

SECTION IV: CASE STUDIES

Introduction to the Three Case Studies

In the following pages, three case studies are presented to demonstrate the utility of the institutional analysis concepts described herein, and to identify a few different ways in which the tenets of alternative problem-solving have found expression in modern natural resource and environment conflicts. The first case examines problems associated with groundwater overdrafting in the South Platte Basin of Colorado. In that region, the failure of Colorado law to adequately manage groundwater usage resulted, for a time, in a situation in which senior surface water rights holders became fearful of reduced flows due to water table declines attributable to unregulated groundwater pumping. This essentially created a spatial and temporal *externality* situation, in which the water demands of junior groundwater appropriators were elevated above those of senior surface rights holders. Groundwater overdrafting also created *depletion problems* affecting groundwater pumpers. While scientific uncertainty about the surface water/groundwater connection slowed efforts to address these highly related problems, legislative action eventually established a framework of rules under which technical expertise and a new collaborative group—Groundwater Appropriators of the South Platte (GASP)—have produced a solution heavily reliant on cooperative action, negotiation, and market incentives, all nested within a framework of private property rights and regulatory oversight.

The second case study presented addresses issues of forest management in the Applegate region of Oregon. The Applegate region is utilized to provide a specific context for an issue that is widespread in the West: determining appropriate timber harvesting levels. In this case, the *depletion problem* takes on a special character as a high-profile endangered species controversy is injected into the debate, raising highly familiar issues about the balancing of economic and environmental interests. These environmental concerns highlight *underinvestment* and *externality* problems characteristic of the modern environmental movement. While enactment of the Northwest Forest Plan of 1994 is the culminating event in the institutional history provided, it is the role and presence of collaborative groups in the region that is of particular interest, as many natural resource scholars see the Applegate region as an important laboratory in alternative problem-solving—a perception that is only partially accurate. As shown by the case study, it is the relationship between the alternative problem-solving strategies and the traditional means of conflict resolution that is of particular analytical interest.

The most complex of the three cases involves environmental restoration in the Truckee-Carson River Basins. In that region, the distribution (or *maldistribution*) of a limited water resource has created a host of problems, including *underinvestment* problems associated with endangered species and migratory waterfowl. The interplay of water allocation regimes and species

76 "Tributary" groundwater, also known as alluvial groundwater, is groundwater that interacts with surface flows, presumably by contributing to surface water flows during low-flow periods and by receiving inflows from surface systems during wet periods. Non-tributary groundwater, in contrast, refers to water resources located in deep aquifers and lacking a significant hydrologic connection to surface waters. Tributary groundwater is generally considered a renewable resource, while non-tributary groundwater is considered non-renewable—at least given the normal time frames upon which water allocation and management decisions are based. The focus in this study is primarily on tributary groundwater.

75 This case study is primarily adapted from the work of Lord in Gregg et al. (1991). Additional background information is available in Hillhouse (1975), Young et al. (1986), and MacDonnell (1986, 1988).

74 Since 1996, several issues have remained under debate; the conflicts in the Truckee-Carson Basin will likely continue for many years. By stopping the analysis at 1996, it is possible to provide some closure to the analysis. A similar rationale is utilized to stop the South Plate case in the early 1990s, and the Applegate case in early 1998.

A variety of institutional arrangements are utilized by western states to coordinate the management of surface and tributary groundwater.⁷⁶ Some states, such as Arizona and California, rely heavily upon water supply districts or similar organizations while others, such as Colorado and New Mexico, pursue this integration primarily through complex frameworks of water rights law. Given the frequently different regimes for water allocation and management between surface water and groundwater, "conjunctive management"—i.e., the coordinated management of surface and groundwater—can be a formidable institutional challenge, especially when this challenge is addressed during a period of conflict

Case Study Description⁷⁵

Conjunctive Management of Water Resources in Colorado's South Plate Basin

protection is a problem found throughout the West; the Truckee-Carson case provides one specific context for analyzing a set of issues that is discouragingly universal to the region. In order to focus on the most illuminating aspects of this situation, the case study primarily focuses on events surrounding the Truckee-Carson Pyramid Lake Water Rights Settlement Act of 1990, but places this event in an approximately 100 year context beginning with the initial development of the region under the auspices of the prior appropriation doctrine and Reclamation Act and ending with the situation as of 1996. Prior to this time period, an *open access situation* presumably existed, as did a broad set of issues associated with the settlement of Anglo populations in territories inhabited by Native Americans. The initial settlement of these issues is largely outside the scope of this case, which is on the modern goal of environmental restoration.⁷⁴

and with incomplete scientific understanding. This case examines some of the strategies used to achieve conjunctive management in the South Platte Basin in northeastern Colorado, from the earliest days of the Colorado territory to approximately 1990, with the greatest emphasis on events from 1957 to 1974.⁷⁷

Colorado Water Law: The Initial Framework of Property Rights

In the latter half of the 19th century, as Colorado evolved from a territory into a state, a framework of laws regarding water emerged (MacDonnell, 1986, 1988). In Colorado, as in other western territories and states, the common law riparian doctrine was judged to be inappropriate given the frequently arid and semi-arid conditions of the West. Riparian law was not well suited to dealing with conditions of scarcity, or to situations in which water usage occurred far from the stream channels. Consequently, out of the mining camps of California (circa 1848) emerged a series of rules known as the prior appropriation doctrine, first recognized by Colorado in 1879. The prior appropriation regime for surface water is based on the notion that all surface waters are owned by the state but can be "appropriated" by individual water users under certain conditions, resulting in the establishment of private usufructuary rights.

Acquiring a surface water right under prior appropriation requires a party to make a diversion from a natural stream course and put it to a "beneficial use," such as irrigation. The amount of the right corresponds to that amount beneficially consumed, and in times of shortage, those rights established first are satisfied completely before more "junior" rights holders receive any water (i.e., the so-called first-in-time first-in-right, or seniority, principle). The enforcement process is known as a "call" on the river, and is administered by the State Engineer. Surface water rights are transferrable through market exchanges, given that such transfers do not impair the rights of other recognized appropriators, a determination in Colorado made by a system of water courts. While Colorado is unique in its use of a water court system, these other elements of prior appropriation are found in similar form in all western states.

In stark contrast, rules governing the allocation and use of groundwater resources in Colorado were largely non-existent until recent decades, in part due to a lack of scientific understanding about the workings of the hydrologic system

⁷⁷ While the resolution of water supply issues through a form of conjunctive management is the focus of this case, it is worth acknowledging that in recent decades, the primary natural resource issue in the Platte Basin has involved environmental issues: namely, the fate of the endangered whooping crane, and the responsibilities of the federal government and Colorado, Wyoming, and Nebraska in addressing this problem. Actions to address this problem are ongoing, and include efforts to prepare an Environmental Impact Statement. The omission of this issue from this case study is not intended to suggest that environmental issues are unimportant, but simply reflects a desire herein to illustrate a different set of concerns. Environmental issues involving endangered species are prominently featured in the following two cases involving forest resources in Oregon and water/wetlands resources in Nevada.

A variety of institutional solutions was potentially available to reduce groundwater pumping. For example, a regulatory framework could be installed prohibiting the usage of certain pumping technologies, or perhaps restricting withdrawals in excess of a given standard. Or, the property rights regime currently governing groundwater could be augmented by quantifying groundwater rights associated with land parcels. Still another approach would be to utilize market-based incentive systems to discourage excessive use. The solution first crafted by the Colorado Legislature in 1957 contained elements of both a regulatory and property rights solution by empowering the State Engineer, under

Search for Institutional Solutions

solution to these problems was needed. Groundwater in the basin. Given this hydrologic connection, a comprehensive surface water users were thus impacted by the growing consumption of withdrawals diminish the yield of the underlying aquifer, both groundwater and system during low flow (and peak use) periods. To the extent that groundwater tributary groundwater is critical in maintaining the base flow of the surface water-groundwater connection progressed. In many systems, including the South Plate, conflict emerged, in part, as scientific understanding of the surface water-pumping levels resulted in declining water tables for all groundwater pumps in a given region, regardless of their individual levels of use. The second type of surface water appropriators. This first type of conflict emerged as escalating groundwater pumps against each other, and groundwater pumps against growing water demands created a host of problems and conflicts, pitting by increased transmountain surface water imports (MacDonnell, 1988).

1950s also contributed to growing demands, which were only partially satisfied following the conclusion of World War II. Major droughts in the 1930s and availability of affordable electricity, and accelerated with the economic boom 1930s with the development of high lift submersible pumps and the widespread groundwater reserves would inevitably climb. That climb began in earnest in the appropriated by the start of the 20th century, ensuring that demands on withdrawals. However, surface waters in the South Plate Basin were fully technology of groundwater pumping—was insufficient to support large problematic, as the demand for ground water—and perhaps more importantly, the land ownership) regarding groundwater pumping rights was not initially The failure of Colorado law to establish limits or other rules (other than

Emergence of Water Supply Controversies

groundwater rights were not effectively quantified or limited in any way. underground, and in part due to a lack of apparent conflicts among water users (MacDonnell, 1986, 1988). Closely following English common law, access to groundwater resources was viewed as a right of land ownership. Landowners enjoyed broad discretion in pumping and using groundwater underlying their lands, and unlike the prior appropriation doctrine for surface water, these

certain circumstances, to establish and implement a permitting system, declaring tributary groundwater subject to the basic rules of appropriation.⁷⁸

This approach, a mixture of regulatory and property rights strategies,⁷⁹ was significantly flawed in two ways. First, the new rules only applied to new wells, an innovation which did nothing to provide pumping limits on those existing wells already causing problems. Regulation of new wells was a wise step, but was clearly an incomplete and politically-motivated solution. Second, new rules calling for the State Engineer to restrict groundwater pumping when senior surface water rights were impaired was of no practical benefit due to long time delays associated with the underground movement of water. The "call" system, which can work quite well for surface water regimes, was not well suited to the conjunctive management situation in the South Platte or in most other parts of the state, prompting the State Engineer to conclude that no groundwater pumping restrictions could be justified during shortage situations. Despite the sound technical basis of this decision, the legislature saw the action of the State Engineer as insubordinate, and ordered the public servant in 1965 to implement the 1957 "solution" by shutting down wells in accordance with a call on the river.⁸⁰ When this was subsequently done in the Arkansas River Valley, it initiated a legal challenge that upheld the original position of the State Engineer. Pumping could not be restricted unless it could be shown to materially benefit senior appropriators.⁸¹

Learning from past mistakes, and from a detailed study authorized in 1967⁸² exploring the surface water-groundwater connection, the legislature in 1969 finally incorporated all nontributary groundwater wells into the prior appropriation system. The Water Right Determination and Administration Act of 1969 established a three-year process during which all undecreed wells would be adjudicated with a priority date of initial diversion.⁸³ Also, new points of diversion for surface water rights, including new wells, were authorized as necessary to avoid injuries to senior rights. Finally, the Act and related legislation provided two strategies groundwater pumpers could utilize to avoid

⁷⁸ Colo. Session Laws, ch 289, § 5; codified at Colo. Rev. Stat., § 148-18-2 (1963).

⁷⁹ Note that prior appropriation, in general, is a mixture of property rights and regulatory elements, since administrators (i.e., State Engineers, water departments, and/or water courts) have a role in program implementation. A pure property rights regime would leave all enforcement actions to civil liability lawsuits.

⁸⁰ Act of May 3, 1965; 1965 Colo. Session Laws, ch 318, § 1.

⁸¹ *Fallhauer v. People*, 167 Colo. 320, 447 P.2d 986 (1968).

⁸² Colo. Rev. Stat. § 148-2-9 (Supp. 1967).

⁸³ Colo. Rev. Stat. § 37-92-101 to -602 (1973), *et seq.*

⁸⁵ GASP operates under rules specified in S.B. 105, 1969 Colo. Sess. Laws 1196 (ch 370, § 8), later codified at Colo. Rev. Stat. § 37-80-120 (1973). Similar organizations exist elsewhere in Colorado (MacDonnell, 1986).

⁸⁴ Initially, the State Engineer attempted to implement the law by establishing a system of zones, defined in terms of transit time of tributary groundwater to the closest surface water source. Wells in zones with the shortest transit time were to be subject to the most frequent curtailments during surface water shortages, while those farther away would often not be curtailed since these reductions would not benefit surface flows in a timely manner. Although approved by the Colorado Supreme Court, these proposed rules were withdrawn before they could take effect due to concerns over administrative complexity, the likely continuance of some injury to senior rights holders, and to a reluctance to impose the greatest restrictions on wells closest to the river channels—often the most productive lands (Gregg et al., 1991; MacDonnell, 1988). Interestingly, a similar system was adopted in the Gila River adjudication by Judge Goldfarb.

After publication of these new rules, one group of pumpers deciding to utilize the replacement water supply strategy organized into an association known as Groundwater Appropriators of the South Plate (GASP).⁸⁵ By the 1990s, GASP had grown to include over 1,400 members, operating over 3,000 wells withdrawing over 400,000 acre-feet annually—about 95 percent of the basin's pumping. GASP functions by collecting funds from pumpers to lease and purchase water rights and reservoir storage rights, to purchase recharge credits, to drill new wells (and extract water from them), and take related actions needed to deliver adequate quantities of replacement water to surface water interests impacted by groundwater pumping. Funds are raised from a tax on water pumped, generally around one dollar per acre-foot—at least 20 times lower than the market value of water in the region.

Groundwater Appropriators of the South Plate (GASP)

After considering various strategies, draft rules for implementing the Water Right Determination and Administration Act were issued in 1972.⁸⁴ Final rules were issued two years later. As first articulated in the 1969 legislation, groundwater users were required to pursue one of the two strategies for avoiding injury to senior surface rights holders—augmentation or replacement—complete loss of groundwater pumping rights within three years. This was a significant regulatory limitation on the property rights of groundwater pumpers. Parties developing a court-approved augmentation plan would be allowed to continue pumping indefinitely; those pursuing a strategy of finding replacement water supplies needed to annually negotiate an acceptable strategy with the State Engineer.

Having their pumping rights curtailed. The first was to adopt and follow a court-approved plan for augmenting water supplies; the second was to provide replacement (or “substitute”) water of sufficient quality, quantity, and timing to forestall injuries to the senior surface water rights holders.

About 100,000 acre-feet of replacement water is annually provided in this way to the State Engineer and eventually to surface water users. Over half of this supply comes from wells operated by GASP.⁸⁶ This level of replacement water required has been increased over time, by order of the State Engineer, in response to learning over the quarter century of operation. Initially, a stipulated decree called for a replacement level of 5 percent (Hillhouse, 1975). However, largely through a process of trial-and-error, this level of replacement was shown to be inadequate, leading to new rules by the 1990s requiring a 25 percent replacement level.⁸⁷ At least for the present, this new set of rules appears to provide a workable institutional framework for conjunctive management in the South Plate.

Case Study Analysis

Review of the Operational Choice Level Problems

As is true for most cases involving complex resources over an entire century, many different types of operational level problems can be identified. This analysis is primarily concerned with that set of problems that emerged in the post-WWII era pertaining to water supply management, and the relationship between surface water and tributary groundwater. With those qualifications, only two major problems—both largely solved—merit a focused analysis:

- (1) *Externality Problem*. The primary problem in this case was the harm (i.e., externality) imposed upon surface water rights holders by junior groundwater pumpers. This problem was not effectively addressed until the early 1970s when Colorado water law finally was modified to reflect the physical reality of the groundwater-surface water connection, and a workable mechanism for conjunctive management was established.
- (2) *Depletion Problem*. The other, and closely related, problem in this case involved the inadequacy of institutional rules to provide any real limits on groundwater pumping, creating burdens for not only surface water users (i.e., the externality problem described above) but also for the community of groundwater users. Burdens borne by particular pumpers

⁸⁶ To understand how this system works, consider the case of the senior rights holder (holding a 1873 priority date) far downstream in the basin near Sterling Number 1 ditch. When that party faces a reduction in surface water supplies, a nearby well owned and operated by GASP pumps groundwater directly into the ditch to satisfy the call. This water is provided to replace surface water depletions presumably caused by groundwater pumping throughout the basin.

⁸⁷ This is consistent with the recommendations by Young et al. (1986).

The depletion problem in this case is also useful in illustrating how the symmetry concept influences the definition of externalities. As used throughout this report (and most similar discussions), the term externality is normally reserved for asymmetric situations—i.e., those in which one party imposes a burden on another, but not vice versa. That is clearly the case in problem # 1 as

and use of finite resources. institutional rules (particularly boundary and authority rules) fail to control access case, as both are useful in illustrating the outcomes that can occur when creation of GASP. Thus, neither metaphor is clearly superior to the other in this community was not organized in any sort of distinguishable collective unit case do not readily meet the typical characterization of a CPR either, in that this of water law doctrines. However, the community of groundwater pumpers in this formal awarding of public domain lands to individuals and the later enactment better reserved for the situation in the first half of the 19th century prior to the limitation on access; thus, this is not a classic open access situation—a term resource. The requirement that groundwater pumpers be landowners is a notable allowing and even encouraging individual actions resulting in overuse of a shared scenarios in which access to a resource is inadequately controlled, thereby depletion problem here has qualities typical of both *open access* and *common pool resource (CPR)* situations. These terms are typically utilized to describe terms and metaphors that can be used in institutional analysis. For example, the case, the depletion problem is perhaps more useful in reviewing some of the While it is the externality problem that is of particular salience in this

total levels of groundwater usage. boundary rule, was not married to authority rules capable of similarly controlling waters. However, the land ownership requirement of groundwater pumping, a rights with some regulatory elements to effectively control direct use of surface For many decades, the prior appropriation doctrine had merged private property (areas). This was a payoff rule encouraging and facilitating groundwater overuse. rural areas) and by groundwater availability (which was now declining in some groundwater pumping was limited only by the cost of electricity) (subsidized in after the technological revolution in pumping technology of the 1930s, groundwater usage. Prior to the institutional reforms beginning in the 1950s and deficiency: i.e., the inability of Colorado water law to adequately control Basin can largely be thought of as two sides of the same coin, caused by the same

Key Attributes of the Problematic Situation

The *externality* and *depletion problems* experienced in the South Platte region through groundwater laws and the GASP mechanism. included both short-term and potential long-term deficiencies in groundwater supplies, and due to the externality problem, institutional reforms that placed potentially significant restrictions and increased costs on the use of groundwater (i.e., the augmentation and/or replacement requirements). These problems have largely been resolved in the study

88 A related complicating factor not discussed in the case study description is that many surface water users are also groundwater pumpers. These are not entirely separate groups. For the purposes of analysis, however, it is useful to describe surface water and groundwater users as distinct groups (i.e., positions), given that each features a different corresponding set of institutional rules.

Only after the technical nature of the problem had become obvious did the legislature enact the skills of technical experts to help define those rules that

of the 1957 legislation to consider pre-1957 wells was also a huge omission. senior surface rights holders suffering from low surface water flows. The failure of pumpers needlessly burdened by restrictions on pumping imposed on behalf of threatened to create a new type of externality problem—that of groundwater rule not address the underlying externality problem, but if implemented, it and surface water depletions. Given this fact, not only would enforcement of this poorly understood (by the legislature) time lag between groundwater pumping approach to limiting groundwater rights, they proved to be unworkable due to the shortage. Although these new reforms did provide a seemingly reasonable State Engineer to prohibit groundwater pumping in times of surface water sought to address this problem by empowering and subsequently requiring the situation and the need for conjunctive management. That body's 1957 action water allocation regime, the Colorado legislature became aware of the externality As growing groundwater usage threatened the integrity of the surface

Problem-Solving Prior to GASP

The two problems discussed in this case were primarily addressed by that set of innovations bounded by the Underground Water Act of 1957 and the publication of implementing rules in 1974 pertaining to the Water Right Determination and Administration Act of 1969. Rules codified in those efforts finally created a framework for prohibiting, or at least constraining, the problem-creating behaviors seen in the South Platte. The primary contribution of GASP, a collaborative group operating at the collective choice level, has been in providing a workable administrative mechanism for implementing conjunctive management. This is no small accomplishment, given the technical demands of conjunctive management, and the sheer magnitude of the water users involved.

The Institutional Solution

junior groundwater pumpers were allowed for a time to diminish needed surface water flows to which other parties had recognized rights. The second problem (i.e., the depletion problem) also describes a situation where the actions of some parties lead to burdens borne by others. However, since there is considerable overlap between the generators and bearers of these "externalities"—i.e., both belong to the community of groundwater pumpers—the relationship is reciprocal (or symmetric), and features a set of incentives and qualities that distinguishes this situation from the classic externality definition.⁸⁸

eventually became the Water Right Determination and Administration Act. This was an important turning point, as a key feature of this case study is the salience of *cognitive conflict* in collective choice (and constitutional choice) level problem-solving. While *value and interest conflicts* also existed in this case, they were quickly addressed by the state legislature and the judiciary in asserting that the priority tenet of prior appropriation was to be applied between surface water and groundwater. There was some hesitancy about treating new and old groundwater users in similar terms; however, that debate was short-lived, and was consistently overshadowed by the more formidable cognitive conflict rooted in the lack of understanding in the state legislature about the hydrologic connection of surface water and groundwater. Resolution of this cognitive conflict did not occur until the legislature invoked the greater technical knowledge of the State Engineer, along with an ad hoc committee of water engineers and lawyers, in the drafting of rules associated with the Water Right Determination and Administration Act.

Key among the innovations found in that body of law was the requirement that groundwater pumpers had to either devise acceptable plans for augmenting or replacing surface water flows, or face complete loss of groundwater pumping rights. This was a tremendously important modification of the rules associated with groundwater pumping, especially the boundary and authority rules, and created a need for a new position: regional replacement water manager. This position, filled by the creation of GASP, was needed given that the technical demands of implementing a replacement water strategy can be most efficiently addressed through collective action.⁸⁹

GASP serves as a vehicle for implementing solutions to the two operational choice level problems, as well as for addressing lingering collective choice problems of cognitive conflict. GASP, working closely with the State Engineer, contributes to the resolution of the first externally problem by implementing what is known as the "physical solution"—i.e., providing replacement waters in the amount, timing, and location needed to offset surface water declines attributable to the pumping actions of GASP members. As the legislature learned in 1957, it is one thing to require surface and groundwater users to both adhere to the priority system of water allocation, and quite another to successfully implement this concept through conjunctive management. Thanks to the joint actions of the Colorado legislature, the State Engineer, and GASP, no longer can surface water users in the South Platte assert that groundwater pumping impairs their senior rights recognized under prior appropriation.

⁸⁹ While GASP is normally viewed as an innovative creation, some parties have called GASP the "illegitimate son of the State Engineer" in part due to the rules, designed by the State Engineer, that encouraged (some would say coerced) groundwater users to join GASP and similar arrangements or risk forfeiture of pumping rights. (For example, see the comments of Bart Woodward, President of GASP, in MacDonnell, 1986:68.)