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Confronting Drought: Water Supply Planning and the Establishment of a Strategic Groundwater Reserve

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ARTICLE: CONFRONTING DROUGHT: WATER SUPPLY PLANNING AND THE ESTABLISHMENT OF A STRATEGIC GROUNDWATER RESERVE

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SUMMARY:
... This points to the Board having the authority to remedy claims of pumping that causes overdraft of a basin and potentially to remedy unreasonable withdrawals that deplete a reserve. 2.Local Authority Given the political resistance thus far to broad state regulation of groundwater, and that the California Water Code also enables local agencies to manage groundwater and control groundwater use to some degree, the second question concerns whether these entities have the authority to mandate more sustainable groundwater management practices, and whether it is sufficient to enable the establishment of a groundwater reserve program on a basin by basin basis? ... Counties also adopted these ordinances to protect against someone purchasing land within a county with groundwater resources for purposes of obtaining groundwater rights, and then transferring water outside of the county for a fee, to the detriment of users within the county. 6. ... JURISDICTION OVER GROUNDWATER California has over four hundred identified groundwater basins, and the amount of water stored in these aquifers is far greater than that stored in the state's surface water reservoirs. ... Legal and Institutional Groundwater governance and management clearly require strategies that take into account not only the physical characteristics of a local aquifer, but also its long-term integrity, the needs of communities overlying a basin, and the overall needs of the state particularly under conditions of climate change and potential prolonged droughts. ... Groundwater Management Plans may, but are not required to, address the control of salt-water intrusion, the management of recharge areas, the regulation of contaminated groundwater migration, the mitigation of overdraft, the replenishment of extracted groundwater, the monitoring of groundwater levels and storage, and the coordination with land use planning agencies to assess activities that create a risk of groundwater contamination.

HIGHLIGHT: "And it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. It was always that way."

- John Steinbeck, East of Eden [n3]

TEXT:

[*296]

INTRODUCTION

California's rainfall varies considerably from year to year, and data indicate that in the past California experienced very dry climatic conditions. Evidence also continues to accumulate that global climate change will have significant impacts on the state's water resources, including increased warming effects in the Sierra Nevada Mountains that will affect snow pack, snowmelt, and the timing and magnitude of runoff in California. [n4] Scientists warn that California could be subject to more prolonged climate-induced droughts in the future. [n5]

At the same time, human-generated pressures on the state's water supplies have also increased. The population has increased by more than 6 million people since the last relatively short dry period of 1987 to 1992, [n6] and legal mandates are having major impacts on water availability for consumptive use. [n7] Concomitantly, the financial, environmental and social costs of building new above ground water storage [*297] reservoirs and transmission systems to increase supply are now formidable. [n8]

Californians are more at odds than ever about how to establish sufficient and reliable water supplies to address these dual issues. While they are related, as climate-induced water scarcity will intensify demand-induced water shortages, to a large extent researchers and policymakers have failed to focus on strategies that could mitigate both conditions. A significant problem is that some of the proposed solutions to address human generated water problems could create increased water shortages when a severe dry period does occur.

This paper examines water supply planning through the lens of a climate-induced drought. It is divided into two parts. The first discusses water supply planning in the state and exposes areas of disconnect between (1) planning for a prolonged climate-induced drought and (2) planning to accommodate the state's burgeoning demand for water. Planning for a climate-induced drought is primarily response oriented, including generating surface and groundwater data and preparing and implementing water shortage contingency plans. Planning for ways to generate additional water to satisfy growing demand by more diverse interests includes strategies such as desalination, recycled water, and increased water use efficiency. [n9] While experts often describe these strategies as also creating water for extended dry periods, the first part of this paper concludes with the strong caveat that if California primarily utilizes water generated through strategies to satisfy increasing demand to support continued growth in water-stressed regions, the outcome could be an eventual upsurge in future water requirements along with a hardening of demand side conservation strategies. [n10] This could actually increase vulnerability to water shortages when a severe drought does occur.

The second part of the paper elaborates on the legal, institutional, and management issues surrounding an alternative proactive approach that could both augment supply and reduce vulnerability to drought, namely by reconfiguring groundwater management to emphasize recharge along with the creation of a strategic groundwater reserve. This [*298] would involve bringing groundwater basins into hydrologic balance through recharge processes to reduce groundwater level decline rates, [n11] and establishing and maintaining sufficient groundwater levels to sustain a strategic groundwater reserve. [n12] The state would only withdraw and use the reserve during a prolonged dry period. The reserve is critical to conserving nature's capital for the inevitable long-term drought. This approach is similar to reserving money for emergencies in a bank account. Thus, water would be "deposited" in an aquifer through recharge techniques best suited to the characteristics of the aquifer, and a portion of that capital would only be withdrawn and used to mitigate severe water scarcity resulting from a climate-induced drought. Conjunctive management methods could be redesigned to encourage recharge processes, to augment seasonal supply, and most important, to guarantee the maintenance of a reserve for use during extreme drought events. The paper concludes with a discussion of the legal authority to create the reserve.

If, as the California Department of Water Resources ("DWR") projects, improving groundwater management is a key strategy to generate more water to meet the state's growing demand, then it is critical that at the same time that the state also create incentives both to protect the quality and quantity of groundwater for future generations and to maintain a reserve for future severe droughts.

I. BACKGROUND

California's Mediterranean climate has distinct spatial and temporal characteristics, with three quarters of the state's precipitation and runoff occurring in Northern California and little or no precipitation occurring during the summer and early fall months. [n13] The inverse relationship between the locations of the State's population and large agricultural regions to its surface water runoff is an additional challenge, with more than seventy percent of California's runoff occurring north [*299] of Sacramento and about the same percentage of water demand south of Sacramento. [n14] California has dealt with these limitations and achieved its growth by developing federal, state, and local projects that capture and store winter and spring runoff, primarily from snow melt in the Sierra and Cascade Mountains, and through a network of transmission systems that carry the stored water to major urban areas and central valley farming regions. [n15] In addition, California meets significant portions of its water supply needs with groundwater. [n16] Communities not connected to the big projects also rely on water storage, albeit smaller systems, and on groundwater. [n17]

Over the past 30 years, claims to water by an expanding number of interests, along with population growth, have caused water supply systems to come under increasing stress. The California Department of Finance projects that population will increase by another 14 million by 2030 adding to demand. [n18] However, legal mandates, such as those to protect endangered species, to support public trust values, and to restrict the pumping of water through the San Francisco Bay Delta, have resulted in a reduction in water availability for consumptive use. [n19] In addition, while groundwater supplies approximately one third of water use in California, [n20] annual overdraft from groundwater pumping is already in the range of one million to two million acre-feet statewide, and many aquifers are overdrawn. [n21]

Added to concerns about insufficient water to accommodate the state's growth and development are worries regarding the impacts of global warming on the state's water supply [n22] and fears of more extreme [*300] drought events. [n23] As changes in temperature directly affect runoff, it is likely that in California there will be increased runoff in late winter/early spring resulting in higher water yields earlier in the season. [n24] In addition, projections are that Sierra snowpack could decrease by 10 to 40 percent from historic levels. [n25] These conditions could exacerbate water shortages in the state. [n26] While the shifts associated with climate change may be small compared to historical year-to-year variations, they will be superimposed onto normal variations and will likely result [*301] in new extremes in the areas subjected to unusual aridity as well as in the severity of drought episodes. [n27]

A prolonged drought affects all sectors of the economy. During the 1988-92 drought, urban users in California paid more for water, lost jobs, saw electricity costs rise, and had their water-based recreation and major fisheries adversely impacted. [n28] Groundwater aquifers suffered significantly as most agricultural users increased their pumping. [n29] The eastern San Joaquin Valley and Tulare Basin had significant overdraft and subsidence, and Kings and Kern Counties had overdraft-induced groundwater pollution. [n30]

It is noteworthy that in past droughts those not connected to the major projects were particularly vulnerable to water shortages, [n31] including rural and less populated coastal areas and in new developments in the Sierra Nevada foothills where communities typically rely on small capacity storage systems fed by annual rainfall and on groundwater. [n32] As California's population growth shifts from the State's densely urbanized coastal areas to inland regions where per capita water use is high, these regions will become even more vulnerable. [n33]

Under existing water supply strategies, water requirements in many areas of the state are barely met during dry and critical water years, yet many water agencies continue to strategize to satisfy projected demand [*302] without setting aside sufficient reserves to be tapped during severe dry periods. [n34] This is despite the fact that urban water agencies throughout California have generally failed to even make good on conservation promises, [n35] and many groundwater aquifers in agricultural regions remain in overdraft. [n36]

II. OVERVIEW OF CALIFORNIA'S WATER RIGHTS SYSTEM

California's water rights regime plays an important role in how communities and individuals address water scarcity issues. The state recognizes a system of water rights that distinguishes between two legal categories of water. [n37] First, surface waters, including surface streams and subterranean streams, [n38] are subject to permitting and regulation, [n39] and riparian and appropriative doctrines primarily govern private rights to use surface water. [n40] Riparian rights are correlative and land based. [n41] Appropriative rights to surface water are priority based, require diversion to demonstrate beneficial use, and the state extensively regulates the rights through an administrative permit system. [n42] [*303]

Second, groundwater, legally defined as percolating groundwater, [n43] follows a dual system of rules. Owners overlying the basin follow a correlative doctrine, which gives all overlying landowners equal rights to a reasonable amount of the water in the basin, but limits that right to water applied to a reasonable beneficial use on land overlying the basin, and requires all to share in any shortages. [n44] Groundwater exporters follow an appropriative doctrine of first in time first in right, which in times of shortage limits them to water that overlying owners do not need. [n45]

The California State Water Resources Control Board is the authority for the distribution of surface appropriative water rights, [n46] and the California Water Code contains the permit application process for appropriating surface water. [n47] The permit process does not apply to riparian rights or, most importantly, to percolating groundwater. [n48] While legal definitions of surface and groundwater bear little resemblance to the hydrologic and geologic reality of water, nevertheless Section 1200 of the California Water Code, which defines the permitting scope of the State Water Resources Control Board, still distinguishes between these categories. [n49]

Along with doctrines that specify the rules for private rights to water, there are several very important public interest principles that oversee all water use in the state. There is no private ownership of water, and all water rights are usufructory, conferring a right to use water. [n50] The Public Trust Doctrine, the California courts interpret it, holds that the state must protect public trust values where feasible, [n51] and that public trust values are flexible enough to encompass changing [*304] public needs. [n52] Most importantly, the Doctrine of Reasonable and Beneficial Use, as required by the 1928 Amendment to the California Constitution, [n53] requires that the use of all water in the state be exercised reasonably. This principle, now codified in the California Water Code, will be discussed later in the paper.

III. WATER SUPPLY PLANNING

The first question this paper examines is whether water supply planning as presently configured sufficiently addresses the problems associated with a climate-induced drought. The process of water supply planning in California is fragmented, proceeding along several different tracks that include urban water management planning, groundwater management planning, and drought management planning. In addition, administrative authority is divided between federal, state, and local institutions. [n54] The Bureau of Reclamation ("BOR") administers California's massive federal Central Valley Water Project, [n55] and the California Department of Water Resources ("DWR") administers the large State Water Project, with both agencies coordinating operations. [n56] [*305] The state administers the California Water Code, provides data and financial incentives to support the local management of water supplies, [n57] provides broad goals and objectives to manage the state's water resource through a statewide water plan produced every five years, and administers the permit process for appropriative rights to surface water. [n58] However, cities and counties are important drivers of local water demand and do most of the water supply planning. [n59] Through their authority over land use decisions, their governments affect local development and, in turn, water demand.

IV. PLANNING FOR A CLIMATE-INDUCED DROUGHT

Drought planning is a response process centered on how to manage water shortages after a dry period occurs. The state has the authority to declare a water shortage emergency and to utilize broad powers to enforce regulations and restrictions, [n60] and the California Department of Health Services ("DHS") can impose terms and conditions on permits for public water systems to assure that sufficient water is available. [n61] Two statewide bonds, Proposition 50 passed in November 2002, [n62] and Proposition 84 passed in November 2006, [n63] established monetary incentives to encourage a regional approach to water management that includes drought planning.

Proposition 84 provides public water suppliers with the authority, after a water shortage has occurred, to declare an emergency drought [*306] condition within its service area. [n64] This allows the supplier to prioritize use, make water available for domestic use, sanitation, and fire protection, and adopt regulations covering measures to stretch supplies, including mandatory rationing or connection bans. [n65] Municipal water districts, for example, have specific authority to adopt a drought ordinance restricting use of water, including the authority to limit the use of water for any purpose other than household use, sanitation and fire protection. [n66] However, in practice the emphasis is on collecting supply and demand data to estimate water availability under different shortage conditions, [n67] and on developing water shortage contingency plans that both reduce demand and find alternate sources of water to temporarily increase supply. [n68] A strategic reserve could provide an important alternate water source during a severe drought. While the State's Urban Water Management Planning Guide does indicate that the best possible solution to drought is to have emergency supplies already held in reserve such as in local groundwater basins, the guidebook does not lay out any strategies or incentives to maintain a groundwater reserve as a buffer against a prolonged drought. [n69]

V. PLANNING TO SUPPORT GROWTH AND DEVELOPMENT

Water supply strategies to satisfy demand, while often presented as all-purpose tools to mitigate water scarcity no matter what the cause, are generally centered on finding more water to support growth and development and on mitigating regulatory constraints on current supplies. Planning historically focused on the construction of very large [*307] storage and transmission systems to move water around the state from regions of high rainfall and runoff to areas with little water and to alleviate groundwater overdraft. Local land-use authorities assumed that water would always be available to satisfy continued growth, and as a result, important land-use decisions were disconnected from water supply planning.

As local land-use decisions began running into water supply concerns, the disconnect between water supply availability and land-use planning came to the forefront. In 1983, the state legislature addressed urban water planning by passing the Urban Water Management Planning Act. [n70] It required the largest wholesale and retail municipal suppliers [n71] prepare 20-year UWMPs and submit them to DWR every five years. [n72] The plans must include water supply assessments with written verifications of water supply and a water shortage contingency analysis that addresses their response to supply reductions of up to 50%. [n73] The Act also requires suppliers to implement the demand management measures described in their UWMPs in order to be eligible for specified state financial assistance. [n74] Additional senate bills added requirements to assess the quality of available water sources and to verify long-term water supply prior to a project's construction, [n75] but enforcement of these requirements relies largely on citizen challenges for [*308] non-compliance. [n76] Importantly, plans have to substantiate rights to extract additional groundwater, if used for the project. [n77] These plans are an initial step in planning for climate-induced water scarcity, but the problem is that only 400 systems are large enough to be required to file UWMPs. [n78]

While the new planning requirements and "show me the water" legislation resulted in greater oversight of water supply availability for new municipal developments, they also pushed suppliers to seek more diverse sources of water to accommodate future growth and deal with regulatory constraints on their accustomed supplies. Water providers emphasized creating a diverse "portfolio" of strategies, [n79] including three major ones: desalination of ocean water and brackish groundwater, water use efficiency, and recycling of municipal wastewater.

Desalination is the process of removing the salt to make certain bodies of water drinkable and usable for other purposes. [n80] The process of desalination is expensive, energy intensive, and waste producing, [n81] but more importantly, it is not economically feasible to run desalination plants only during dry periods. [n82] Given the high operating and capital costs of desalination, it is likely that without incentives for appropriate conjunctive management arrangements, "new" water produced would not be primarily reserved for use during a severe drought. [n83] Recycled water as a source of additional supply is generally used to satisfy current demand, but it can be costly and the health as [*309] pects of recycled water are controversial. [n84] Most importantly, management of recycled water is rarely designed to create an emergency reserve. [n85] Water use efficiency is a demand-side measure that can free up water supplies. [n86] Estimates are that water use efficiency could result in millions of acre-feet of untapped, cost-effective conservation. [n87] But while many communities and water suppliers now require water-use efficiency practices, there is no automatic lever to induce conservation in communities that choose not to conserve, and incentives such as tiered pricing tend to be least prevalent in some of the fastest growing regions of the state. [n88] A common complaint is that the water that communities require residents to conserve generally goes to new development, reducing the likelihood of this water being available during a long-term drought. [n89]

Desalination, water use efficiency, and recycling are very valuable strategies that are integral to a comprehensive program for the sustainable management of the state's water resources. Water use efficiency, for example, is more environmentally friendly and less costly than constructing new surface storage. [n90] Peter Gleick and his col [*310] leagues at the Pacific Institute have argued that with very aggressive efforts, by 2030 human use of water in California could decline by as much as 20 percent from 2000 levels by phasing out subsidies to reflect the true costs of water, increasing the use of water-efficient technologies, supporting water transfers that improve efficiency, and integrating water supply planning with land use planning. [n91]

The important caveat is that if communities just use "new" water, whether from desalination, recycling or water use efficiency, to further development in the short term, future demand could actually increase, thus exacerbating the impacts of future droughts. [n92] That is the historical narrative of water use in California. [n93] Recycling and water-use efficiency can also result in demand hardening. For example, as urban water agencies implement water programs that include plumbing fixture retrofit programs and stocking new housing with low water use fixtures, it becomes increasingly difficult for the agencies to implement rationing programs during a drought. [n94] Demand hardening also applies to agricultural water use. For example, in recent years, a number of farmers in the Central Valley shifted from annually planted field and row crops to more profitable permanent plantings of less water intensive orchards and vineyards. [n95] However, farmers can leave row crops fallow a water-short year, whereas withholding water from permanent plantings will ultimately result in loss of a grower's capital investment. [n96] [*311]

VI. THE SPECIAL CASE OF GROUNDWATER

In an average year, groundwater meets approximately 30% of California's overall water needs. [n97] It is particularly important during a drought, when consumptive use rises to as much as 60% and Californians turn to groundwater extraction as a key strategy to increase supply. [n98] A major problem is that experts also project groundwater to be the largest single source of "new" supply for growth in the UWMPs, and anticipate that two thirds of the increase will be in areas outside fully managed basins where unsustainable use is more likely. [n99] Yet, estimates of groundwater overdraft in the state are already at about 1-2 million acre-feet annually. [n100]

In overdrafted basins, groundwater pumping has led to a depletion of the storage reserve with undesirable results, [n101] including subsidence, [*312] salt-water intrusion, and water quality degradation. Severely overdrafted basins may never fully recover even in wet years, [n102] and groundwater overdraft can impact surface waters and other groundwater-dependent ecosystems, as well as the base flow of streams and rivers. [n103] Aside from the negative physical impacts of overdraft, the condition of the groundwater basin at the beginning of a drought is critical to maintaining adequate water supplies throughout drought events, as an overdrafted basin reduces opportunities to utilize groundwater during a severe drought. [n104] When the governor issued a drought declaration in June 2008 that allowed farmers in the Westlands Water District to pump groundwater into the California Aqueduct and move it to parts that were in critical need, one farmer noted that nobody has much extra groundwater to pump because, "we already do that." [n105]

VII. JURISDICTION OVER GROUNDWATER

California has over four hundred identified groundwater basins, [n106] and the amount of water stored in these aquifers is far greater than that stored in the state's surface water reservoirs. [n107] Hydrologists estimate that about 143 million of storage capacity could be used as potential storage space, considerably more than surface reservoirs, which can [*313] store approximately 42 million of. [n108] Who may claim the right to use and manage groundwater are clearly important to creating the capacity to cope with water shortages during a severe drought.

The California Legislature has repeatedly decided that management of groundwater should not be subject to the permitting authority of the State Water Resources Control Board ("SWRCB") but should instead be a local responsibility. [n109] Although the state does not have the authority to issue permits for groundwater, through the California Constitution, Article X, Section 2, various sections of the California Water Code, and the Public Trust Doctrine, it does have authority to regulate certain aspects of groundwater use. For example the state may regulate pumping that is adversely affecting surface in-stream benefits such as fish populations and riparian values, [n110] and pumping that it deems unreasonable. [n111] These regulatory powers will be discussed in greater detail later in the paper. In practice, because of the reluctance of the state to step in with a comprehensive program, local authorities generally initiate groundwater management [n112] In keeping with the emphasis on local management, in the last twenty-five years, the California Legislature has enacted a series of laws giving local water agencies more authority and providing them with financial incentives to improve groundwater management. [n113] [*314]

VIII. GROUNDWATER MANAGEMENT TO PROACTIVELY ADDRESS WATER SHORTAGES AND DROUGHT

Groundwater is clearly a critical component of any drought planning strategy. A groundwater aquifer, unlike most surface water reservoirs, can provide natural ready-made long-term water storage for unlimited periods of time, thus sustaining a reserve for drought years. By controlling flow at the pump, one can extract water only when needed, and as long as the aquifer has water and the well is deep enough.

This paper offers the following proposals:

. Groundwater recharge should be a prime objective of water

supply planning for drought.

. Groundwater management should include the establishment of

a strategic groundwater reserve.

. The reserve should only be used to alleviate severe water short

ages during a prolonged drought. Recovery of water to satisfy

reasonable short-term demand could occur so long as the reserve is maintained.

The strategies of groundwater recharge, groundwater storage and conjunctive management of surface and groundwater are outlined below, followed by an analysis of the issues involved in utilizing these approaches to establish a groundwater reserve.

A. GROUNDWATER RECHARGE

Groundwater recharge is the first step in stabilizing and sustaining groundwater aquifers over the long term and building up a groundwater reserve. [n114] Three basic processes can replenish aquifers: (1) natural recharge, (2) active recharge (also referred to as enhanced, direct, or artificial recharge), and (3) in-lieu recharge. [n115] Natural recharge can occur as part of the hydrologic cycle or as the result of water seeping or percolating into the aquifer from various surface water sources: streams, rivers, lakes; surface water conveyance facilities; and irrigation water when rainfall infiltrates the land surface and percolates into the underlying aquifers. [n116] Natural recharge rates differ across areas due to [*315] variations such as soil type, plant cover, land slope, and rainfall intensity. [n117]

A second replenishment method, active recharge, occurs when water is pumped or injected into wells or spread over a land surface to allow it to seep into the aquifer. [n118] This method uses imported water in several different scenarios. A storage and release regime can modify an existing reservoir to allow it to capture a larger fraction of peak flow events and move a substantial portion of this imported water into groundwater basins with un-utilized aquifer storage capacity. [n119] Alternatively, users can extract native groundwater from full aquifers, export it to create storage space, and subsequently fill the space with the imported water through injection or spreading. [n120]

A third process, in-lieu recharge, reduces groundwater extraction so that a depleted aquifer can recharge through natural or active processes. Parties then substitute more available surface water supplies that often include imported water. [n121] Recharge processes depend upon factors such as the area available for recharge, surface and subsurface geology in the groundwater basin and recharge rate, and are influenced by whether the source of recharge water is local or imported. [n122]

B. Groundwater Storage

One can also use some groundwater aquifers as storage reservoirs. [n123] A range of physical systems utilizes managed underground storage of recoverable water [n124] to provide more secure water supplies. [n125] [*316] The significant advantages to storing water in groundwater basins include avoiding expensive surface storage and conveyance facilities, protecting stored water from evaporation, and providing a natural purification system through percolation. Moreover, groundwater storage uses less energy to extract water when the groundwater table rises and causes less environmental damage. [n126] Challenges include design, construction and monitoring costs, chemical reactions with aquifer materials, environmental impacts, spillover costs to third parties, and potential over-consumption of stored water leading to further overdraft. [n127]

California courts address the rights to store, protect, and recapture water in underground basins in several cases. For example, courts have held: (1) Los Angeles has the right to import river water from the Owens Valley and bank it underground in the San Fernando Valley; [n128] (2) public agencies have the right to store water and a right to the return flow from water imported into a groundwater basin (adding that "natural underground basins should be used as storage reservoirs ... whenever practicable"); [n129] and (3) Alameda County Water District has the authority to store water in a groundwater basin pursuant to its police powers. [n130]

C. Conjunctive Management of Surface and Groundwater

A conjunctive water management program coordinates the use of groundwater and surface water. [n131] Natural, active, or in-lieu recharge processes deposit surface water in groundwater aquifers, and the program then "banks" the water there until its extraction for use. [n132] Using different combinations of recharge and recovery methods, an aquifer typically recharges in winter months and during years of abundant surface water availability, and recovery occurs in the summer and fall or during several consecutive years of less water availability. [n133]

Conjunctive water management clearly lacks a "one-size-fits-all" approach, and the unique set of local conditions such as institutional constraints, environmental concerns, economic considerations, and [*317] political climate dictate the management method. Today, elaborate conjunctive management programs operate in southern Central Valley counties, including Kern and Tulare, where farmers initially relied almost exclusively on groundwater to irrigate their crops. [n134] This resulted in severely over-drafted and degraded groundwater basins. [n135] To remedy the deteriorating basins, water districts attempted to find other sources of water through conjunctive management arrangements that utilized imported surface water primarily from the State Water Project. [n136] Today, these programs still rely heavily on this imported surface water as a major component of their conjunctive management programs. [n137]

Localities administer these projects, and while the rule is generally that groundwater overdraft conditions cannot worsen, a very significant issue is that no requirements exist for any district utilizing a conjunctive management arrangement to actually attain and maintain sustainable groundwater levels. For example, Semitropic Water District has a fifteen-foot/three-year rule, where Semitropic will not make groundwater withdrawals that cause the average groundwater levels in an area to decline more than fifteen feet over a three-year period compared to the average groundwater levels that would occur without the project. [n138] But these levels existed when the aquifer was already in serious overdraft. [n139] While the Orange County Water District has one of the more sustainable groundwater management programs in the state and focuses on the prevention of groundwater depletion, if a series of very dry years occurs, it will be unable to replenish the withdrawal that would occur. [n140]

An important objective of conjunctive management is cycling recharge and recovery over a time period to achieve an appropriate balance. [n141] However, as presently designed and practiced, the strategy can and typically does cause larger than normal declines in local groundwater levels during more intensive periods of recovery, potentially posing problems for other groundwater and surface water users in the [*318] basin not part of the conjunctive management effort, as well as for surface water flows. This is particularly problematic in already overdrafted basins during a severe drought. In addition, many of the large projects rely on: (1) recharge supplies exported from the Sacramento-San Joaquin Delta subjecting operations to present Delta export restrictions; (2) the availability of conveyance capacity; and (3) the availability of non-firm water from the State Water Project and/or the Central Valley Project. [n142] While benefiting banking partners, these projects impact non-participating parties as the recovery of banked water can increase the pump lift for other local landowners, increase aquifer contamination, and cause subsidence and damage native vegetation. [n143]

IX. DISCUSSION

According to the 2009 DWR Draft State Water Plan, the state still fails to provide for sustainable use of groundwater, including the protection of recharge and discharge areas. [n144] Yet future water supply security depends on managing groundwater to prevent overdraft and pollution, boost recharge, and support more sustainable conjunctive management programs that incorporate a strategic groundwater reserve. Similar to a bank savings account, protecting natural capital in groundwater basins provides essential backup for extended and severe water shortages. Issues to consider in establishing standards to maintain a groundwater reserve include both hydrologic and geologic characteristics of groundwater aquifers and legal and political questions. [*319]

A. Hydrologic and Geologic Characteristics

"Because the physical characteristics of groundwater basins vary greatly, the suitability of a particular basin to serve as an area for immediate storage and later extraction depends on its hydrological and geological features, as well as on the quality of the water stored within the basin." [n145] Pertinent factors include the movement of water between hydrologically connected surface and groundwater systems; movement between other aquifers; [n146] the porosity of the basin material and the depth of the basin; [n147] and the geologic and hydrologic variability in the character, thickness, and hydraulic conductivity within geologic materials overlying aquifers. [n148] At present, there is limited geologic mapping to identify the geologic, hydrologic, and geochemical characteristics of aquifer sites, and limited spatial and temporal information characterizing groundwater levels and groundwater storage zones. [n149]

The source of storage water may be contentious, particularly regarding imported or recycled water. Pollution concerns arise when chemically and microbiologically different waters mix, and a conjunctive management program may need to include control over the type of land uses overlying the basin. The fluctuation in water levels in a basin can alter the rate or direction of groundwater flow, which forces contaminated water in the basin to flow towards wells. In this way, project water can exacerbate pollution problems within a basin by hastening the dispersal rate of pollutants throughout the aquifer. Thus, prior to recharge, an assessment of the level and location of contaminants within a basin is important. [n150] When a basin is adjacent to the ocean or [*320] a saline aquifer, the withdrawal of water can allow for intrusion of saltwater into the freshwater aquifer, potentially rendering the water stored within the basin unusable without treatment. [n151]

B. Legal and Institutional

Groundwater governance and management clearly require strategies that take into account not only the physical characteristics of a local aquifer, but also its long-term integrity, the needs of communities overlying a basin, and the overall needs of the state particularly under conditions of climate change and potential prolonged droughts. Yet, authority over groundwater today is complex and fragmented with overlapping jurisdictions, and the management arrangements presently in place function as a response system that averts "crisis and system collapse," and suffers from "a variety of dysfunctional results." [n152]

The first question is what presently available sources of authority would allow the state to step in to achieve the establishment and maintenance of healthy groundwater aquifers, including a strategic groundwater reserve? Second, given the political resistance thus far to state regulation, what authority do local entities have that could enable them to establish these goals; is it sufficient; and how could policymakers improve this authority?

1. State Authority

As already indicated, the state currently does not have clear authority to regulate the pumping of percolating groundwater through a permitting process. Despite the legislature's frequent consideration of whether more comprehensive groundwater regulation is necessary, [n153] [*321] political reality has precluded the adoption of a permit-based groundwater management program administered at the state level, and the legislature's preference so far is for the local administration of groundwater management. [n154]

Given the reluctance of the state to step in through a permitting system, other existing sources of state authority allow the state to regulate groundwater more broadly, including the establishment of a no overdraft policy, incentives for recharge, and sufficient groundwater levels to sustain a strategic reserve. These sources include the California Constitution Article X, Section 2, and various sections of the California Water Code.

The California Constitution, Article X, Section 2, codified in Section 100 of the California Water Code, mandates the reasonable use of the state's water resources. [n155] In Peabody v. City of Vallejo, the court held that Article X, Section 2 applied to both surface and groundwater rights. [n156] The court stated:

The right to the use of water is limited to such water as shall be reasonably required for the beneficial use to be served . . . . Such right does not extend to unreasonable use or unreasonable method of use or unreasonable method of diversion of water . . . . The foregoing mandates are plain, they are positive, and admit to no exception. They apply to the use of all water, under whatever right the use may be enjoyed. [n157]

In Joslin v. Marin Mun. Water Dist., the court affirmed once again that the 1928 Constitutional Amendment applied to all the waters of the [*322] state including groundwater. [n158]

In addition, the courts interpret reasonable use broadly, holding that water use must be reasonable for both the needs of water rights holders and in light of competing public uses of the resource. As the court stated in Joslin, [n159] "what is a reasonable use of water depends on the circumstances of each case, such an inquiry cannot be resolved in vacuo from statewide considerations of transcendent importance." [n160] Most importantly, the courts employ a dynamic definition of reasonable use, and the law must keep pace with the needs and transformations constantly taking place in a rapidly changing society. [n161] As stated in Envtl. Def, Fund v. E. Bay Mun'l Utility Dist.: "What constitutes reasonable water use is dependent upon not only the entire circumstances presented but varies as the current situation changes." [n162] Thus, the state could limit groundwater withdrawals that are unreasonable within the broader context of drought planning and the need to sustain a strategic groundwater reserve.

The next issue is what constitutes a violation of unreasonable use in the context of establishing a groundwater reserve. California Water Code, Section 12922 gives the state the authority to prevent impaired use or irreparable damage to groundwater basins caused by overdraft and depletion. [n163] In addition, Section 104 states that: "It is hereby declared that the people of the State have a paramount interest in the use of all the water of the State and that the State shall determine what water of the State, surface and underground, can be converted to public use or controlled for public protection." [n164] The sections of the California Water Code and court cases discussed above affirm the authority of the state to regulate groundwater with respect to (1) reasonable use, where reasonable use encompasses the public interest; (2) the prevention of [*323] groundwater overdraft, depletion and degradation; and (3) public protection.

Given the reasonable use requirement and the above water code provisions, the next question concerns whether the State Board can step in to remedy groundwater withdrawals that are unreasonable when they deplete a strategic reserve established to protect the public against statewide drought conditions? Joseph Sax argues that the State Board can issue remedial orders against water users not abiding by the reasonable use mandate despite its lack of permitting authority, and "that the Board, through the California Attorney General, can institute litigation to control groundwater use that . . . constitutes waste, unreasonable use, or method of use within the meaning of Article X, Section 2 of the California Constitution, and Section 100 of the Water Code . . . ." [n165]

Sax adds that, under Section 275 of the California Water Code, the Board can also assert its own jurisdiction to adjudicate and remedy complaints about unreasonable groundwater use. [n166] In United States v. State Water Res. Control Bd., [n167] (the Racanelli decision), and Imperial Irrigation Dist. v. State Water Res. Control Bd, [n168] the courts affirmed that Section 275 of the Water Code [n169] gives the Board the power to take any necessary steps to prevent unreasonable use of water. As Sax notes, these are lower court decisions, and while the California Supreme Court has not expressly addressed whether Section 275 provides an independent source of jurisdiction over groundwater pumpers, the lower courts establish that the Board can assert jurisdiction over the pumping of percolating groundwater to adjudicate and remedy claims that come within the scope of waste and unreasonable use covered by [*324] section 275 of the Water Code. [n170] This points to the Board having the authority to remedy claims of pumping that causes overdraft of a basin and potentially to remedy unreasonable withdrawals that deplete a reserve.

2.Local Authority

Given the political resistance thus far to broad state regulation of groundwater, and that the California Water Code also enables local agencies to manage groundwater and control groundwater use to some degree, the second question concerns whether these entities have the authority to mandate more sustainable groundwater management practices, and whether it is sufficient to enable the establishment of a groundwater reserve program on a basin by basin basis? [n171] The following is a summary of local districts' ability to engage in sustainable groundwater management and some of the problems with this approach.

3. Local Agencies and Districts with Authority Under the California Water Code or Legislation

More than 20 types of local agencies have authority to manage some aspect of groundwater depending upon the individual agency's enabling legislation [n172] including, for example, water replenishment districts [n173] and water conservation districts. [n174] Depending on their enabling legislation, these districts can limit or regulate extraction, levy groundwater extraction fees, [n175] and collect fees to establish recharge programs that address overdraft. [n176] [*325]

In addition, the legislature also creates special groundwater management districts [n177] that can manage groundwater to control in-basin pumping upon evidence or threat of overdraft, limit exports out of the district, regulate well spacing to minimize well interference, and levy fees for groundwater management activities and for water supply replenishment. [n178] While these special districts have stronger mandates and could serve as a model for regulation in the public interest, they exist in only a few regions. [n179]

4. Local Districts with Groundwater Management Plans

Assembly Bill 3030, passed in 1992, [n180] expanded the ability of agencies to address the problem of critical overdraft by increasing the number of public agencies authorized to develop a groundwater management plan; however, this ability is contingent on receiving a majority of votes in favor of the plan in a local election. [n181] When adopted, the plan allows the agency to fix and collect fees for groundwater management. [n182] Senate Bill 610 added that if groundwater is a source available to a water supplier in a non-adjudicated basin, and if the basin is in overdraft, the plan must include current efforts to eliminate any long-term overdraft. [n183]

Groundwater Management Plans may, but are not required to, address the control of salt-water intrusion, the management of recharge areas, the regulation of contaminated groundwater migration, the mitigation of overdraft, the replenishment of extracted groundwater, the monitoring of groundwater levels and storage, and the coordination with land use planning agencies to assess activities that create a risk of [*326] groundwater contamination. [n184] A significant issue is that groundwater management plans are not mandatory and do not have to be reported to DWR, [n185] limiting both their reach and an understanding of their effectiveness. [n186] Legislation now requires that any public agency seeking state funds for groundwater projects to prepare and implement a groundwater management plan that includes basin management objectives and monitoring protocols. [n187]

5. City and County Ordinances

A third general method of managing groundwater in California is through ordinances that local governments adopt. Almost 30 percent of California's counties have local groundwater management ordinances [n188] in which a county will only issue a permit if an export of groundwater will not cause overdraft, affect safe yield, reduce water quality, cause subsidence, or injure water users within the county. [n189] [*327]

The court upheld the authority of counties to regulate groundwater in Baldwin v. County of Tehama, [n190] stating that state law does not occupy the field of groundwater management; therefore, cities and counties may adopt ordinances to manage groundwater under their police powers. [n191] Groundwater-rich counties adopted these ordinances out of concern that their groundwater resources will be exported to meet the growing demands of the Bay Area and Southern California. Counties also adopted these ordinances to protect against someone purchasing land within a county with groundwater resources for purposes of obtaining groundwater rights, and then transferring water outside of the county for a fee, to the detriment of users within the county. [n192]

6. Adjudication

Groundwater over-pumping that results in the decline of the water table, salt-water intrusion and subsidence can stimulate basin adjudications or settlements. [n193] A lawsuit generally initiates the adjudication, and then a court decides the groundwater rights of all the overlying owners and appropriators. Adjudicated basins operate according to specific rules, including who may pump and how much they may pump. A court-appointed water master or a user committee from a groundwater district monitors compliance and resolves disputes. Thus far, adjudicated basins account for a small percentage of California's groundwater resources, with the limiting factor being the cost and delay associated with adversarial litigation. [n194]

The first basin-wide adjudication in the Raymond Basin in Southern California, which took thirteen years to resolve, [n195] established the [*328] doctrine of mutual prescription. [n196] Modified in Techachapi-Cummings County Water Dist. v. Armstrong, [n197] the court ruled that overlying owners' quantified water rights rest on the basis of current, reasonable and beneficial need, not past use. In City of Los Angeles v. City of San Fernando, [n198] the court stated that all public agency rights are prior to rights dependent on ownership of overlying land. [n199]

Adjudicated basins generally result in either a reduction or no increase in the amount of groundwater extracted, and these basins have the best record for establishing mandates for sustainable groundwater management. However, any increase in demand generally requires the use of imported surface water, and adjudicated basins account for a only a small percentage of California's groundwater resources, and adjudication is costly and time-consuming. [n200]

7. Urban Water Management Plans

Additional legislation addresses groundwater overdraft by requiring urban areas with groundwater as an available source of water to include groundwater management in its Urban Water Management Plan, and if the basin is in overdraft, the plan must detail current efforts to eliminate any long-term overdraft. [n201]

8. Court Directives

The courts also affirmed a constitutionally based authority for local public institutions to prevent aquifer degradation. [n202] In a footnote in City of Barstow v. Mojave Water Agency the court stated: "If Californians expect to harmonize water shortages with a fair allocation of future use, courts should have some discretion to limit the future groundwa [*329] ter use of an overlying owner who has exercised the water right and to reduce to a reasonable level the amount the overlying user takes from an overdrafted basin." [n203]

9. Financial Incentives

Financial incentives are available to local agencies to encourage them to implement improvement programs for recharge and water quality. [n204] Recent bond measures, voter approved propositions, and legislation provide significant financing for groundwater studies, recharge projects, groundwater storage facilities, and conjunctive management programs. [n205] The bulk of funding, thus far, goes to the large water districts in Southern California, the San Joaquin/Tulare Central Valley region, and the Sacramento Region. [n206]

10. Problems with Local Groundwater Management

While local entities clearly have authority and incentives to improve groundwater management, numerous problems with local supervision presently exist. Management is primarily reactive rather than proactive, and movement towards sustainable management usually occurs after a groundwater basin is in trouble due to overdraft and/or contamination. Most policies are voluntary, highly variable in the degree of protection against overdraft, and essentially non-existent with respect to the establishment and maintenance of a groundwater reserve as a hedge against prolonged drought.

CONCLUSION

"A drought is like watching a train wreck in slow motion. You would think slow motion would allow us to prepare." [n207]

- Paul H. Betancourt [*330]

Much of California faces a future of increasing aridity. Periodic droughts, common throughout the state's history, coupled with climate change, will likely exacerbate water problems even as the state faces increasing water demands from potential population growth and more diverse interests. The time is ripe for more potent and innovative strategies to cope with anticipated future droughts; [n208] to sustain a reliable water supply during these periods, California will increasingly rely on groundwater, the world's subsurface water reservoir. Although large financial assistance programs are currently available to help local communities implement groundwater improvement programs, groundwater overdraft and deteriorating quality remain significant problems. [n209]

Clearly, the most effective way to achieve broad and sustainable groundwater management, including the establishment of a strategic groundwater reserve, involves setting basic standards at the state level. These should be mandatory and broadly applicable; moreover, the standards should be interconnected with broader planning mechanisms for land, water and environmental protection, and flexible enough to account for local conditions. [n210]

Specifically, the state should establish policies to:

(1)Coordinate land use activities to protect groundwater recharge areas and monitor human activities that can degrade them; [n211]

[*331]

(2)Establish a system to collect data and monitor the size, storage area, and hydrologic balance of state aquifers, as well as trends in levels and quality; [n212]

(3)Establish aquifer standards to prevent overdraft, pollution, degradation and loss of the aquifer; [n213]

(4)Establish, and maintain a strategic groundwater reserve, and establish the conditions under which the reserve may be tapped.

By overdrawing aquifers, Californians have "overdrawn their account with Mother Nature," and "rather than living off the interest of natural capital ... have taken a large portion of the principal." [n214] As articulated in the Sacramento Bee, California can no longer ignore the consequences of a potential severe drought, and solutions must move beyond the general notions of linking water and land-use planning [n215] and the reduction of water use after a drought is declared. In taking the first step and thinking proactively about reducing vulnerability to a drought through the establishment and maintenance of a strategic water reserve, this paper contributes to the debate over how to live sustainably in a fundamentally dry landscape.

Legal Topics:

For related research and practice materials, see the following legal topics:
Environmental LawNatural Resources & Public LandsEndangered Species ActTakingsGovernmentsState & Territorial GovernmentsWater RightsReal Property LawWater RightsNonconsumptive UsesGeneral Overview

FOOTNOTES:

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n2 The author would like to thank Joseph Sax, Andrew Fisher and Robert Gottlieb for very helpful comments on early drafts of this paper.

n3 JOHN STEINBECK, EAST OF EDEN 6 (Penguin Books 2002) (1952).

n4 GUIDO FRANCO, CLIMATE CHANGE IMPACTS AND ADAPTION IN CALIFORNIA 10-11 (2005). See also Katharine Hayhoe et al., Emissions Pathways, Climate Change and Impacts on California, 101 PROC. OF THE NAT'L ACAD. OF SCI. OF THE U.S.A., Aug. 24, 2004, at 12422-12427.

n5 Brad Udall, Potential Climate Change Impacts on Colorado River Streamflows During the 21st Century, in CAL. DEP'T OF WATER RES., CALIFORNIA DROUGHT: AN UPDATE 61, 61 (2008) [hereinafter CALIFORNIA DROUGHT UPDATE]; H. G. Hidalgo, M. D. Dettinger & D. R. Cayan, Changes in Aridity in the Western United States, in CALIFORNIA DROUGHT UPDATE, supra, at 54 (A climatic drought occurs when "broad areas . . . are subjected to drier conditions than normal, imposing-at least temporarily-arid climatic conditions on many semiarid and even humid areas.").

n6 CAL. DEP'T OF WATER RES., URBAN DROUGHT GUIDEBOOK 2008 UPDATED EDITION 15 (2008) [hereinafter URBAN DROUGHT GUIDEBOOK 2008].

n7 CALIFORNIA DROUGHT UPDATE 2008, supra note 5, at 16.

n8 See Ruth Langridge, Changing Legal Regimes and the Allocation of Water Between Two California Rivers, 42 NAT. RESOURCES J. 283, 299-300 (2002). See also, Brian E. Gray, The Modern Era in California Water Law, 45 HASTINGS L.J. 249, 278 (1994).

n9 CAL DEP'T OF WATER RES., FUTURE PLANS, http://www.publicaffairs.water.ca.gov/swp/future.cfm (last visited Mar. 8, 2009) ("Based on recent studies, increased urban water conservation efforts could save up to 2.5 million acre-feet annually by the year 2030; another 1.2 million acre-feet could be generated by municipal recycling projects; and new agricultural conservation could supply an additional 500,000 acre-feet." (internal citations omitted)).

n10 See CAL DEP'T OF WATER RES., PREPARING FOR CALIFORNIA'S NEXT DROUGHT 50 (2000) [hereinafter PREPARING FOR CALIFORNIA'S NEXT DROUGHT] (recommending monitoring effects of demand hardening on water agencies' ability to implement shortage contingency measures).

n11 See Marios Sophocleous, On the Elusive Concept of Safe Yield and the Response of Interconnected Stream-aquifer Systems to Development, in PERSPECTIVES ON SUSTAINABLE DEVELOPMENT OF WATER RESOURCES IN KANSAS 61, 62-63 (Marios Sophocleous ed., 1998)(explaining that balancing pumping and recharge will generally result in a balance that reflects the initial status of the aquifer).

n12 Marios Sophocleous, Senior Scientist, Kan. Geological Survey, Speech at the California Colloquium on Water: Groundwater Sustainability and its Application in Kansas (Nov. 11, 2008) (PowerPoint presentation available at http://www.lib.berkeley.edu/WRCA/pdfs/ccowSophocleous18Nov2008.pdf). To establish a reserve in an already over-drafted and depleted aquifer, withdrawal will need to be less than recharge over a period of time. In this case, the sustainable yield of an aquifer is then significantly less than recharge to allow adequate amounts of water to both sustain rivers, wetlands and streams and to be available for withdrawal during periods of extended climate-induced droughts.

n13 PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 1.

n14 CAL. DEP'T OF WATER RES., CAL. WATER PLAN UPDATE BULLETIN 160-98, 3-2 (1998) [hereinafter BULLETIN 160-98].

n15 CAL. DEP'T OF WATER RES., CALIFORNIA'S GROUNDWATER: BULLETIN 118 20, 24 (2003) [hereinafter BULLETIN 118], available at http://www.groundwater.water.ca.gov/bulletin118/update2003/index.cfm.

n16 Id. at 24.

n17 See generally id.

n18 MARY HEIM & MELANIE MARTINDALE, NEW STATE PROJECTIONS SHOW 25 MILLION MORE CALIFORNIANS BY 2050; HISPANICS TO BE STATE'S MAJORITY ETHNIC GROUP BY 2042 1 (2007), available at http://www.dof.ca.gov/HTML/DEMOGRAP/ReportsPapers/Projections/P1 /P1.php; see also ELLEN HANAK, WATER FOR GROWTH: CALIFORNIA'S NEW FRONTIER, 1 (2005), available at http://www.ppic.org/main/publication.asp?i=429.

n19 See generally 4 CAL. DEP'T WATER RES., CALIFORNIA WATER PLAN UPDATE 2005 (2005), available at http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm#vol4 (follow "PDF" hyperlink located to the right of "Water Allocation, Use and Regulation in California).

n20 BULLETIN 160-98, supra note 14, at ES3-5.

n21 Id. at ES3-7. Analysis of data from the California Water Plan Update projects that, even under a less resource intensive scenario, net water demand in the state could continue to grow. HANAK, supra note 18, at 19-20.

n22 FRANCO, supra note 4, at 16.

n23 The state has always been subject to periodic droughts including two epic ones. The first lasted more than two centuries before the year 1112, when a wetter century ensued and rainfall was higher than in modern times. The second drought before 1350 lasted more than 140 years. A 1994 study of tree stumps rooted in present day lakes, rivers, and marshes suggest that California sustained two epic drought periods, extending over more than three centuries. PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 9. During the middle-12th century drought, there existed a period of 23 consecutive years that represented the single greatest North American mega-drought since AD 951. Larry Benson, Impact of Drought on Prehistoric Western Native Americans, in CALIFORNIA DROUGHT UPDATE, supra note 5, at 28. Historical multi-year droughts in the twentieth century include: 1912-13, 1918-20, 1923-24, 1929-34, 1947-50, 1959-61, 1976-77, and 1987-92. While measured hydrologic data for droughts in California prior to 1900 are minimal, multi-year dry periods in the second half of the 19th century can be qualitatively identified from the limited records available combined with historical accounts. PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 9.

n24 FRANCO, supra note 4, at 1.

n25 CAL. ENVT'L PROT. AGENCY, CLIMATE ACTION TEAM REPORT TO GOVERNOR SCHWARZENEGGER AND THE LEGISLATURE 28 (2006) [hereinafter CLIMATE ACTION TEAM REPORT], available at http://caclimatechange.net/ (follow "Reports" hyperlink; then follow "2006 California Climate Action Team Final Report" hyperlink and view the entire report). Studies by the National Water Assessment Team for the U.S.

Global Change Research Program's National Assessment of the Potential Consequences of Climate Variability and Change point to potentially higher snow levels leading to more precipitation in the form of rain, earlier runoff, a rise in sea level, and possibly larger floods. PETER H. GLEICK, WATER: THE POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY AND CHANGE FOR THE WATER RESOURCES OF THE UNITED STATES 4 (2000), available at http://www.gcrio.org/NationalAssessment/water/water.pdf. This would affect the balance between storage and flood control of reservoirs, and could cause changes in vegetative water consumption that would impact patterns of irrigated and dry land farming. While a warmer, wetter winter would increase the amount of runoff available for groundwater recharge, the additional winter runoff would occur when some basins are either being recharged at their maximum capacity or are already full. Conversely, reductions in spring runoff and higher evapo-transpiration because of warmer temperatures could reduce the amount of water available for recharge and surface storage.

n26 CLIMATE ACTION TEAM REPORT, supra note 25, at 28. This is particularly the case because surface water runoff stored in reservoirs, along with water directly diverted from streams, provides much of the current water used in California. PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 1-2. Note that because droughts vary in their spatial and temporal dimensions and no single definition of drought applies in all circumstances, determining precise changes in drought frequency or intensity that might be expected to result from climate changes is complicated and uncertain. Id. at 12.

n27 Hidalgo, Dettinger & Cayan, supra note 5, at 58.

n28 See Brian E. Gray, The Market and the Community: Lessons from California's Drought Water Bank, 1 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 17, 18-20 (1994). During the 1987-92 drought, statewide reservoir storage was about 40 percent of average by the third year of the drought, and did not return to average conditions until 1994. Id. at 18-19. Water districts did utilize price incentives, conservation, fallowing, water re-allocation and water transfers to cope, and there were changes in irrigation practices including an increase in low volume irrigation systems, but there was also a 25 percent annual increase in the sale of pumps during the drought and groundwater pumping accounted for a significant portion of the water substitution resulting from a lack of surface water supplies. DAVID ZILBERMAN ET. AL., INDIVIDUAL AND INSTITUTIONAL RESPONSES TO THE DROUGHT: THE CASE OF CALIFORNIA AGRICULTURE 19, http://www.ucowr.siu.edu/updates/pdfn/V121A3.pdf (last visited April 15, 2009).

n29 Gray, supra note 28, at 19.

n30 Id.

n31 See PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 55.

n32 Id. at 48, 50.

n33 Id. Regions expected to have the highest percent growth rates over the next 20 years are the Inland Empire, Central Valley, and Sierra Nevada foothills. As greater development occurs in these inland areas, the ex-urban ring around them also will expand. PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 48. Rural homeowners with private wells are largely an un-served population with respect to drought-related assistance programs. The majority of past drought problems in these small systems resulted from dependence on groundwater in fractured rock systems or in small coastal terrace groundwater basins. Even though the total population served by small water systems statewide is relatively small, these communities are typically isolated and have limited back-up water supplies. Id. at 48, 50; see also CALIFORNIA DROUGHT UPDATE, supra note 5, at 21.

n34 See Mike Lee and Michael Gardner, Builders Facing Water Pressure: New Developments Urged, or Required, to Offset Impact, SAN DIEGO UNION TRIBUNE, May 22, 2008, available at http://www.signonsandego.com/uniontrib/20080522/news1n22water.html. For example, the Eastern Municipal Water District, an Inland water agency, indicated it could serve nine major new industrial and residential projects in the southwest Riverside County area, utilizing conservation measures and other resources that would provide enough water for the long-term future. Dan Lee, Water Agency Approves Project, THE PRESS ENTERPRISE (Riverside, Cal.), June 5, 2008, at C01.

n35 Matt Weiser, Capital Gushes Wasted Water: Metropolitan Region's Per-Capita Use Tops U.S. Daily Average as Conservation Pledges Go Unmet, THE SACRAMENTO BEE, June 19, 2008, available at http://www.sacbee.com/101/story/1024692.html.

n36 BULLETIN 118, supra note 15, at 2 ("It is estimated that overdraft [of state aquifers] is between 1 million and 2 million acre-feet annually.").

n37 ARTHUR L. LITTLEWORTH & ERIC L. GARNER, CALIFORNIA WATER 27 (1995) (dividing water into two classes: surface waters and underground waters). But cf.

BULLETIN 118, supra note 15, at 3 ("Surface water and groundwater are connected and can be effectively managed as integrated resources.").

n38 Joseph L. Sax, We Don't Do Groundwater: A Morsel of California Legal History, 6 U. DENV. WATER L. REV. 269, 273 (2003) (explaining that a subterranean stream consists of the underflow or subflow of a surface stream and is defined as water in the soil, sand, and gravel immediately below the bed of the open stream, which supports the surface stream in its natural state or feeds it directly).

n39 Id. at 272.

n40 People v. Shirokow, 605 P.2d 859, 864 (Cal. 1980) ("California operates under the so-called dual system of water rights which recognizes both the appropriation and the riparian doctrines.").

n41 JOSEPH L. SAX, BARTON H. THOMPSON, JR., JOHN LESHY & ROBERT H. ABRAMS, LEGAL CONTROL OF WATER RESOURCES 27-37 (4th ed. 2006).

n42 Id. at 124-126, 131-132.

n43 Vineland Irrigation Dist. v. Azusa Irrigation Co., 58 P. 1057, 1059 (Cal. 1899) ("It is essential to the nature of percolating waters that they do not form part of the body or flow, surface or subterranean, of any stream. They may either be rain waters, which are slowly infiltrating through the soil, or they may be waters seeping through the banks or bed of a stream, which have so far left the bed and other waters as to have lost their character as part of the flow.").

n44 See Katz v. Walkinshaw, 74 P. 766, 771-72 (Cal. 1903).

n45 City of Barstow v. Mojave Water Agency, 5 P.3d 853, 864 (Cal. 2003). In addition, prescriptive rights can be acquired, although water rights held by a public agency cannot be lost by prescription. Los Angeles v. San Fernando, 537 P.2d 1261, 1304 (Cal. 1975).

n46 CAL. WATER CODE ß 179 (West 2009).

n47 See id. ßß 1250-76.

n48 City of Pasadena v. City of Alhambra, 207 P.2d 17, 33 (Cal. 1949).

n49 CAL. WATER CODE ß 1200 ("Whenever the terms stream, lake or other body of water, or water occurs in relation to applications to appropriate water or permits or licenses issued pursuant to such applications, such term refers only to surface water, and to subterranean streams flowing through known and definite channels.").

n50 Nat'l Audubon Soc'y v. Superior Court of Alpine County, 658 P.2d 709, 724 (Cal. 1983).

n51 See id. at 712.

n52 See Marks v. Whitney, 491 P.2d 374, 380 (Cal. 1971).

n53 CAL CONST. art. X, ß 2 ("Because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable and that the waste or unreasonable use or unreasonable method of use of water be prevented and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interests of the people and for the public welfare.").

n54 See Morris Israel & Jay R. Lund, Recent California Water Transfers: Implications for Water Management, 35 NAT. RESOURCES J. 1, 3 (1995); see generally NATIONAL DROUGHT MITIGATION CENTER, MITIGATING DROUGHT (2007), http://drought.unl.edu/mitigate/status.htm. There is considerable variation among states with respect to drought planning: "as of October 2006, thirty-seven states had drought plans . . . two delegated planning to local authorities instead of having a single state-level plan, and two states were in the process of developing a plan. Only nine states did not have formal drought plans."

n55 U.S. DEP'T OF THE INTERIOR: BUREAU OF RECLAMATION, THE CENTRAL VALLEY PROJECT (2008), http://www.usbr.gov/mp/cvp/index.html. However, in California v. United States, 438 U.S. 645, 674-75 (1978) the New Melones decision, the Supreme Court held that states may condition Reclamation project water rights if "not inconsistent with congressional provisions authorizing the project in question."

n56 CAL. DEP'T. OF WATER RES., STATE WATER PROJECT (2009), http://www.publicaffairs.water.ca.gov/swp/. The major urban areas in the state also administer large water projects that import water. San Francisco Public Utilities Commission, a department of the City and County of San Francisco, provides water to San Francisco and 28 wholesale water agencies that supply water to 1.6 million additional customers within three Bay Area counties. SAN FRANCISCO PUB. UTIL. COMM'N, WATER, http://sfwater.org/mcmain.cfm/MCID/13 (last visited Apr. 16, 2009). The Metropolitan Water District serves approximately 18 million people within about 5,200 square miles in Los Angeles, Orange, San Diego, Riverside, San Bernardino and Ventura counties. THE METRO. WATER DIST. OF S. CAL., THE DISTRICT AT A GLANCE (2008), http://www.mwdh2o.com/mwdh2o/pages/news/news01.html. The East Bay Municipal Utility District (EBMUD) supplies water for parts of Alameda and Contra Costa counties on the eastern side of San Francisco Bay in northern California. EBMUD, OVERVIEW, http://www.ebmud.com/aboutebmud/overview/ (last visited Apr. 16, 2009). All three districts rely on large storage and transmission systems that import water.

n57 CAL. DROUGHT UPDATE 2008, supra note 5, at 17-18. Funding for water supply planning has included Proposition 204 (The Safe, Clean, Reliable Water Supply Act of 1996), and additional state general obligation bond acts that, among other things, provide funding for water supply infrastructure improvements. These acts include the $ 1.97 billion Proposition 13 (The Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act) in 2000, the $ 3.44 billion Proposition 50 (The Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002), and the $ 5.4 billion Proposition 84 (The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006).

n58 CAL. WATER CODE ß 10621 (West 2009).

n59 HANAK, supra note 18, at v.

n60 CAL. WATER CODE ß 350, 353 (Water needed for domestic purposes is given priority and discrimination within a class of customers is not permitted.); URBAN DROUGHT GUIDEBOOK 2008, supra note 6, at 17.

n61 See e.g. CAL. DEP'T OF PUB. HEALTH, DROUGHT PREPAREDNESS AND WATER CONSERVATION (2009), http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DroughtPreparedness.aspx.

n62 CAL. WATER CODE ß ß 79510-79512.

n63 Prop. 84 (Cal. 2006) (Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006).

n64 CAL. WATER CODE ß 353.

n65 Id. ß ß 353-54.

n66 Id. ß ß 350-53

n67 Id. ß 350. However, for small systems, those most vulnerable to drought, there is no explicit statutory requirement to plan for drought, and emergency response plans have been completed for only a limited number of these systems.

n68 See e.g. CITY OF MOUNTAIN VIEW, URBAN WATER MANAGEMENT PLAN 2005 UPDATE, 29-36, 43-45, 61-65, available at http://www.ci.mtnview.ca.us/cityhall/publicworks/urbanwatermanagementplan.asp; CITY OF BENICIA, URBAN WATER MANAGEMENT PLAN 2005 UPDATE, Sec. 7-1 to 7-3, 9-1 to 9-14, available at http://www.ci.benicia.ca.us/vertical/Sites/%7B3436CBED-6A58-4FEF-BFDF-5F9331215932%7D/uploads/%7B2045C66E-6F35-466B-A070-307306EA6566%7D.PDF; see also Donald A. Wilhite and Mark D. Svoboda, Drought Early Warning Systems in the Context of Drought Preparedness and Mitigation, in EARLY WARNING SYSTEMS FOR DROUGHT PREPAREDNESS AND DROUGHT MANAGEMENT, 1, 1 (Donald A. Wilhite, M.V.K. Sivakumar, and D.A. Woods eds., 2000) Proceedings of an Expert group Meeting, Lisbon, Portugal, September 5-7, 2000, World Meteorological Organization, Geneva, Switzerland, available at www.unisdr.org/eng/library/Literature/7819.pdf (stating that plans generally contain three critical components: (1) a comprehensive early warning system; (2) risk and impact assessment procedures; and (3) mitigation and response strategies that are specifically targeted at mitigating impacts when dry conditions are actually being experienced.).

n69 URBAN DROUGHT GUIDEBOOK 2008, supra note 6, at 40.

n70 CAL. WATER CODE ß ß 10600-10656.

n71 Largest wholesale and retail municipal suppliers are those with at least 3,000 connections or delivering at least 3,000 acre-feet of water per year. Id. ß 10617.

n72 Id. ß 10621(a). The Management plans must also be submitted for review to any city or county within which the supplier provides water. The act does not require DWR to review the plan's quality. Id. ß 10631(a)-(b).

n73 Id. ß ß 10631(b), 10632(a).

n74 Id. ß 10631.5.

n75 See S.B. 901, 1995 Sess. (Cal. 1995) (enacted). Senate Bill 901 requires local governments to conduct water supply assessments during the environmental reviews for projects above 500 units, including the quality of existing sources of water available to an urban water supplier and the effect of water quality on supply. It also requires a lead agency to identify the water system that would likely supply water to the project, assess whether the projected water demand associated with the proposed project was included as part of its most recently adopted urban water management plan, and whether its total projected water supplies available during normal, single-dry, and multiple-dry water years would meet the need of the projected water demand associated with the proposed project. In 2001, the Senate added a requirement for verification of water supply sufficiency. S.B. 610, 2001 Sess. (Cal. 2001) (enacted). The same year, a Senate Bill also added verification of long-term water supply as a precondition of final subdivision map approval for more than 500 dwelling units. Verification has to be by the water purveyor, city, or county. This requirement also applies to increases of 10 percent or more of service connections for public water systems with less than 500 service connections. The law defines criteria for determining "sufficient water supply," including using normal, single-dry, and multiple-dry year hydrology and identifying the amount of water that the supplier can reasonably rely on to meet existing and future planned uses. S.B. 221, 2001 Sess. (Cal. 2001) (enacted).

n76 See generally CAL. WATER CODE ß 10850.

n77 Id. ß 10631(b); but see Jim Holt, Tainted Water Still Counts for Land Developers, SANTA CLARITA SIGNAL, June 3, 2008, available at http://www.the-signal.com/news/archive/2178/ (Land developers can still use tainted water, despite an unsuccessful attempt by the California Assembly to set tougher conditions on the quality and quantity of groundwater being assessed for the water supply for a 500 unit housing development.).

n78 HANAK, supra note 18, at 2. With more than 500 members of the Southern California Water Utilities Association, this leaves a number of water suppliers not required to develop UWMPs. See S. CAL. WATER UTIL. ASS'N, WELCOME TO SCWUA, http://www.scwua.org/ (last visited Apr. 18, 2009).

n79 See 2 CAL. DEP'T OF WATER RES., CALIFORNIA WATER PLAN UPDATE 2005 1-2 (2005), available at http://www.waterplan.water.ca.gov/docs/cwpu2005/vol2/v2ch01.pdf

n80 HEATHER COOLEY, PETER GLEICK & GARY WOLFF, DESALINATION, WITH A GRAIN OF SALT: A CALIFORNIA PERSPECTIVE 10, 13 (2006), available at www.pacinst.org/reports/desalination/desalinationreport.pdf.

n81 See id. at 4-6, 39, 41-42, 45, 44-57, 59; see also CAL. RURAL WATER ASSOC., CALIFORNIA DROUGHT PREPAREDNESS, http://www.cadroughtprep.net/watshort.htm (last visited Mar. 16, 2009) (explaining that water from a $ 250 million desalination plant proposed for Long Beach would produce as much as 50 million gallons of fresh water daily and would sell for $ 800 per acre-foot, which is considerably more than other water sources).

n82 COOLEY, GLEICK, & WOLFF, supra note 80, at 57.

n83 See id.

n84 See HANAK, supra note 18, at 24; see also PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 40 (Substantial federal funding through Public Law 102-575 and Public Law 104-266, has resulted in plans to implement regional projects in densely urbanized coastal areas). Most experts agree, depending on the treatment process, recycled water, wastewater that has been treated and had contaminants removed, is safe for everything but drinking. A downside of recycled water for residential use is found in the cost of installation for extra pipes for pure and recycled water. CAL. RURAL WATER ASSOC., CALIFORNIA DROUGHT PREPAREDNESS, http://www.cadroughtprep.net/watshort.htm (last visited Mar. 16, 2009).

n85 Ronnie Lipschutz & Ruth Langridge, Securing Access to Water: Institutional Strategies for Coping with Drought, 2007-08 ANNUAL REPORT UNIV. OF CAL. CTR. FOR WATER RES., available at www.lib.berkeley.edu/WRCA/WRC/pdfs/LIPSCHUTZ08WRC.pdf.

n86 See CAL. DEP'T OF WATER RES., CALIFORNIA WATER PLAN UPDATED 2009, WORKING PLAN, URBAN WATER USE EFFICIENCY 1 (2008), available at http://www.waterplan.water.ca.gov/strategies/index.cfm (follow hyperlink for "Urban Water Use Efficiency").

n87 PETER H. GLEICK, ET AL., WASTE NOT, WANT NOT: THE POTENTIAL FOR URBAN WATER CONSERVATION IN CALIFORNIA 2 (2003), available at www.pacinst.org/reports/urbanusage/wastenotwantnotfullreport.pdf; see also HANAK, supra note 18, at 21.

n88 HANAK, supra note 18, at 98.

n89 See, e.g. CAL. WATER RES. CONTROL BOARD, DEVELOPMENT OF AN URBAN WATER CONSERVATION REGULATORY PROGRAM, PUBLIC WORKSHOP OCTOBER 1, 2008, SUMMARY OF COMMENTS 3 (2008) [hereinafter PUBLIC WORKSHOP COMMENTS], www.swrcb.ca.gov/waterissues/programs/waterconservation/docs/.../urbanconservationworkshopcommentssummary121908.pdf.

n90 GLEICK ET AL., supra note 87, at 122. However, the debate over increasing surface storage remains contentious. See, e.g., Lester Snow, With Water Precious, State Faces Heat, Fires-and Drought, CAPITOL WEEKLY, July 10, 2008, http://www.capitolweekly.net ("But here's the plain truth: conservation will not help much in the sixth or seventh year of a statewide drought. To mitigate dry periods, California needs more surface storage to capture excess water provided in wet years."); but see Mindy McIntyre, California's Water Management Must Adapt to Climate Change, CAPITOL WEEKLY, July 10, 2008 available at http://www.capitolweekly.net ("While many policy makers have accepted that we need to reduce our production of greenhouse gases in order to combat climate change, fewer are willing to acknowledge that our conventional wisdom on water management must also change. Much of the water conversation in the Legislature focuses on a water bond to support old water strategies. The proposed water bonds would allocate billions of dollars for new dams to capture water in 'wet' years. Yet, state and federal agencies have spent over $ 100 million studying those dams and, even based on past hydrology, the dams fail to provide benefits that are worthy of their price tags. No one has even considered how these dams would work under a drier future.").

n91 GLEICK, ET AL., supra note 87, at 2, 32-33.

n92 See PUBLIC WORKSHOP COMMENTS, supra note 89, at 3.

n93 See generally id.

n94 PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at ix.

n95 Jacob Adelman, Water Cuts Force Farmers to Scramble, THE ASSOCIATED PRESS, Nov. 10, 2007, available at http://www.pe.com/business/local/stories/PEBizDwatershortage11.738d56.html

n96 PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 50, 52-53. Vineyard acreage in Amador and San Luis Obispo Counties, for example, is up by 36 to 37 percent since the last drought. In the San Joaquin Valley, the problem is that agricultural water users rely extensively on less secure Delta exports and on already over-drafted groundwater basins. Yet the San Joaquin Valley is also the area experiencing the greatest increase in acreage of permanent plantings since the last drought-more than 230,000 acres.

n97 BULLETIN 118, supra note 15, at 2. Californians have always relied on groundwater to support agriculture and municipal development. Id. at 14. Today about 43 percent of all Californians rely on groundwater. Most groundwater results from rain and melted snow that has soaked into the ground, making it a self-replenishing source, and some has existed for millions of years. Id. at iii.

n98 Id. at 2; see also PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at x (explaining the total number of well construction/modification reports filed during the last drought was approximately 25,000 reports per year, up from less than 15,000 prior to the drought).

n99 HANAK, supra note 18, at 99.

n100 BULLETIN 118, supra note 15, at 2. Most of the overdraft is occurring in the Tulare Lake, San Joaquin River, and Central Coast hydrologic regions California Water Plan Update. BULLETIN 160-98, supra note 14, at 3-7. As early as 1980, DWR Bulletin 118-80 identified 11 over-drafted basins where the continuation of present water management practices "would probably result in significant adverse overdraft-related environmental, social, or economic impacts." BULLETIN 118, supra note 15, at 98. Estimates of groundwater overdraft in California today are 1.5 million acre feet annually; 1 million acre feet of this comes from the San Joaquin Valley. PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 7; see also Hanak, supra note 18, at 8. There is also concern that the basins that are not yet in over-draft may show evidence of overdraft in the future. David Sandino, Symposium on the Effective Management of Groundwater Resources: California's Groundwater Management Since the Governor's Commission Review: The Consolidation of Local Control, 36 MCGEORGE L. REV. 471, 474 (2005).

n101 See City of Pasadena v. City of Alhambra, 207 P.2d 17, 30 (Cal. 1949). The phrase undesirable result means a gradual lowering of the ground water levels resulting eventually in depletion of the supply. See id. When more water is removed than is recharged, the aquifer is described as being out of safe yield. Safe yield is an ambiguous concept however, and the term is both basin-specific and reliant on management objectives. It is generally described as a groundwater management goal to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial recharge in the active management area. METRO. WATER DIST. OF S. CAL., GROUNDWATER ASSESSMENT STUDY III-3 (2007), available at http://www.mwdh2o.com/mwdh2o/pages/yourwater/supply/groundwater/gwas.html#1. The term sustainable yield is also used and refers to a policy that selects a specified amount of groundwater use based on an appraisal of social and hydrologic conditions. Sustainable yield may be expressed as a percentage of recharge. VICTOR PONCE, SUSTAINABLE YIELD OF GROUNDWATER (2007), http://gwsustainability.sdsu.edu.

n102 I. Portoghese et al., Groundwater Safe Yield in Semi-Arid Regions, 5 GEOPHYSICAL RES. ABSTRACTS 12287 (2003), available at http://www.cosis.net/abstracts/EAE03/12287/EAE03-J-12287.pdf (stating that research has actually indicated that an inter-annual cycle of dry years followed by a wet year run in a Mediterranean climate of strong inter/intra-annual variability of rainfall together with a water demanding cropping policy does not even imply the full recovery of the quantitative status of a groundwater reservoir).

n103 PONCE, supra note 101.

n104 See PREPARING FOR CALIFORNIA'S NEXT DROUGHT, supra note 10, at 6 (2000). For example, "Paul Hendrix, manager of the Tulare Irrigation District, said the agency has entered into partnership with the county to build more ground-water recharge facilities. 'People are relying heavier on their wells,' he said. 'It used to be that we only used groundwater in the driest of years Now we are using ground water in modest or average years.'" Valerie Gibbons, Drought Hits Ranchers Hard, VISALIA TIMES-DELTA, June 27, 2008, at A1.

n105 Seth Nidever, Westside Farmers Say Drought Declaration Unlikely to Help Situation, HANFORD SENTINEL, June 13, 2008, available at http://www.hanfordsentinel.com/articles/2008/06/13/news/doc4852c3686a050002951533.prt.

n106 CAL. DEP'T WATER RES., INDIVIDUAL BASIN DESCRIPTIONS, http://www.groundwater.water.ca.gov/bulletin118/basindesc/index.cfm (last visited Apr. 18, 2009) ("There are currently 431 groundwater basins delineated, underlying about 40 percent of the surface area of the State. Of those, 24 basins are subdivided into a total of 108 subbasins, giving a total of 515 distinct groundwater systems.").

n107 Ella Foley-Gannon, Institutional Arrangements for Conjunctive Water Management in California and Analysis of Legal Reform Alternatives, 6 HASTINGS W. NW. J. ENVTL. L. & POL'Y 273, 276 (2000).

n108 Id. (explaining that these can accommodate approximately eight hundred fifty million acre feet of water); see also Tara L. Taguchi, Whose Space is it Anyway: Protecting the Public Interest in Allocating Storage Space in California's Groundwater Basins, 32 SW. U. L. REV. 117, 118 n.6 (2003) (One acre foot of water is the amount needed to cover an acre one foot deep and is equal to 325.851 gallons).

n109 Sax, supra note 38, at 302-303; BULLETIN 118, supra note 15, at 33. This lack of a statewide groundwater regulatory system is an anomaly among western state. Sandino, supra note 100, at 474.

n110 See Marks v. Whitney, 491 P.2d 374, 380 (Cal. 1971).

n111 CAL. WATER CODE ß 275 (West 2009).

n112 See BULLETIN 118, supra note 13, at 32 (explaining that the State sees its role as a provider of technical and financial assistance to local agencies for their groundwater management efforts, such as through the Local Groundwater Assistance Grant Program). Water districts and agencies manage groundwater supplies under four basic methods: (1) Under authority granted in the California Water Code or other applicable state statutes, (2) Under adopted groundwater management plans developed in accordance with water code provisions, (3) Under groundwater ordinances or joint powers agreements, and (4) Under court adjudications. Local ordinances and basin adjudications are generally a response system instituted after a specific groundwater problem is recognized. Some groundwater basins are not governed, managed or adjudicated. Kelley J. Hart, The Mohave Desert as Grounds for Change: Clarifying Property Rights in California's Groundwater to Make Extraction Sustainable Statewide, 14 HASTINGS W.-NW. J. ENVTL. L. & POL'Y, 1213, 1224-25 (2008).

n113 Sandino, supra note 100, at 471-72.

n114 See generally GREGORY A. THOMAS, DESIGNING SUCCESSFUL GROUNDWATER BANKING PROGRAMS IN THE CENTRAL VALLEY: LESSONS FROM EXPERIENCE (2001) (discussing the benefits of groundwater recharge).

n115 DEP'T OF WATER RES., STATE OF CAL., CALIFORNIA WATER PLAN UPDATE 2009 PUBLIC REVIEW DRAFT, 8-1, 8-2 (2009) [hereinafter CALIFORNIA WATER PLAN UPDATE 2009]; see also TOCCOY DUDLEY & ALLAN FULTON, CONJUNCTIVE WATER MANAGEMENT: WHAT IS IT? WHY CONSIDER IT? WHAT ARE THE CHALLENGES? 2 (2005).

n116 Id.

n117 See MARIOS SOPHOCLEOUS, UNIV. OF KAN., GROUNDWATER RECHARGE 17, 25 (2004) (discussing general effects on natural recharge and specific results of a daily water balance modeling analysis in south-central Kansas).

n118 See CALIFORNIA WATER PLAN UPDATE 2009, supra note 115, at 8-2 (discussing this recharge methodology).

n119 THOMAS, supra note 114, at 2.

n120 Id. at 2-3. The Kern Water Bank and Arvin Edison/MWD arrangements are an example of this approach which generally requires large areas dedicated to recharge and good soil permeability. KERN WATER BANK AUTHORITY, THE KERN WATER BANK 2 (2009), available at http://www.kwb.org/main.htm; The Metro. Water Dist. of Southern Calif., Expanded Central Valley Groundwater Banking Program Offers Southern California Additional Drought Insurance, May 8, 2007, http://www.mwdh2o.com/mwdh2o/pages/news/pressreleases/2007-05/arvinedison.htm.

n121 TOCCOY & FULTON, supra note 115, at 1. Parties use this method where soils have low permeability, such as the east side of the Sacramento Valley. See THOMAS, supra note 114, at 3.

n122 TOCCOY & FULTON, supra note 115, at 1.

n123 THOMAS, supra note 114, at 2

n124 For example, different aquifer types, hydro-geological and geochemical conditions, and depths. See generally THE NAT'L ACADEMIES, PROSPECTS FOR MANAGED UNDERGROUND STORAGE OF RECOVERABLE WATER (2007) (discussing the properties of general underground water storage techniques).

n125 CALIFORNIA WATER PLAN UPDATE 2009, supra note 115, at 8-1.

n126 Ella Foley-Gannon, Institutional Arrangements for Conjunctive Water Management in California and Analysis of Legal Reform Alternatives, 14 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 1105, 1111-12 (2008).

n127 See id. at 1118-1120; THOMAS, supra note 114, at 12, 34-35.

n128 City of Los Angeles v. City of Glendale, 142 P.2d 289, 294 (Cal. 1943).

n129 City of Los Angeles v. City of San Fernando, 537 P.2d 1250, 1292-96 (Cal. 1975).

n130 Niles Sand and Gravel Co. v. Alameda County Water Dist., 112 Cal. Rptr. 846, 855 (Cal. Ct. App. 1974).

n131 See CALIFORNIA WATER PLAN UPDATE 2009, supra note 115, at 8-1.

n132 Id.

n133 THOMAS, supra note 114, at 2-3.; see also CAL. WATER CODE ß 1011.5 (West 2009) (explaining that for a conjunctive use program to function properly, the rights of parties who depend on each source of water, and the right to store and withdraw the water must be clarified).

n134 THOMAS, supra note 114, at 79.

n135 Id.

n136 See generally ROBERT GOTTLIEB & MARGARET FITZSIMMONS, THIRST FOR GROWTH: WATER AGENCIES AS HIDDEN GOVERNMENT IN CALIFORNIA 194-201 (1991) (providing a detailed history of these arrangements).

n137 See generally THOMAS, supra note 114 (offering examples of large regional projects, such as those operated by the Semitropic Water Storage District, Arvin-Edison Water Storage District, Kern Water Bank Authority and Sacramento Water Storage District).

n138 Id. at 13.

n139 Telephone Interview with Paul Oshel, Dist. Eng'r, Semitropic Water Dist. (July 7, 2008).

n140 Paula K. Smith, Coercion and Groundwater Management: Three Case Studies and a Market Approach, 16 ENVTL. L. 797, 839 (1986).

n141 TOCCOY & FULTON, supra note 115, at 3.

n142 See generally CALIFORNIA WATER PLAN UPDATE 2009, supra note 115, at 8-8 to 8-13. Additionally, federal litigation over the role the Clean Water Act's National Pollutant Discharge Elimination System (NPDES) permitting process plays in water transfers causes further uncertainty for conjunctive management systems. See, e.g., S. Fla. Water Mgmt. Dist. (SFWMD) v. Miccosukee Tribe of Indians, 541 U.S. 95 (2004). In SFWMD, the Supreme Court held that the transfer of water from one body of water to another could require an NPDES permit if the waters differed in quality. Id. at 106-07; see also Catskill Mountains Chapter of Trout Unlimited, Inc. v. City of New York, 451 F.3d 77, 84-85 (2d. Cir. 2006) (affirming New York City's need to obtain an NPDES permit for the conveyance of water from its Catskill Aqueduct system into a local creek). The U.S. Environmental Protection Agency published a proposed rule in 2006 to exclude water transfers from its NPDES permitting system. See National Pollution Discharge Elimination System (NPDES) Water Transfers Proposed Rule, 71 Fed. Reg. 32887 (proposed June 7, 2006). The agency has taken no further action on this rule, and further litigation is likely.

n143 Foley-Gannon, supra note 126, at 1118.

n144 CAL. DEP'T OF WATER RES., PUBLIC REVIEW DRAFT OF THE CALIFORNIA WATER PLAN UPDATE 2009 8-12 to -13 (2009), available at http://www.waterplan.water.ca.gov/docs/cwpu2009/1208prd/vol2/ConjMgmt-GWStorPRD09r1.pdf; see Foley-Gannon, supra note 126, at 1119.

n145 Interview with Andrew Fisher, Professor, Univ. of Cal.-Santa Cruz, in Santa Cruz, (May, 29, 2008); Foley-Gannon, supra note 126, at 1113.

n146 Foley-Gannon, supra note 126, at 1114 ("the movement ... will depend on the relative water levels in each system. For example, when the water table of a groundwater basin intersects with a streambed, the groundwater will provide a base flow for the stream. In this circumstance, water added to the basin will not increase the amount of water contained within the basin, but will increase the flow of the connected stream. Similarly, extractions from a groundwater basin can result in the lowering of the water table and cause water from a connected surface water system to percolate into the basin").

n147 Id. at 1115 (discussing that porosity partly determines the available storage space, as well as the amount of energy required to extract water from a well).

n148 Id. This causes great variability in recharge to underlying aquifers, and recharge must be inferred from measurements and determinations of related geologic and hydrologic properties. See id. (discussing variables impacting water mobility).

n149 See Cal. Geological Survey - Geologic Maps Home Page, http://www.consrv.ca.gov/CGS/information/geologicmapping/Pages/index.aspx (last visited April 22, 2009) (illustrating the limits of California's geologic maps).

n150 ALEX N. HELPERIN ET AL., NATURAL RES. DEF. COUNCIL, CALIFORNIA'S CONTAMINATED GROUNDWATER vi-vii, ix (2001) (stating the most recent edition of the report produced by the State Water Resources Control Board, and updated every two years, the "305(b) Report," suggests that more than one third of groundwater in the state is highly contaminated. The causes of this contamination include septic systems, landfills, leaking underground storage tanks, and agricultural operations. The State Water Resources Control Board, the Department of Health Services, and the Department of Water Resources are the agencies responsible for addressing this pollution).

n151 Foley-Gannon, supra note 126, at 1116 (noting that a basin adjacent to a saltwater body is not necessarily unsuitable for a groundwater storage project: "if the groundwater levels are maintained at a sufficiently high level, contaminated water will not migrate into the basin. Moreover, even if the water table is significantly lowered during extraction, the flow of water from an adjacent system can be prevented by the use of injection wells to create a hydraulic barrier and block the movement of water into the basin").

n152 Sax, supra note 38, at 271.

n153 For example, the background study for the Governor's Commission to Review California Water Rights Law raised the issue of whether to require permits where critical groundwater problems existed or were threatened. See GOVERNOR'S COMM'N TO REVIEW CAL. WATER RIGHTS, STATE OF CAL., SUMMARY FINAL REPORT 7 (1978). Even in 1957, the State Water Plan stated: "...while it is not an immediate problem, it is evident that effective administration of the development and utilization of ground water resources, either by the State or by local agencies, or by both, will become mandatory as the stage of full water development is approached." DEP'T OF WATER RES., STATE OF CAL., THE CALIFORNIA WATER PLAN 221 (1957).

n154 See Sax, supra note 38, at 303 (illustrating the legislature's reluctance to regulate groundwater by pointing to the area-of-origin law where the legislature added ß 1221 to the water code that states "this article shall not be construed to authorize the board to regulate groundwater in any manner," and to the provision that grants the Board authority over general adjudications of stream systems but specifically excludes percolating groundwater).

n155 CAL. WATER CODE ß 100 (West 2009) (stating "because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interests of the people and for the public welfare").

n156 Peabody v. City of Vallejo, 40 P.2d 486, 498-99 (Cal. 1935) (holding that "the rule of reasonable use as enjoined by . . . the Constitution applies to all water rights enjoyed or asserted in this state, whether the same be grounded on the riparian right or the right, analogous to the riparian right, of the overlying land owner, or the percolating water right, or the appropriative right").

n157 Id. at 491.

n158 Joslin v. Marin Mun. Water Dist., 429 P.2d 889, 893 (Cal. 1967) (holding that "the constitutional amendment was generally construed as applying a rule of reasonable use 'to all water rights enjoyed or asserted in this state, whether the same be grounded on the riparian right or the right, analogous to the riparian right, of the overlying land owner, or the percolating water right, or the appropriative right." (quoting Peabody, 40 P.2d at 499)).

n159 Id. at 894.

n160 Envtl. Def. Fund v. E. Bay Mun. Util. Dist., 605 P.2d 1, 6 (Cal. 1980) (quoting Joslin, 429 P.2d at 894).

n161 See Tulare Irrigation Dist. v. Lindsay-Strathmore Irrigation Dist., 45 P.2d 972, 1007 (Cal. 1935) (stating "what may be a reasonable beneficial use, where water is present in excess of all needs, would not be a reasonable beneficial use in an area of great scarcity and great need"); Foley-Gannon, supra note 126, at 1126-27.

n162 Envtl. Def. Fund, 605 P.2d at 6.

n163 CAL. WATER CODE ß 12922 (West 2009) (stating "it is hereby declared that the people of the State have a primary interest in the correction and prevention of irreparable damage to, or impaired use of, the ground water basins of this State caused by critical conditions of overdraft, depletion, sea water intrusion or degraded water quality").

n164 CAL. WATER CODE ß 104 (emphasis added).

n165 Sax, supra note 38, at 308-09.

n166 Id. at 309; CAL. WATER CODE, ß 275 ("The department and board shall take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state").

n167 United States v. State Water Res. Control Bd. (Racanelli), 227 Cal. Rptr. 161, 195 (Cal. Ct. App. 1986).

n168 The court in Imperial Irrigation Dist. cited the Racanelli decision, which also pointed to section 275 of the Water Code as giving the Board "the separate and additional power to take whatever steps are necessary to prevent unreasonable use or methods of diversion ...." Imperial Irrigation Dist. v. State Water Res. Control Bd., 275 Cal. Rptr. 250, 265 (Cal. Ct. App. 1990). In an earlier case, the court concluded "section 275 is not to be construed as a limitation on the Board's adjudicatory authority, but rather as a statute granting separate, additional power to the Board." Imperial Irrigation Dist. v. State Water Res. Control Bd., 231 Cal.Rptr. 283, 289 (Cal. Ct. App. 1986).

n169 " The department and board shall take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state." CAL. WATER CODE ß 275 (West 2009).

n170 In the Racanelli decision, the court also cited section 275 of the Water Code as authority for the proposition that "the Board has the separate and additional power to take whatever steps are necessary to prevent unreasonable use or methods of diversion." Racanelli, 227 Cal. Rptr. at 195.

n171 Both special and general act districts, by virtue of their statutory powers, and especially adjudicated districts, have made progress in protecting and managing water resources around the state and courts have also supported groundwater management at the local-regional level. Foley-Gannon, supra note 126, at 1108.

n172 These number more than two thousand and "include irrigation districts, water conservation districts, water districts, county service areas, community services districts, and water storage districts." Sandino, supra note 100, at 482-83; BULLETIN 118, supra note 16, at 33-34.

n173 CAL. WATER CODE ß ß 60221, 60230. The legislature authorized the groundwater management districts to establish groundwater recharge programs that address overdraft and to collect fees for that service.

n174 Id. ß 74508. The groundwater management districts can levy groundwater extraction fees.

n175 Id.

n176 Id. ß ß 60221, 60230(j).

n177 The seven districts are Sierra Valley Groundwater Management District, Id. ß 119-102; Honey Lake Valley Groundwater Management District, Id. ß 129-102, Long Valley Groundwater Management District, Id. ß 119-102; Mono County Tri-Valley Groundwater Management District, Id. ß 128-201; Ojai Basin Groundwater Management Agency, Id. ß 131-102; Fox Canyon Groundwater Management Agency, Id. ß 121-102; and Willow Creek Valley Groundwater Management District, Id. ß 135-102.

n178 See id. ß 119-709 (providing districts with authority to regulate overdrafts).

n179 DEP'T OF WATER RES., GROUNDWATER MANAGEMENT IN CALIFORNIA: A REPORT TO THE LEGISLATURE PURSUANT TO SENATE BILL 1245 (1997), at 4, 6 (1999), available at http://www.dpla2.water.ca.gov/publications/ groundwater/gwmreport.pdf [hereinafter SENATE BILL 1245 REPORT]; Sandino, supra note 100, at 483-84.

n180 BULLETIN 118, supra note 16, at 35 (discussing that prior to AB 3030, the legislature passed AB 255 in 1991, authorizing some overdrafted basins to develop plans to manage for extraction, recharge, conveyance and quality control); see also CAL. WATER CODE ß 10750 (codifying AB 3030).

n181 CAL. WATER CODE ß 10754.3; Sandino, supra note 100, at 484-85.

n182 CAL. WATER CODE ß 10754.

n183 Id. ß 10910 (mandating any project subject to the California Environmental Quality Act (CEQA) and supplied with water from a public water system to provide a water supply assessment compiled by the water or by the city or county).

n184 Id. ß 10753.8 (identifying twelve technical components that may be included in the groundwater management plan); See also DEP'T OF WATER RES., AB 3030-GROUNDAWATER MANAGEMENT ACT, http://www.groundwater.water.ca.gov/waterlaws/ab3030gma/ (noting AB 3030 plans cannot be adopted in adjudicated basins or in basins where groundwater is managed under other sections of the Water Code without the permission of the court or the other agency).

n185 See DEP'T OF WATER RES., LAWS AND LEGISLATION, http://www.groundwater.water.ca.gov/waterlaws/index.cfm#sb1938 (noting that the requirements apply to agencies adopting groundwater management plans as well as agencies that do not overlie groundwater basins identified in Bulletin 118 and its updates, but the requirements do not apply to funds administered through the Local Groundwater Management Assistance Act or to funds authorized or appropriated prior to September 1, 2002).

n186 SENATE BILL 1245 REPORT, supra note 179, at IX, 1 ("The water code does not establish a mechanism requiring local agencies to report such information, so DWR relied on information obtained from three surveys conducted by the Association of California Water Agencies, a DWR questionnaire mailed to more than 1,000 local agencies, and local agency contact with DWR staff; 650 agencies responded to DWR's questionnaire." Because the plans are not monitored, some agencies that enacted them under AB 3030 are not implementing them). Some plans are simply summaries of an agency's existing programs, and no state clearinghouse to reviews the plans despite the DWR requirement to publish a report to the legislature listing all agencies that have adopted groundwater management plans. BULLETIN 118, supra note 16, at 44; SENATE BILL 1245 REPORT, supra note 179, at 1.

n187 CAL. WATER CODE ß ß 10753.7, 10755.2 (encouraging coordinated plans between public agencies and public or private entities that provide water service); BULLETIN 118, supra note 16, at 35 ("At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.").

n188 DEP'T OF WATER RES., PREPARING FOR CALIFORNIA'S NEXT DROUGHT: CHANGES SINCE 1987-1992, at X (July 2000), available at http://www.water.ca.gov/drought/docs/DroughtRptChp1.pdf.

n189 Sandino, supra note 100, at 479-80 (noting only three of the twenty-seven counties that have adopted groundwater ordinances maintain the goal of managing their groundwater basin to account for users needs inside and outside the county whereas the remaining counties have not attempted to restrict overdraft or establish management objectives for the basins).

n190 Baldwin v. County of Tehama, 36 Cal. Rptr. 2d 886, 891 (Cal. Ct. App. 1994).

n191 Id. at 890-91 (leaving a Tehama County ordinance in effect).

n192 " There are currently twenty-seven counties that have adopted groundwater ordinances within the state. Three counties, including Glenn County, aim to manage their groundwater basin to account for users sic needs both inside and outside the county. However, the remaining counties have not attempted to restrict overdraft or establish management objectives for the basins. Instead, their ordinances only serve to restrict the exportation of groundwater from the basin. In such counties, it is unlawful to export groundwater outside of the county or use groundwater in lieu of exported surface water without an extraction permit issued by the county Board of Supervisors ("Board") and without first complying with the California Environmental Quality Act. The Board typically has discretionary authority over the issuance of the permit and the permit may be issued only if the Board first determines that the export will not cause overdraft, will not affect safe yield, and will not injure water users within the county." Sandino, supra note 100, at 479-80 (internal citations omitted).

n193 Sax, supra note 38 at 271.

n194 Sandino, supra note 100, at 478 (internal citations omitted).

n195 See City of Pasadena v. City of Alhambra, 207 P.2d 17, 22-23 (Cal. 1949).

n196 Id. at 32-33 (holding all parties gained prescriptive rights against each other and the extraction of water from the basin should be limited by a proportionate reduction by the amount taken by each party throughout the statutory period).

n197 Techachapi-Cummings County Water Dist. v. Armstrong, 122 Cal. Rptr. 918, 924 (Cal. Ct. App. 1975).

n198 City of Los Angeles v. City of San Fernando, 537 P.2d 1250, 1314 (Cal. 1975).

n199 In City of Barstow v. Mojave Water Agency, 5 P.3d 853, 858, 861 (Cal. 2000), the court upheld equitable apportionment as a tool for adjudicating basin groundwater rights, but only if all parties stipulate to its use.

n200 Sandino, supra note 100, at 478 (stating the SWRCB may initiate and referee groundwater adjudications on behalf of the state to protect groundwater quality but does not use this authority).

n201 CAL. WATER CODE ß 10631(b)(1)-(2) (West 2009).

n202 Alameda County Water Dist. v. Niles Sand and Gravel Co., 112 Cal. 846, 854-55 (Cal. Ct. App. 1974) (upholding the trial court's decision in favor of the water district and finding Niles' practice of pumping and discharging water into the bay wasteful and unreasonable and that the California Constitution's demand that "'waste or unreasonable use or unreasonable method of use of water be prevented,'... expressed a legitimate exercise of the police power of the state"); see Baldwin, 36 Cal. Rptr. 2d at 890-91 (upholding a state ordinance implementing protection for subterranean waters).

n203 City of Barstow, 5 P.3d at 868-69 n. 13.

n204 Sandino, supra note 100, at 487.

n205 Id. ("Assembly Bill 303, the Local Groundwater Management Assistance Act of 2000, provided $ 21 million in grants to local entities for groundwater studies or management activities. In 2000, the voters approved Proposition 13, the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act, which authorized $ 230 million for groundwater storage facilities and conjunctive management programs ... the voters approved yet another bond measure, Proposition 50, in 2002, the Water Security, Clean Drinking Water, Coastal Beach Protection Act, for which $ 500 million is to be used for water management programs, including groundwater management and groundwater recharge projects") n206 Div. of Local Assistance and Planning, Dep't of Water Res., Conjunctive Management Program Update 11 (2004), available at http://www.groundwater.water.ca.gov/cwm/docs/CWMAnnualReport2004.pdf.

n207 Paul H. Betancourt, Op-Ed., Betancourt: Planning, More Storage Would Have Prevented This Year's Water Shortages, SACRAMENTO BEE, June 15, 2008, at 4E.

n208 Richard Seager, Making a Bad Situation Worse: Human-Induced Climate Change and Intensifying Aridity in Southwestern North America in CALIFORNIA DROUGHT AN UPDATE 79 (Jeanine Jones ed., 2008), available at http://www.water.ca.gov/drought/docs/DroughtReport2008.pdf.

n209 DWR recently concluded that overdraft is continuing at a rate of one million to two million acre-feet annually. Moreover, some basins in the state are showing a growing decline of groundwater levels and the DWR is concerned that other basins are at risk of over-draft in the future. Sandino, supra note 100, at 474.

n210 Gray, supra note 8, at 1459-60 (arguing for "a supervening legal power to put pressure on counties, regional water agencies, and overlying land owners to use their groundwater resources - as well as available aquifer storage - for both their private advantage and the broader public welfare" in a manner consistent with the reasonable use doctrine) (emphasis added).

n211 Land use activities that impact groundwater include urban development, paving, building on former agricultural land, and lining of flood control channels. Other land use changes have reduced the capacity of recharge areas to replenish groundwater, which effectively reduces the safe yield of some basins. To ensure that recharge areas continue to replenish high quality groundwater, water managers and land use planners need to work together to identify recharge areas so the public and local zoning agencies are aware of the areas requiring protection from paving and contamination. These professionals should also "consider the functions of recharge areas in land use and development decisions." BULLETIN 118, supra note 16, at 51.

n212 Groundwater levels can provide critical information about the hydrologic relationships of recharge and discharge to storage within an aquifer, and the direction of groundwater flow. Long-term, systematic measurements of water-level data are essential to develop groundwater models and to design, implement, and monitor the effectiveness of groundwater management programs including a strategic reserve. The Groundwater Monitoring and Assessment Program of the SWRCB, a recently enacted program to assess water quality in wells throughout the state, and the Groundwater Quality Monitoring Act of 2001 (AB 599 Cal. Water Code ß ß 10780 et seq., are a step in that direction. See STATE WATER RES. CONTROL BD., GROUND-WATER AMBIENT MONITORING AND ASSESSMENT PROGRAM 1-2 (2004), available at http://www.swrcb.ca.gov/gama/docs/usgsgamafactsheetfs2004-3088.pdf; CAL. WATER CODE ß ß 10780-10782.3.

n213 For example, any conjunctive management project would be required to recharge more water than it recovers to build up the water table sufficient to maintain a groundwater reserve. The state legislature could set basic standards, but implementation would be locally based and relate to specific local conditions. See, e.g, Assemb. B. 2153, 2007-08 Reg. Sess. (Cal. 2008) (requiring DWR to establish a numeric water conservation target for the state).

n214 PAUL MOLYNEAUX, SWIMMING IN CIRCLES: AQUACULTURE AND THE END OF WILD OCEANS x (Thunder's Mouth Press 2007).

n215 Editorial, Slowly, Slowly Water Legislation Advances, SACRAMENTO BEE, June 3, 2008, at 6B.