Conjunctive Management of Surface and Ground Water Resources In the Western United States

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Note: The opinions presented in this report belong to the authors only and are not necessarily those of the Clark Fork River Basin Task Force or the Montana Department of Natural Resources and Conservation.

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Executive Summary

Organization of the Report

This report is divided into two main sections: an Executive Summary that provides an overview of the three main approaches for the conjunctive management of surface and ground waters in nine western states, as well as a brief analysis of the utility and or/efficacy of each; and a State Reports section that provides more detailed information concerning the practices of each state. Following the State Reports section, a list of references is provided (organized in order of the states as presented in the previous section) as well as a list of agency contacts.

The 2009 Montana Conjunctive Water Management Conference

On June 8-9, 2009, the Clark Fork River Basin Task Force, the University of Montana's Department of Geography, and the Montana Department of Natural Resources and Conservation cosponsored the "Montana Conjunctive Water Management Conference" at the University of Montana. The conference was organized and convened in response to recent changes (i.e., HB 831) to Montana water law that mandate a scientifically oriented approach to the conjunctive management of surface and ground waters[1] in particular river basins. While being seen as progressive in nature, these changes have produced considerable uncertainty in the water right permitting process. In order to fully explore the context for conjunctive water management in Montana, and in order to compare the new law with approaches that are utilized in other states, the conference was organized into three main sessions. These included one that focused on the experiences of Montana water users as well as the regulatory framework and the state's new Groundwater Investigation Program administered by the Montana Bureau of Mines and Geology, one that focused on conjunctive management in New Mexico, Idaho, and Washington, and one

[1] The terms "ground water" and "groundwater" are used interchangeably in this report in order to accurately represent their use by the sources that were consulted, and to facilitate its readability.

that allowed four different break-out groups to address particular topics relevant to the implementation of conjunctive management in Montana. The presentations and discussions are documented and summarized in the *Proceedings of the Montana Conjunctive Water Management Conference* which is available from the internet at http://www.dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/conjunctive_mgmt_proceedings.pdf , and from the University of Montana's Department of Geography.

Why This Analysis?

The conjunctive management conference represented an initial foray into analyzing the effectiveness and ease of implementation of Montana's conjunctive management approach. Following its conclusion, and upon review of the proceedings, the members of the Clark Fork River Basin Task Force and its liaison with the Montana Department of Natural Resources and Conservation's Water Management Division felt that a more thorough review of approaches taken throughout the western United States would assist Montana policy-makers in any future attempts to fine-tune the Montana approach. Accordingly, this analysis was undertaken by a graduate student and faculty member of the Department of Geography at the University of Montana. The outcomes of the 2009 conference were used as a starting point, and from there we took a detailed look into the approaches used in eight other western states.

Analytical Approach

Nine states were selected for this analysis: Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Each of these states relies on the prior appropriation doctrine for water rights administration; prior appropriation (i.e., first in time, first in right) means that the first person to appropriate water has the most senior rights, and all rights

initiated afterwards are junior rights. When the supply of water is limited, appropriators are cut-off starting with the most junior right holder (Thompson 1999).

Sources of information utilized in the analysis include: statutes corresponding to the selected states, secondary sources in the academic literature, documents and information provided by water management agencies of the states, and related information. Following the review of state policies, and their summarization for the purposes of this report, the authors considered their salient characteristics and undertook to classify them into three different classes or categories for ease of understanding. These are described and discussed in the next section of this Executive Summary.

Arizona and California are the only two western states not involved in this analysis due to the doctrines they follow. Arizona does not conjunctively manage ground and surface waters (Bryner and Purcell 2003). Arizona water law is administered based on a bifurcated system in which surface water is regulated separately from groundwater (Bureau of Land Management 2001). Arizona groundwater is governed by the American rule which allows landowners to capture and use groundwater from below the surface, but not to transport the groundwater away from the land it was withdrawn from (Pearce 2003). California water law does not coordinate surface water and ground water use. California is different from other western states because it not only uses the prior appropriation doctrine but also the riparian doctrine (Bryner and Purcell 2003). The riparian doctrine holds that if you own property adjacent a stream or lake, you have a right to use that water (Thompson 1999). These two states' approaches are so different from the other nine western states that they were purposefully excluded from this analysis.

Conjunctive Water Management Approaches in the Western United States

Introduction

From our research it is apparent that each state's conjunctive water management policies are quite different from the others. Even though all of these western states use the prior appropriation doctrine for surface water right administration, each follows a different approach in the management of groundwater and its integration with overlying surface water. However, as a result of this analysis, we have grouped the states' approaches into four main categories based on the rationales underlying each approach. Montana, Idaho, and Washington all share a strong reliance on the *scientifically demonstrated connectivity* of surface and ground water; New Mexico uses a *judicially affirmed* approach; Colorado, Oregon, Utah, and Wyoming all follow the *classification of hydrologically connected waters* approach, and Nevada has a unique approach different from all other states being analyzed. Each approach is summarized in the following section, and described more fully in the context of each state in the State Reports section of this report following the Executive Summary.

Scientifically Demonstrated Connectivity

The scientifically demonstrated connectivity of surface and ground water requires that linkages be either calculable using sophisticated groundwater modeling procedures, be measurable (i.e., in the field), or both. Groundwater modeling today relies on three dimensional digital representations of groundwater basins and overlying surface waters in which three dimensional inflows and outflows for discrete cells are parameterized based on aquifer characteristics, relative saturation, pressure gradients, etc.[2] It can be easily characterized as an exacting method that requires large and detailed inputs of data, many of which must come from

[2] For an overview of the nature and use of ground water models, see the proceedings of the Clark Fork River Basin' Task Force's Groundwater Technical Conference, Managing Groundwater in the Clark Fork Basin, available at http://www.dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/groundwater_tech_summary-12-5-06.pdf .

the field. Accordingly, this method is intensive with respect to expertise, time, and money, and produces results that are only as refined as the scale at which the models are run.

Our analysis of the statutes and literature show that three of the western states considered (Montana, Idaho, and Washington) generally appear to rely on calculable connectivity, and none on measurable connectivity.[3] Montana has a strong reliance on scientifically demonstrated connectivity when dealing with conjunctive water management because of specific language in HB 831 and its corresponding statutes. Similarly, Idaho and Washington also use scientific (i.e., modeling) approaches to show the impact that groundwater pumping might or might not have on surface water.

The Judicially Affirmed Approach

The principle of conjunctive water management of surface and hydrologically connected groundwater was early established in New Mexico as a result of a legal case (Albuquerque v. Reynolds, 71 NM 428, 379 P.2d 73, 1962) which was finally resolved by the New Mexico Supreme Court in 1962. In this case the New Mexico State Engineer was essentially given complete authority to administer any waters s/he *feels* to be hydrologically connected based on her/his expert judgment (these include surface waters and unconstrained aquifers that might underlie them. Hence, New Mexico's conjunctive water management approach is a judicially affirmed one. Though other states have had their conjunctive management approaches tested in the courts, we consider New Mexico's judicially affirmed approach to be unique because there is a de facto linkage between surface waters and certain groundwaters beneath them – it does not necessarily require that this be demonstrated scientifically.

[3] Montana does allow for the submission of hydrogeologic data associated with field studies.

Classification of Hydrologically Connected Waters

The most widely used approach for conjunctive water management in the western United States is the classification of hydrologically connected waters. Colorado, Oregon, Utah and Wyoming all use this approach which relies, like New Mexico's approach, on expert judgment concerning linkages between surface and ground water. In contrast with New Mexico where an essentially de facto one-to-one relationship is assumed between surface and ground water in given cases, those states that employ the classification approach either first engage in local studies to affirm the assumed hydrologic linkages, or they assume that the strength of the relationships will vary depending on hydrologic criteria or parameters (i.e., distance from stream, aquifer characteristics, etc.). Colorado utilizes a classification scheme for groundwater that first considers its relevance to existing surface water rights, and then its physical relationship with surface waters. In both Oregon and Wyoming, certain areas are classified (based on specific criteria) as critical groundwater areas where further groundwater appropriation is prohibited and permitted levels of pumping can be required to be reduced. In Utah, classifications of groundwater are determined by the State Engineer through studies of precipitation, recharge rates, and discharge rates. *Conjunctive use* and aquifer storage and recovery are also used in Utah to improve the efficiency of the conjunctive water resource.

Other

Nevada uses a unique approach for conjunctive water management in the western United States. In Nevada, groundwater and surface water are regulated separately under prior appropriation rules, but managed conjunctively in practice. Here water resources are evaluated on a case-by-case basis because the hydraulic connection between ground and surface water

varies throughout the state. As such, Nevada's approach is a blend of the scientific and classification approaches.

Conclusion

In considering the three approaches for the conjunctive management of surface and ground water with respect to their utility and/or efficacy, the authors make the following observations. First, the scientific approach undertaken in Montana, Idaho, and Washington is obviously the most rigorous of the three in that it relies on local to regional scale modeling of surface and ground water relationships using large amounts of high quality data obtained in the field. This approach also relies on the technical expertise of hydrogeologists. Based on these facts, it will be a more sophisticated and expensive approach to implement and employ than the others, and may not always be entirely accurate because groundwater models are only as good as the data and personnel used in compiling them[4]. This has clearly been demonstrated in Montana where the new rules for conjunctive management requiring the production of high resolution results (i.e., a calculated impact on surface water of 0.01 ft) have produced considerable uncertainty for water users and water managers alike regarding the accuracy and results of the models used. This uncertainty has led the state to take the lead with its new Groundwater Investigation Program (GWIP) in developing models for those river basins where conjunctive management is likely to be most difficult and contentious.

Secondly, the judicial approach utilized in New Mexico which affects almost all waters of the state (except for very deep groundwater) is seemingly the easiest to employ given the a priori assumption of direct one-to-one linkages between surface and ground waters. On the other hand it might be seen as the approach most fraught with error because geohydrologic science has

[4] For discussions that address the accuracy and efficacy of ground water modeling, see the following: Clark Fork Groundwater Technical Conference Report, Clark Fork Task Force Conjunctive Management Report.

demonstrated repeatedly that such linkages are extremely variable across time and geographic space. Its ability to be utilized does rest on a judgment coming from a state Supreme Court that was not appealed in the federal courts, and thus it is affirmed though not necessarily correct in every place and case. Even though the state of New Mexico incurred a significant expense in fighting this case through the state courts, the costs and administrative difficulties associated with implementing it are likely much less than for the other two approaches.

Third, while the classification method employed in Colorado, Oregon, Utah, and Wyoming might be seen as being an acceptable compromise between the scientific and judicial approaches, it too is likely subject to considerable error where it is not well supported by adequate local studies or is not well defined (for instance Oregon employs the method only when groundwater levels have become critical as a result of over-pumping). Furthermore, this approach would seem to be quite vulnerable in the courts if it were not adequately supported by existing case law. Lastly, Nevada's approach is relatively sophisticated in that it relies on both the scientific determination of linkages between surface and ground water, as well as the classification approach.

In considering these observations, we consider the three approaches with regard to their complexity, degree of scientific uncertainty, and expense in administering. The scientific approach for demonstrating connectivity between surface and ground waters is certainly the most complex and expensive of the three, but that it has a much lower degree of scientific uncertainty – especially where agencies and water users can agree on model and data parameters. This is the point that Montana has nearly reached, though at considerable expense with remaining legal uncertainty (i.e., the judicial vulnerability of the GWIP models have not been tested in the courts). Also, the judicial approach utilized by New Mexico is easily the most simplistic and

unscientific, but it is deceivingly elegant and conservative. It assumes a direct linkage between surface and ground waters in most cases, is conservative with respect to precious water resources, is inexpensive to administer, and is legally untouchable owing to the high court decision that affirmed it.

Given these characterizations, we feel that Montana is on the right track with its GWIP. This program should enable the state to develop groundwater models that will be deemed acceptable to both water users and water managers alike, though this will likely be tested in the courts. This effort and any legal challenges do come at a considerable expense, but one that the Montana Legislature should continue to underwrite given the alternative – competing models and experts, prolonged litigation, and continued uncertainty in conjunctive management that will hamper effective water management and economic activity in the state.

State Reports[5]

Montana

Introduction

Conjunctive water management in Montana was significantly influenced by the 2006 Montana Supreme Court decision, Trout Unlimited vs. Department of Natural Resources and Conservation (Case Number 05-069). This case led to the Montana State Legislature's passage of House Bill 831, which requires a geohydrologic assessment be performed by an applicant (i.e., by a qualified professional) for a new well in a closed basin to ensure that the new appropriation will not result in a net depletion of surface water. The difficulty in implementing this law (MCA 85-2-360) lies in trying to determine if any surface waters and existing water rights would be adversely affected. Due to the cost and complexity of the application requirements, developers began to avoid applying for wells for community water systems for new subdivisions by drilling exempt wells for each new dwelling unit or by leaving new homeowners to drill them.

According to Article IX, Section 3(3), of the Montana Constitution, "all surface, underground, flood and atmospheric waters within the boundaries of the state are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law." Because of this Montanans cannot own the water itself; however, they can possess the right to use it. Montana water rights are based on prior appropriation (first in time, first in right). According to the Clark Fork River Basin Task Force (CFTF), challenges for the continued use of prior appropriation are arising due to an increased competition for water resources and an increased management complexity (2008). Other challenges include: incomplete adjudication,

[5] Note: the state reports are ordered such that Montana leads the scientific conjunctive management category, it is then followed by the other two states in this group, and then the classification states are discussed, then Nevada.

full appropriation in most basins, and statutory recognition of hydraulic linkage between surface and ground water. Before July 1, 1973, water rights were easily acquired by simply putting the water to beneficial use or by posting a notice of intent to use water and then filing that with the county clerk. Water rights were not consistently recorded. With no written records, Montana was having problems administering the development of new state water rights. Article IX section 3(4) of the 1972 Montana Constitution states that the legislature must "provide for the administration, control, and regulation of water rights…establish a system of centralized records, in addition to the present system of local records." In response to this provision, the legislature passed the Montana Water Use Act in 1973 which was the most comprehensive change in Montana's water rights law in the state's history (Montana DNRC et al. 2009). This act required that all water rights existing prior to July 1, 1973 must be verified through a statewide adjudication process in state courts. It also established a centralized record system, established an authorization system for changing water rights, and established a permit system a permit system administered by the state's Department of Natural Resources and Conservation (DNRC) for obtaining new and changed water uses.

Appropriation of Water

Out of the Montana Water Use Act of 1973 one must obtain a permit to appropriate water when planning a new or changed development for a beneficial use of water from surface or ground water after June 30, 1973 (Montana DNRC et al. 2009). Many river basins and sub-basins have been closed by the legislature or the DNRC because they are considered to be fully appropriated. A basin closure declares that water is no longer legally available for new uses. DNRC cannot accept new permit applications in closed basins. However, changes can be made to existing water rights. Basin closures protect senior water rights holders by not allowing any

new junior uses and by saving the seniors time and money they would spend in objecting to applications for new rights (CFTF 2004). Permits are not required for a new surface water use for small livestock pits or reservoirs located on a stream that does not flow continuously year round (Montana DNRC et al. 2009).

In 1961, the Montana Legislature passed a groundwater code establishing a system for the appropriation of groundwater which allowed Montana to begin to regulate groundwater development. Before that code was passed, groundwater could be appropriated only if it was in a permanent and known channel. In 1991, after realizing the importance of groundwater as a resource for Montana water users, the legislature passed the Montana Ground Water Assessment Act which "established the Montana Ground Water Assessment Program to characterize and monitor the state's groundwater and conduct long-term, statewide monitoring of groundwater quality and water levels" (Petersen-Perlman and Shively 2009, 1). In 1991, the legislature also changed the flow rates and volumes for wells (outside of controlled groundwater areas) that are exempt from DNRC's permitting process from the 100 gallons per minute allowed by the 1973 Water Use Act to a flow rate of less than 35 gallons per minute and a volume less than 10 acre-feet per year (Petersen-Perlman and Shively 2009).

House Bill 831

The Montana Supreme Court's 2006 decision in Trout Unlimited (TU) vs. DNRC was extremely influential for conjunctive water management in Montana (Petersen-Perlman and Shively 2009). Prior to this case, Montana basin closure laws defined groundwater as "water that is beneath the land surface or beneath the bed of a stream, lake, reservoir, or other body of surface water and that is not immediately or directly connected to surface water" (CFTF 2008, 8). In response to a DNRC approval of a groundwater permit in the Smith River basin that a senior

surface right holder believed would adversely affect[6] his water right, TU filed a lawsuit against the DNRC over its interpretation of "immediately or directly connected to surface water." According to Petersen-Perlman and Shively, "the Supreme Court ruled that in a closed basin, DNRC must assess not only whether a groundwater development would take directly from a source of surface water but also whether it would capture tributary groundwater" (2009, 2). This decision stopped DNRC processing of groundwater developments in closed basins until the passage of House Bill 831 by the Montana Legislature in 2007 (Petersen-Perlman and Shively 2009). This bill requires that a hydrogeologic assessment be provided by an applicant for a new well in a closed basin to determine if the proposed well would cause net depletion to surface water. If a net depletion is found then the applicant must determine whether it would adversely affect any existing water rights, and if an adverse effect is determined the applicant must submit a plan to mitigate for it. If the DNRC cannot find that the new water right or changed use does not adversely affect any existing right, then a permit can be issued. Determining whether an adverse effect has taken place on any existing water right has become controversial because the DNRC uses a calculated, rather than measured, basis for evaluating the adverse effect test, meaning an adverse effect need not be measurable. As long as an existing water right holder or the DNRC can show a calculable impact of a new or changed appropriation, either by use of computer programs or calculations, an adverse effect would exist (CFTF 2008). Unfortunately this is a highly sophisticated approach that produces as much uncertainty as it seeks to address.

Unlike most other western states utilizing a prior appropriation system, Montana does not provide a domestic water use priority (CFTF 2008). Under the 1973 Water Use Act, no permits are required before appropriating groundwater by means of a well or developed spring with an

[6] HB 831 utilizes the term "adverse affect." For grammatical purposes, we use the terms "affect" and "effect" where most appropriate.

anticipated use of no more than 35 gallons a minute and no more than 10 acre-feet a year (Montana DNRC et al. 2009). This exemption has changed the way subdivisions are being developed in Montana. The DNRC's policy did not take into account whether a number of these small individual wells were being used for the same development, and only recognized a 'combined or manifold appropriation' when these wells were physically joined together into a larger distribution system. In response to developers' use of this exemption, the DNRC is in the process of amending that rule due to the effect it was having on senior water rights (Maier 2010, 1).

In 2007, the Montana Legislature also passed House Bill 304 which established the Water Policy Interim Committee (WPIC) to evaluate and research water-related issues (Petersen-Perlman and Shively 2009). The WPIC realized that the high competition for water resources and the lack of information available to potential new water users and water managers posed significant challenges for conjunctive water management. The WPIC found that "continued and expanded study of groundwater resources is vital to shaping statewide policy as well as providing the data necessary for local decisions regarding water" (Montana Bureau of Mines and Geology 2010, 1). From these findings, House Bill 52 creating a Groundwater Investigation Program (GWIP) was drafted by the WPIC and enacted by Montana Legislature in 2009 (Petersen-Perlman and Shively 2009). John Tubbs, the Water Resources Director for DNRC, stated, "[House Bill 52] marked the first time the state has invested a significant amount of money to systematically model groundwater-surface water interactions. This modeling, conducted by the Montana Bureau of Mines and Geology, will improve the DNRC's ability to grant or deny permits based on adverse affect in closed basins" (2009, 8). The GWIP will help Montana deal with these important water resource issues (Montana Bureau of Mines and

Geology 2010). According to Petersen-Perlman and Shively, "the GWIP is meant to produce three main products: a detailed report that describes a given basin's hydrogeologic system, models that simulate hydrogeologic features and processes, and a comprehensive set of hydrogeologic data available through the MBMG's Ground-Water Information Center (2009, 3).

Conclusion

In summary, Montana's system for the conjunctive management of surface and ground water is new and quite sophisticated scientifically, but relatively untested and fraught with uncertainty. Because the state places the burden of demonstrating hydrologic linkages between surface and ground waters on the applicant, who is required to submit the results of hydrologic models, the permitting of new and changed groundwater rights in closed basins is seen by applicants as prohibitively complicated and expensive. This has resulted in the state appropriating a large amount of money to fund groundwater investigations that will measure and model such linkages in high priority basins with the intent of providing applicants and the DNRC with validated models and data that will decrease the uncertainty. The Montana system is also evolving in order to deal effectively with the effects that multiple exempt domestic wells have on senior water rights. DNRC is committed to amending its exempt well policy to take into account whether a number of small individual wells are being used on the same development to ensure that they will not adversely affect senior surface water right users.

Idaho

Introduction

Similar to Montana, Idaho has a strong reliance on scientifically demonstrated connectivity in conjunctive water management. Idaho uses computer models to show the impact of groundwater pumping on surface waters. The Idaho Department of Water Resources (IDWR) is responsible for regulating the use and appropriation of groundwater and surface water rights in the state. The mission of the Idaho Department of Water Resources is "to serve the people of Idaho by ensuring that water is conserved and available for the sustainability of Idaho's economy, ecosystems, and resulting quality of life" (IDWR 2010, 3). According to the Idaho Constitution and statutes, all of the state's waters, both groundwater and surface waters, are public property. Like many other western states, Idaho's water rights are based on the prior appropriation doctrine.

Water Rights

Since March 25, 1963 the only way to establish groundwater rights is through the application process (IDWR 2007). The only exception to this rule is if the groundwater is used beneficially for domestic purposes. According to Bureau of Land Management, [in Idaho] "domestic purpose is limited mainly to single-family domestic purposes, but is defined by statute as water for homes, organizational camps, public campgrounds, livestock and for any other purpose in connection therewith, including irrigation of up to one-half acre of land, if the total use is not in excess of 13,000 gallons per day, or any other uses if the total use does not exceed a diversion rate of 0.04 cubic feet per second and a diversion volume of 2,500 gallons per day" (2001, 1).

After May 20, 1971, the only way to obtain a right to surface water in Idaho is by filing an application through the IDWR (Bureau of Land Management 2001). The only exception for obtaining a water right for surface water is if the water right is used for instream watering of livestock (IDWR 2007).

Areas in Idaho that seem to have, or that may soon have, an insufficient groundwater supply are designated either as Critical Ground Water Areas (CGWA) or Ground Water Management Areas (GWMA). In 1953, amendments to Idaho's Ground Water Act granted the Director of IDWR authority for designating critical ground water areas. The authority for designating groundwater management areas was granted to the agency in 1982 through amendments to Idaho's Ground Water Act. A CGMA is either all or a section of a groundwater basin where there is not enough groundwater to provide a safe supply for irrigation or other uses at the current or projected rates of withdrawal, and a GWMA is all or part of a groundwater basin that may be approaching the conditions of a CGMA. Only after determining that other (more senior) water rights will not be injured, and sufficient supply is available, can new water appropriation applications be approved (Idaho Department of Water Resources 2010a).

Water Banks

The Idaho Water Supply Bank, established by Idaho Code 42-1761, allows the sale or leasing of water, which is very important at this time as the state has inadequate water available for new appropriation (Idaho Water Resource Board 2010a). Idaho's water supply bank is a system that began in the 1930s and is now operated by the Idaho Water Resources Board. According to the Idaho Water Resource Board, "the purposes of Idaho's Water Supply Bank are to encourage the highest beneficial use of water, provide a source of adequate water supplies to benefit new and supplemental water uses, and provide a source of funding for improving water

user facilities and efficiencies" (Idaho Water Resource Board 2010b). Water right holders can offer water rights to the bank for rent to people who must have these rights to meet their needs (Idaho Water Resource Board 2010b). The Board's water supply bank and local rental pools are the two distinct categories which form the Idaho Water Supply Bank.

The Board's water supply bank contains water rights from both surface and ground water sources throughout the state. Local rental pools usually use reservoir storage water, except in specific basins where natural flow water is utilized. These rental pools are established under the same authority as the Board's water supply bank but only pertain to specific watersheds in Idaho (Idaho Water Resource Board 2010b).

Conjunctive Management

Idaho, along with most other western states, has developed a priority system in which all water, both surface and ground, is managed under the appropriation system (Petersen-Perlman and Shively 2009). According to Idaho Constitution Article XV Section 3, "priority of appropriation shall give the better right as between those using water; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall (subject to the limitations as may be prescribed by law) have the preference over those claiming for any other purpose." The goal of conjunctive management is to protect senior water rights holders while at the same time getting the most out of Idaho's water resources. According to the Idaho State Water Plan, "where a hydraulic connection exists between ground and surface waters, including spring flow, they are to be managed and administered conjunctively to ensure a sustainable water supply, in accordance with the prior appropriation doctrine as established by law" (Idaho Department of Water

Resources 2010b). Furthermore the Idaho State Water Plan states the state has several conjunctive management implementation strategies:

> Continue to quantify the hydraulic relationship between ground water supplies, surface water supplies, and spring flows in designated river basins; develop prioritized list of basins where additional technical information is needed to assess ground and surface water interaction; develop enhanced technical tools for evaluating the interaction between surface and ground water resources for use in planning and administration; increase measurement and monitoring of spring flow and promote cooperative efforts to better quantify spring flow hydraulics; on a continuing basis, assess conditions and trends of ground water levels in primary aquifers to estimate the rate of future aquifer recharge and withdrawal under various climatic conditions; and procure funding for studies (Idaho Department of Water Resources 2010b, 11).

Conjunctive management involves complication. For example, interference between surface water and groundwater users is very difficult to identify and resolve. Water law was originally developed for surface water when the effects were immediate, visible, and downstream, but with groundwater the effects are difficult to identify in any direction (Baxter 2010). During water shortages, pinpointing a specific groundwater user causing injury to senior users is very difficult. Another complication is quantifying the timing and magnitude of the impacts groundwater use on surface water (Cosgrove and Johnson 2004).

Quantification and monitoring of the hydraulic relationship between groundwater and surface water is essential for optimal utilization of the water supply and protection of senior water right holders (Idaho Water Resource Board 2010b). The Idaho Water Resources Research Institute (IWRRI) is currently working for the IDWR providing technical assistance regarding groundwater and surface water. The IWRRI has created computer models to show the impact groundwater pumping has on different reaches of rivers in Idaho (Petersen-Perlman and Shively 2009). Another important aspect of the models is the transient response functions which can analyze the effects of groundwater development on river gains and losses. Transient response functions allow for the quantification of the impact groundwater use on surface water. In the

past, water managers have had a major problem managing the hydrologic system as a whole without having adequate means of quantifying the timing and magnitude of the impacts of groundwater use on surface water resources, but these models offer the ability to quantify these impacts which allows for easier enforcement and permitting of state water rights (Cosgrove and Johnson 2004). Updates and improvements are continuing to be made on this model.

Conclusion

In summary, in Idaho where a hydraulic connection exists between groundwater and surface water, they are to be managed and administered conjunctively. Quantification and monitoring of the hydraulic relationship is essential for optimal utilization of the water supply and protection of senior water right holders. The IWRRI has developed computer models to show the impact groundwater pumping has on different reaches of the river. An important aspect of the model, the transient response functions, can quantify the impact of groundwater use on surface water. Changes continue to be made to the models for more accurate readings.

Washington

Introduction

Similar to Montana, Washington has a strong reliance on scientifically demonstrated connectivity when dealing with conjunctive water management. Evaluation of the significance of the hydraulic connection takes place on a case-by-case basis due to different characteristics throughout a river basin. The Washington Department of Ecology (Ecology) is responsible for managing the state's water resources and for the appropriation of all ground and surface water rights in the state. The Washington Legislature adopted the first comprehensive water code for surface water in 1917, which established a mechanism for adjudication of water rights, enforcement and regulation of water rights, and a permit system for obtaining new water rights. According to Gregoire et al., "the 1917 Water Code…still remains the foundation for management of the state's waters" (2000, IV:3-5). In 1945 the Washington Legislature enacted a comprehensive groundwater code to extend surface water statutes to the appropriation and beneficial use of groundwater. Washington water rights, for both surface and ground waters, are based on the prior appropriation doctrine (Bryner and Purcell 2003).

Water Rights

Since 1917, no surface water may be appropriated until a permit has been obtained. Since June 6, 1945, public groundwaters of the state may not be withdrawn or a well constructed without a permit issued by Ecology. The application process to obtain a groundwater right is basically the same as the process for obtaining surface water rights in all western states. One difference is that Ecology must also analyze whether a proposed groundwater project is reasonable and feasible in terms of the pumping practices to be employed. Case law provides, if pumping practices are unreasonable or harmful to the aquifer or to the rights of other users, even

senior appropriators may be regulated. This concept of reasonable pumping level can limit the seniority of a groundwater right (Gregoire et al. 2000). In 1985, the Washington Legislature enacted a groundwater management program to enforce the maintenance of safe sustaining yields. Ecology designates groundwater areas or sub-areas where withdrawals may be administratively controlled to prevent overdraft, so that groundwater resources are preserved and protected for present and future use.

Under certain conditions, the law allows a person to drill a well and withdraw groundwater without a permit. The exempt well provision was added to Washington law so that in certain circumstances the uses of small quantities of water are not required to go through the same formal permit process as larger uses of water (Washington Rivers Conservancy 2009). According to Ecology, "the only exception to the permit requirement is for withdrawals of groundwater for providing water for livestock (no gallon per day limit); watering a non-commercial lawn or garden one-half acre in size or less (no gallon per day limit, however limited to reasonable use); providing water for a single home or groups of homes (limited to 5,000 gallons per day); and providing water for industrial purposes, including irrigation (limited to 5,000 gallons per day but no acre limit)" (2010, 1). The recent legal case, *Ecology v. Cambell & Gwinn, LLC,* raised the question of how groundwater exemptions apply to residential subdivisions. The Washington Supreme Court ruled that if someone wishes to develop land and supply the development with domestic water from several wells, which pump less than 5,000 gallons per day each but over 5,000 gallons per day when added together, the project is considered a single withdrawal of groundwater and therefore is not exempt from the permit requirement (Washington State Department of Ecology 2006).

Although an exempt well may be constructed without obtaining a permit from Ecology, it is still subject to the priority system, supplemental to surface rights, and must comply with the beneficial use requirement. The Washington Legislature realized that in some conditions small withdrawals may affect the water system, so it authorized Ecology to require the person making the withdrawal to provide the means for and the quantity of that withdrawal. According to Gregoire et al., the "legislature tried to be careful to avoid letting the exemptions swallow the rule, by balancing the policies behind the exemptions with the state's need for information to operate the water system and resolve disputes" (2000, V:20-21).

Conjunctive Management

The state of Washington has implemented a conjunctive management system. As early as the 1945 code, the Washington Legislature recognized the connection between surface and ground water. Both statute and case law has confirmed that the prior appropriation doctrine should govern the extent to which the appropriation of surface water affects groundwater rights, or vice versa, so senior groundwater rights may have priority over a junior surface water right (Gregoire et al. 2000).

In the Okanogan River Basin, groundwater permits must be conditioned to maintain minimum instream flows if there is 'significant hydraulic continuity' between surface water and the proposed source of groundwater, but the phrase 'significant hydraulic continuity' is not defined. In the case *Hubbard v. Department of Ecology*, (86 Wash. App. 119, 936 P.2d 27, 1997), the Washington Court of Appeals considered the meaning of this phrase. The Hubbard brothers owned land near the Okanogan River. Both brothers obtained temporary permits to withdraw groundwater depending on the outcome of their application. The wells were located 5,700 and 4,000 feet from the Okanogan River. Both wells withdrew from the Wagonroad

Coulee aquifer which drains into the Okanogan aquifer, which in turn feeds the Okanogan River. Ecology performed an investigation and determined that there was a significant hydraulic connection between the aquifer and the river, so it granted conditional permits which required the Hubbards to stop pumping when the Okanogan River fell below its minimum instream flow. The Hubbards appealed, and argued that a calculated decrease of 0.00006 percent is not measurable or significant (Minier 2000). According to Gregoire et al., "the court of appeals ruled that the connection between ground water and surface water may exist even when the point of withdrawal of the ground water is several miles removed from the affected stream. Even though the effect of the proposed pumping on the flow of the river would be minimal, the court upheld Ecology's decision to restrict ground water withdrawal in order to protect instream flows in Okanogan River given the 'significant hydraulic continuity' between the aquifer and river" (2000, V:30). Due to unique hydrogeologic characteristics of various locations within a river basin, evaluation of the significance of the hydraulic connection between a proposed groundwater source and a river will most likely need to happen on a case-by-case basis (Minier 2000).

Conclusion

In summary, Washington uses a similar approach as Montana for conjunctive water management. Both states have a strong reliance on scientifically demonstrated connectivity. Also similar to Montana, Washington's water code is evolving to deal with the effects that multiple exempt domestic wells have on senior water rights. In Washington, a groundwater permit must be conditioned if there is 'significant hydraulic continuity' between surface water and the proposed source of groundwater. The phrase 'significant' is not defined (in the case

Hubbard v. Department of Ecology the term was very controversial), and even today uncertainty in the application of the rule remains.

New Mexico

Introduction

The principle of conjunctive water management of surface waters and hydrologically related groundwaters was early established in New Mexico. Here conjunctive water management uses a judicially affirmed approach. In New Mexico, the State Engineer is responsible for supervising the state's water resources through the appropriation and distribution of all of the state's surface and groundwater. The State Engineer is also secretary for the Interstate Stream Commission, which is responsible for investigating, protecting, conserving, and developing New Mexico's water supply. Five years before statehood, in 1907, New Mexico's surface water code was created. When New Mexico became a state in 1912, the new constitution adopted the prior appropriation doctrine. In 1931, a groundwater code was adopted by the state legislature, so under the State Engineer's jurisdiction New Mexico water users began appropriating groundwater by permit (New Mexico Office of the State Engineer 2007). According to the 2008-2009 Annual Report of the State Engineer,

> Water Management in New Mexico is guided by several 100-year-old principles in the New Mexico Constitution: all unappropriated water belongs to the public and is subject to appropriation by law; the acquisition or continuation of a water right and where and how much water can be used is put to beneficial use; older water rights have priority over more recent water rights. Since 1907, a permit from the State Engineer has been required to divert surface water and put water to beneficial use. Permits are required for diverting groundwater anywhere that the State Engineer has declared a groundwater basin, which is now the entire State of New Mexico (New Mexico Office of the State Engineer 2009, 4-5).

Water Rights

In New Mexico, any appropriation of surface water initiated on or after March 19, 1907 requires a valid permit issued by the State Engineer. Since March 29, 1907, New Mexico has considered most surface water in the state to be fully appropriated, so most recent water rights

activity has involved groundwater (New Mexico Office of the State Engineer 2009). Brockmann states, "New Mexico's groundwater law accomplishes four broad objectives: promotes the orderly development and optimum utilization of a diminishing groundwater resource; allows the transfer of existing water rights to address ever-evolving needs and priorities; protects existing surface water and groundwater rights; and provides for interstate stream compact compliance" (2009,1). Instead of giving the State Engineer administrative jurisdiction over all of the groundwater in New Mexico, the Ground Water Code of 1931 states that groundwater will only be subject to State Engineer jurisdiction after he issues an order declaring an underground water basin. A declared underground basin is defined as an area underlain by a groundwater source having reasonably ascertainable boundaries. The State Engineer had no authority over the appropriation and use of groundwater in an area that was not declared. However, on September 23, 2005, the State Engineer declared the remaining groundwater basins in New Mexico, thus giving him full regulation over all of the state's groundwater (Brockmann 2009). New Mexico is divided into 108 separate groundwater basins or extensions of groundwater basins, and each basin has a date of declaration. The application process for a new appropriation of groundwater is very similar to that of surface water.

Conjunctive Management

In New Mexico, ground and surface water are conjunctively managed. Groundwater rights are subject to prior appropriations and applications for new wells must show that drilling will not impair existing rights (Bryner and Purcell 2003). The Case of *City of Albuquerque v. Reynolds*, 71 NM 428, 379 P.2d 73 (1962), established the principle of the conjunctive management of surface water and hydrologically related groundwater. On November 29, 1956, the Rio Grande Underground Water Basin was declared by the State Engineer, and following this

declaration the City of Albuquerque filed four separate applications for permits to appropriate underground waters in the basin. The State Engineer found that if these applications were granted they would impair existing surface water rights in the Rio Grande. Because the city was not taking the steps required to offset the adverse effects of its use upon other users, the State Engineer denied all the applications (Brockmann 2009). The State Engineer's decision was reversed in District Court, but when he appealed to the New Mexico Supreme Court, the court rejected all of the applications holding that groundwater and surface waters were in fact hydrologically connected in the Rio Grande Basin. The only way to abide by New Mexico's prior appropriation law and protect senior user rights was to give the State Engineer authority to administer the connection. The Supreme Court found it would be anomalous for the legislature to enact laws that would allow underground water users to deprive surface water prior appropriators of their vested rights. According to Franks, "The court stated: We feel constrained to hold that the state engineer adopted the only known plan to avoid impairment to existing rights and that his requirement, that surface rights be retired to the extent necessary to protect prior stream appropriators as a condition of the granting of an application to appropriate from the basin, is within the lawful power and authority of the state engineer" (2007, 8).

Conclusion

In summary, conjunctive water management was established through the case *City of Albuquerque v. Reynolds* in New Mexico. In this ruling the State Engineer denied applications by the city because they would impair existing water rights and no actions were being taken by the city to offset these adverse effects. The Supreme Court ruled that groundwater and surface water in this instance were hydrologically connected, and the State Engineer was given authority to administer the connection. Without this authority prior appropriation would be undermined

and senior water rights would not be protected. The *City of Albuquerque v. Reynolds* case has been cited as the basis for the conjunctive management of surface and ground water throughout the western United States (Brockmann 2009).

Colorado

Introduction

Conjunctive water management in Colorado is based on a classification of hydrologically connected waters approach. This approach defines almost all of the state's groundwater as tributary groundwater, because groundwater is presumed to be tributary unless otherwise designated. Classification of the state's water is determined by the Colorado Geologic Survey's *Groundwater Atlas of Colorado* which "is a comprehensive study of the location, geologic and hydrologic characteristics, and water quality of the state's major aquifers and groundwater resources" (Bryner and Purcell 2003, 21).

The Colorado Division of Water Resources (CDWR), also known as the State's Engineer's Office, administers all of Colorado's surface and ground water rights. Its duties include: the issuing of surface water right permits, groundwater well permits, dam inspections, and monitoring water levels throughout the state (CDWR 2008). The State Engineer's Office is broken up into seven division offices located in each major drainage basin throughout the state. Water commissioners from each division are charged with the enforcement of Colorado water laws (CDWR 2010d). Colorado water rights are established through a water court system. The Colorado Constitution, under Article XVI, states that water of streams is public property and that no one shall be denied the right to divert the unappropriated waters of any natural stream for beneficial use. Domestic water use has priority over all other uses if there is an insufficient water supply. And most importantly, in the context of conjunctive management, "although Colorado law is quite complex it is built on the idea that groundwater and surface waters are interconnected, and groundwater is presumed to be tributary unless otherwise designated" (Bryner and Purcell 2003, 21).

The Colorado Ground Water Law of 1957 required obtaining a permit for new wells and the registration of existing wells (CDWR 2010b). Through the Ground Water Management Act of 1965 and the Water Rights Determination and Administration Act of 1969, the Colorado Legislature regulated groundwater pumping and integrated surface water appropriations with groundwater appropriations. The 1965 Act not only differentiated groundwater by location and effect on surface water, but it also confirmed the standard of prior appropriation for surface water and implemented a modified prior appropriation system to determine groundwater rights to allow the full economic development of designated groundwater. The 1965 Act also formed the Ground Water Commission and created designated basins. The basins that were created were removed from water courts' jurisdictions and given to the Ground Water Commission which determines and administers the water rights in these basins. The Water Rights Determination and Administration Act of 1969 created seven divisions, as discussed above, that have separate water courts and in them jurisdiction is given to the water courts over all surface water and groundwater tributary to surface water. The 1969 Act claims that a sound and flexible integrated use of both surface and groundwater is needed for the future welfare of the state. According to Bryner and Purcell,

> The 1969 Act integrated tributary groundwater into the surface water regime. Tributary water is administered under the prior appropriation system and the water courts have jurisdiction over it. The same statute also claims that the existing use of groundwater, either independently or conjunctively with surface water, shall be recognized to the fullest possible extent, subject to preserving existing rights. In addition it goes on to maintain that the use of groundwater may be considered as an alternate or supplemental source of supply for surface decrees entered prior to June 7, 1969 (2003, 23).

Water Rights

The process to obtain a water right in Colorado is very complex; sometimes it requires assistance from a water lawyer and/or a water resource engineer (CDWR 2010c). Colorado

water rights are established through one of the seven water court systems, each consisting of a water judge appointed by the Colorado Supreme Court, and a water referee, who hear all water associated matters within their jurisdiction. The water right application must be filed in the division where the diversion is located and must be handled by an attorney (Bureau of Land Management 2001).

Colorado water rights are either absolute or conditional. A water right is recognized as absolute when water is diverted and used beneficially. A conditional right is a right that will be used in the future. A conditional right is useful for protecting priority before a project is complete. This ensures that water that was available at the beginning of the project is still available once complete. To maintain a conditional right, one must show significant progress toward the completion of the project. Once the project is complete one may file for an absolute water right (Bureau of Land Management 2001).

Groundwater and Conjunctive Management

Groundwater regulations in Colorado differ depending on how the groundwater is classified. As stated above, the Colorado Geological Survey's *Groundwater Atlas of Colorado* is a comprehensive study which helps with the classification of the state's groundwater (Bryner and Purcell 2003). Colorado groundwater is classified as either designated or non-designated groundwater. Designated groundwater is groundwater located in a designated groundwater basin not available or required for fulfilling surface water rights, and non-designated groundwater is located outside of these basins. The Colorado Ground Water Commission (CGWC) regulates designated groundwater and the State Engineer and water courts regulate the non-designated groundwater. Groundwater basins outside of designated areas are then classified as either tributary groundwater, non-tributary groundwater, or not non-tributary groundwater (Bryner and

Purcell 2003). Designated, non-tributary, and not non-tributary groundwater are not subject to the prior appropriation doctrine (Holland & Hart LLC 2007). Not non-tributary groundwater is water in the Denver Basin that does not follow the definition of non-tributary groundwater (Bryner and Purcell 2003). According to the Bureau of Land Management,

> A modified form of prior appropriation governs the establishment and administration of ground water rights in Colorado. Colorado ground water use is governed by the Ground Water Management Act of 1965, which was adopted to allow the full economic development of water resources while protecting the right of senior appropriators"(2001, 3).

Designated groundwater is not hydrologically connected to surface water and its use is governed by a modified system of prior appropriation. In order for water to be appropriated from a designated basin, one must obtain a permit from the CGWC rather than the State Engineer and Water Courts (Bryner and Purcell 2003). The Commission can also limit extractions interfering with prior appropriation to protect senior water users but permits the full economic development of groundwater resources. In order to obtain a new well permit, the proposed appropriation must not cause injury to existing rights from that same source (Holland & Hart LLC 2007). According to Bryner and Purcell, "the goal behind designated basins is to stop mining in these specific areas" (2003, 22).

Tributary groundwater, which is the most common type of groundwater in Colorado, is water adjacent to and connected to surface water sources. Tributary groundwater is regulated by water courts. Bryner and Purcell state, "water withdrawn that will deplete the natural stream's flow within 100 years of pumping at the rate of 0.1 percent of the annual rate is considered tributary" (2003, 22). Due to the fact that tributary groundwater is connected to surface water, it is administered conjunctively and governed by the prior appropriation doctrine. Therefore, wells withdrawing tributary groundwater and surface diversions from a stream are treated the same way (Holland & Hart LLC 2007).

Non-tributary groundwater is water that is separated from surface water and located outside of the designated basins. According to Holland & Hart, LLC, "unlike all other water rights in Colorado, ownership of non-tributary water is dependent upon ownership of the land overlying the water itself" (2007, 4-5). Non-tributary groundwater is not subject to the prior appropriation doctrine and is regulated by the State Engineer and the water courts (Bryner and Purcell, 2003). The State Engineer is responsible for issuing permits for drilling a well for use of non-tributary groundwater, but may regulate the use so other users rights are not harmed and so waters of the aquifer are conserved (Holland & Hart LLC 2007). Permits are based on an aquifer life of 100 years (Bryner and Purcell 2003). The Bureau of Land Management states, "when a non-tributary aquifer is established by law, the water in the aquifer is allocated based on the percentage of land owned on the surface above the aquifer" (2001, 3).

Another type of groundwater in Colorado is "not non-tributary ground water," which according to Douglas County Water Resources, "is legally defined as ground water located within those portions of the Denver Basin aquifers that are outside the boundaries of any designated basin and will, within 100 years, deplete the flow of a natural stream at an annual rate greater than one-tenth of one percent of the annual rate of withdrawal" (2010, 2). Water courts issue the required permits, which have to include augmentation plans from the State Engineer's Office (Bryner and Purcell 2003). An augmentation plan is a court-approved document that is in place to protect senior water rights by replacing the amount of water used by a junior water rights holder. An augmentation plan allows for the junior water rights holder to be able to use their well without causing harm to senior water rights even when a call has been placed (CDWR 2010a).

Conclusion

In summary, Colorado's system for the conjunctive management of surface and water is based on the classification of hydrologically connected waters. Groundwater regulations in Colorado differ depending on if the groundwater is classified as designated or non-designated. Non-designated groundwater is further classified as either tributary, non-tributary, or not non-tributary. Most of Colorado's groundwater is classified as tributary, which is administered conjunctively and governed by the prior appropriation doctrine that protects senior surface water users.

Oregon

Introduction

Conjunctive water management in Oregon also uses a classification of hydrologically connected waters approach. These classifications are provided for by basin programs which were adopted by Oregon's Water Resource Commission. In Oregon, the Water Resources Commission is charged with administering laws governing surface and ground water resources; the Oregon Water Resources Department (OWRD) is administrative arm of the commission (OWRD 2004). The goal of the department is "to restore and protect stream flows and watersheds in order to ensure the long-term sustainability of Oregon's ecosystem, economy, and quality of life" (OWRD 2009a, 1). The department is also responsible for the protection of existing water use rights. Under Oregon law, both surface and ground water are publicly owned. One must obtain a permit or water right from the OWRD in order to use water. Oregon's water laws are based on the prior appropriation doctrine.

Before the first unified water code was passed in Oregon, the only way to defend one's rights was through local courts. The Oregon code created state control over the right to use water (OWRD 2009b). A property owner may have a vested water right if water was used on one's land before the enactment of the 1909 water code and had continued to be used on that land since then. A water right is attached to the place of use even if the ownership has changed (OWRD 2009b).

The Oregon Legislature added groundwater management to the department's duties in 1995, which made all surface and groundwater public property. It is the department's job "to manage this water for the protection of existing water uses, the environment, and future needs" (OWRD 1999, 3).

Water Rights

In Oregon, the Water Resources Commission has adopted basin programs to better manage river basins. According to Bryner and Purcell, "basin programs are administrative rules which establish water management policies and objectives and which govern the appropriation and use of the surface and ground water within each of the respective basins" (2003, 48). The basin programs provide 'classifications' which describe the types of new water right applications that may be considered by the Water Resources Department. The Bureau of Land Management states, "due to the basin program, ground water and surface water are managed conjunctively within basins" (2001, 1-2). In order to assure sustained supplies for existing water users and to protect important natural resources, some waters in certain basins within the state are closed to new appropriation. These closures do not affect existing water users unless they are in a critical ground water area (OWRD 2009b). The Water Resource Commission declares certain areas as 'critical ground water areas' when the pumping of ground water exceeds the long term natural recharge of the aquifer. In these critical areas, according to Bryner and Purcell,

> All wells that produce water from an aquifer that is determined to be hydraulically connected to a surface water source shall be assumed to have the potential to cause substantial interference with the surface water source if the existing or proposed ground water appropriation is within one of the following categories: the point of appropriation is less than one-fourth mile from the surface water source; the rate of appropriation is greater than five cubic feet per second, if the point of appropriation is less than one mile from the surface water source; the rate of appropriation is greater than one percent of the pertinent adopted minimum perennial streamflow or instream water right with a senior priority date, if one is applicable, or of the discharge that is equaled or exceeded 80 percent of time, as determined or estimated by the Department, and if the point of appropriation is less than one mile from the surface water source; or the ground water appropriation, if continued for a period of 30 days, would result in stream depletion greater than 25 percent of the rate of appropriation, if the point of appropriation is less than one mile from the surface water source (2003, 48).

Oregon law restricts further groundwater appropriation in these areas and water use is restricted to stop excessive decline in groundwater levels and quality degradation (Bureau of Land Management 2001).

In order to use water from any ground or surface water source in Oregon one must obtain a form of authorization from the OWRD. Once the application for water rights is submitted it is reviewed by the OWRD "to ensure other water users or public resources will not be injured by the proposed use and determine if water is likely to be available for use" (OPSW and OWEB 2000, 18). The department also looks into basin plan restrictions, local land use restrictions, and water quality during this process. Even with the water right permit, one is not guaranteed water because under the prior appropriation doctrine the amount one receives is determined by the water supply and senior right holder (OWRD 2009b). According to the OWRD, "in water-short times, water users with the oldest priority date can demand the amount specified in their right regardless of the needs of junior users" (OWRD 2009b, 1-1). Water rights are permanent and attached to the land where the use was approved unless the rights are transferred, abandoned, or forfeited which occurs from five consecutive years of non-use.

Conclusion

In Oregon, the Water Resources Commission has adopted basin programs to better manage river basins. These programs provide classifications which describe the type of new water right applications that can be accepted. Groundwater and surface water are managed conjunctively within basins due to these basin programs. In areas that are classified as critical ground water areas Oregon law prohibits further groundwater appropriation if it falls within several categories. These classifications help protect senior surface water right holders.

Utah

Introduction

The management of surface water and groundwater in Utah is conjunctive, a technique that water suppliers in Utah have been using for many years. In the case *Wrathal vs. Johnson*, 40 Pac. 2d 755 (1935), the Utah Supreme Court decided that all groundwater should be treated as an integrated resource with surface water and subject to appropriation under the permit system, so surface water and groundwater appropriation were to be treated the same under Utah's water laws (Bryner and Purcell 2003). However, even though conjunctive water management was recognized by the court in 1935, state laws and State Engineer did not begin to engage in this approach until much later. And as we will see below, Utah uses a classification of hydrologically connected waters approach similar to that of Colorado for conjunctive water management.

The Utah Division of Water Rights, led by the State Engineer, is the agency within the Utah Division of Water Resources (in the Department of Natural Resources) that controls the state's water resources. The Utah Division of Water Rights is responsible for the appropriation, distribution, and management of Utah's surface and groundwater. Utah's water rights are based on prior appropriation like most other western states. All waters in Utah, both ground and surface waters, are public property (Christensen et al. 2008). In Utah, unlike Montana, domestic water use is given priority over all other uses. According to Utah Code Section 83-3-21, "in times of scarcity, while priority of appropriation shall give the better right as between those using water for the same purpose, the use for domestic purposes, without unnecessary waste, shall have preference over use for all other purposes."

Role of the State Engineer

In Utah, water rights are administered by the state since water is public property. According to Smith, "since 1903, when statutory administrative procedures to appropriate water were first established, the exclusive method of obtaining a new surface right, (and since 1935, an underground water right) is through filing an application with and ultimately obtaining a certificate from the State Engineer" (2000, 2). The application shall be approved if "there is unappropriated water in the proposed source; the proposed use will not impair existing rights or interfere with a more beneficial use of the water; the proposed plan is physically and economically feasible and would not prove detrimental to the public welfare; the applicant has the financial ability to complete the proposed works; and the application was filed in good faith and not for the purpose of speculation or monopoly" (Bryner and Purcell 2003, 52-53). In Utah only about 26% of the state is open to new groundwater appropriation, and even then applications are closely reviewed and may not be approved (Utah Division of Water Resources 2005a).

Another job of the State Engineer is to create Groundwater Management Plans in regions of Utah to protect existing rights, to maximize beneficial use of water, and address issues unique to a specific groundwater basin (Utah Division of Water Resources 2005a). Bryner and Purcell note that "in these management plans, [the State Engineer] may limit the amount of new appropriations, set total maximum annual withdrawals, or even close the area to any new appropriations. His decision rests upon his belief of whether or not there is unappropriated water in the area. Some of the plans assert that groundwater and surface water systems need to be jointly managed as one system because the groundwater system is hydrologically connected to some surface sources" (2003, 53). Whether or not there is unappropriated water in the area is

determined from multiple measurements and studies of annual precipitation, recharge rates, and discharge rates performed by the State Engineer in these specific areas. The State Engineer also estimates future needs and demands of these specific areas (Bryner and Purcell 2003). Because no application studies are performed for the linkages between surface and ground waters, and water rights, we group Utah's approach with that of Colorado's – a classification approach.

Conjunctive Management

In 2000, Utah was the fourth fastest growing state in the country. Water was being used at an alarming rate because of a growing population and little precipitation. Several areas of the state had seen groundwater levels drop. To meet the state's increasing needs, water suppliers and the Utah Division of Water Resources began to look into conjunctive management. Conjunctive management not only improves the efficiency of a water system, but also adds to the amount of usable water and makes the water supply more reliable (Utah Division of Water Resources 2005a).

In Utah two main conjunctive management strategies are used. The first strategy is known as conjunctive use which is the planned and coordinated use of surface and groundwater resources. The second strategy involves conjunctive use, but also uses aquifer storage and recovery (ASR). This involves deliberately storing surface water in aquifers so that it can be taken out later when desired. Aquifer storage and recovery is implemented when excess surface water is available because building surface reservoirs and treatment facilities large enough to capture and treat all surface water runoff is not always possible. Events that point to the need for conjunctive management are increasing water demand, fewer opportunities to build surface reservoirs, declining groundwater levels resulting from groundwater mining, and the need to

maintain minimum stream flows for wildlife and their habitat (Utah Division of Water Resources 2005a).

Whether surface water or groundwater is used to satisfy the state's declining water levels, the key restriction is the small amount of precipitation occurring at irregular intervals. Utah averages only thirteen inches of precipitation a year, which is the second lowest of all the states. Droughts in Utah are a continuing pattern so planning ahead before the next drought occurs is imperative (Utah Division of Water Resources 2005a).

During a drought, the use of groundwater typically rises. While using more groundwater when surface water is unavailable is a part of conjunctive use, if nothing is done to replenish the groundwater reservoir after the drought is over, depletion can result (Utah Division of Water Resources 2005). In conjunctive management both surface and groundwater are important, but aquifers as reservoirs have several benefits over surface water reservoirs. For instance, they are not subject to evaporation losses. Also, because of increasing urban development, the number of available surface reservoir sites has dropped. Furthermore, the most economic surface reservoir sites have already been built, which leaves only the more expensive and technically challenging sites (Utah Division of Water Resources 2005).

Storage of water in a groundwater aquifer can be achieved in two different ways. One technique is in-lieu recharge, in which the amount of groundwater is increased in an aquifer by substituting surface water supplies for a user that would otherwise pump groundwater. The other technique is direct recharge, which places surface water into the ground to allow water stored in the aquifer to be available in high demand months (Utah Division of Water Resources 2005).

Conjunctive Use

The conjunctive use of surface and ground water sources allows for a more complete use of the available water supply and improves the reliability of that supply. However, conjunctive use has issues such as water rights, water quality, and physical location of surface and ground water supplies (Utah Division of Water Resources 2005). According to the Utah Division of Water Resources, "perhaps the most simple, and inexpensive, conjunctive use strategy is to maximize deliveries of treated surface water during the spring runoff months accompanied by the reduction or elimination of groundwater pumping while surface flows are available" (2005, 30). This allows the groundwater to naturally recharge. For this to be possible, the water suppliers must lower the cost of the treated surface water so local communities have an incentive to buy it and reduce the pumping of groundwater.

The greatest opportunities for conjunctive management in Utah lie with public water suppliers, not agricultural communities, because agricultural water users have little incentive to invest in this type of project due to the complexity and cost of storing water underground. When agricultural land is converted to urban land, the surface water rights of that land become available to the city. The city then has both surface water and groundwater rights, which allows greater flexibility to conjunctively manage the two supplies (Utah Division of Water Resources 2005a).

In 1991, the legislature enacted the Groundwater Recharge and Recovery Act, which defines the State Engineer's authority to permit and regulate conjunctive management projects, which contain an aquifer recharge and recovery component (Utah Division of Water Resources 2005a). Conjunctive use with ASR deliberately stores water in underground aquifers so it can be used at a later date when desired. According to the Utah State Water Plan, "an aquifer with

declining ground water levels can be looked upon as an empty reservoir just waiting to be filled and emptied, the same as a surface water reservoir. However, the empty aquifer is already 'built' and need only be developed and put to use. Full aquifers do not inhibit ASR projects; they can be used by first removing water and later refilling" (Utah Division of Water Resources 2005b, 32).

Conclusion

In summary, Utah's system for the conjunctive management of surface and ground water uses a classification approach. Groundwater Management Plans created by the State Engineer may limit the number of new appropriations, or completely close areas for new appropriations, or set the total maximum annual withdrawals. Classification of hydrologically connected waters in certain areas is determined by the State Engineer through studies of precipitation, recharge rates, and discharge rates. Due to a growing population and little precipitation Utah uses both conjunctive use and aquifer storage and recovery to improve the efficiency of the water system and make the water supply more reliable.

Wyoming

Introduction

Conjunctive water management in Wyoming also uses a classification of hydrologically connected waters approach. Classifications of critical areas are made to slow water development and help protect senior water rights. In Wyoming the State Engineer is the water rights administrator and is responsible for the appropriation, distribution, and management of all of the state's ground and surface water. Wyoming is divided into four water divisions, each of which is headed by a superintendent. The state engineer and the four superintendents make up the Wyoming Board of Control, which meets quarterly to adjudicate water rights and to consider other matters dealing with water rights and water appropriation (Brosz et al. 1995). Under Article 8, Section 1, of the Wyoming Constitution water is established as state property. According to Holland & Hart LLC, "the water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state are hereby declared to be property of the state" (2007, 1). Wyoming's water rights are based on the prior appropriation doctrine. In 1890, Wyoming adopted a comprehensive water rights code under the leadership of the state's first state engineer. This code still serves the basis for regulating Wyoming's surface and ground water (Holland & Hart LLC 2007). In Wyoming, prior to statehood in 1890, water rights could be established by a process predicated on the use of water and the filing of a claim with a territorial official. These water rights are called "territorial water rights".

Water Rights

To use surface water in the state of Wyoming, one must apply to the State Engineer for a permit. The permit process is very similar to all other western states. In Wyoming, water rights have the status of property and can be sold. Once approval is issued by the Board of Control the

type of use or place of use of a water right may be altered, although the historic use of water limits the transfer of these rights. The Board of Control must assure that no other appropriators are affected by these changes. The Board may also deny a water transfer when it determines that an unacceptable economic loss would occur in the community because of these actions (Holland & Hart LLC 2007).

Wyoming passed its first groundwater statute in 1947 and prior appropriation for groundwater was established and the registration system was provided. In 1969, legislation was passed requiring a permit from the State Engineer's office for the drilling of any water well. In the absence of a permit objection by an existing water right holder, surface and ground water are treated as hydrologically separate. If an objection is filed, the state engineer will investigate a possible connection by using monitoring wells. If the state finds a hydrological connection, then the source water use is treated as one source (Bureau of Land Management 2001). Bryner and Purcell note:

> Wyoming law provides that where aquifers are so interconnected as to in fact constitute one source of supply; or where ground and surface water are so interconnected as to in fact constitute one source of supply, priorities of rights to the use of all interconnected waters shall be correlated and such single schedule of priorities shall relate to the whole common water supply. Every groundwater permit includes an express condition that it may be subject to regulation and correlation with surface water rights if the ground and surface waters are determined to be interconnected (2003, 63).

The application processes for obtaining a groundwater right and surface water right are very similar except in a ground water control area. A ground water control area is designated by the Board of Control when it determines that "the use of ground water is approaching a use equal to the current recharge rate; ground water levels are declining or have declined excessively; conflicts between users are occurring or are foreseeable; the waste of water is occurring or may occur; or other conditions exist or may arise that require regulation for protection of the public

interest" (Brosz et al. 1995, 10). Three ground water control areas have been designated in Wyoming. The Board of Control creates an advisory board for each control area to review new permit applications, review requests for water right changes, and to advise the State Engineer's office on related matters (Wyoming State Engineer's Office 2006). Any unadjudicated well in a ground water control area must be adjudicated. The Board of Control then records the water use priorities to use water, the amounts of appropriations, the character and use of land, and the places or points of use in the control area. After the adjudication, the State Engineer decides if there is enough surface and ground water in the area to meet the needs of all appropriators in the area. If the State Engineer determines there is insufficient water in the area, he may close it to additional appropriations, stop or reduce withdrawals from junior users, institute the spacing of wells, or use a system of rotation of use. Designating a ground water control area helps to slow water development and protect senior water rights (Bryner and Purcell 2003).

The process for acquiring groundwater rights depends on the location of the well and the declared use. When a well is located in a control area the process becomes much more complicated. According to Holland & Hart LLC, "the State Engineer may grant a permit only if the there is unappropriated water, the well is adequate, the new use will not conflict with any state groundwater regulations, and the appropriation is not detrimental to the public interest" (2007, 1). After a final well examination by the State Engineer, a certificate of appropriation may be issued by the Board of Control. Regardless of priority dates, appropriations of groundwater for domestic or stock use may have preference rights over all other uses (Bryner and Purcell 2003).

Conclusion

In summary, Wyoming treats surface and ground waters as hydrologically separate, but if an objection is made to a new permit because the waters are part of the same source, the state will investigate by using monitoring wells to determine if there is a hydrological connection. If a connection is determined from the investigation the waters are treated as one source. The Wyoming Board of Control is in charge of the classification of hydrologically connected waters. When an area is classified as a ground water control area, water development is slowed and senior water rights are protected.

Nevada

Introduction

Under Nevada law, groundwater and surface water are regulated separately under prior appropriation rules, but managed conjunctively in practice (Bryner and Purcell 2003). The Nevada Division of Water Resources (NDWR), headed by the State Engineer, is responsible for the administering and enforcing of the Nevada water law. The NDWR is in charge of the adjudication, appropriation, and management of both ground and surface water in the state. All the water in Nevada, both surface and ground water, belongs to the public. Nevada water law was adopted on March 1, 1905. According to the NDWR, the state's water law is considered one of the most comprehensive water laws in the West. "Nevada water law has the flexibility to accommodate new and growing issues of water in Nevada while protecting those who have used the water in the past" (NDWR 2010, 1).

Water Rights

In Nevada, the only way to establish a new surface water right is by filing an application to appropriate water with the State Engineer. Since the Nevada Underground Water Act of 1939, the Nevada Division of Water Resources has had total jurisdiction over all groundwater in the state. Groundwater provides about forty percent of the water used in the state, and most groundwater supplies have been developed from relatively shallow aquifers, less than 500 feet below the ground surface (NDWR 1999). Surface water resources in the state are essentially fully appropriated and further development must rely either on the reallocation of surface water supplies or on groundwater sources (NDWR 1992). The process for acquiring a groundwater right is very similar to the process for surface water, but may be restricted if a new use would cause interference with preexisting wells. Prior appropriation is not strictly applied to

groundwater use because the State Engineer has the authority to designate certain preferred uses when making groundwater appropriations (Bureau of Land Management 2001).

Nevada is divided up into several Designated Ground Water Basins, which are basins where permitted groundwater rights approach or exceed the estimated average annual recharge and the water resources are being depleted or require additional administration. The State Engineer can designate basins either by petition or by calling a public hearing. In these Designated Ground Water Basins the State Engineer, in the interest of the public welfare, may declare preferred uses. The State Engineer also has additional authority in the administration of the water resources in these basins (NDWR 1992). The State Engineer will appropriate only as much water in a basin as can safely be expected to be recharged on average over the long run. Only if there is unappropriated water may the state engineer issue a permit. According to Bryner and Purcell, "if the well is for municipal, quasi-municipal or industrial use and the reasonably expected rate of diversion is one-half cubic foot per second or more, the engineer shall include as a condition that the right to pump water may be limited or prohibited to prevent any unreasonable adverse effects on an existing domestic well located within 2,500 feet of the well, unless the holder of the permit and the owner of the domestic well have agreed to alternative measures that mitigate those adverse effects" (2003, 39-40). Permits are not required only when groundwater use is for wells for domestic purposes and the withdrawal does not exceed 1,800 gallons/day and cannot be furnished by an entity such as a water district or municipality (NDWR 1999).

Conjunctive Management

In Nevada the state's rapidly expanding population is causing increased pressures on available water supplies and an increased need for integrated ground and surface water

management (NDWR 1999). The State Engineer tends to regulate surface and ground water within hydrographic basins separately. The water supplies of Reno and Las Vegas depend primarily on the surface flows of the Truckee and Colorado rivers. Water use everywhere else in the state depends primarily on underground pumping (Harris 2003). As previously stated, ground and surface water are regulated separately, but managed conjunctively. According to the NDWR, "the State of Nevada encourages conjunctive management of ground and surface water resources, to improve the reliability, economics and yield of available water supplies. The goal of conjunctive use of water systems in Nevada is to maximize the total yield of water" (1999, 2). The State Engineer encourages the practice of conjunctive use for both public water supply systems and irrigation systems in the state of Nevada (NDWR 1999).

Water resources must be evaluated on a case-by-case basis to assess the best management practices for each specific use, because the degree of connection between ground and surface water and the impacts due to water use can vary. Groundwater withdrawals from near surface aquifers in excess of perennial yield may affect the surface water base flow by drawing water down below the reach of a nearby stream. The over pumping of groundwater can not only impact stream flows, but also may cause ground subsidence over time. In the Las Vegas Valley, ground subsidence of up to five feet has occurred (NDWR 1999).

Conclusion

In summary, Nevada is divided up into several designated groundwater basins. These basins are determined in areas where permitted groundwater rights approach or exceed the estimated average annual recharge and the water resources are being depleted or require additional administration. Due to the state's expanding population there is an increasing need for integrated ground and surface water management. The State Engineer regulates surface and

ground water separately, but manages them conjunctively. Similar to Washington, water resources are evaluated on a case-by-case basis due to the fact that the connection between groundwater and surface water varies throughout the state.

References[7]

Executive Summary

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Bureau of Land Management - National Science and Technology Center. 2001. *Western States Water Laws*. Water Rights Fact Sheet. Available: http://www.blm.gov/nstc/WaterLaws/abstract1.html

Pearce, Michael J. 2003. *Southwest Hydrology*. Interactive Groundwater/Surfacewater Regulation in Arizona. Available: http://www.swhydro.arizona.edu/archive/V2_N4/feature3.pdf

Thompson, Stephen A. 1999. *Water Use, Management, and Planning in the United States*. Water Quality Law: The Legal System. Elsevier Science Inc.

Colorado

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Bureau of Land Management - National Science and Technology Center. 2001. *Western States Water Laws*. Water Rights Fact Sheet. Available: http://www.blm.gov/nstc/WaterLaws/abstract1.html

Colorado Division of Water Resources (CDWR). 2008. *Guide to Colorado Well Permits, Water Rights, and Water Administration*. Available: http://water.state.co.us/DWRIPub/Documents/wellpermitguide.pdf

Colorado Division of Water Resources (CDWR). 2010a. Augmentation Plans. *The Beginners Guide to Augmentation Plans for Wells*. Available: http://water.state.co.us/dwripub/documents/beginnersguidetoaugmentationplansforwells.pdf

Colorado Division of Water Resources (CDWR). 2010b. *History of Water Rights in Colorado*. Available: http://water.state.co.us/SurfaceWater/SWRights/Pages/WRHistory.aspx

Colorado Division of Water Resources (CDWR). 2010c. *Obtaining a Water Right*. Available: http://water.state.co.us/SurfaceWater/SWRights/Pages/HowGetWaterRights.aspx

[7] Note: the states' references are listed alphabetically rather than in the order presented in the report above.

Colorado Division of Water Resources (CDWR). 2010d. *General Information Brochure*. Available: http://water.state.co.us/DWRIPub/DWR%20General%20Documents/dwr_brochure.pdf

Douglas County Water Resources. 2010. *Colorado State Water Law.* Available: http://www.douglas.co.us/water/Colorado_State_Water_Law.html

Holland & Hart LLC. 2007. *Western Water Law.* Available: http://www.westernwaterlaw.com/

Idaho

Baxter, Garrick. Idaho Department of Water Resources. 2010. *The Fundamentals Underlying Conjunctive Administration*. Available: http://www.idwr.idaho.gov/WaterBoard/WaterPlanning/CAMP/TV_CAMP/PDF/2010/07-30-2010_Conjctv-Mngmt.pdf

Bureau of Land Management - National Science and Technology Center. 2001. *Western States Water Laws*. Water Rights Fact Sheet. Available: http://www.blm.gov/nstc/WaterLaws/abstract1.html

Cosgrove, Donna M. and Johnson, Gary S. 2004. Transient response functions for conjunctive water management in the Snake River Plain, Idaho. *Journal of the American Water Resources Association.* Volume 40, Issue 6 (1469-1482). Available: http://onlinelibrary.wiley.com/doi/10.1111/j.1752-1688.2004.tb01599.x/pdf

Idaho Department of Water Resources. 2007. *A Water Users Information Guide – Idaho Water Rights A Primer*. Available: http://www.idwr.idaho.gov/WaterManagement/WaterRights/PDFs/Water_Rights_Primer_Brochure_Aug07.pdf

Idaho Department of Water Resources. 2010a. *Ground Water Management and Critical Ground Water Areas*. Available: http://www.idwr.idaho.gov/WaterInformation/GroundWaterManagement/default.htm

Idaho Department of Water Resources. 2010b. *Strategic and Organizational Plan FY2011 – FY 2015*. Available: http://dfm.idaho.gov/Publications/BB/StrategicPlans/SP2011/WaterResources_SP.pdf

Idaho Water Resources Board. 2010a. *Current State Water Plan – 1996*. Revised 2010. Available: http://www.idwr.idaho.gov/waterboard/WaterPlanning/StateWaterPlanning/PDFs/2010/SWP.pdf

Idaho Water Resources Board. 2010b. *Water Supply Bank*. Available: http://www.idwr.idaho.gov/WaterManagement/WaterRights/waterSupply/ws_default.htm

Petersen-Perlman, Jacob, and Shively, David (Eds). 2009. *Proceedings of the Montana Conjunctive Water Management Conference*. http://dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/conjunctive_mgmt_proceedings.pdf

Montana

Clark Fork River Basin Task Force (CFTF). 2004. *Clark Fork River Basin Water Management Plan*. Chapter 4 - The Legal Framework for Water Management. Available: http://dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/chapter_4.pdf

Clark Fork River Basin Task Force (CFTF). 2008. *Managing Montana's Water: Challenges Facing the Prior Appropriation Doctrine in the 21st Century*. Helena, MT: Montana Department of Natural Resources and Conservation. Available: http://dnrc.mt.gov/wrd/Water_mgmt/clarkforkbasin_taskforce/pdfs/appropriation_paper.pdf

Maier, Allison. 2010. Independent Record. DNRC Reaches Water-Rights Agreement With Ranchers. Available: http://helenair.com/news/article_94cdf4e2-f2e2-11df-b783-001cc4c03286.html.

Montana Bureau of Mines and Geology (MBMG). 2010. *HB 52 – Ground Water Investigation Program*. Available: http://www.mbmg.mtech.edu/gwip/gwip.asp

Petersen-Perlman, Jacob, and Shively, David (Eds). 2009. *Proceedings of the Montana Conjunctive Water Management Conference*. Available: http://dnrc.mt.gov/wrd/water_mgmt/clarkforkbasin_taskforce/pdfs/conjunctive_mgmt_proceedings.pdf

Montana Department of Natural Resources and Conservation (DNRC), Montana Legislative Environmental Quality Council, Montana Water Center. . 2009. Available: http://leg.mt.gov/content/Publications/Environmental/2009waterrightshandbook.pdf.

Nevada

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Bureau of Land Management - National Science and Technology Center. 2001. *Western States Water Laws*. Water Rights Fact Sheet. Available: http://www.blm.gov/nstc/WaterLaws/abstract1.html

Harris, Richard W. 2003. *Water Law in Nevada: The Example of Mines at the Surface-Water/Groundwater Interface*. Available: http://www.swhydro.arizona.edu/archive/V2_N4/feature6.pdf

Nevada Division of Water Resources (NDWR). 1992. *Nevada Water Facts*. Available: http://www.pg-tim.com/files/NV_Water_Facts.pdf

Nevada Division of Water Resources (NDWR). 2010. *Nevada Water Law – An Overview*. Available: http://water.nv.gov/Water%20Rights/Water%20Law/waterlaw.cfm

Nevada Division of Water Resources (NDWR). 1999. *Nevada State Water Plan*. Available: http://water.nv.gov/WaterPlanning/wat-plan/con-main.cfm

Southern Nevada Water Authority. 2010. *Nevada Water Rights and Water Law.* Available: http://www.snwa.com/html/system_gdp_waterlaw.html.

New Mexico

Brockmann, James C. 2009. Overview of New Mexico's Groundwater Code. *27th Biennial Groundwater Conference and 18th Annual Meeting of the Groundwater Resources Association of California.* Available: http://pg-tim.com/files/NM_Groundwater_Paper_JBrockmann.pdf

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Franks, Martha. 2007. *The New Mexico Water Code, 1907 – 2007*. Available: http://www.ose.state.nm.us/PDF/Legal/Presentations/NM-WaterCodePresentation-byMarthaFrank.pdf

New Mexico Office of the State Engineer. 2007. Brief History of the Office of the State Engineer. Available: http://www.ose.state.nm.us/state_engineer_history.html

New Mexico Office of the State Engineer. 2009. *New Mexico Office of the State Engineer Interstate Stream Commission 2008-2009 Annual Report*. Available: http://www.ose.state.nm.us/PDF/Publications/AnnualReports/08-09-annual-rpt.pdf

Oregon

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Bureau of Land Management - National Science and Technology Center. 2001. *Western States Water Laws*. Water Rights Fact Sheet. Available: http://www.blm.gov/nstc/WaterLaws/abstract1.html

Oregon Plan for Salmon and Watersheds and Oregon Watershed Enhancement Board (OPSW and OWEB). 2000. *A Guide to Oregon Permits: with a focus on permits for Watershed Restoration Activities*. Available: http://www.oregon.gov/OWEB/docs/pubs/permitguide.pdf

Oregon Water Resources Department (OWRD). 1999. *Overview of Mission and Programs*. Available: http://www1.wrd.state.or.us/pdfs/overview99.pdf

Oregon Water Resources Department (OWRD). 2004. *Managing Oregon's Water - Infosheet No. 1*. Available: http://www1.wrd.state.or.us/pdfs/infosheet1.wrd.pdf

Oregon Water Resources Department (OWRD). 2009a. *Strategic Outlook 2009 - 2011*. Available: http://www1.wrd.state.or.us/pdfs/StrategicOutlook.pdf

Oregon Water Resources Department (OWRD). 2009b. *Water Rights in Oregon: An Introduction to Oregon's Water Laws.* Available: http://www.oregon.gov/OWRD/PUBS/aquabook.shtml

Utah

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Christensen, Keith, Hill, Robert, and Reid, Chad R. 2008. *Water Rights in Utah*. Available: http://extension.usu.edu/files/publications/publication/ENGR_WaterManagement_2008-01pr.pdf

Smith, J. Craig. 2000. *Overview of Utah Water Law.* Available: http://www.smithhartvigsen.com/resources/archive/overview.htm

Utah Division of Water Resources. 2005a. Utah State Water Plan. *Conjunctive Management of Surface and Ground Water in Utah.* Available: http://www.water.utah.gov/cmreport/cmreport1bcc.pdf

Utah Division of Water Resources. 2005b. *Water Right Information*. Available: http://www.waterrights.utah.gov/wrinfo/default.htm

Washington

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Gregoire, Christine O., McDonald, Thomas P., and Pharris, James K. 2000. *An Introduction to Washington Water Law.* Available: http://www.atg.wa.gov/uploadedFiles/Home/About_the_Office/Divisions/Ecology/Intro%20WA%20Water%20Law.pdf

Minier, Jeffrie. 2000. *Conjunctive Management of Stream-Aquifer Water Rights; the Hubbard Decision.* Available: http://repository.unm.edu/bitstream/handle/1928/2906/JeffrieMinier.pdf?sequence=1

Washington Rivers Conservancy. 2009. *Landowner's Guide to Washington Water Rights.* Available: http://www.warivers.org/wrc_handbook.pdf

Washington State Department of Ecology. 2006. Washington State Water Law – A Primer. Available: http://www.ecy.wa.gov/pubs/98152.pdf

Washington State Department of Ecology. 2010. State Water Use Law: The Groundwater Permit Exemption RCW 90.44.050. Available: http://www.ecy.wa.gov/programs/wr/comp_enforce/gwpe.html

Wyoming

Brosz, J. Donald, Fassett, Gordon, and Jacobs, J. James. 1995. *Wyoming Water Law: A Summery*. Available: http://library.wrds.uwyo.edu/wrp/90-17/90-17.html

Bryner, Gary, and Purcell, Elizabeth. 2003. *Groundwater Law Sourcebook of the Western United States*. Available: http://www.colorado.edu/law/centers/nrlc/publications/Groundwater%20Law%20Sourcebook.pdf

Bureau of Land Management - National Science and Technology Center. 2001. *Western States Water Laws*. Water Rights Fact Sheet. Available: http://www.blm.gov/nstc/WaterLaws/abstract1.html

Holland & Hart LLC. 2007. *Western Water Law.* Available: http://www.westernwaterlaw.com

Wyoming State Engineer's Office. 2006. About the SEO. Available: http://seo.state.wy.us/about.aspx

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