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Water Banking and Traditional Irrigation Enterprises

How Lessons from the Past Lead to Successful Water Banking and Marketing

John Wilkins-Wells, Ph.D.
Principal Investigator
Department of Sociology, Colorado State University
Sociology Water Lab

Troy Lepper, Ph.D. Candidate
Principal Investigator
Department of Sociology, Colorado State University
Sociology Water Lab

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John Wilkins-Wells, Ph.D., Sociology Water Lab, Colorado State University
Troy Lepper, M.S., Sociology Water Lab, Colorado State University

Introduction

The Colorado State University Sociology Water Lab has been conducting research on water banking and water marketing in the West. This has involved (1) comparing and contrasting recent water banking initiatives in the Arkansas Valley, Colorado, with the Upper Snake River water banking tradition in Idaho, (2) investigating numerous new water banking initiatives in the southern San Joaquin Valley of California, and (3) examining the efforts of traditional irrigation enterprises in water management to adopt market-type mechanisms to address competition for water resulting from urbanization.[1]

A recent effort by the State of Colorado to introduce water banking on a regional basis has shown very limited success. Meanwhile, water banking in Idaho and in California, particularly groundwater banking, proceeds with greatly renewed interest.[2] Groundwater banking in those states appears at least partly due to the difficulties of obtaining environmental approval and adequate financing to build additional surface storage systems.

Our study is attempting to understand the apparent lack of local landowner interest in Colorado's state initiated water banking program. There may be important lessons here for similar efforts in other states. The results of the Colorado initiative were rather unexpected, given a generally robust state tradition of innovative and successful water marketing. This includes a long tradition of mutual irrigation company rental markets, very early and clever trans-mountain diversion projects initiated by many different local groups throughout the state, the recent success of a group of landowners in the Arkansas Valley to fallow a portion of their land and lease their irrigation company water stock to cities, and a long-standing and innovative market-oriented federal water project; the Colorado-Big Thompson Project.[3]

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[1] We define mutual irrigation companies and irrigation districts as traditional irrigation enterprises. The term "irrigation enterprise" is not used very frequently today. It was a term used by Wells Hutchins in his many publications on these organizations. See "Irrigation Enterprise Organizations," USDA Circular No. 934 (October, 1953) for a still valuable discussion of these organizations. For a discussion of the financing of irrigation in the West, see R. Smith, *Troubled Waters: Financing Water in the West*. The Council of State Planning Agencies, Washington, D.C., (1984). This is still a very relevant contribution to understanding the role of these enterprises in the West.

[2] California Water Plan Update, Volume 1, Bulletin 160-93 (October, 1994). State of California Department of Water Resources.

[3] Maass, A. and Anderson, R.L., …and the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments. Robert E. Krieger Publishing (1986); Brand, C.C. and Lusk, K.D., Agricultural Water Leasing: A Supplemental Water Supply Strategy for a Growing City. Proceedings, 2006 U.S. Committee on Irrigation and

In 2001, the State of Colorado passed HB-1354 authorizing the creation of a basin-wide, state administered water bank in the Arkansas Valley.[4] This was conceived as a pilot program with a well-thought out administrative procedure protecting third party injury and utilizing state-of-the art computer facilitated procedures. However, very shortly after the passage of the bill, and during the state's administrative formation of the Arkansas Valley water bank, communities in the lower portion of the valley proceeded with a totally separate initiative of their own. This involved the creation of the Lower Arkansas Valley Water Conservancy District (LAVWCD) in 2002. Under energetic leadership, LAVWCD is currently exploring many different approaches to in-basin water marketing in Colorado's lower Arkansas River basin.[5]

The new Arkansas Valley conservancy district appears to have been largely inspired by landowners and communities who were concerned about a proposed purchase by a Louisiana-based investment firm of 40 percent of the water rights in the Fort Lyon Canal Company, the largest mutual irrigation company in Colorado. The conservancy district formation appears to have been at least in part an emergency initiative designed primarily to keep decreed water from being transferred out of the lower basin through such purchases and exchanges.[6]

Since its formation, LAVWCD has developed a successful but limited land conservation easement program, and has been purchasing water outright from local landowners when advertised for sale. Water is leased back to landowners or to ditch companies for local groundwater augmentation programs and surface irrigation. The conservancy district generally expresses no interest in allowing the valley's decreed water to be transferred out of the lower basin, thus placing some limits on the nature and scope of future water marketing in this area.

In addition, several years ago a groundwater management association was established in Colorado's lower Arkansas Valley. It is called the Lower Arkansas Valley Water Management Association (LAWMA).[7] This organization operates very much like a mutual irrigation company, issuing stock certificates and purchasing water for the purpose of reallocating it to association shareholders to meet interstate compact

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Drainage, Ground Water and Surface Water Under Stress.; Tyler, D., The Last Water Hole in the West. University Press of Colorado (1992).

[4] Colorado General Assembly. (2001). "House Bill 01-1354: Concerning the Establishment of a Water Banking System and, in Connection Therewith, Making an Appropriation." http://www.leg.state.co.us/2001/inetcbill.nsf/billcontainers/2FA4967802CC2A07872569C9004D0385/$FILE/1354_enr.pdf

[5] Lower Arkansas Valley Water Conservancy District Website (What We Do) gives a brief explanation of the approach that the newly formed conservancy district is taking to address water problems in the lower Arkansas River Basin. www.lavwcd.org.

[6] Mestas, A. "51 Counties Back Water Ballot Issue." Pueblo Chieftan. October 23rd, 2002. Baird, R. "Creation of New Lower Arkansas Valley Water Conservancy District On Ballot" Rocky Ford Gazette. October 2nd, 2002. Wood, M. "Ballot Issue to Hold Water: November 5th proposal would establish new valley district." Pueblo Chieftan. October 6th, 2002.

[7] Williamsen, T.A., Development of Replacement Water Supplies by the Lower Arkansas Water Management Association. Proceedings, 2006 U.S. Committee on Irrigation and Drainage, Ground Water and Surface Water Under Stress.

requirements. This effort has been quite successful in finding new ways to utilize a traditional and familiar organizational design for water banking. A central theme of this report concerns such efforts by irrigators in the West to utilize traditional organizational designs for water banking.

Meanwhile, the State's pilot water bank initiated under HB-1354 has been virtually terminated for lack of utilization and interest. The need to better understand these events, particularly why recent and past local efforts at water banking were successful while the state-sponsored program was not, is of great importance to the present research. In an effort to better understand successful and unsuccessful attempts at water banking and water marketing in the West, the current research is focusing on important social factors.

Research Perspectives

The Sociology Water Lab's perspective on water banking rests on the notion that it is simply one of a family of water marketing and transfer institutional mechanisms used to move water around the landscape. As water marketing experiments occur throughout the West, water users and organizations must sort through locally unique traditions, circumstances, and constraints to find suitable mechanisms to conduct this marketing. The limited success of the recent HB-1354 initiative suggests that future state efforts to form these institutions could allow for somewhat more participation and inclusiveness in the outreach program associated with building these innovative institutional arrangements. It is also important to ensure that these initiatives are welfare-enhancing to the local community and in keeping with local values and norms, along with the emphasis on marketing water more efficiently.

There is often a certain degree of historical path dependency playing into these initiatives.[8] The local water culture or tradition, water supply, age and temperament of the landowners, population trends and other pressures often determine what is likely to be the best approach to introducing water marketing concepts. This understanding can generally only be accomplished by soliciting from local residents what their communities will accept in the way of water marketing designs. Furthermore, it is believed that a more comprehensive approach to water marketing that includes institutional support for field fallowing programs, interruptible supply agreements, water exchanges, conservation easements, and perhaps some canal consolidation and/or modernization, along with water banking, has a greater potential to stimulating interest in water marketing.

The HB-1354 inspired water bank was clearly directed at the economic interests of individual landowners. However, the lower Arkansas Valley is the home of 20 mutual ditch and irrigation companies and numerous incorporated and unincorporated lateral and reservoir storage enterprises. All of these are joint stock companies with decreed flow rights and/or storage rights to Arkansas River flows. In any effort to market water in the

[8] The term "path dependence" is used in development economics to refer to the general effects of history, social development and culture on the evolution of institutions, policies and overall economic opportunities for a particular economic system. Lal, D., and Myint, H., The Political Economy of Poverty, Equity and Growth: A Comparative Study (p. 295-99).

valley, through a water bank or other means, these enterprises constitute a significant collective interest group on their own, apart from the individual landowners who own stock in these companies.

Unlike many other prior appropriation states, where the board of directors of such enterprises may have an important trustee role in approving or denying water transfers, Colorado generally treats canal company stock as real personal property. Unless stated in the bylaws of the enterprise, the selling of water stock out of the ditch is legal in Colorado, although only the historical consumptive use of the water on the landowner's land is allowed to be transferred. Such transfers generally do not require board approval either, unless stated in the bylaws of the organization. In retrospect, it appears that the recent state water banking initiative which could be said to have successfully targeted the economic interest of the individual landowner, nevertheless left out an important interest group; the collective economic interests of the mutual irrigation companies in the valley.

Even in the recently successful parallel effort by landowners under a mutual ditch company in the lower basin of the Arkansas Valley to fallow land and lease water to a local municipality, the board of directors of the ditch company was apparently involved to some degree in determining what lands under the irrigation company were to be fallowed. This general oversight of the state water banking initiative to factor in mutual irrigation company interests may have led to some confusion and perhaps distrust toward the initiative by local landowners, who historically have often deferred to ditch company boards and neighboring landowners before contemplating water exchanges or sales of any form.

Given the way the West's water supplies are generally organized, if water banking and water marketing are to have any success, then it would appear that some effort should be made to better incorporate the interests of traditional mutual irrigation companies and irrigation districts. This is a key idea running through this study.

Productivity of Irrigation Enterprises

In the context of increased competition over water and its effect on traditional social values and behavior in agriculture, it may be of use to view mutual irrigation companies as having both a productivity-oriented (growth-oriented) dimension as well as a maintenance sustainability dimension to their day-to-day management. It might be worth taking a minute to briefly explore this point. These organizations may be crucial to the future success of water banking and water marking initiatives in the West.

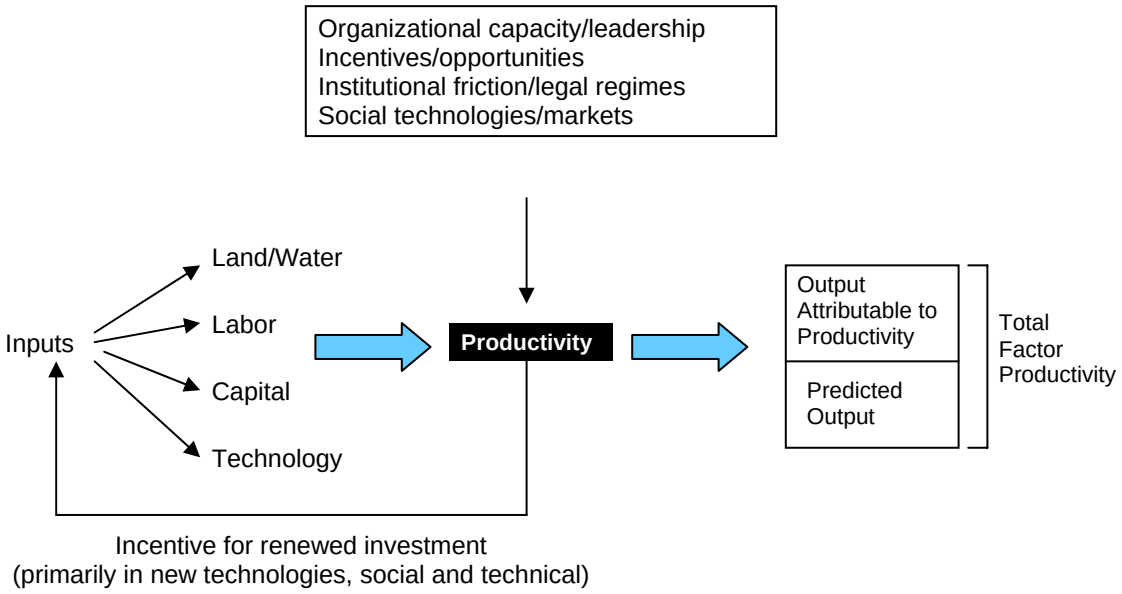
Using a traditional "economics of the firm" analogy to understand these organizations, we might envision factors of production (inputs) entering into the "black box" of any firm's overall productivity (Figure 1). This productivity is in turn affected by the quality of the firm, its leadership, the opportunities placed before it to pursue innovative management ideas, institutional and legal problems in its immediate environment, and the quality and robustness of the markets it is exposed to. In Figure 1, the arrow running from the productivity box and pointing back toward factor inputs (normally defined as

common factor prices) tends to represent the new thinking in economics concerning the incentive of firms to grow and innovate.[9]

In this model of productivity of the firm, output or total factor productivity might be said to have two components. One is more or less predictable, given the quality and cost of factor inputs, and is often in a one to one ratio to these inputs. An increase or decrease in factor input costs can potentially affect innovativeness and productivity. However, economists are increasingly recognizing that an important additional component of a firm's innovativeness and productivity is derived from the internal organizational capabilities of the firm itself, along with the institutional environment it operates in, rather than simply changes in factor prices. Together, both of these inputs, factor prices and organizational design and capabilities, combine to realize the total factor productivity (TFP) of the firm.

Put another way, the firm's incentive to grow and innovate is often the result of increased productivity, but more frequently defined by such things as organizational capacity or leadership, flexibility in legal regimes, effectively controlling "free riders," local control over sanctioning and conflict resolution, and of course the quality of markets. These are often as important, if not more important, than the changing economic value (and price) of the various factor inputs to the firm.[10]

Figure 1 – Economics of the Firm as Applied to Non-Profit Irrigation Enterprises



[9] A good review of current ideas on productivity, and from the viewpoint of development economics, can be found in E. Helpman, The Mystery of Economic Growth. Cambridge, Mass.: Belknap Press of Harvard University Press, (2004).

[10] An excellent discussion of these issues can be found in Vernon W. Ruttan's, Technology, Growth, and Development: An Induced Innovation Perspective. Oxford University Press (2001).

In order to apply this concept to mutual irrigation companies and irrigation districts, we would seemingly need a sound measure of productivity for them? They do not normally produce a marketable commodity per se. On the other hand, could their measure of productivity be irrigation efficiency, or perhaps the adoption of new canal management technologies? Could it be routine canal maintenance and infrastructure improvements over the years? Is it perhaps some measure of the productivity of its employees? How about the productivity of these non-profit enterprises being defined by way of increased farm income for the landowners who pay annual assessments for the upkeep of these water delivery systems? How about the productivity of such organizations being represented by the exploration and implementation of new forms of water service or water marketing designed to adjust to increased local competition for water, and for which additional revenue could conceivably be earned by them to cover the costs of infrastructure improvements in the future?

Again, Figure 1 shows several social factors (organizational frameworks) that might be said to potentially help or hinder this productivity, however it is defined. Institutional friction is probably a major one, but mutual irrigation company leadership and governance may be just as important.[11] In addition, one might be genuinely concerned about the productivity of these enterprises, given declining farm income in many agricultural areas. A non-profit entity relying on farm income for its sustenance would surely appear to be in harm's way today.

In any event, the incentive to explore technological innovations or water wheeling (perhaps a more appropriate term for what these organizations are beginning to entertain in the way of water marketing), is likely linked to their productivity in a real way. Capital investment, in the form of infrastructure or technological improvements, or training for enterprise staff (human capital investment), don't just occur in firms because they are good ideas. These input investments are motivated by something. They are usually driven by the expectation of increased profits, comparative advantage, and increased market shares. Unfortunately, these are motives that mutual irrigation companies and irrigation districts generally do not possess in their role as non-profit enterprises. So, one has to search for other motives that lead to technological adoption or innovation in water marketing in these traditional irrigation enterprises.

What about simply increasing water rates (factor prices), as some federal water projects administering water service contracts are prone to do in the name of water conservation? Yet it is often clear that innovation in a for-profit firm generally occurs as a result of the profit motive, not from government price setting, perhaps a rough analogy to the contractual setting of water rates for irrigation districts formed under federal water supply contracts.

[11] Institutional friction might include local or regional legal battles, conflicting state and federal policies regarding water use and water marketing, imperfect markets, etc. Institutional friction may in part be synonymous with so-called "transactional costs," although the former would tend to refer more to countervailing policies and legal doctrines, rather than purely marketing issues (i.e., linking willing buyers with willing sellers).

It is possible that increasing water rates under federal water service contracts, in the name of water conservation, could be self-defeating when it comes to innovation-adoption of new technologies and innovative water marketing strategies. Some economists, with their occasional inordinate emphasis on water pricing, may have missed something here of real importance. As this paper will try to show, utilizing traditional organizational arrangements to promote water wheeling would often appear to be a much better way to stimulate increased productivity; that is to say, the adoption of new water management technologies and innovative "marketing." We will see this playing out in several examples later.

Following this line of thinking for a moment, it is curious how the recent invoking of the market concept by at least one federal agency, and in the name of efficiency and reallocation of water resources out of agriculture (nominally at least), often results in growing concern by regional administrators of this same agency about what is happening to its traditional relationship with its managing partners (i.e., irrigation districts).[12] However, unleashing the market concept through a promotional grant program in what was traditionally a non-profit sector might be expected to profoundly challenge the existing order of "business as usual." Markets invariably move existing institutions and social arrangements to a new plane. They have been doing so for centuries. As Joseph Schumpeter long ago pointed out, markets are "the perennial gale of creative destruction" that push aside existing institutional arrangements, demanding new social arrangements and new thinking by everyone involved.[13]

The recently strong policy focus on markets and water pricing to improve water management in the West may have inadvertently let the "genie out of the bottle," so to speak.[14] State and federal water agencies should not be surprised if their traditional method of doing business with these non-profit enterprises is severely challenged to move to a new plane of policy thinking, as the market concept applied to water captures the imagination mutual irrigation company and irrigation district boards. Can a federal or state agency realistically respond by saying to the mutual irrigation company or district that "your contract (or state law) says you can't do that," after this genie is let out? It would appear inevitable that this unleashing of the market on water management, including water banking, will create a demand for new policies and broad institutional change in agency and traditional water enterprise relationships. But to where, to what?

Because of their historical development, mutual irrigation companies are now largely what we call in the social sciences, bounded (or constrained) social technologies; bounded by their own evolution or path dependence. They are somewhat like outdated

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[12] One thinks of the U.S. Bureau of Reclamation's Water 2025 Initiative in this regard.

[13] J.A. Schumpeter, Capitalism, Socialism, and Democracy. New York: Harper & Bros., 1947.

[14] The U.S. Bureau of Reclamation's Water 2025 program is an excellent example of an agency desiring and promoting increased marketing of water in the name of water conservation, but at the same time perhaps a little unprepared for the implications this may have for contracts with its long-time managing partners, irrigation districts. For other discussions of water marketing perspectives, see Cummings, R.G. and Nercissiantz, V., The Use of Water Pricing as a Means for Enhancing Water Use Efficiency in Irrigation: Case Studies in Mexico and the United States, Nat. Rec. Law Journal. 32:731 (1992). One of the best and most recent econometrics analyses of regional water pricing schemes relevant to federal policy is Schaible, G.D., et al., Economic Analysis of Selected Water Policy Options for the Pacific Northwest. USDA/ERS Agricultural Economic Report #720 (1995).

firms with old technologies that tend to hold onto traditional values very strongly in the face of social change. However, this suggests a rather inevitable adaptation principle – social change generally requires bounded technologies to "break out" of their traditional mold rather than remaining "locked into" the past way of doing things. Markets will help these irrigation enterprises break out of the past. Water rate setting and state or federally initiated water marketing initiatives, such as HB 1354, directed at individual landowner economic interests rather than the collective interest of these traditional enterprises, may very well not accomplish that goal as effectively, or at least in the same way.

State and federal policy might consider being more open and receptive to the potential for more "enterprise" oriented water marketing initiatives by mutual irrigation companies and irrigation districts, rather than emphasizing purely an appeal to the economic interests of individual landowners, as was largely done in the recent state initiated Arkansas Valley water banking program. This means being open and supportive of the attempts by mutual irrigation companies and irrigation districts to examine the potential for new sources of revenue, as long as the enterprise can remain whole and honor any contractual obligations it may have. Mutual irrigation companies may now be entering a dimension of "competition" with the surge of interest in groundwater recharge, banking and marketing. These options can emulate the long recognized productivity growth engines of "profit motive," "competition," and "market shares" in the otherwise limited market situation exemplified by these non-profits.

Given these important research perspectives, the current study has focused on understanding the different design principles represented by three different water banking or water marketing initiatives in the Arkansas Valley, as well as other water banking initiatives throughout the Western United States. Perhaps these observations will have application elsewhere in Colorado, as well as in areas of the West yet to see viable water markets established. We strongly believe that viable markets will more likely occur with the assistance of traditional irrigation enterprises, rather than relying exclusively on the individual self interests of landowners who hold water rights in a particular locality. More on this idea will be discussed in the summary and conclusions of this report.

Methodology

The approach that the Sociology Water Lab has taken to better understand what happened with the recent water banking initiatives in Colorado is to carefully assess the social interaction approaches used by those initiating the program. Was the initiative largely bottom up or top down in its execution? How much were local people and local traditions really consulted? Was emphasis placed on customizing the initiative to local circumstances, or was the design of the water bank designed to be a template programmed to be replicated throughout the state? Was an effort made to build upon local water wheeling customs such as irrigation enterprise water rental systems, or were "outside experts" simply given a free hand to design the water bank? The study has interviewed water users and ditch company representatives from Colorado's lower Arkansas Valley, as well as having attended numerous public meetings and visits with

state agencies, in an effort to better understand the approaches used and obtain answers to these important questions.

The study has also provided numerous educational opportunities to landowners and ditch company representatives over the past two years. These efforts have been designed to improve the working trust between the researchers and local landowners. The subject of water is a sensitive one, and researchers coming in from outside the community are often at a disadvantage, and can be viewed somewhat suspiciously when doing sensitive research of this nature. In order to facilitate this research process, the Sociology Water Lab conducted the following activities in support of the study:

1. Organized a three day study tour for the board members of the Fort Lyon Canal Company in the Arkansas Valley, which is the largest mutual irrigation company enterprise in Colorado. This tour included a visit to another large mutual irrigation company in northeastern Colorado that is undergoing canal modernization to develop a groundwater augmentation program for well users in its service area. The New Cache La Poudre Irrigating Company, located in Weld County, has an active water exchange program on the Cache La Poudre River as well, and participates in traditional water banking with other ditch companies in the basin. This banking includes numerous exchanges and transfers through water storage facilities that allow a great deal of flexibility in the allocation of water to landowners, and is a practice that is well over one-hundred years old.[15]

2. Organized a two day study tour for the superintendent of the Fort Lyon Canal Company to the Irrigation Training and Research Center at the California Polytechnic State University, San Luis Obispo, California. The purpose of this study tour was to familiarize the Fort Lyon Canal Company with some of the important technological innovations being adopted by irrigation districts in California, including SCADA, GIS, and the automation of headgates and canal check structures.[16] It is becoming clear that these new technologies often play an important role in assisting traditional agricultural water supply organizations in participating in water banking and other forms of water marketing.

3. Organized a one day workshop for sixty landowners and mutual water company representatives in the lower Arkansas Valley. Guest speakers for this workshop included two representatives from the Idaho water banking tradition, a representative from the Palo Verde Irrigation District, California who spoke on successful fallow leasing programs, a representative from the City of Fort Collins, Colorado who explained the innovative and long-standing water rental market in northeastern Colorado, and additional speakers from California and Utah who addressed canal consolidation and

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[15] Wilkins-Wells, J., et al, Water Exchanges and Agricultural Production in Northeast Colorado: Opportunities and Constraints for the Future. Agricultural Experiment Station Technical Report TR03-3, March 2003.

[16] GIS is a well-known acronym for Geographical Information Systems, a technology that is eminently suited to the needs of irrigation enterprises with their extensive service areas and irrigation infrastructure. SCADA refers to Supervisory Control and Data Acquisition Systems, part of the new water management control and telemetry technology being extensively adopted by irrigation districts throughout the West.

joint operation of canal companies on the Kern River (California) and Sevier River (Utah).[17]

4. Organized a two day forum on groundwater management, water banking and canal and pipeline corridor easement protection in Tulare, California, scheduled for January 30-31, 2007, and hosted by the Tulare Irrigation District. This activity will provide the research project with important information on current approaches to water banking and water marketing in California.

Overview of Case Study Area

We may now turn to the principal case study of water banking that the Sociology Water Lab at Colorado State University has undertaken. Following this discussion, an attempt will be made to see how the state initiated water banking program appears to have differed from some of the other more successful water banking initiatives elsewhere in the West.

The Arkansas River is a major tributary river of the Mississippi River. It flows east and southeast though the states of Colorado, Kansas, Oklahoma, and Arkansas. Geographically located in the southeastern part of the state, Colorado's Arkansas River Basin is the largest in Colorado (Figure 2). The topography of the Arkansas River in Colorado is also quite diverse, ranging from spiraling peeks in the upper basin west of the City of Pueblo, to flat plains in the lower basin east of Pueblo. The combined upper and lower basins comprise 27 percent of the state, or an area of 28,268 square miles. The largest cities in the upper basin are Colorado Springs (population 370,000) and Pueblo (population 104,000).[18] The lower basin has two communities of approximately 8,000 people (La Junta and Lamar), while many of the remaining communities are quite small, on the order of 400-600 people.

The river drops precipitously in elevation from the headwaters near Mount Democrat (14,125 feet) in Leadville, Colorado to the Colorado/Kansas border (3.400 feet). This represents an elevation drop of 10,725 feet over a 350 mile stretch of the river. Needless to say, the upper basin of the river supports a booming tourist industry, providing a variety of recreational activities such as white water rafting and kayaking, in addition to some world class fly fishing. The lower basin is characterized predominately by irrigated farm production.

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[17] Smolnik, S., Water Rental Markets in Northern Colorado: The City of Fort Collins and North Poudre Irrigation Company Water Rental Program; Rigby, J., The Idaho Division 1 Water Bank: Brand New Innovations in an Old Concept; Anderson, D., The Sevier River Project, Utah: Improving Cooperation Between Canal Companies to Achieve Economies of Scale; Smith, E., Land Fallowing and Water Leasing Programs in California: The Palo Verde Irrigation District Program; Nicholas, S., How to Work with the Cities to Achieve What You Want and Need: The Kern Delta Water District Program. Presentations made at a regional workshop titled, Innovative Approaches to Water Leasing and Canal Company Cooperation in the Face of Municipal Demands for Agricultural Water Supplies, Rocky Ford, Colorado. Funded through Colorado State University Agricultural Experiment Station.

[18] County Level Population Forecasts. Colorado Division of Local Affairs (2003). Water Supply and Needs Report for the Arkansas River Basin. Colorado Water Conservation Board, Colorado Department of Natural Resources: p. 17 (2006).

Figure 2: Map of the Arkansas River Basin

Colorado Department of Natural Resources 2006

The lower basin, which is the focus of this study, is about 15,000 square miles in extent. Prior to some of the major water transfers out of the lower basin that began around the 1970s, the irrigated area of the lower basin comprised about 322,000 acres. Present estimates of irrigated acreage are not available, but are believed to be in the neighborhood of 220,000 acres. This is based on subtracting from the earlier figure what is known about mutual irrigation companies whose water rights have been sold since 1970. The vast majority of this remaining acreage has traditionally received irrigation water from the main stem of the river. However, the river is augmented by several important tributaries, including Fountain Creek, Timpas Creek, Grape Creek, St. Charles Creek, Huerfano Creek, Apishapa Creek, and the Purgatoire River.

Irrigation in the lower basin began in the early 1860s. By the early 1890s, the Arkansas River had largely become over appropriated. Total population in the lower basin, excluding Pueblo County, was about 54,000 in 1930. In 2000, it was 46,310. There are 20 major irrigation companies in the lower basin that were developed in the early years, some after the turn of the century. The largest, from west to east in the lower basin, include the Bessemer Irrigating Ditch Company (23,526 acres) near Pueblo, the High Line Canal Company (24,839 acres), the Catlin Canal Company (19,329 acres) near Rocky Ford, the Holbrook Mutual Irrigation Company (17,526 acres), the Fort Lyon Canal Company (97,273 acres), and the Amity Mutual Irrigation Company (34,784 acres)

east of Lamar. Many of these company service areas are in the process of being greatly reduced in acreage due to water sales to municipalities along Colorado's Front Range (i.e., the Colorado Springs and the Denver metro areas).[19]

Irrigation in the lower basin occurs primarily on river terraces or bench lands, approximately 85 percent of the lands being thus classified. An important and extensive irrigated area on the south side of the river between Pueblo and La Junta, Colorado is known to be some of the most productive land in the state. There is another large extent of land located in Crowley County, about 55,000 acres, which no longer receives irrigation water due to water transfers out of the valley, but which was very productive farm land in the past. An earlier U.S. Bureau of Reclamation study estimated that about 53 percent of the total area in the lower basin was classified as Class I lands. Another 42 percent were identified as Class II lands, while the remaining lands were identified as Class V and VI lands. Before the occurrence of substantial water transfers out of the lower basin, it was clearly a very productive agricultural area.[20] Local communities and many landowners hope that the water transfers will stop, thus permitting the lower basin to re-establish its role as an important agricultural area in the state.

Drainage and salinity are currently considerable problems in the lower basin, particularly after nearly 150 years of irrigation. Many drainage districts with underground tile lines were established in the 1920s, some of which still operate today, although drainage in the valley appears to be somewhat of a lost art. Most drainage problems occur on the bottom lands near the river, rather than on the bench lands. About 100,000 acres of land are drained with open drains and deep tile lines, but this older drainage infrastructure is in generally poor condition today and in need major repairs. The Sociology Water Lab is currently mapping the location of the old tile lines in the lower valley, with the purpose of providing baseline information to assist landowners in developing an operation and maintenance program for these drains in the future.

Agricultural production has been quite diverse over the years, and has included such crops as alfalfa, sugar beets, corn, wheat, barley, sorghums, pinto beans, cantaloupes, seed crops, onions, tomatoes, and truck gardening. The lower basin has always supported significant livestock production of cattle and sheep as well. Melons and onions remain important crops today, while some of the other specialty crops have disappeared due to water sales. Sugar beet production was important up until the mid 1970s. Sugar producers in the past have included such major companies as the American Crystal Sugar Company, Holly Sugar Company, and National Sugar Company. All of these have departed the lower basin, however. There was also an important canning industry in the past, with such prominent companies as Libby, Western Canning, and others. All of these have departed as well.

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[19] Engineering Report on Water District 17. Federal Land Bank of Wichita. Recently, the Sociology Water Lab received permission from a long-time employee of the Federal Land Bank to acquire copies of these engineer appraisal reports. They represent some of the most thorough studies of mutual irrigation companies in the West. The Sociology Water Lab has these publications archived for Colorado, Wyoming and Utah.

[20] Footnote 21.

The climate in the lower basin varies greatly, but is nevertheless some of the mildest in the state. The mean annual temperature in Pueblo, Colorado is 51 degrees, while that of Holly, Colorado near the Kansas border is about 54 degrees. Daily average temperatures vary about 10ºF, with the upper basin west of Pueblo averaging 46ºF and the lower basin averaging 56 ºF. Temperatures in the lower basin range from 100ºF in mid-summer to 0ºF in the winter. During the growing season, daytime temperatures in the lower basin often exceed 100 degrees, while night temperatures can be comfortably cool. The lower basin is a windy region, with prolonged cold winds in the winter and hot winds in the summer. These winds contribute significantly to high evapotranspiration rates and subsequent difficulties with irrigation. The frost free season in the lower basin averages about 165 days. This ranges from late April to early October in the vicinity of Pueblo, to mid-April to mid-October near the Kansas state line.

Growth in the lower basin of Colorado's Arkansas River reach has been minimal, while growth in the upper basin has been more significant. Between 1990 and 2000, the population in the region increased 22 percent, with Colorado Springs accounting for the majority of this growth.[21]

The recent Colorado Statewide Water Supply Initiative (SWSI), an effort to harmonize the state's water development and forecasting by bringing together diverse interests groups around the state into valuable roundtable discussions, has projected population growth of Colorado's Arkansas River basin to be 1,293,000 in the year 2030, from 835,130 in the year 2000. This would be an annual growth rate of 1.5%, and would increase the overall population of the river basin by 55%. Most of this growth would likely occur in the upper basin.[22]

SWSI also projected gross increase in the Arkansas River Basin water demands. The total gross demand for the river basin in 2000 was 256,900 acre feet. That number will increase by 98,000 acre feet to 354,900 in 2030. Of that additional 98,000 acre feet requirement, 81,600 acre feet are expected to be provided through future water projects and conservation efforts, leaving 16,800 acre feet of water still to be accounted for. Unless additional water projects are built, this will most likely be obtained from the lower basin's agricultural sector, through water banking, leasing, or permanent transfer of water rights out of agriculture.

The upper and lower basins are served by a series of major water storage facilities. These include, east to west, John Martin Reservoir (flood control and storage), the Great Plains Reservoir system (storage), Pueblo Reservoir (primarily storage), and Twin Lakes and Turquoise Reservoir; the latter two receiving transmountain water supplies from the west side of the continental divide. Supplemental water is also provided to the upper and lower basins through the Arkansas-Fryingpan Project, a federal water project managed by the Southeastern Colorado Water Conservancy District.

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[21] History of Water Rights in Colorado. Colorado Division of Natural Resources (2006).

[22] Colorado Statewide Water Supply Initiative power point report given by Rick Brown at the Western States Water Council in Salt Lake City, September of 2004.

The Southeastern Colorado Water Conservancy District imports water from the west side of the continental divide, which is then used as a supplemental supply for irrigators. Rather than being sold to individual landowners, this project water was sold exclusively to mutual water companies within the conservancy district service area holding water rights before January 1, 1950. Thirteen of the 20 companies in the lower valley qualified as being able to purchase this project water. All water was to be equitably allocated annually by contract, subject to approval by the conservancy district board, and based on the annual availability of water and the merits of each application.

Today, mutual irrigation companies participating in the project frequently use their historically decreed priority water in April, May and June, or as long as this water is available from the river. They then draw on any winter water stored in the project's Pueblo Reservoir under contract for release during the irrigation season. The actual project water, the transmountain diversion water, is often used by the irrigation companies in July and August. These practices change with the availability of water in the basin, and droughts can alter these procedures as well.

At the conclusion of the irrigation season, these companies then store whatever water is available to them in their own individual reservoirs located throughout the upper and lower basins. The introduction and expansion of municipal water demands have modified the project's operational plans somewhat over the years, and available storage space in the project has been a source of tension between the agricultural water users and the municipalities.

Lower Basin Groundwater Issues

It is important to briefly discuss groundwater conditions in Colorado's Arkansas River basin. This is because the most promising efforts at water banking and water marketing in this region appear to center on groundwater management. As will be discussed shortly, groundwater management has generally been made mandatory by the state, particularly if irrigation wells are being used in an area. Colorado is governed by many interstate compacts, and groundwater management is essential to ensuring that stream depletions from wells do not adversely affect these compacts.

The State of Colorado finally recognized the connection between surface water and groundwater with the passage of the Groundwater Management Act of 1965 and the Water Rights Determination and Administration Act of 1969. These two acts recognized that groundwater and surface water were hydrologically connected, and that groundwater pumping inevitably depleted rivers flows, which injured senior appropriators on the river as well as in neighboring states.

In 1985, the State of Kansas filed suit against the State of Colorado claiming that well pumping in the lower basin of Colorado's Arkansas River was depleting river flows to such an extent that Kansas was not receiving its allotted share of 40% of the river flows in accordance with the Arkansas River Compact of 1949. This lawsuit was recently settled, resulting in the shutting down of many wells in the upper and lower basin.

Irrigation wells using centrifugal pumps in the lower basin of Colorado's Arkansas River were installed in the 1930s to address the drought conditions of the Dust Bowl era. Well pumping then increased dramatically after WWII with the introduction of affordable electricity and the development of the high-capacity turbine pumps. Well use then increased further with the introduction of center pivot systems and more efficient irrigating techniques.

Irrigation wells have generally always been favored by farmers over traditional headgates served by an irrigation canal, for the simple reason that more regular flows and on-demand water supplies were often better attained with wells. Irrigation wells were of great value to landowners under mutual irrigation company water delivery systems if river degrees were not strong, or if the organization itself was not well managed. Such benefits continue today, and are additionally supplemented by the need to conserve water and use it more efficiently. Pumping from open ditches is practiced, but has generally nowhere the same results as pumping from an aquifer, particularly one that can be recharged effectively through surface water supplies.

There are reported to be approximately 5,450 wells of record in Water Division 2, which covers most of the lower basin (Figure 3). The Colorado Department of Water Resources has divided the aquifers in this division into three categories. These include (1) alluvial, bedrock (Raton Basin and Dakota-Cheyenne formation), (2) a designated basin (High Plains), and (3) wells in the lower basin with a permitted or decreed yield of 500 gallons per minute (gpm) or higher.[23]

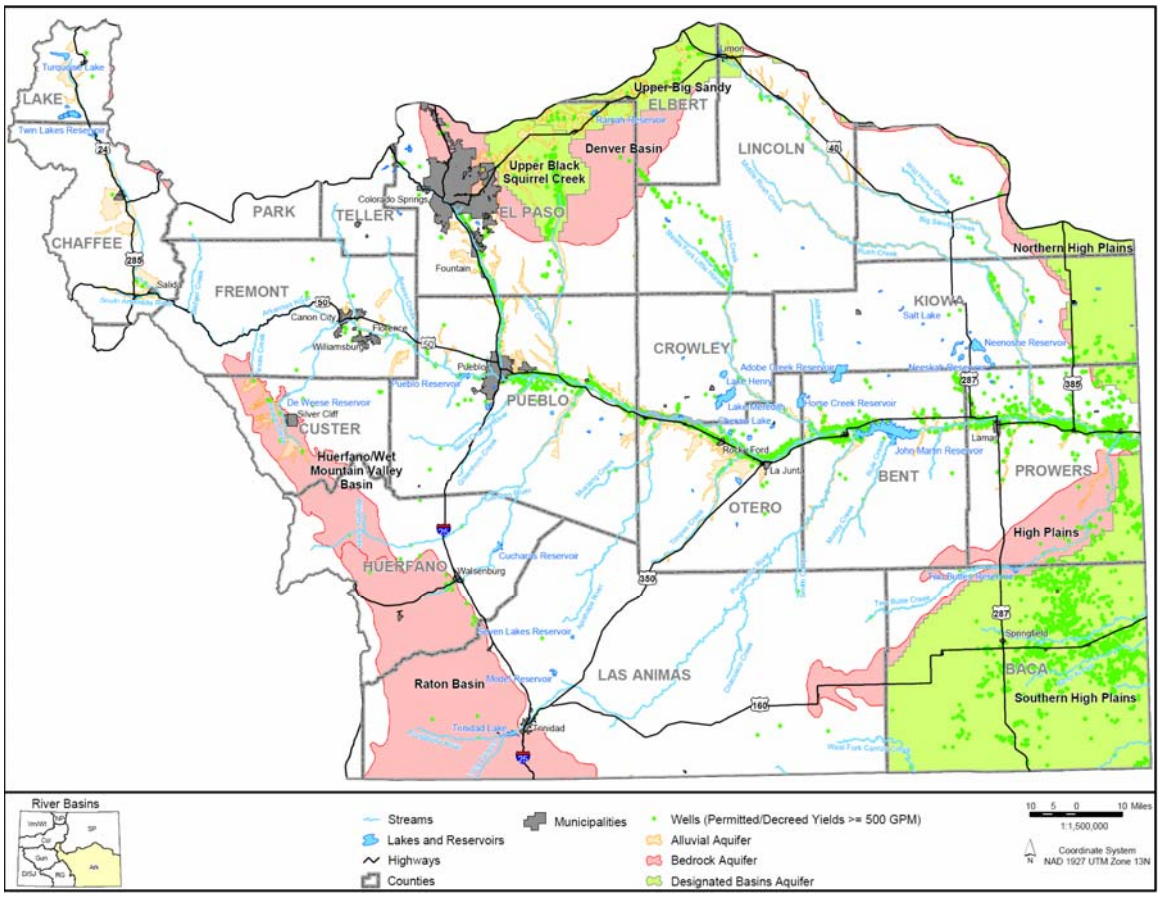
Groundwater Management and Banking in the Lower Basin

Several local groundwater management associations have been formed over the years, primarily to augment well use and address interstate compact needs. The Arkansas Groundwater Users Association (AGUA) has approximately 400 member wells, while the Colorado Water Protection and Development Association (CWPDA) has approximately 800 member wells. Finally, the Lower Arkansas Water Management Association (LAWMA) has 650 member wells.[24] AGUA and CWPDA wells are located generally west of John Martin Reservoir. This organization leases water for groundwater recharge from the City of Colorado Springs, the Pueblo Water Works, and the Southeastern Colorado Water Conservancy District. The LAWMA service area lies east of John Martin Reservoir. This organization purchases surface water for groundwater augmentation from local sources in the lower basin, financed through low interest agricultural loans received from the state.

[23] Water Supply and Needs Report for the Arkansas River Basin. Colorado Water Conservation Board, Colorado Department of Natural Resources: p. 18 (2006).

[24] Harrison, Sperling and Sims, 2005

Figure 3: Lower Arkansas Valley Groundwater Resources



Source: Colorado Department of Natural Resources (p. 25)

What is of importance to this study is that all of these groundwater users associations are generally organized along the lines of the traditional mutual irrigation companies that have been active in the valley for over 100 years. They are non-profit entities that are comprised of members who buy shares in the organization to finance the enterprise. Shareholders then receive the benefit of water deliveries to make whole the river flows depleted by their out-of-priority wells.

What can also be garnered from this short history of the lower basin's groundwater regime is that more recent individual economic interest has seemingly reverted back to collective economic interest. Individual pursuit of groundwater during the post-WWII era initially led to interference with the Colorado-Kansas compact. In recent years, part of the remedy to this crisis has been to draw upon past local experiences in collective action represented by the mutual irrigation company tradition of the lower basin. As mentioned earlier in this report, it appears that one of the oversights of the HB-1354 water banking initiative was not to have effectively drawn upon this local experience for ideas on how to develop the water bank. This brings us to a discussion of the state initiative.

A Brief Overview of the HB-1354 Water Bank

As mentioned earlier, the state administered water bank established under HB-1354 was inaugurated in 2002. It was given a five year trial period, at which time a determination would be made by the state as to whether or not the program should continue. However, no significant water transactions occurred through the bank during this five year trial. Consequently, the program has now been terminated. It is important understand why this occurred.

What were the conditions of the water bank? First, individual landowners wishing to lease or sell their shares of mutual irrigation company stock through the water bank were required to fill out an application and submit it to the local conservancy district. There was no stipulation that this step requiring a review by the board of directors of the affected irrigation company, even though such a sale might be expected to have some bearing on the management of the irrigation canal in the future. The state then made a determination as to the legal standing of the sale, followed by a posting of the water right on the water bank's website.

The program was restricted to in-basin transfers (the upper and lower basin of the Arkansas River), then in subsequent legislation, potentially to out-of-basin transfers. Bids were posted by potential lessors, and these bids were viewed as binding offers. On the 11th business day following the posting of the offering, the state agency carefully reviewed all bids, followed by acceptance of the bid by the lessor or seller. This initiated an important thirty-day public review waiting period, followed by a few more additional steps before the water was released to the lessee or purchaser. The thirty-day public review waiting period was a sound approach, and designed to give ample time for examining all possible consequences of the sale. However, it would seemingly have been helpful if some deference could have been given to the mutual irrigation companies in the valley. It was here that the potential success of the program might have hinged on.

Initial thinking was that the water bank would function more as a rental market rather than as one processing permanent water transfers. However, in the end, the bank did not process any transactions. Even if one were to assume that this was due to inexperience, confusion about the procedures, or the fact that bids were inadequate to promote interest in transactions, one is still left with the feeling that it was simply not trusted by local landowners as a market.

More importantly, in assuming that transactions were driven largely by individual economic interest, despite the public review step that figured into the transaction process, it is nevertheless clear that posting notification of a willingness to lease or sell water stock would have had at least some repercussions on a landowner's standing with other mutual irrigation company shareholders. These stock certificates, having real property value in Colorado, are nevertheless part of a decreed right to the ditch company as a collective entity serving a large number of farmers in the area. This is an example of a transaction cost or institutional friction issue that lurked in the background. Individual

economic interest was confronted with collective economic interest in a valley already tense over permanent water transfers out of the lower basin in recent years.

Institutional change in an already complex social environment was apparently more difficult than the Colorado Legislature anticipated. Although there was some notable and sound public involvement in determining what the Arkansas Valley needed, the effort largely appears to have been politically motivated by outside interests. It would appear that the public involvement process could have focused more on agricultural landowners owning shares of stock in local mutual irrigation companies, since these individuals and enterprises had the largest standing and economic interest at stake. In short, it would appear that mutual irrigation companies in the lower basin should have been more directly involved in the development of the water bank.

Recent efforts at water marketing throughout the West are frequently driven by interests wishing to transfer water out of agriculture, rather than looking at ways to better secure agriculture's future and the sustainability of the communities that the water bank is nominally designed to serve. It was the opinion of many water users in the lower basin, especially those representing the interests of mutual irrigation companies, that their input into the creation of the water bank was largely overlooked.

Other Banking Initiatives in the Lower Colorado Arkansas River Basin

Two other water banking initiatives of importance are found in the lower basin. The first is the more recent conservancy district initiative mentioned earlier in the study, and which was organized at about the same time that the state administered water banking program was inaugurated. The second water banking initiative is a slightly older one that was organized to manage groundwater usage in the lower basin. It was designed utilizing some of the organizational concepts from the mutual irrigation company tradition. Both of these efforts appear to be successful, although organized considerably differently. Most importantly, both of them are locally developed.

The Lower Arkansas Valley Water Conservancy District

Many people might not consider the Lower Arkansas Valley Water Conservancy District a true water bank, but as we discussed earlier, we interpret water banking as a tool to be used in a larger water marketing scheme. The LAVWCD was created with the passage of a public referendum in 2002 and supported by 64 percent of the voters in Bent, Prowers, Pueblo, Otero and Crowley counties. This public referendum empowered the representatives of the five counties to create a conservancy district with the expressed intent of keeping water in the valley. The history of the conservancy district is relatively new, but the ideas behind the conservancy district date back to the early 1970s when communities in the Denver metro area made their first Arkansas Valley water purchases.

Over 100,000 acre-feet of water have been transferred out of the valley since the early 1970s, causing serious damage to the lower basin economy. These transfers became of even more concern in 2002 when the Arkansas Valley experienced its most severe

drought in approximately 300 years. As if the problems of the drought were not enough, the Fort Lyon Canal Company was threatened with a buyout of a large portion of their ditch by a Louisiana-based investment firm.

The LAVWCD has approached the valley's problems from a variety of different perspectives. The first step taken was to further an already existing program, the Arkansas Valley Preservation Trust. This program was designed to accept conservation easements in an effort preserve the condition of the land and to tie water to the land in perpetuity. The conservation easement program has been well received in the valley. However, it is not the only strategy that the LAVWCD has used to preserve the valley. The conservancy district has also been developing a water portfolio of its own. It has purchased shares of stock in several local mutual irrigation companies as well as a groundwater management association to be discussed shortly; our other example of a locally organized water bank.

The LAVWCD is also promoting bio diesel and other income enhancing programs for local landowners. Finally, it has recognized the importance of the mutual irrigation company tradition in the valley. Efforts are being made through the conservancy district to promote more cooperation between these companies in the name of the valley's future. The conservancy district is in its infancy stage, but has been blessed by excellent and dynamic leadership.

The Lower Arkansas Valley Water Management Association (LAWMA)

The Lower Arkansas Valley Water Management Association (LAWMA) was established in 1972, but no real organizational activity was undertaken until 1985. This is a non-profit association, not surprisingly designed along the lines of a mutual irrigation company. Voting in the organization is governed by shares of stock. The governance and administration of the organization is controlled by local interests rather than by a state agency. Its service area is generally defined by irrigation wells situated in the alluvial plain of the river east of John Martin Reservoir, although there are a few members (stockholders) west of the reservoir as well (Figure 2).

The purpose of LAWMA is to provide a mechanism to replace depletions from irrigation wells and other enterprises that can adversely affect the state's required Arkansas River allocation to the State of Kansas. This is done through the purchase of senior water rights in the lower basin that are then kept in the river as payment in return for water used by irrigation wells and other enterprises that can potentially cause river depletions. This has involved the purchase of several million dollars in water rights, leading to the fallowing of over 8,000 acres of irrigated lands in the lower basin.[25]

The financing of LAWMA occurs through the issuing of preferred water stock as well as regular stock, the former functioning to augment uses that are generally considered to result in continuous river depletions throughout the year; so-called non-curtailable uses in local parlance. These non-curtailable uses include gravel mines, concrete batching

[25] Footnote 7.

facilities, beef and swine feeding operations, and other industrial and municipal uses for which stream depletions are known to be fairly constant. However, well users pumping from the aquifer that is tributary to the river are also major shareholders in the organization, most of whom are subscribers to regular stock. In LAWMA's operation plan, it assigns a predetermined annual yield per share of replacement water for its preferred stock, and a prorated share for the regular stock which is based on the remaining water in the organization's portfolio after the preferred water stock has been subtracted out. Needless to say, the preferred stock in the organization is about double the price of regular stock.

It appears that this water banking organizational design has been successful because it is driven by the need to reallocate water from previous low value uses under local irrigation ditches to new high value uses. As mentioned earlier, wells in the lower basin are of considerable importance to irrigators for a number of reasons. They frequently serve center pivots. Irrigators use wells when it is difficult to get water to their lands through irrigation ditches that have significant transit losses. Well water is more or less available on demand. Meanwhile, feed lots and gravel pits are an important source of income and of significantly more economic value than some of the traditional crops in the lower basin. These factors provide a considerable economic incentive for water users to participate in the LAWMA program and to adhere to its governing rules of operation.

LAWMA has well defined boundaries for its service area and carefully monitors its member water users. This monitoring of water is important because the program is situated in such a way as to potentially affect the interstate compact between Colorado and Kansas. This provides a strong organizational incentive to make sure that the actions of individual shareholders do not injure the investment of other shareholders. Not following organizational rules of operation can negatively affect the collective interests of all the shareholders.

LAWMA is welfare-enhancing to the local community. It is equitable in its organizational framework. It administers its own sanctions. It has well defined boundaries for its service area. Through the share system, it equitably links benefits received by its shareholders to the costs of operating the enterprise. It utilizes graduated sanctions for organizational infractions. Finally, the resolution of potential disputes associated with the program can normally be resolved within the community of irrigators, rather than having to depend upon a state agency to resolve such disputes. In short, the program is designed after the familiar mutual irrigation company tradition in the valley, and seemingly for that reason is well received, trusted, and successful.

Returning to our earlier discussion regarding some new and important perspectives on the productivity of the firm and its relevance to these non-profit enterprises, the LAWMA water bank is an example of a non-profit organization whose productivity can be measured through its successful organizational framework, rather than simply through factor price adjustments (the value of water in the marketplace). This productivity is in the form of output via the number of active subscribers in the organization, the improved income generated by these subscribers through the increased economic value and security

of water supplied through the organization, and the increased value of the commodity itself as shown in the value of its stock in the local market. This increased productivity is leading to continuous and further investment in the program, not only by local irrigators, but by state agencies themselves. This is most recently exemplified in the form of stock purchases made by the Colorado Division of Wildlife and the Colorado Division of Parks for use in their local water management programs.

Neither the LAVWCD program nor the LAWMA program represented an attempt to link willing sellers with willing buyers simply for the purpose of moving water around the landscape in the name of more efficient use of the resource and presumably enhancing the economic value of the water. Rather, these local efforts were organized to address pressing local water management concerns, to increase the flexibility of water use to meet local needs and state obligations to downstream appropriators, and to secure the perpetuation of the resource in the local community. These appear to be quite different objectives from those of the state initiated water bank.

Let us now turn to some other successful examples of water banking and water marketing that would appear to support our contention that perhaps the best way to approach this issue is to first look at local organizational capacity and tradition in the community. Perhaps there are lessons there for the future. It may only be a question of finding a way to better unleash the productivity of more traditional irrigation enterprises, by way of crafting new federal and state policies that allow these organizations to go where they need and want to go.

Water Rental Markets in Northeastern Colorado

Informal water rental markets have existed in northeastern Colorado most likely since the beginning of irrigation in that area in the 1860s, most certainly since the early 1900s. These water rental markets were largely conducted internally within mutual irrigation company service areas, individual irrigators renting shares of water to neighbors along the ditch. Later, as water exchanges began to occur between irrigation companies in the Cache La Poudre River Basin, these markets expanded to include reservoir rental pools.[26] This feature of the mutual irrigation company organizational design was not unique. It occurred elsewhere in the West as this joint stock company tradition expanded, although how these rental markets were implemented varied from one locality to the next.[27]

The formation of the Northern Colorado Water Conservancy District in northeastern Colorado represented a continuation of this tradition. This conservancy district was formed to finance and operate certain portions of the federal Colorado-Big Thompson Project, a transmountain diversion project that was designed to provide supplemental irrigation water to farmers in the Cache la Poudre and South Platte River basins.

The administration of the project's water supply was very unique, in that it was allocated to individual irrigators and mutual irrigation companies at an open subscription

[26] Footnote 17.
[27] Footnote 1.

inaugurating the project. Individuals or entities subscribed to units of the project's water supply, very much like they would subscribe to shares of stock in a mutual irrigation company upon its formation. Subscribers then paid an annual assessment on each unit, the revenue of which, along with an ad valorem tax on all appraised property in the district, helped pay for the project's development and operation. These units were then made freely transferable or rentable, including from agricultural to urban uses, provided that such transactions occurred within the service area of the conservancy district and the water was used beneficially.[28] This tradition has continued, with the addition that cities in the region have gradually purchased these units from irrigators or mutual companies over time as they have been put up for sale in the want ads of local newspapers. Today, Colorado-Big Thompson units are prized by municipalities and represent an important part of city water portfolios.

Drawing upon this local tradition, cities began to purchase shares of stock in mutual irrigation companies in the region as more municipal water supplies were needed. Although this provided additional water to the cities, it also placed them in a position of gradually assuming more control over the governance of these irrigation companies. Today, cities own a considerable amount of voting stock in such companies. However, due to the tradition of rental markets in the area, several cities now rent their irrigation company water stock back to irrigators when it is not needed for municipal use. Although this largely occurs whenever water in the basin is plentiful, it nevertheless represents an opportunity for irrigation companies and irrigators in the area to obtain supplemental water supplies. These supplemental supplies can be stored in reservoirs for use later in the irrigation season as well.

The City of Fort Collins has organized a rental market along these lines. Since the city is obligated to pay annual assessments on the shares of stock it owns in local irrigation companies, the rental of this water back to irrigators and other entities helps offset the cost of these annual assessments. Renting water back to irrigators when it is available also represents a good neighbor policy and helps support agriculture in the area. Rental agreements are generally for a single irrigation season, although there are some long-term lease arrangements as well. Procedures commonly used to equitably allocate water in this city rental pool include a lottery format, proration, and/or on a first come first serve basis. The City uses sophisticated computer modeling to estimate how much water is available to the rental pool during various periods of the irrigation season and annually, since it must be careful not to short its own municipal and industrial water needs.

This concept of city rental pools, and the availability of water to agriculture in such pools, was not a tradition characteristic of the Arkansas Valley. Although informal renting of water between irrigators was known to occur within irrigation companies in the lower basin, there never developed any sort of basin wide rental system as occurred in the Cache la Poudre basin up north. Even the federal Arkansas-Fryingpan Project, which was built and inaugurated nearly 25 years after the Colorado-Big Thompson Project, never utilized the concept of transferable units of water within its service area. It is not

[28] Maass, A.; Anderson. R. (1986). …and the Dessert Shall Rejoice: Conflict, Growth and Justice in the Arid West. Malabar, Fla.: R.E. Krieger Pub. Co.

known why this was so, given the positive reception to the concept up north, but was likely due to the fear that irrigation water would eventually migrate to ownership by municipalities; which of course has actually occurred under the C-BT Project.

Instead, as described earlier in the paper, the transmountain water supply of the Arkansas-Fryingpan Project was sold to irrigation companies in the lower basin, but not to individual irrigators, and therefore ended up being under the trusteeship of these companies. A rental market, as it was known up north, never materialized. In addition, rather than having an active city rental pool and a good neighbor policy of renting or leasing water back to irrigators when available water supply permitted it, cities in the vicinity of the Arkansas Valley turned to outright purchase of shares of stock in these mutual irrigation companies and permanent removal of irrigation water from the valley. This has left the lower basin with large areas of dried-up high quality agricultural land that will probably never be irrigated again.

The social reasons for why these different patterns occur are many. In addition, there are issues surrounding the negotiations of water development contracts, including federal stipulations and variations in state water law that constrain these unique practices. Nevertheless, water banking and rental markets are found in a variety of localities in the West. They appear to develop mostly out of local traditions. Irrigators in a particularly locality become familiar with such transactions and develop organizational rules which guarantee equity and trust in these marketing. They often appear not to be easily transferable from one locality to the next, for instance, to an area where they may not have been practiced in the past, because irrigators for whatever reason have not developed an adequate level of trust over the years to believe that such transactions can be implemented.

The Idaho Water Banking Tradition

The Idaho water banking tradition, particularly that portion represented by irrigation communities in the Upper Snake River above Twin Falls, Idaho, was designed to minimize the statutory problems typically associated with water transfers between individual irrigators and/or mutual irrigation companies.[29] It is a long-established and highly successful program that includes both the separate rental of reservoir storage space by irrigators, irrigation companies, and federal and state agencies (i.e., spaceholders in local parlance), as well as the rental of water supplies. Both rental space and rental water supplies have stipulations pertaining to their priority of use, carryover from one year to the next, and when both storage space and rental water must be cleared or utilized.

The Idaho water banking tradition was clearly founded on the tradition of rental of irrigation water between irrigators and mutual irrigation companies, going back many years, at least to the construction of the American Falls Reservoir in the 1920s.

[29] There are essentially five water banking entities. These include a statewide water bank, three locally governed rental pools in the Upper Snake River above the Idaho-Oregon border, and the more recently formed Shoshone-Bannock Tribal Water Bank.

Numerous publications have described the program in detail.[30] However, our interest here centers on better understanding the overall philosophy of the program; what social goals the organizers have set out to accomplish with this Idaho banking tradition. This might have a bearing on our efforts to better understand the state water banking initiative in the Arkansas Valley.

As in most western states, transfers (or sales) of water in Idaho are normally required to pass through several statutory tests that are designed to ensure that there is no third party injury or local public interest. The formation of the Idaho water banking tradition was thus designed as a substitute for otherwise statutorily complicated water transfers. It was designed to facilitate the movement of water to where it was most needed, and not purely as a means of "marketing" water to the highest bidder, as in an auction environment.

In fact, the price of water and the use for which it is rented through the water banking system is closely regulated by the state's Department of Water Resources (Water Resources Board), but more importantly, by local governing committees of irrigators; the latter of which assist the state in overseeing the administration of water banking. These local committees manage rental pool districts along reaches of the Snake River as it passes through Idaho, and in the name of local irrigator interests and concerns.

At this point, there is already a noticeable difference between the state initiated Arkansas Valley water bank and that of the Idaho tradition. This is mainly in the form of local governing committees of irrigators, and for which numerous mutual irrigation company diversions in each district rental pool have important stakeholder interest. The state is in nominal control, but local governing committees are in control of day-to-day banking procedures, only having to meet broad procedural guidelines established by the state.

The procedural rules established by the State of Idaho to govern water banking are also in conformity with an Idaho Water Code that tends to give strong deference to the interests of mutual irrigation companies. These include protecting water placed in the bank from being subject to the enlargement of its use, danger of forefeiture of water rights, any attempt to permanently dedicate the use for which water is temporarily rented, and other factors that might jeopardize the water rights of these companies. The purpose of the bank is to provide a "safe haven" for water which is not in demand by one set of irrigators, but which can be made available to another set of irrigators, and at a price which is deemed reasonable by a committee of irrigators jointly overseeing water banking in one of the three district pools. This is suggestive of an approach to water banking which treats the exchange process (rental or sale) as being in the public or collective interest of the community of irrigators, rather than exclusively in the interests of individual economic gain. If there is an emphasis on economic gain, it is rather in the form of improving the efficient use of water in the basin, and in temporarily moving water to a location where it can generate the most farm income.

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[30] Macdonnell, L., Water Banks in the West: Untying the Gordian Not of Western Water. Boulder : Natural Resources Law Center, University of Colorado, School of Law, (1994). See also MacDonnell, L.J., et al, Water Banks in the West. Natural Resources Law Center, University of Colorado, School of Law (August, 1994).

In summary, the role of local irrigator advisory committees (and their legal council) is very important to the Idaho water banking process. The state has approached the development of water banking and its administration with due recognition to local input concerning procedures of operation. This local input is felt to be essential to the success and trust in water banking operations. Again, the state's Water Resources Board is authorized to appoint these local committees, which have the authority to "market" stored water, and to determine what portion of the proceeds from a lease go to the lessor and what portion is held back to pay for the costs of administrating the overall program.

The program is largely self-financed and operated at cost. A small pricing differential for rental water actually penalizes users who are renting from outside a given district rental pool. Meanwhile, the benefits of renters are carefully weighed against the benefits of the community of irrigators. The bottom line is to maximize flexibility in water use while protecting the local community of irrigators. This is not what one would call a free-wheeling marketplace where willing sellers wait for the highest bid. It is not a "farmer's market" or "auction house." Rather, it is clearly a carefully crafted "socialized" marketplace, where the collective interest of the local community of irrigators is placed above individual gain.

Water Banking in California.

The state-wide water bank that was organized during the severe California drought of 1987-1992 is generally considered to have been a success. In addition, it may have initiated much more interest recently in water transfers than in the past. It was a high profile program organized in 1991 by the Governor of California, and administered by the California Department of Water Resources. It was designed to move water to where it was in greatest need during the drought, rather than to facilitate the marketing of water per se. This is an important observation because, as with most successful water banks that have been developed in the West recent years, the emphasis has generally been on distributing water to areas of critical need and planning for drought rather than as a means of pricing water more efficiently through a market mechanism.

Several water transfer policies were temporarily invoked as part of the bank's operations and that were later made permanent. These included prevention of injury to existing water rights, fish and wildlife resources, and groundwater basins. Water was to be put to beneficial use, and supported by best management practices instituted where the transferred water was going to be applied. Finally, strong consideration was given to protecting the economies of agriculturally-based communities.[31]

Some restrictions were also placed on land fallowing, which was potentially another source of water transfer through the bank during the drought, although no land was actually fallowed during the bank's existence. The bank terminated along with the drought. However, a few important policy questions were left unanswered, such as how to transfer water that was part of a federal water supply contract. Later, with the passage

[31] California Water Plan Update (2005). Water Resources Bulletin 160-05, December 2005. California State Department of Water Resources.

of the Central Valley Project Improvement Act (1992), irrigation districts and other types of water suppliers utilizing federal contract water were allowed to transfer such supplies to other federal contracting entities, but generally not to entities outside the federal project. In other words, State Water Project (SWP) and federal Central Valley Project (CVP) water were generally not to be commingled. Nevertheless, important precedents were set leading to a "water marketing mentality" in the minds of many of California's mutual irrigation company and irrigation district boards.

In recent years, there has been increased interest in groundwater banking and conjunctive use programs, particularly in California's Central Valley. In fact, surface and groundwater conjunctive use and management programs are considered vital for a state whose population will likely exceed 50 million by 2030. One of the earliest such programs in the post-WWII era was that of the Arvin-Edison Water Storage District located just south of Bakersfield, California. It is important to take a brief moment to discuss this program, since it is now being viewed by many other water users in the southern San Joaquin Valley as a model to expand groundwater management programs that resemble water banking enterprises, as well as for conjunctive use.

The Arvin-Edison Water Storage District is both a typical agricultural irrigation district and a groundwater bank. The banking program began in the 1960s a little before the beginning of another well known water banking enterprise in this area, the Kern County Water Agency's water bank. At present, there are at least eight such groundwater banking programs in the southern San Joaquin Valley, all of which have seemingly drawn upon the experience of the Arvin-Edison Water Storage District.

Approximately on-half of the irrigators in the district utilize surface supplies that the district receives from several sources, the main source being the federal Central Valley Project. However, an additional one-half of the water users in the district rely primarily on groundwater. Due to extensive depletions in the local aquifer over the years, the district began acquiring additional surface supplies to recharge the aquifer, thereby protecting the district's well users. This has gradually evolved into a very active groundwater banking program that includes storing water for other neighboring irrigation districts as well. The key to such programs is, of course, a workable aquifer with good porous sedimentary materials providing easy recharge through water spreading basins.

Today, the program includes important water exchanges, as well as the district's well recharge program for its own irrigators and groundwater banking for neighboring districts. Efforts are being made to move in the direction of a joint operation groundwater management program with other nearby irrigation districts. This is due to the fact that as new good quality spreading basins are found, many of these districts are in effect recharging and withdrawing water from the same general aquifer as the Arvin-Edison program. Boundaries between the different programs are becoming vague, and it is believed that a joint operation plan would help harmonize the different recharge and withdrawal programs.

There are many unique features of the Arvin-Edison program. Since the district relies on several different sources of water, and since the district is comprised of both well users and surface users, as well as entities wanting to place water in the bank (i.e., utilize its recharge basins), a method has been devised to prorate the cost of operation in such a way as to ensure equity in the distribution of benefits for all these different user types. In addition, recently the district entered into an agreement with the Metropolitan Water District of southern California serving the five counties of the Los Angeles basin to store water from California's State Water Project in the Arvin-Edison bank. This has been a lucrative opportunity for the district, providing millions of dollars to upgrade its canals, the many lift pumps serving the system, and to make improvements in water delivery facilities for the surface water users in the district.

Many other irrigation districts in the southern San Joaquin Valley are now looking to the Arvin-Edison model as a means of banking federal and state water that is made available locally. This includes flood waters that can be purchased by the valley's districts from the federal project, as well as from neighboring districts that temporarily have surplus supplies. This is gradually bringing some 30 plus irrigation districts served by the Central Valley project into a collaborative working relationship in a way that has not existed before.

It might be expected that this trend will gradually lead to a thriving regional water market. However, as with several of the other examples, water banks in the Central Valley have developed out of a local example used to protect the interests of irrigators, rather than programs being constructed solely for the purpose of marketing water. Most of these entities operate at cost, and the mission of the various programs is to stabilize water supplies for local districts, rather than being driven solely by the profit motive. In essence, this tends to be how this non-profit business sector operates. Productivity is measured by the ability of local organizations to guarantee a timely and reliable water supply for irrigators, and potentially for surrounding municipalities. The concept of water use extends beyond efficiency to include protecting already developed property and valuable irrigated crops. It would appear important for those focusing on researching ways to increase the price of water so as to guarantee its more efficient use, to also look at how these traditional institutional mechanisms secure the investments made by local landowners in the face of pending drought, which is always around the corner.

Summary and Conclusions

The current research on water banking reported here has focused on understanding some of the social and organizational issues facing traditional irrigation communities in developing more market-oriented approaches to water management. Water banking is viewed as one of many marketing techniques, but which more often than not, appears to be designed more to protect and secure local water rights for continued use rather than as a means of earning profit and/or seeking the highest economic value of the resource.

In other words, it often appears that approaches to water banking, whether in the Arkansas Valley of Colorado, or in Idaho and California, represents more of a "social

contract" approach than a utilitarian one. The social contract approach is one of safeguarding the collective interests of a local community of water users, whereas the utilitarian approach might be said to emphasize individual landowner economic interest or efficiency in price setting. Additionally, more successful water banking examples appear to emphasize security and permanency in resource use for a local community of irrigators. This is seemingly in contrast to the emphasis often given by federal and state water marketing programs to promote water banking largely in the name of water conservation and more efficient pricing of the resource.

There are often important value conflicts emerging in this process as well. On the one hand, recent emphasis on water marketing is seemingly in conflict with viewing water as a public good. Somehow, markets are supposed to ensure that this public good is distributed to where it is most needed. Yet, it is routine to see the "gale of creative destruction" represented by the marketplace to not only place new demands on institutional arrangements that even state and federal agencies are often reluctant to see occur, but also negate long standing social arrangements in local communities. These arrangements include, but are not limited to, non-profit organizations with unfortunately limited opportunities to make use of the profit motive and other market mechanisms to improve the performance and productivity of the "firm."

The utilitarian approach to water management is further exemplified by the arguments put forth by economists that the market is the most efficient means of moving water to its most beneficial use. This is most often supported by a utilitarian argument that it is "the greatest good for the greatest number" that defines this efficiency. Therefore, it is sound policy to move water out of agriculture where presumably the beneficiaries are fewer, to cities where the resource will realize a higher economic value as well as serving a greater number of people. Any regard for a social contract based on local tradition or community values in the management of the resource, or prior investment in the development of irrigated lands or production facilities for food production are of little consequence to this utilitarian calculus.

In addition, people who own water rights are divided over this issue. Those potentially benefiting from the market are in opposition to those who stand to gain most by seeing the traditional social contract maintained. Tension develops within mutual irrigation companies and irrigation districts over how to best accommodate individual landowner needs and adjust to the penetration of the marketplace into traditional water management. In response, what we have often seen in our initial research of successful water banks is an attempt to temper the market, to socialize it in order to secure and perpetuate existing uses.

The successful water bank in the Arkansas Valley is based on the mutual irrigation company tradition. The district irrigator committees governing the Idaho water banking system has made that program a success. The "good neighbor" approach taken by the City of Fort Collins to manage its shares of stock in local irrigation companies in a way that ensures that the water rental market maximizes the continuation of agricultural production in its vicinity has maintained irrigator trust in that program. The newly

emerging groundwater banks in the southern San Joaquin Valley of California designed to secure water rights for valuable crop production in light of continued opposition by environmental interests to see more surface water storage developed is yet another instance of the social contract approach overriding the utilitarian approach. The emphasis in these water banking initiatives is placed on "community," rather than "utility." They are designed to be equitable in operation, inclusive and participatory in governance, and welfare enhancing to the member beneficiaries.

In a way, it is not surprising that successful efforts at water banking and water marketing have largely come out of the mutual irrigation company and irrigation district tradition. These organizations are generally considered to be part of the farmer cooperative organizational tradition in the West, although differing somewhat from typical cooperatives. Nevertheless, they are largely non-profit in nature, are governed by locally elected boards, distribute water by shares of stock or by acreage, and for which the cost of management is equitably prorated across all beneficiaries. However, they are legally bound to state nonprofit corporation acts, water codes or statutes, or federal contracts-in the case of irrigation districts formed under federal water projects. For these reasons, they are often limited in the degree to which they can utilize market mechanisms to advance their interests.

However, this has not deterred many of these organizations from exploring at the edges of the marketplace. Some enter into leasing arrangements with cities for the rental of their canal and storage facilities. Others lease canal corridor easements for pedestrian trails and other uses. Yet others enter into agreements with cities to provide pressurized water service for residential landscape irrigation. These innovations continue at the edge of the market. Therefore, it would appear incumbent on federal and state agencies to assess the degree to which contracts, water codes and statutes facilitate this exploration even more.

If the interest is in making these non-profit enterprises more productive, then it would seem that greater emphasis could be placed on increasing organizational opportunities and reducing institutional frictions that promote these innovations, rather than simply attempting to find ways to increase the cost of factor inputs into these "firms." The point was made earlier that new ideas concerning productivity of the firm seemingly have important application to this non-profit enterprise sector. It might be better to explore this option, rather than instituting a water marketing mechanism simply for the purpose of moving water to the highest bidder.

What previous research findings in water management and institutional development might have helped the State of Colorado create a marketing mechanism that would have sufficiently addressed the needs of the Arkansas Valley? First, public involvement in the creation of the water bank did not reach all significant stakeholders, which in turn raised legitimacy issues with those left out of the process. More public meetings like the ones utilized in the Statewide Water Supply Initiative would have helped alleviate this problem.

Secondly, a water banking program that utilized a variety of mechanisms to move water around the landscape would appear to have been more flexible than a water bank that focused solely on short-term water leases. Thirdly, a water bank that only utilized stored water located in the valley's winter water storage program excluded potential water wheeling between mutual irrigation companies, and between these companies and other entities. Direct flow rights could not be leased in the pilot water bank, which prevented mutual ditch companies like the High Line Canal Company from leasing water to the City of Aurora; an action which occurred anyway, but through other means. This kind of short term wheeling was the type of transaction that could have allowed the exploration of exchange agreements between mutual irrigation companies in the lower basin. There were obviously Colorado-Kansas compact issues to consider in allowing this sort of water wheeling, but this should not have prevented the bank's administrators from experimenting with procedures that could have measurably justified its very existence.

In the end, the State of Colorado has decided to move away from water banking in the Arkansas Valley. In 2005 the board of the Southeastern Colorado Water Conservancy District elected to no longer manage the water bank, leaving a water marketing void that still needs to be filled. If the water users in the lower Arkansas Valley are going to successfully create a water market that benefits the entire basin, then another organization, most likely the Lower Arkansas Valley Water Conservancy District, is going to have to initiate it. Right now the conservancy district is moving in that direction with such concepts as a "super ditch company" and the like. Only time will tell if these will be successful initiatives, but one thing is certain, it will not be easy. Institutional change is a time consuming and laborious process, but the longer that process continues, the more it is likely to gain legitimacy and ultimately find its place in the already complex institutional world of the Arkansas Valley. The ultimate criteria in evaluating such an effort should be that it is participatory, inclusive and welfare-enhancing for those whose property is being transacted.

Annotated Bibliography

Clifford, P.; Landry, C.; Larsen-Hayden, A. (2004) Analysis of Water Banks in the Western States. Washington State Department of Ecology and West Water Research Inc. http://www.ecy.wa.gov/pubs/0411011.pdf

The Analysis of Water Banks in the Western States is a nice update on MacDonnell's Water Banks in the West. The authors revisit some of the programs the MacDonnell reviewed but they also add many more water banks to their analysis. States like Arizona, Montana, Nevada, and New Mexico are analyzed. This report is mostly descriptive in nature, but it represents a great overview of water banking as well as illustrating the variety of designs being used throughout the Western United States.

Colorado Department of Natural Resources. (2006) Water Supply and Needs Report for the Arkansas Basin. http://dnr.state.co.us/NR/rdonlyres/0DA2ABE8-7813-490F-AE37-9A451DA2C6FE/0/ArkansasBasin_WaterSupplyandNeeds.pdf

Much like the Arkansas River Basin Needs Assessment, the Water Supply and Needs Report for the Arkansas Basin is an in-depth look into the basin, but unlike the Arkansas River Basin Needs Assessment, the Water Supply and Needs Report for the Arkansas Basin goes a step further and offers options for the Arkansas River Basin. These options are focused on meeting future water needs in the basin as well as offering an evaluation framework for assessing whether these needs are sufficiently addressed with the maximum amount of input and involvement from the primary stakeholders in the Arkansas River Basin.

Colorado 63rd General Assembly. (2001). "House Bill 01-1354: Concerning the Establishment of a Water Banking System and, in Connection Therewith, Making an Appropriation."
http://www.leg.state.co.us/2001/inetcbill.nsf/billcontainers/2FA4967802CC2A07872569C9004D0385/$FILE/1354_enr.pdf

This is the original legislation that created the Arkansas River Water Bank Pilot Program. House Bill 01-1354 created a pilot water bank in the Arkansas River Basin designed to move water around the landscape using short-term leases that enabled irrigators the ability to realize the economic benefit of their water right without permanently transferring that right.

Colorado State Engineer. (2001). "Rules Governing the Arkansas River Water Bank Pilot Program."

Colorado State Engineer Hal Simpson promulgated the rules governing the Arkansas River Water Bank Pilot Program in 2001. These rules map out the legal and procedural guidelines for operating the new water bank in the Arkansas Valley. These rules were developed by the Colorado State Engineer's Office and were subject to a series of public meetings before they were finally administered. These rules of the game structured the

new market, but ultimately were never put to use because no water transactions were ever completed through the water bank.

Colorado 64th General Assembly. (2003). "House Bill 03-1318: Concerning the Creation of Water Banks to Operate in Each Water Division, and, in Connection Therewith, Making an Appropriation."

This is the legislation that expanded upon the Arkansas River Pilot Program by allowing water banking in every river basin in the State of Colorado. One difference between House Bill 01-1354 and House Bill 03-1318 that is worth mentioning is that out of basins transfers which were allowed under House Bill 01-1354 were not allowed under House Bill 03-1318. This is an important point and may have rendered the Arkansas River Water Bank Pilot Program ineffective because out of basin users with deep pockets were seen as potential participants in the water bank on the demand side of the equation.

Corbridge, J. and Rice, T. (1999). Vranesh's Colorado Water Law. Niwot, University of Colorado Press.

Vranesh's Colorado Water Law is essential if you are trying to understand the doctrine of prior appropriations and how that doctrine has conditioned the legal and institutional framework in which Colorado water law is administered. This comprehensive look at Colorado water law takes an in-depth look at the water right, how that right is administered and adjudicated, the organizations that formed around use of that right, and how that right fits into the federal and state nexus. Vranesh also looks at water quality, transmountain water, and water rights condemnation. Any person interested in developing water banks or water markets in the State of Colorado should become familiar with this revised volume.

Dunbar, R. (1983). Forging New Rights in Western Water. Lincoln, Nebraska: University of Nebraska Press.

Dunbar's Forging New Rights in Western Water takes a look at the early development of water systems in the West. Dunbar goes from the first irrigators to the development of mutual irrigation companies to the construction of state and federal projects. Dunbar also looks at water as an evolving property right and how that property right forms the basis of the prior appropriations doctrine. Dunbar looks at the Wyoming System as well, and how that system differs from the doctrine of prior appropriations. All in all, this book is a great over view of how the legal and institutional framework of water in the arid West developed in a variety of settings.

Garcia, L., A. Elhaddad, et al. (2001). "Monitoring and Modeling Salinity and its Impact on Irrigated Fields in Colorado's Lower Arkansas River Basin." Colorado Water. February: 9-12.

This short piece published in Colorado Water gives a brief description of the problems the lower Arkansas River Basin has with salinity. Since salinity is a significant problem

in the lower Arkansas River Basin it is important to have a familiarity with the problem and its impacts on the productivity of the land.

Gates, T.; Garcia, L.; Labodie, J. (2006). Towards Optimal Water Management of the Lower Arkansas River Valley: Monitoring and Modeling to Enhance Agriculture and Environment. Completion Report No. 205. Agricultural Experiment Station Technical Report TR-06-10. Fort Collins, CO: Colorado Water Resource Research Institute.

Gates and Garcia go into great depth on the problems of shallow groundwater tables, excessive salt buildup, and high selenium concentrations and their affects on land management and ecosystem preservation. Gates and Garcia propose to model the Arkansas River Basin in order to manage the water available for use in the lower Arkansas River Basin. Better information on field conditions and how those field conditions play into the legal and economic framework of the valley are essential for ensuring that agriculture remains a viable economic engine in the lower Arkansas River Basin while simultaneously protecting the river's ecosystem.

Howe, C. W. (1994). "Issues in the Design and Operation of a Water Bank: Using Water Banks to Promote More Flexible Water Use" Final Report submitted to the US
Geological Survey. MacDonnell et al.

Howe uses this report to look at the design and operational strategies necessary for creating viable water banks in the West. Water banking has been promoted as an innovative water management strategy that allows water to move around the landscape to its most beneficial and efficient use. Howe gives an economic analysis of the development of water banks with an emphasis on design principles and pricing mechanisms necessary for the creation of water banks.

Landry, C. and Anderson, T. (2000) "The Rising Tide of Water Markets." ITT Industries Guidebook to Global Water Issues. ITT Industries.
http://www.itt.com/waterbook/tide.asp

Landry and Anderson look at the global water shortage problems that are beginning to surface in the U.S. and the rest of the world, and whether those water shortages can be addressed through the development of water markets. Landry and Anderson find that there is great potential in privatizing water supplies and redistributing those supplies through newly formed water markets.

Macdonnell, L., Water Banks in the West: Untying the Gordian Not of Western Water. Boulder: Natural Resources Law Center, University of Colorado, School of Law, (1994). See also MacDonnell, L.J., et al, Water Banks in the West. Natural Resources Law Center, University of Colorado, School of Law (August, 1994).

Lawrence MacDonnell's Water Banks in the West is one of the seminal works on water banking in the Western United States. MacDonnell takes a brief look at the history of water banking (Idaho and California) and examines four water banking strategies (Lower Colorado River Water Bank, Texas Water Bank, Fort Lyon Water Bank, and Truckee-Carson Water Bank) in this report. MacDonnell uses the remainder of the report to propose frameworks and design principles for future water banks.

Milenski, F. (1990). Water: the Answer to a Desert's Prayer. Boone, CO: Trails Publishing Company.

This is a great place to start if you want to get an irrigators perspective on water management in the Arkansas River Basin in Southeastern Colorado. Frank Milenski was considered by many to be the one of the most knowledgeable people in the lower Arkansas Valley on issues related to water supply and management. This book looks at the development of the Catlin Canal Company, but in doing so it also gives an account of the development of the entire water system in the lower Arkansas River Basin. Milenski also wrote In Quest of Water: A History of the Southeastern Colorado Water Conservancy District and the Fryingpan-Arkansas Project, which gives a comprehensive documentation of the events that took place to bring transmountain water from the west slope of the Rocky Mountains to the Arkansas River Basin.

The Natural Heritage Institute. (2001). Designing Successful Groundwater Programs in the Central Valley: Lessons from Experience. Berkeley, CA. www.N-W-I.org.

This report looks at new institutional and legal water management strategies for the Central Valley water project which provides the vast majority of California with its available water supplies. The search for new stores of water is being driven by a Congressional mandate to protect and reconstruct fish and wildlife habitat in accordance with the Central Valley Project Improvement Act. This act requires that the a new environmental water account be created that will divert approximately 355,000 acre-feet of water for the purpose of habitat restoration.

Ostrom, E. (1992). Crafting Institutions for Self-Governing Irrigation Systems. San Francisco, CA: Institute for Contemporary Studies Press.

Ostrom's companion book to Governing the Commons is a map to crafting locally run self-governing irrigation systems throughout the world. Ostrom looks at institutions as the embodiment of the rules of governance, what one should think about when crafting institutions, what design principles are the most important when structuring these

institutions, and how one applies these design principles when crafting a new institutional system.

Purkey, D.; Thomas, G.; Fullerton, D.; Meonch, M.; Axelrad, L. (1998). Feasibility Study of the Maximal Program of Groundwater Banking. Natural Heritage Institute. http://www.weap21.org/downloads/BayDelta2.pdf

This report looks at the feasibility of a groundwater banking program in the State of California as a means of alleviating the pressures on both the environmental challenges of habitat protection and restoration in California, as well as the economical challenges related to the enormous population growth and development that has happened over the past sixty years. The feasibility study reports that groundwater banking may be a win/win solution to the strains being placed on environmental as well as economical uses of California's available water supplies.

Raloff, J. 2000. "Liquid Assets: A New Breed of Bankers is Helping Communities Save for Un-Rainy Days." Science News 157: 72-74.
http://www.sciencenews.org/pages/pdfs/data/2000/157-05/15705-13.pdf

This article published in Science News looks at a variety of different water banking strategies throughout the United States. Usually water banking is seen as a water management strategy for Western water managers, but this short piece looks at water banking in the Southeast and the Northeast as well.

Ed. Smith, R. and Hill, L. (2000). Arkansas River Water Needs Assessment. Colorado Department of Natural Resources, U.S. Bureau of Land Management, U.S. Department of Interior Bureau of Reclamations, and USDA Forest Service.
http://dnr.state.co.us/Home/ColoradoWaterforthe21stCentury/Arkansas/Arkansas+River+Water+Needs+Assessment.htm

This report is a comprehensive analysis of the Arkansas River Basin. The Arkansas River Water Needs Assessment examines the river basin in regards to its institutional and legal characteristics, hydrological characteristics, natural resource characteristics, and its recreational characteristics. If you are interested in an in-depth look into Division 2 then this is your report. This report is also full of maps, charts and tables useful for describing the Arkansas River Basin.

Thompson, Barton H., Jr. (1993). "Institutional Perspectives on Water Policy and Markets." California Law Review 81 (3): 671-764 MAY.

Thompson is looking at the failure of traditional common law and statutory procedures at addressing many problems facing Western water managers. These problems include but are not limited to insufficient conservation incentives, excessive groundwater withdrawal, and a lack of adequate environmental protections. Thompson then looks at the use of water markets to address problems of efficiency and environmental protection in water management. Thompson illustrates the importance of local institutions/organizations in

creating internal markets that allow for the lease and transfer of water around the local service area, but those same institutions serve as a barrier to the creation of regional markets.

Williamsen, T. (2006). Development of Replacement Water Supplies by the Lower Arkansas Water Management Association.

Williamsen describes in detail how the Lower Arkansas Water Management Association operated its groundwater augmentation plan. The groundwater bank has been operating in the Arkansas Valley longer than any proposed or implemented water bank in Division 2 with very little fanfare. LAWMA uses a mutual irrigation company format for operating their water bank. LAWMA sells stock certificates in the company in order to purchase water, operate their facilities, and legally protect their water rights against claims of injury from senior water rights appropriators as well as the State of Kansas.