Aquifer Recharge

AQUIFER RECHARGE AND STORAGE

ONGOING IMPLEMENTATION CONCERNS

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INTRODUCTION

Diminishing groundwater supplies is a problem of the first importance for resource managers in many locations around the globe. Already, the problem is recognized as a priority in the arid western United States where groundwater is relied upon heavily. However, the scope and importance of the problem is not appreciated fully by the public, presumably because it has not yet matured into a general and immediate crisis and, perhaps, because groundwater is not visible—out of sight, out of mind.

Technical Challenges

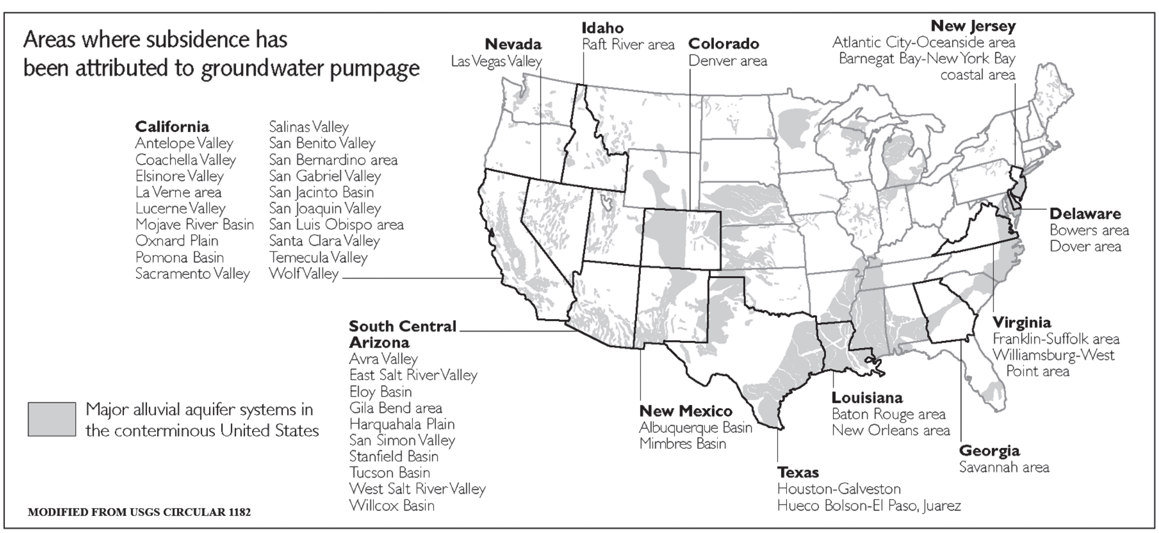
The idea of recharging aquifers has been around for many years. However, as those directly involved in the development of groundwater recharge and storage projects have learned, they often present difficult technical and regulatory challenges. Common technical challenges may include adequate reliable storage capacity, suitable locations for infiltration or injection, clogging, water quality issues such as oxidation, and difficulty monitoring and accounting for the storage and recovery of recharged water. See e.g., Brown, Hatfield and Newman, *Lessons Learned from a Review of 50 ASR Project from the United States, England, Australia, India and Africa*, US Army Corps of Engineers (2005). While technical issues can be significant, and sometimes controlling, experience has demonstrated that under the right circumstances recharge, storage and recovery is technically feasible at a range of scales. The subject of this article is some of the key regulatory impediments to recharge, such as the availability of source water and the authority to hold and control recharged water. This article also addresses the need to reform certain policies that have contributed to aquifer depletion, because without such reform, efforts to augment groundwater supplies will lead to the same result.

Regulatory Impediments

BACKGROUND

Aquifer Depletion

Data collected by the United States Geological Survey (USGS), shows that groundwater withdrawals increased significantly during the 30 years following World War II before leveling off at about 80 billion gallons per day, or a little over 20 percent of all fresh water withdrawn for use nationwide (see USGS website: http://ga.water.usgs.gov/edu/wugw.html). A very high percentage of municipal uses are served by groundwater sources. Aquifer depletion — or "water mining"— occurs when water is withdrawn from the ground faster than it is recharged. The consequences can be serious and may include: declining water tables; higher pumping costs; lower yields; degraded water quality; reduced surface water flow; and ground subsidence. The solution is straight-forward but difficult to achieve, requiring a lower rate of withdrawal, a higher rate of recharge or some combination of the two. Nevertheless, a solution is needed because, as Figure 1 demonstrates, many of the important aquifers in the West and nationwide are being "mined" with observable adverse impact.



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WGA Report

At the 2008 summer meeting of the Western Governors Association (WGA) the topic of water management occupied an entire morning on the agenda. In advance of the meeting, WGA released its draft annual report called *Water Needs and Strategies for a Sustainable Future: Next Steps* (see WGA website: www.westgov.org and Brief, this TWR). The Next Steps report attempts to present a reasonably balanced approach to water management, calling for steps that could lower demand for groundwater through improved efficiencies, conservation, and the use of reclaimed water, desalinization and weather modification. The WGA also called upon Congress, the federal administration and states to support research and the development of projects to augment groundwater supplies on a regional scale using recharge, storage and recovery.

Sustainable Future

At present there are about 80 aquifer storage projects operating across the US, performing a variety of functions such as: enhancement of fresh water supplies, aquifer restoration and oil recovery. Pyne, R.D.G., *Aquifer Storage Recovery: A Guide to Groundwater Recharge Through Wells*, 2nd ed. (2005). Something over half of the identified recharge projects exist in coastal areas where saltwater intrusion is a major concern. In the 1990s, interest in developing recharge and storage projects was high, but it now seems fair to observe that the scope and number of groundwater recharge and storage projects actually completed have lagged somewhat. In part, that is due to a failure by the public and decision makers to recognize the scope of the problem — that may change as adverse impacts from aquifer depletion become more prevalent. Certainly, there seem to be a number of aquifer systems in the West with significant available storage capacity created by long-term drawdown. For many of those aquifers current pumping rates cannot be sustained and the resulting depletion must eventually force some water users to find other sources of water or discontinue their use of water. In recognition of the potential social, environmental and economic implications, the WGA proposes taking steps, with federal assistance, to augment aquifers of regional and national importance with water from other sources as one of its *Strategies for a Sustainable Future*.

TERMINOLOGY CONCERNS

Regional Projects

As the source water discussion below suggests, few if any recharge projects can be undertaken on a regional scale without inter-state and federal cooperation. With that in mind, Chris Rayburn, Director of Research at Awwa Research Foundation, during the 2008 Winter Meetings of the Committee on Water for the National Association of Regulatory Utility Commissions, correctly noted that terminology is one of the first hurdles to overcome. The WGA could go a long way in support of its proposal by convening a task force to draft a common statement of principals and uniform language for use by member states seeking to participate in regional recharge efforts. Most, if not all, states have adopted some groundwater recharge authority but, perhaps not surprisingly, many use different terms to describe similar concepts or the same term to describe dissimilar concepts. The same is true in academic literature. Establishing common terminology is a deceptively important step because, like the preparation of a mission statement, the process will require public debate and agreement on the purpose or purposes of the enterprise. The debate over recharge must center on whether to divert and use enormous volumes of source water to recharge aquifers depleted by over-drafting and consideration of how stored water will be allocated and for what purposes. These are fundamental questions that should be resolved before any recharge project is undertaken. This is especially true for projects on a regional scale where more than one state and very likely one or more Indian tribes will be impacted.

Uniformity Issues

SOURCE WATER SUPPLY

Without source water there can be no augmentation of groundwater by recharge. Yet, those who advance recharge as a water management strategy are often vague or even glib about the availability of suitable source water. The National Academies describes the first step to managed recharge as capturing water from sources such as surface, ground, storm runoff and treated water. See e.g., National Research Council, *Prospects for Managed Underground Storage of Recoverable Water* at 25-27 (2008). However, the volume of water necessary to accomplish recharge at a scale sufficient to maintain current pumping levels is staggering.

Necessary Volume

According to the High Plains Underground Water District No. 1, the Ogallala Aquifer system, stretching from South Dakota to Texas, held an estimated 3.3 billion acre-feet (AF) of water in 1990. Recent estimates now peg the stored volume at less than 3.0 billion AF, a decline of more than 300 million AF in something over ten years (HPUD's website: http://www.hpwd.com/the_ogallala.asp). This volume represents slightly more than 10 times the capacity of Lake Mead, the nation's largest surface reservoir with a capacity of more than 28 million AF (www.ussdams.org/uscold_s.html). The reservoir took over six

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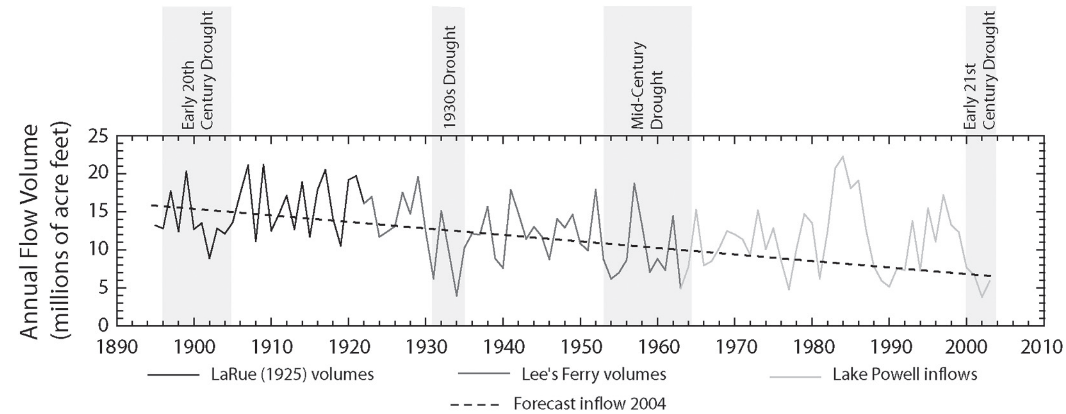
years to fill in the 1930s when downstream demands were relatively low (http://3dparks.wr.usgs.gov/2005/lakemead/html/lame1022.htm). Thus, in the roughest of terms, the volume of water needed annually to maintain the current rate of pumping from the Ogallala Aquifer is roughly equivalent to the capacity of Lake Mead, or about four times the present mean annual flow of the Colorado River measured at Lee's Ferry. A crucial point is that no new water rights would be created from such an effort.



Time-series plot of the annual flow volume (in millions of acre-feet) for the Colorado River at Lee's Ferry. Dashed line is the linear trend for the period. Vertical bars and shading delineate drought periods as defined using the Palmer Drought Severity Index for the climate divisions encompassing the upper Colorado River basin.

Surface Water Limits

In the plains states and intermountain west, where desalinization is not a practical option, groundwater augmentation means diverting surface water. It is widely asserted and believed that essentially all of the surface water available for use in the western United States is spoken for in the form of legal property rights issued by the states — most of them for irrigation. The United States Geological Survey (USGS) states that 68% of groundwater withdrawals in 2000 were for irrigation and 19% was for public supply (see USGS website: http://ga.water.usgs.gov/edu/wugw.html). Whether true or not, the perception exists and is closest to accurate during the low-flow period of late summer when the demand for irrigation water is highest. Consequently, most authors point to uncaptured spring runoff as the best source of water for recharge.

Spring Runoff

The concept is elegant: capture and store water when it is plentiful for later recovery and use in a process sometimes referred to as "flattening the hydrograph." As with any use of water in the west, diverting spring runoff to recharge aquifers will require the responsible entity to apply for and obtain a water right. However, to a significant extent, spring runoff is spoken for in the form of instream storage rights and is relied on by surface right holders to refill drawn down reservoirs for use by irrigators, municipalities and power companies. In some states, instream water rights themselves take up more of the sping runoff. In the well publicized case of Lake Powell, runoff has been unable to keep up with reservoir drawdown and the water level is going down drastically. Declining levels in Lake Powell are analogous to the less visible but far larger problem of declining aquifer storage.

Practical Limitations

Even where runoff may be available, there are practical limitations such as the ability to get enough water underground during the period of annual runoff. Moreover, flattening the hydrograph has proven to be controversial. Many argue that natural ecosystems require annual flushing flows in order to function normally. In March of 1996, former Secretary of the Interior, Bruce Babbitt, famously presided over a high-volume release of water from Glen Canyon Dam to simulate the scouring and redeposition of sediments by spring flows. It is reasonable to suppose that proposals for large-scale diversion of spring runoff will meet with resistance from fishery advocates and environmental groups.

REGULATORY ISSUES

Ownership Issues

The preceding is not to say that opportunities for groundwater recharge should not be researched and developed as an important component of water management. However, it is clear that groundwater recharge alone is not going to solve the problem of over-drafting aquifers. Assuming source water can be secured and the technical issues addressed, the next significant regulatory impediment to recharge is ownership of the stored water. This issue represents a spectral choice for legislators. At one end of the spectrum, recharged water reverts to public ownership, in which case it is available for appropriation and use in accordance with the established system of priority. Many early recharge statutes follow this

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Withdrawal Control

approach. See Western States Water Council (WSWC), *Groundwater Recharge Projects in the Western United States* at IV-36 and 37 (1990). A major advantage of the public ownership approach is simplicity — just put it in the ground and continue to regulate use as before. A key disadvantage may be the perception that such an approach is little more than a subsidy for those holding water rights and of little benefit to the public as a whole. This perception may control the debate unless steps are taken to ensure that the issuance of new water rights is not allowed to perpetuate over-drafting of the receiving aquifer.

At the other end of the spectrum, water is stored under a primary water right held by the recharging entity that has some degree of control over its distribution and use, which typically requires the issuance of secondary rights. In contrast to public reversion, the retained ownership approach ensures that the recharging entity will realize a direct benefit and some ability to limit over-drafting of augmented aquifers. On the other hand, the cost and difficulty of monitoring and administering such a project is much greater. In between the endpoints is a nearly infinite variety of possible blended approaches in which the recharging entity controls stored water to a limited extent. This generally means the recharging entity controls and uses some percentage of the amount recharged with the remainder going back to the public. In some instances the recharging entity would retain control over a percentage of any unused amount that may carry-over for use during the next year or years. (See e.g., Oregon Revised Statutes, ORS §§ 537.531-.534). The blended approach still requires careful monitoring to allow for accurate accounting and equitable administration of the project.

JURISDICTION OVER RIGHTS

Interstate Aquifers

It can be argued, and is asserted here, that before recharge can be an effective water management strategy at the regional scale (or at any scale), lawmakers must take steps to reform policies that led to aquifer depletion in the first place. For example, even though the occurrence and movement of groundwater does not observe state boundaries, its use is regulated by states individually. The multi-jurisdictional approach to allocation all but assures over-allocation of large interstate aquifers because each state is free to issue water rights without any requirement to consider the possible impact on existing water rights in neighboring states. The only recourse available to states unable to resolve disputes over shared groundwater resources is equitable apportionment under the original jurisdiction of the United States Supreme Court. *Hood v. City of Memphis, Tenn.*, 533 F. Supp.2d 646 (N.D. Miss. 2008).

Reform Needed

The Ogallala Aquifer system provides a clear example of the need to reform multi-jurisdictional management before it would make sense to undertake large-scale recharge. A recent article details plans by T. Boone Pickens to profit from the withdrawal and sale of large volumes of water from a relatively untapped part of the Ogallala Aquifer that underlies his ranch in Texas, where the "Rule of Capture" for groundwater means that the biggest pump wins. S. Berfield, *There Will Be Water*, Business Week (June 12, 2008). Importantly, the "race to the bottom" mentality is not limited to Texas, but the example does serve to illustrate a need for reform. Simply stated, large scale recharge is unlikely to occur when others can drill a well and capture any amount of water for personal gain with limited recourse for injured parties. For intrastate recharge projects, this suggests a need to employ the retained ownership approach summarized above. For interstate projects it suggests a need to exercise compacting authority in order to allocate storage and provide recourse to resolve disputes. [Editor's Note: As set out in TWR #52, the counsel for Mesa Water LP and the Pickens Group pointed out that the proposed project in Texas includes production limits to help protect the aquifer from overdrafting.]

Regional Recharge

Perhaps the best example of a regional recharge and storage project involving interstate allocation is operated by the Arizona Water Banking Authority (AWBA). The project uses Central Arizona Project infrastructure to deliver Colorado River water for direct recharge and storage in aquifer space made available by long-term drawdown. To understate the matter, the AWBA project is legally and administratively complex, involving federal and interstate agreements, Indian rights, and recourse for other states that depend on the Colorado River. Briefly, the AWBA allows Arizona to optimize delivery of its river allocation and to accrue credit that can be redeemed in the future when Arizona's communities or neighboring states need this backup water supply. According to the AWBA webpage, the project is comprised of eight Underground Storage Facilities and sixteen Groundwater Savings Facilities. The WSWC reviewed data provided by the AWBA and reports a total average annual recharge of 272,000 acre-feet. WSWC, *Water Laws and Policies for a Sustainable Future: A Western States' Perspective* at 123 (June 2008). Project costs through 2007 have exceeded $216 million. AWBA, *Annual Report* 2007 at 2. These are sobering numbers when applied to the overall problem of aquifer depletion. Obviously, the stakes are immense and the costs are high. (see Davenport, TWR #17 for additional information regarding *Interstate Water Banking* and AWBA's website: www.azwaterbank.gov/awba/).

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CONJUNCTIVE USE

Allocation Conflicts

Another historic disconnect between the occurrence of water and its regulation is the early failure by states to recognize and address the essential physical connection between groundwater and surface water when allocating water rights. In some systems the connection is direct and observable, such as water tables that go up and down in response to elevation changes of a nearby surface reservoir. In other systems the relationship is not so easily seen and may take decades to occur, but in all cases groundwater comes from surface sources. Now many states have been forced to implement conjunctive management strategies to mitigate impacts and resolve conflicts between groundwater and surface water users, who hold separate rights to use what is essentially the same water. A good example of this is the allocation of surface water rights to springs in the East Snake River Plain (ESRP) of Idaho that were enhanced, and in some cases created, by groundwater recharge accumulated over years of irrigation from surface water sources. However, as irrigators shifted from surface sources to groundwater and grew more efficient in their delivery of water, some of the springs began to dry up and conflict ensued. For more on conjunctive management in Idaho see J. Fereday, *Idaho Conjunctive Use*, TWR # 40 (June 15, 2007).

Washington Project

While early irrigation of the ESRP was not intended to be a recharge project, the resulting conflict serves as a valuable lesson to ensure that the relationship between surface and groundwater resources is understood and addressed before making major new commitments. Presently, in Washington State a large recharge project is under consideration to restore surface flows and rehydrate part of the Odessa Aquifer. The basalt aquifers in the Odessa area have been dropping several feet per year due to over-drafting. In response to the recent enactment of the Columbia River Water Basin Supply Act (ESSHB 2860), Lincoln County, together with the Watershed Resource Management Group for Water Resource Inventory Area (WRIA) No. 43 (a volunteer watershed planning group set-up under Washington State Watershed Planning Act – RCW 90.82), and the Lincoln County Conservation District are working with the Washington State Department of Ecology to fund a Passive Rehydration Feasibility Study in Lincoln County. The proposed study will evaluate the feasibility of diverting Columbia River water during the winter months, and conveying it to the headwaters of the Lake Creek drainage in Lincoln County, Washington. The proposal calls for filling several lakes in the drainage that went dry in the mid-1980's as a presumed consequence of intensified pumping from the Odessa Aquifer. Just as Idaho has been forced to deal with conjunctive management issues on the ESRP, Washington was forced to do so in connection with the issuance of groundwater rights in the Odessa area. See e.g., *Rettkowski v. Ecology* (the Sinking Creek decision), 122 Wash.2d 219, 858 P.2d 232 (1993). It is expected that water diverted to the lakes will infiltrate and recharge the underlying Columbia River basalt aquifers. The proposal calls for two-thirds of the annual diversion (approximately 300,000 AF) to be recharged and one-third to enhance stream flows, habitat, and recreational value of the lakes by keeping surface water present year round (from personal communication with Gene St. Godard, Project Manager for the WRIA 43 Watershed Group and Principal Hydrogeologist for the Water and Natural Resource Group).

Odessa Aquifer

Split Proposal

AQUIFER PROTECTION

Instream Flow Analogy

For projects like the one proposed for the Odessa Aquifer to work over the long term, it must be possible to preclude further appropriation of any excess water using a retained ownership model of recharge that includes surface water bodies used to deliver and store water diverted for the purpose. The State of Washington has various tools that should allow it to avoid the appropriation of recharged water that is intended to alleviate harm caused by earlier appropriations, including the State's water banking and trust authority (RCW 90.42) or the establishment of instream flows (RCW 90.82.080). It is interesting to consider the evolving concept of instream flows, and the need for an analogous concept in the management of groundwater. Until quite recently, instream flow was not considered by many to be a beneficial use for which water rights could be obtained. While the amount of water needed for instream flow rights is hotly disputed, most now seem to agree that reserving some flow for instream use is beneficial. This has resulted in a baseline that is related to the systems ability to function within acceptable parameters. Yet, there has been no such recognition and there is no direct corollary in the area of groundwater management. Undeniably, the driving factor for development and acceptance of instream flows has been the legal requirement to protect certain fish species. As noted above, groundwater is out of sight and out of mind — it is easy to ignore. Lacking a driver such as fish, it will be that much more difficult to implement a similar baseline approach to the management of groundwater. It is submitted, however, that without taking steps to preclude appropriation of water stored by recharge, such projects will do nothing to alleviate over-drafting and will likely deepen the long term challenge of water management in the western United States.

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Interstate Cooperation

Adjudications

WATER QUALITY DISCONNECT

Finally, the development of large-scale recharge projects is also impeded by the historic disconnect between the regulation of water rights and water quality. By and large, every state adopts and maintains separate water quality standards for the two types of water. Federal law may also apply in the form of protections imposed under the Underground Injection Control (UIC) Program of the Safe Drinking Water Act. See 42 U.S.C. 300h. In most cases, states have federally-delegated authority to administer their own UIC programs. Quite apart from the challenge of meeting water quality standards when developing intrastate recharge projects, dissimilar state standards may have a significant bearing on the ability of one state to recharge water that may end up, by design or otherwise, in a neighboring state.

Discussion of the Spokane Valley/Rathdrum Prairie (SVRP) Aquifer provides an opportunity to tie together a number of the issues presented. The SVRP Aquifer is an unusually productive “sole-source” aquifer that supplies water to most of the half-million or so people living in the borderline area of Eastern Washington and North Idaho. Generally, the aquifer recharges in Idaho and discharges in Washington, where it is tributary to the Spokane and Little Spokane Rivers. A recent USGS study completed with remarkable cooperation by and between both states, concluded that the ability of the SVRP Aquifer to deliver water has not been exceeded, but cautioned that withdrawals may be contributing to reduced flows observed in the Spokane River, which also has a number of water quality issues (USGS website: http://wa.water.usgs.gov/projects/svrp/publications.htm). The two states are now embarking on general adjudications for the purpose of establishing the validity of their respective water rights in the shared basin. While many have characterized adjudication as a necessary step toward joint management of this critical resource, others note simmering tensions between the two states in competition for use of the resource. In the meantime, there has been significant pressure for Washington to address water quality issues in the Spokane River. Because of the relationship between the SVRP Aquifer and river conditions, increasing pressure is being put on Idaho to consider the impact that new groundwater appropriations may have on the river downstream in Washington. One suggestion calls for recharge of the aquifer to enhance, or at least sustain, tributary flows to the Spokane River. *Meeting Summary of Planning Units for WRIA 55 and 57* (July 21, 2004). With or without recharge, it is apparent that cooperative management of the SVRP Aquifer will require the two states to consider the intrinsic relationship between groundwater and surface water, and it is likely that water quality issues will drive some of that effort.

CONCLUSION

A recent proposal by the WGA to enlist federal assistance to research and develop regional groundwater recharge and storage projects signals a growing recognition of the threat posed by the over-drafting of aquifers in the western United States. Such projects face a number of practical and historical impediments. It seems doubtful that adequate water sources exist to allow current pumping rates to continue. It is therefore apparent that recharge alone is not a solution to water supply problems facing the rapidly urbanizing west. This does not mean that regional aquifer recharge should not be pursued. However, the development of such projects will require states to reform historic policies that have contributed to widespread over-drafting. Specifically, states must ensure that recharge water is not simply made available for general appropriation. Also, when allocating recharge water states must consider the connection between surface and groundwater supplies and the relationship between water quantity and water quality. States seeking to develop regional recharge projects should first work together to establish the standard terms and concepts they will need to effectively use their legislative and compacting authority in the development of large-scale groundwater recharge and storage projects.

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