR Bulletin 118 should be operated by local agencies and / or stakeholders consistent with a locally developed groundwater management plan that achieves sustainability with the level of management appropriate for the basin. Groundwater management agencies within any basin where extractions are a significant percentage of the groundwater budget should develop formal groundwater management plans with stated policies and practices. The development of these plans should be open and transparent to allow public engagement in the process and should specifically address all factors related to groundwater management including, but not limited to, conjunctive use where appropriate.

2. Consistent with their respective groundwater management plans and state law, groundwater management agencies should be encouraged to collect and disseminate comprehensive groundwater information to demonstrate short- and long-term sustainability of the basin. Agencies should actively provide that information to DWR and make it accessible to the public.

3. Agencies that do not have an SB 1938 groundwater management plan (or functional equivalent), where applicable, should be ineligible for water-related state grants and loans. Financial support and incentives should be made available to agencies that lack sufficient resources but are committed to developing a groundwater management plan.

### State and Regional Agencies

1. DWR should improve the functionality of existing online access portals such as IWRIS and the Water Data Library for groundwater information that utilizes the data collected from local agencies to provide improved public access. Representative information should also be transparent and accessible statewide through other avenues, including the California Water Plan (Bulletin 160) and any updates to Bulletin 118.
2. Where an SB 1938 groundwater management plan (or the functional equivalent) exists, state agencies should develop procedures, where applicable, to issue necessary permits for groundwater projects within 60 days of the certification of the CEQA document by the lead agency. This is especially critical for groundwater replenishment projects.
3. A multi-agency team led by DWR should be created and charged with developing an approach to both coordinate review and facilitate implementation of new local and regional groundwater recharge, groundwater banking and conjunctive use projects. Interagency coordinated review and facilitation of groundwater projects is required to ensure that these sustainable resource management opportunities are implemented efficiently once approved by a local agency as part of its groundwater management plan.
4. The Natural Resources Agency and Cal/EPA should work together to develop incentives for local agencies to implement small-scale groundwater replenishment projects, consistent with the applicable local groundwater management plan.
5. Regional Water Quality Control Boards should encourage and facilitate the process for capable local agencies responsible for groundwater management to proactively remediate contaminated groundwater basins when the local agency determines such remediation will contribute to more sustainable groundwater management.
6. The California Department of Public Health should develop draft criteria for SB 918 (2010), which directs the California Department of Public Health to develop criteria for using recycled water to supplement water storage, no later than December 31, 2011.
7. California agencies must develop a new methodology for encouraging, promoting and supporting infrastructure investments, particularly those that would improve water supply reliability at the local level and those that can work in conjunction with the state's backbone water delivery systems.

### Legislative / Legal

1. The state of California should designate the use of surface water for groundwater recharge as a "beneficial use." The designation should apply even when there is no plan for future extraction of the water, as long as it is consistent with an SB 1938 groundwater management plan (or the functional equivalent).
2. California law should be clarified to state that once surface water is recharged as part of a conjunctive use project consistent with an SB 1938 groundwater management plan (or the functional equivalent), such water becomes "groundwater" outside the scope of State Water Resources Control Board jurisdiction.
3. The state of California should provide appropriate protection from liability for any agency responsible for groundwater management that undertakes the cleanup of a contaminated groundwater basin in order to use that basin, including as part of a conjunctive use program.
4. Voting requirements should be reduced to 55 percent for approval of local funding initiatives targeted at investments in new or existing water management infrastructure.
5. California anti-degradation policy, as it is currently interpreted with respect to groundwater recharge projects, should allow local agencies to optimize their groundwater resources, providing that maximum benefit to the public is maintained. Any changes should be made in coordination with groundwater management plans, recognizing the variety of different circumstances throughout the state.
6. County general plans should be required to incorporate land use elements that contribute to and promote effective implementation of an SB 1938 groundwater management plan (or the functional equivalent), as determined in consultation with local agencies responsible for groundwater management.

7. The state of California should ensure that "in-lieu" recharge is protected as part of a conjunctive use program. Put otherwise, a conjunctive use project need not require the direct recharge of surface water or the actual extraction of groundwater if near-term demands can be shifted from one source to the other, thereby accomplishing the goal of the conjunctive use project in both wet and dry years.

**Collaborative Actions**

1. In order to implement large-scale conjunctive use projects in the Central Valley and elsewhere, the Legislature and federal government should invest in surface water storage and improved Delta conveyance, provide financial support for local and regional infrastructure projects, and modify operations and regulatory policies to optimize conjunctive use opportunities.
2. The state, working with appropriate local entities, should address groundwater-related drinking water quality issues in small or disadvantaged communities by providing technical assistance to identify the best approach to protecting public health.
3. In implementing applicable state laws and developing ordinances, local governments should carefully consider the implications of policies and regulations that affect land use in the areas that overlie basins and advocate projects in collaboration with the developer community that maximize opportunities for recharge and conjunctive use.
4. Sustainable groundwater management may be improved through the use of quantitative groundwater models; state and federal agencies should provide financial support to assist local agencies in constructing such models where appropriate.
5. Protecting groundwater quality should be considered as important as the development of sustainable groundwater supplies. Using the best available science, regulatory and policy efforts to identify long-term solutions for the remediation of contamination issues should be supported on a local, regional and statewide scale, such as the salt and nutrient management plans identified in the State Water Resources Control Board Recycled Water Policy.

# ACWA Policy Principles on Groundwater Management

## "Groundwater – Invisible No More"

Groundwater is an invaluable resource for California and a critical asset in the state's comprehensive water management portfolio. Groundwater management should be implemented throughout California, and should be done so consistent with the following policy principles adopted by ACWA's Board of Directors.

1. Groundwater resources are best managed by local jurisdictions to effectively and efficiently manage water quality and supplies for beneficial uses. ACWA encourages and supports regional groundwater management strategies such as Integrated Regional Water Management Plans (IRWMP) and other regional partnerships.
2. Local management of groundwater resources requires accountability, stewardship and transparency; and appropriate local monitoring, measurement and reporting of groundwater basin activity to assure groundwater basin objectives are being achieved.
3. ACWA opposes state interference with existing legal rights to groundwater and believes that a state-administered water rights system for groundwater would undermine effective groundwater management and local investments.
4. California's groundwater resources are unique and diverse in physical characteristics, beneficial uses, water rights, legal and institutional governance and management structures, stakeholders and other features. One-size-fits-all state mandates are ineffective and counterproductive.
5. ACWA supports expansion of conjunctive management of surface water and groundwater supplies that contributes to the protection, reliability and sustainability of local, regional and statewide water supplies for water users and the environment. Such an expansion requires increased groundwater and surface storage, the re-operation of surface reservoirs as appropriate, and improved Delta conveyance.
6. Groundwater quality management is integral to optimizing California's groundwater resources. It must be science-based and include improved data management, basin assessments, monitoring, reporting, protection and, where appropriate, remediation.
7. ACWA supports the use of potable, desalinated, recycled and storm waters for groundwater recharge, with appropriate water quality safeguards that protect beneficial uses.
8. Land use policies and regulations that identify, preserve and protect natural and artificial recharge and extraction capabilities are essential for sustainable groundwater management. Land use policies must consider and analyze impacts and potential impacts to groundwater quality.
9. ACWA supports statewide and regional regulatory consistency that acknowledges the diversity of groundwater resources to facilitate the achievement of local and statewide groundwater storage and basin utilization goals.
10. Groundwater management strategies must anticipate and adapt to the effects of climate change.
11. Optimal groundwater management throughout California will require significant federal, state, regional, local and private investment in infrastructure and related facilities. ACWA further supports increased funding for groundwater research, monitoring, and other management programs.
12. ACWA encourages other statewide associations, regional entities and groundwater-related organizations to educate and advocate for expanded and more effective groundwater management throughout California, and will help coordinate such activities.

# ACWA Groundwater Committee

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ACWA is a statewide non-profit association whose 450 public agency members are responsible for about 90% of the water deliveries in California.

## MISSION.

ACWA's mission is to assist its members in promoting the development, management and reasonable beneficial use of good quality water at the lowest practical cost in an environmentally balanced manner.