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Water Exchanges and Agricultural Production in Northeast Colorado: Opportunities and Constraints for the Future

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INTRODUCTION

One of the more interesting and continually important river basin water management practices found in the West is represented by water exchanges (river exchanges). The Cache La Poudre River Basin in northeast Colorado is renown for its water exchanges (Figure 1 and Figure 9 at end). The history of water exchange development in the basin provides important lessons in how irrigators have worked together to solve mutual problems, without going to great expense to further engineer the river.

The implementation of water exchanges requires extensive knowledge of a river's legal underpinnings as well as a high degree of cooperation and trust, elements that may often be lacking in today's world of competing uses and dwindling per capita water supplies due to population growth.

Water exchanges continue to be important to agricultural production in northeast Colorado, particularly in the Cache La Poudre Basin. Part of this is because of their unique relationship to cropping systems in the basin. However, the future of these exchanges may be threatened by new competing water uses, particularly urban and recreational water uses.

Water exchanges belong to a family of unique institutional approaches to water management. Water exchanges can maximize the use of existing physical infrastructure, such as dams, off-stream storage, pipelines, and diversions, obviating the need (and cost) of constructing new infrastructure. Other members of this family of institutional approaches include water renting, water banking, and water markets. This family of water management practices is known for its utilization of "social capital," in the form of local hydrologic knowledge, agreements, practices, trust and ingenuity to better allocate water supplies. These approaches often make use of market principles to allocate water, but in ways that are designed to protect and/or enhance local community values and interests, along with private interests.[7]

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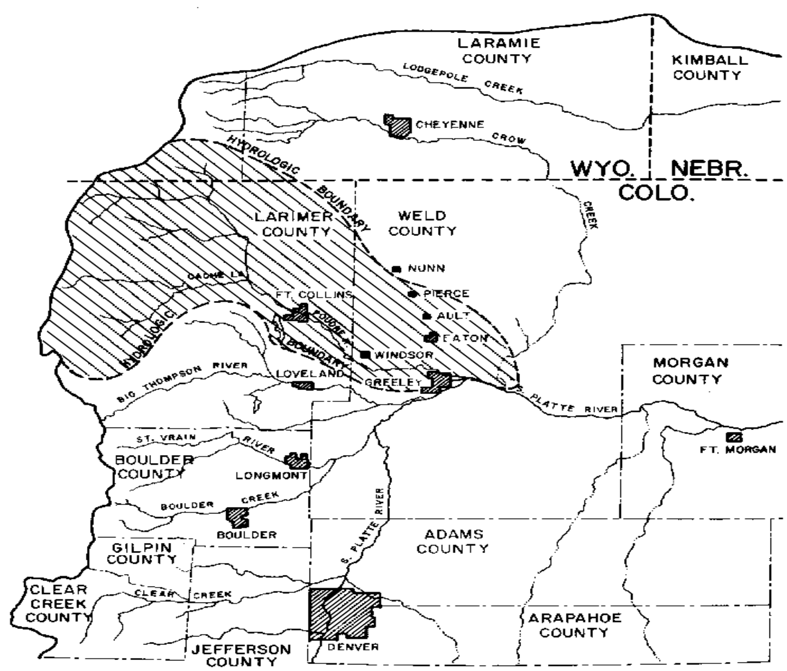
[7] For a review of some important water exchanges in the Rocky Mountain region, see M. White, *Water Quality Exchanges*, Rocky Mtn. Mineral Law Institute. (39:19-1:1993.

FIGURE 1 – CACHE LA POUDRE BASIN



Agricultural production in the Cache La Poudre Basin has been greatly affected in recent years by urban encroachment. Housing subdivisions are springing up throughout the basin. Both land and water values have risen exponentially during the growth rate of the 1990s (25 percent). Meanwhile, prices for crops in recent years have been such that many growers are more and more inclined to sell their land and water rights to developers. However, this growth still leaves behind in its wake a large number of farmers who will not realize the benefits of increased land and water values due to growth for several years to come. These farmers are left with the problem of continuing to get water to their farms on a timely basis, and often in the face of the threat of drought. Water exchanges in the basin continue to provide a means for farmers to meet these local water needs. We will highlight how water exchanges have developed to meet agricultural production needs in the basin, and perhaps what can be done to ensure their continued use for as long as they are needed.

Water exchanges may be defined as voluntary, temporary, and generally localized (intrabasin) transfers of water between closely neighboring water supply or water storage entities. Generally, a change of ownership in water does not occur as a result of a water exchange. A water exchange can occur simultaneously between two or more entities, but more often than not occurs over a short time delay, say an hour, a day, a week or a month. Exchanging entities may include canal companies, reservoir companies, irrigation districts, other special water districts and even municipalities.

Most water exchanges are direct, one-for-one acre-foot exchanges between participating entities. Exchanges commonly utilize two or more points of diversion or release. Several entities can be cooperating in a given exchange at the same time, or at different times, resulting in quite elaborate multiple exchanges, several of which will be discussed later. Finally, an exchange adheres to the concept of maintaining the character or use of the water being exchanged. For instance, when irrigation water is exchanged between two parties, both parties must use the exchanged water for irrigation and not for other purposes. Otherwise, a “change of use” filing would have to be processed through the State Engineer’s Office.

An exchange usually involves years of deliberation on the part of entities before they enter into an exchange partnership. Once adjudicated, entities may have “standing exchanges” in the river system, meaning that unless otherwise specified, they are to occur on a given date or whenever the river (or a storage facility) has reached a certain water level. However, most agreed upon exchanges appear to be implemented on an “as needed” basis.

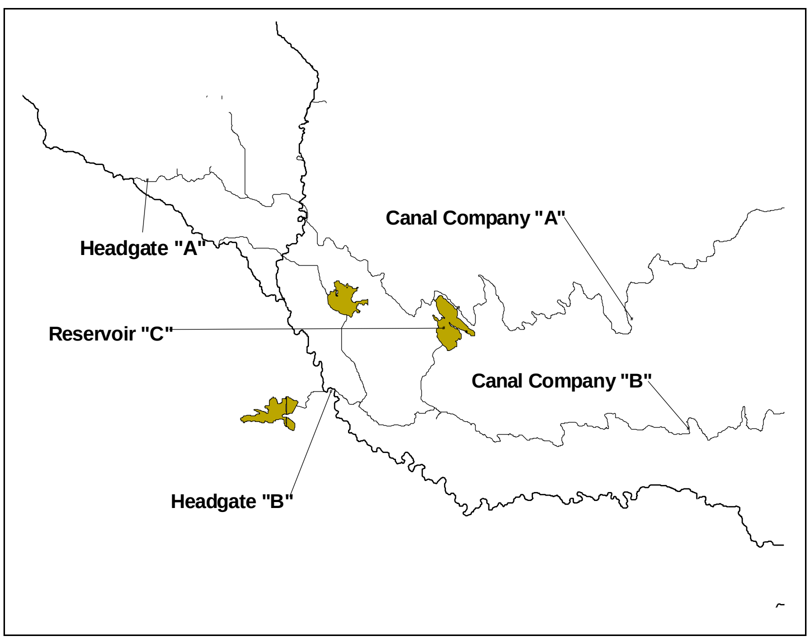
In Colorado, water exchanges have been filed and adjudicated at some point in the past through district water court proceedings. This has occurred to ensure that there is no injury to other parties not participating in a given exchange. Unadjudicated exchanges are permitted but only at the discretion of the Water Commissioner or designated State water official, and only if such an exchange does not interfere with adjudicated exchanges or cause third party injury. The State Engineer’s Office supervises water exchanges in Colorado. The maintenance of records on exchanges, including their oversight when they are being implemented, is generally the responsibility of the local Water Commissioner. This is because exchanges affect the management of the river, and any time the river is manipulated it will likely affect water rights, and therefore the state's presence is mandatory.

Why do exchanges occur? They occur primarily because water supply entities, in attempting to maximize the beneficial use of their river or storage decree, often must overcome geographical constraints affecting their water supply, address temporary water shortages, minimize river or canal transit losses, improve the timing of water releases from storage, address local water quality issues or better regulate irrigation canal flows.

For instance, low river flows can prompt a junior decree holder to request borrowing the use of a senior decree diversion, then subsequently repaying the senior decree holder an equal amount of water diverted at another geographical point or time. It is frequently not immediately apparent to an observer how such an exchange benefits a senior decree holder. However, closer inspection often reveals significant improvements in the timing and quality of water to the senior decree. Figure 2 shows a typical exchange occurring between two canal companies in the Cache La Poudre Basin. In this instance, the canal companies with diversion headgates on the river exchange water by utilizing reservoir storage. Canal company " A" diverts water, through its headgate, decreed to canal company "B," and then pays back canal company "B" by releasing water from reservoir "C" operated by canal company "A."

Cooperating parties enter into these exchanges to better manage and increase the economic value of their decreed water rights. Generally, an exchange is mutually beneficial to the exchange partners or they would not enter into it. Successful water exchanges occur repeatedly year after year unless water flow conditions prohibit them. However, they are potentially affected by drought and other long-term changes in water supply. Although difficult to document, there is a tendency for water exchanges to occur less frequently in both very dry years and very wet years. Very dry years limit their implementation, while very wet years minimize their need.

FIGURE 2 – A TYPICAL EXCHANGE



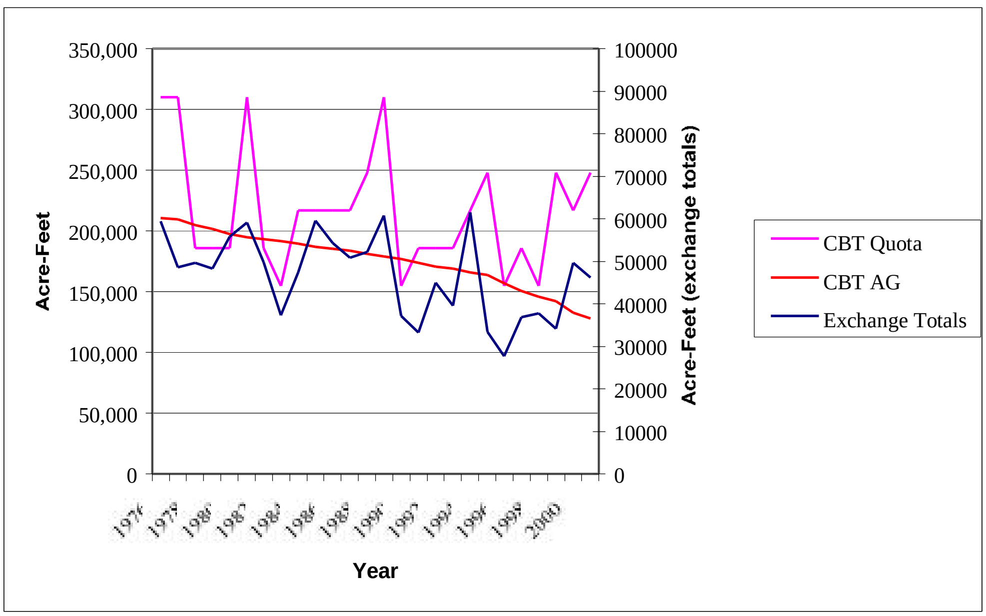
Although water exchanges do not create additional water for a particular basin, they can improve the timing, efficiency and allocation of existing water supplies. This is accomplished with minimal expense. It appears that financial costs are primarily for record keeping, rather than for significant new engineering needs. This is one of the many reasons why exchanges have been attractive to canal companies and irrigation districts over the years. Water exchanges, water rentals and water banking are relatively inexpensive options for these nonprofit enterprises to improve the delivery of water to farms.

Water exchanges are widely practiced in Colorado and traditionally have been important to irrigated agriculture in the state. As will be shown, water exchanges may have had a late 19th century fluorescence in Colorado, due to favorable circumstances brought about by early pioneer settlement and geography. However, new values and needs in river basin water management throughout the West have recently called into question the continued importance and desirability of these exchanges. Water exchanges do manipulate river flows, often substantially, and in ways that environmental and recreational groups do not readily approve of today. Despite this, water exchanges communicate a somewhat "timeless" lesson in river basin cooperation and innovativeness, particularly when water is so unequally distributed across the region.[8]

There are numerous instances of exchanges in the Cache La Poudre Basin. The practice evolved so dramatically in a relatively short time just prior to 1900 that a future Water Commissioner was compelled to develop a working table of some 1243 potential exchanges he might be called upon to oversee.[9] These exchanges were formally adjudicated in 1976.[10] Although there are 1243 adjudicated river exchanges in the Cache La Poudre Basin today, only 11 account for the majority of water exchanged. Certain years may see activity in some of the 1232 other exchanges, but nowhere to the degree exhibited by the eleven principal exchanges. These eleven exchanges together averaged about 46,000 acre-feet of water annually over a twenty-five year period (1973-2001), or more than 95 percent of all exchange activity occurring in the basin. A rough indicator of the importance of these exchanges to river basin management is that 46,000 acre-feet amounts to approximately 17 percent of the average total annual flow of the river.[11]

FIGURE 3a – THE EFFECTS OF WATER SUPPLY ON RIVER EXCHANGES

Exchange Totals Compared against C-BT Quota and C-BT Water in Agriculuture
R-square = .415



Although several of the eleven principal exchanges precede in time the coming of transbasin water supplied by the Northern Colorado Water Conservancy District through the Colorado-Big Thompson (C-BT) Project, the economic value of these exchanges to their participants has increased as a result of the project. The exchanges have been, for the most part, easier to perform since C-BT project water was first made available in 1953. Over the years, the amount of water actually exchanged between entities in the Cache La Poudre Basin appears to have been dependent upon the quota of water announced by the conservancy district for its water users. High quota years generally see more exchange activity than low quota years. Thus, many of the exchanges may be said to be "quota dependent." [12]

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[8] An example of unequal factor endowments in Colorado is that 95 percent of the population located on the east side of the Continental Divide has access to only 5 percent of the state's water supply. U.S.G.S. data on state border water crossings.

[9] This exchange matrix was compiled by Mr. Jack Neutze, former District No. 3 Water Commissioner, for the State Engineer's Office.

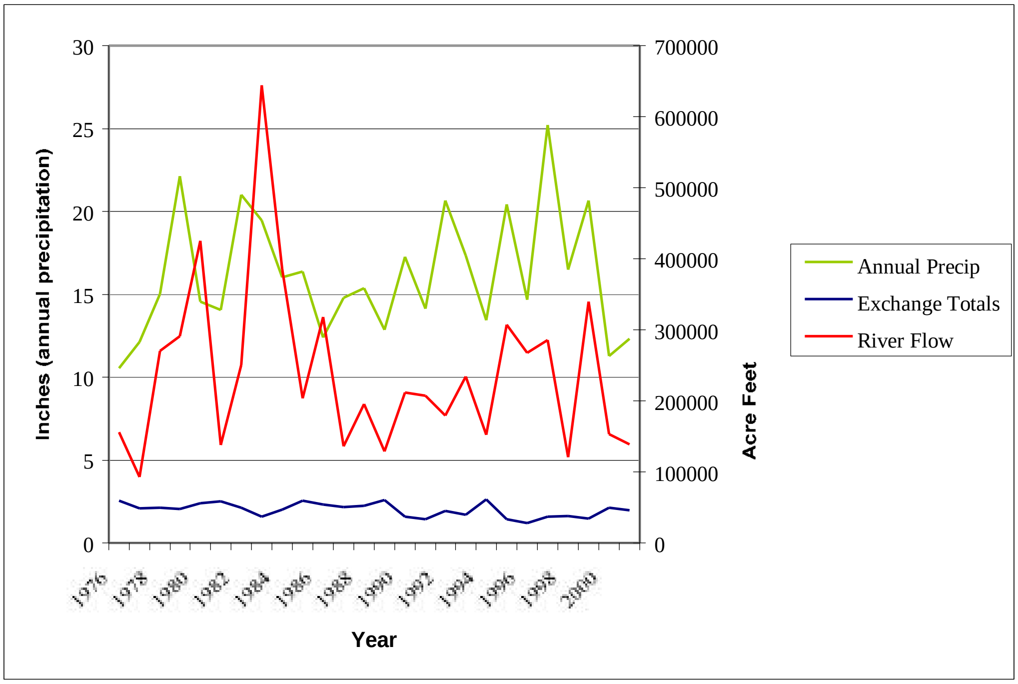
[10] Case No. W-8086-75, State of Colorado.

[11] The historic average annual stream flows for the Cache La Poudre River is 269,600 acre-feet, taken at the mouth of the canyon of the river where it enters the plains. Historic averages obtained from USGS Water Data Report CO-93

However, as C-BT water has slowly migrated from agricultural to municipal ownership over the years, there has been a noticeable change in the volume of water exchanged among agricultural entities. Figure 3a and 3b give some indication of these trends. Figure 3a shows historical trends in water exchanges set against historic trends in the C-BT quota and historic trends in the transfer of C-BT units out of agriculture and into municipal-commercial ownership. Figure 3b shows historical trends in water exchanges set against historical trends in river flows and precipitation in the basin. In contrast with the evident relationship between the activity of water exchanges and the annual C-BT quota, Figure 3b shows that the availability of native water supplies in the basin is not as dramatic a factor in water exchange activity, nor is it clearly evident that exchanges are more frequent in high and low water years. A few low water years show more frequent exchanges. Obviously, many factors play into these water exchanges, including both water supply and demand factors.

FIGURE 3b – THE EFFECTS OF WATER SUPPLY ON RIVER EXCHANGES

Exchange Totals Compared against River Flow and Precipitation
R-square = .246



Many farmers today speculate that once the C-BT water has been transferred completely out of agriculture, many of the current principal exchanges will decline in importance or become inactive. This transfer appears inevitable due to the greater purchasing power of municipal and commercial interests for C-BT units of water for potable use. Figure 3a tends to support the notion that water exchanges are declining as water is transferred from agricultural to municipal use. It should be noted that when an entity is utilizing C-BT units in an exchange, the amount of water exchanged may vary from year to year. This is because the acre-foot quota per C-BT unit varies from year to year. Figure 3a tends to show a relationship between reduced exchanges and low quota years, although this relationship is conditioned by drought as well.

Table 1 shows a classification of types of water exchanges in the Cache La Poudre River Basin, along with the average amounts of water annually exchanged by each type of exchange between the years 1973 and 2001. The exchanges are additionally divided into three groups according to the water supply entities involved in the

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[12] Each C-BT unit represents 1/320,000th of the available water supply (quota) announced each year by the conservancy district for its water users. The quota has averaged about 75 percent of 320,000 acre-feet of water since the project's first issuance in 1953.

exchanges. Direct exchanges occur more or less simultaneously, while paper exchanges represent water transferred from one entity's account to another's for use sometime in the future, traditionally by the end of irrigation season. Extending exchanges across the end of the irrigation season (traditionally November 1st in the Cache La Poudre Basin) increases the potential for third party injury, and therefore is avoided. Table 1 indicates the hydrological unit involved in the exchanges. Reservoir-to-river exchanges are more common, indicating the importance of reservoirs to major river basin exchanges.

TABLE 1 – Principal Chart of Exchanges on the Cache La Poudre River, Colorado

Principal Entity	Name of Exchange	#	Average Acre Feet Exchanged	Type of Exchange					Type of Decree	
				Direct		Paper		Triple Exchange		
				River to River	Res. to River	Res. to River	Res. to Res.		River/ Storage	Reuse
North Poudre Irrigating Co.	C-BT / River	1	15,953	X					X	
	C-BT / Worster	2	3527			X			X	
	C-BT / Fossil Creek	3	3200			X			X	
	C-BT / City of Ft. Collins	4	2398			X			X	X
	C-BT / City of Greeley	5	2252			X			X	
	Fossil Creek / River	6	1723		X	X			X	
Windsor Reservoir & Canal	Water Supply & Storage	7	8385				X		X	
	Windsor Reservoir	8	4415			X			X	
	New Cache / Windsor Reservoir	9	3956		X				X	
	Grey Lakes / Windsor Reservoir	10	599 (6 yr avg)				X	X	X	
PVLCC	PVLCC – Claymore Lake / River	11	555	X					X	

The first group of six exchanges involves the North Poudre Irrigation Company (NPIC), an entity now majority-owned by the City of Fort Collins but still delivering water to 30,000 acres of irrigated land. Five of the six NPIC exchanges also involve the transfer of C-BT units between exchange partners.

Of the remaining eleven principal basin exchanges, four occur fairly low in the basin and involve the Windsor Reservoir and Canal Company and the Larimer and Weld Irrigation Company, the latter being a carrier canal that provides water to irrigators under the former enterprise. One of these four exchanges also involves C-BT units. The eleventh exchange involves the Pleasant Valley and Lake Canal Company.

EARLY GROUNDWORK FOR WATER EXCHANGES

The story of the Cache La Poudre Basin begins well before the Carey Act of 1894 or the Reclamation Act of 1902, both of which finally brought much needed public financing mechanisms to help irrigation development in the West.[13] The Cache La Poudre Basin shares the uniqueness of being developed almost exclusively through private financing mechanisms and local community effort.[14] The establishment of the Union Colony at Greeley in 1870, and the building of Greeley No. 2 Canal shortly thereafter–and now owned and operated by the New Cache La

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[13] Roy E. Huffman, *Irrigation Development and Public Water Policy*. The Ronald Press, New York (1953).
[14] David Boyd, *Irrigation Near Greeley, Colorado*. Water Supply and Occasional Papers of the USGS, No. 9. Washington, Department of Interior (1897).

Poudre Irrigating Company of Lucerne, Colorado--is generally considered to be the beginning of cash crop irrigated agriculture in the basin.[15]

An important study commissioned at the turn-of-the-century by Elwood Mead observed that water exchanges in the West may well have originated in their most developed form in the Cache La Poudre Basin.[16] Today, old-timers in the basin still speak of three essential ingredients necessary for successful river basin management: cooperation, trust and, most of all, creativity. These were needed to overcome gravity and perhaps occasional greed in the early years of settlement and river decree filings. Innovativeness and creativity have been the cornerstones of the basin's water development ever since.

In an era when much negativism is voiced about the prior appropriation doctrine and its declining usefulness as a mechanism for managing water efficiently and equitably in the West,[17] one must turn back to a period when the issues and concerns of river basin management were quite different. In the early years of irrigation development, water was scarce, or at least extremely variable in quantity. Most rivers in the Rocky Mountain region had negligible flows in all but one or two months of the year. Water had to be developed. Most of all, it had to be developed with limited financial resources.

In 1900, the previous fifteen-year average flow for the Cache La Poudre River during the month of July was only 840 cubic feet per second. In addition, the river was characterized by extreme diurnal fluctuations in its flow pattern, much as it shows today even in a more developed water situation. Yet, in the same year, at least 140,000 acres of land were being irrigated with this very small and highly variable water supply.[18] How was this possible?

First, most of this turn-of-the-century acreage was in wheat and other cereals, much of which did not require late season watering (August through October). In addition, 100 years of precipitation records shows a history of variable but constant rains in the basin during the middle of the summer.[19] In the early years, this was sufficient to support wheat and small grains.[20] However, the introduction of alfalfa as an important feed and soil regeneration crop, first planted in the basin in 1872, would slowly begin to create more demand for late season watering to support additional cuttings.[21]

Water needs for irrigation continued to change as more settlers arrived. By 1900, the basin showed a thriving production of potatoes, onions, cabbage, alfalfa, orchards and small fruits. Major increases in sugarbeet production were occurring by 1910, eventually supporting four sugar factories in the basin.[22] By 1920, Larimer County alone was harvesting 223,000 bushels of orchard fruit, mostly apples and cherries.[23] As a result, there was growing concern about adequate water supplies for late season irrigation. Many of the crops in question, particularly onions and sugarbeets, required late season watering.[24] The river flows simply could not support further development in the direction of these specialty crops unless the problem of late season irrigation was resolved.

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15 C.W. Beach and P.J. Preston, *Irrigation in Colorado*. USDA, Office of Experiment Stations, Bulletin No. 218 (1910).

16 E.S. Nettleson, *The Reservoir System of the Cache La Poudre Valley*. USDA Office of Experiment Stations, Washington, D.C. GPO (1901). At the turn-of-the-century, Colorado, and particularly the Cache La Poudre River Basin, was considered second only to California in terms of its importance to irrigation development in the West, and particularly for its innovativeness in water development.

17 C.F. Wilkinson, *Aldo Leopold and Western Water Law: Thinking Perpendicular to the Prior Appropriation Doctrine*. Land and Water Law Review (1989:24:1)

18 Supra note 16, at 7.

19 J. Kleist, N.J. Doesken and T.B. McKee, *A Snapshot of Colorado's Climate During the Twentieth Century*. Climatology Report 91-2, Department of Atmospheric Science, Colorado State University (1991).

20 Supra note 16, at 15.

21 Supra note 16, at 12.

22 Supra note 14, at 33.

23 Fourteenth Census of the United States. Vol VI, Part 3, Agriculture, pp. 193 (1920).

24 Even today, sugarbeets require irrigation in October.

Meanwhile, all river decrees were finally adjudicated in 1882, following approximately 20 years of filings. The conclusion was that the river was clearly over-adjudicated. Following the 1882 adjudication, 12 major reservoirs with an original combined capacity of about 50,000 acre-feet were built in the basin to store flood-stage and winter flows, mainly by entities that had very junior decrees on the river.[25] Most of these reservoirs were built off the main stem of the Cache La Poudre River, frequently several miles from the river itself, or on one of the river's two principal tributaries. The reservoirs were built by small groups of irrigators who owned stock in local ditch companies or carrier canals. It was common for irrigators to have a portfolio of water stock, often consisting of both canal company and reservoir stock. By 1920, the total potential storage capacity of the basin's privately developed reservoirs amounted to about 55 percent of the total annual flows of the river as measured at the mouth of the canyon of the river where it enters the plains. This amounted to more than 150,00 acre-feet of reservoir storage.[26] These reservoirs created the foundation of many water exchanges.

Early storage included Chamber's Lake, Cache La Poudre (Timnath) Reservoir, Big Windsor Reservoir built by ex-Governor Eaton, Larimer and Weld Reservoir (Terry Lake), several of the small "mountain reservoirs" of the Water Supply and Storage Company, and several of the "plains reservoirs" making up the North Poudre Irrigation Company system.[27] Except for Chamber's Lake (1886), most of the aforementioned storage facilities were built around 1892-93, a period when river flows were quite low, and not coincidentally a period when thoughts were first being hatched about the feasibility of water exchanges.[28]

Other activities were underway at the time of reservoir building that would contribute to water exchanges. Small transmountain diversions built by two of the major canal companies in the basin were diverting on the average 35,000 acre-feet of water into the basin from the other side of the Continental Divide. Most of this 35,000 acre-feet of "foreign water" was diverted into canals prior to the river entering the open plains just west of the City of Ft. Collins. Thus, 35,000 acre-feet of "foreign water" were added to the basin's annual yield of about 340,000 acre-feet.[29] Although this "foreign water" could be used to extinction by those diverting it across the Continental Divide, it would contribute to the basin's overall supply and be used by other irrigators in the form of return flows.

There remained the issue of proper timing and location of all water supplies, native or foreign. The original 12 reservoirs were all situated at elevations well below the main distributing canal serving the irrigated lands of these reservoir owners, or at great distances from their canal systems. Therefore, the stored supply in these "late comer" reservoirs could not be utilized to irrigate the lands of their builders. Other entities with senior decrees lower down in the river suffered from considerable shrink (seepage losses) in the river itself as the river moved out of its rock enclosure onto the more porous sandy plains where the principal irrigation diversions were located. These factors created a local demand for exchanging what amounted to unusable storage water in return for frequently depleted direct flows owned by irrigation entities and mills with higher priority decrees on the Cache La Poudre River.

With the advent of the reservoirs, and with many water exchanges now firmly implanted in local custom, in an average water year (cir. 1920) water exchanging frequently amounted to about 14 percent of the total water supply used for irrigation in the basin.[30] The principal exchange activity involved the participation of four large

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[25] Supra note 16.

[26] Various sources arrive at different estimates. Hemphill states well over 150,000 acre feet of privately developed storage in the valley as of 1920 (R.G. Hemphill, *Irrigation in Northern Colorado*, USDA Bulletin No. 1026 (1922, pg. 72).

[27] Supra note 16.

[28] Supra note 16, 15 to 31.

[29] Hemphill reported total water yield in the basin as 340,000 acre-feet from the river and its tributaries, 35,000 acre-feet from transmountain diversions, 5,000 acre-feet pumped from wells, and 84,000 acre-feet available from seepage, giving a total of 464,000 acre feet for about 225,000 acres of irrigated land. Excluding the seepage and pumping sources, this would show a water availability of approximately 1.67 acre-feet per irrigated acre; probably a very conservative figure and not a comfortable water supply for the specialty crop production then developing in the basin. Supra note 26, at 10. The figure of 35,000 acre feet for the transmountain diversion water has remained fairly steady over the years, the majority being provided through the Laramie-Poudre Tunnel and the Grand Ditch, most of this water supply being owned by one canal company in the basin.

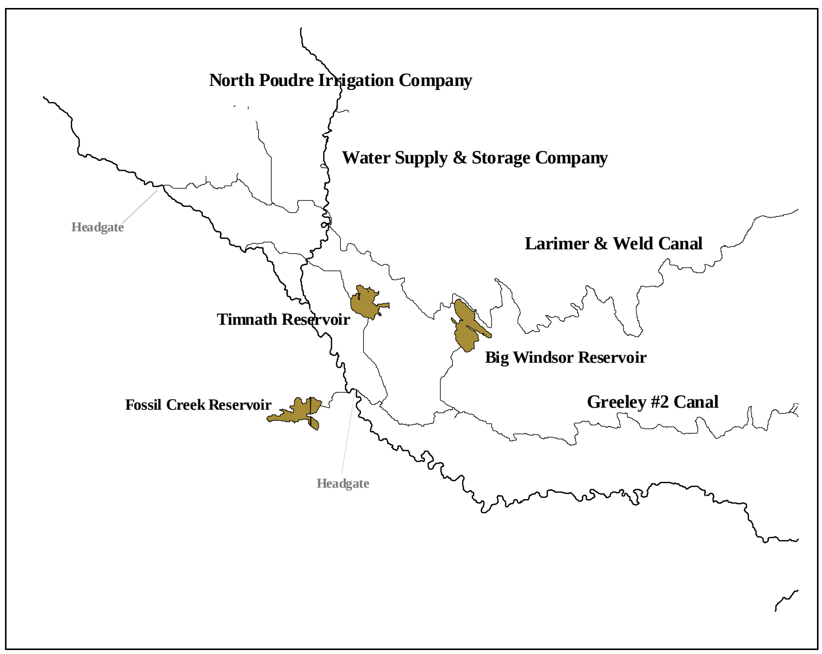
[30] Supra note 26, at 12.

mutual ditch and irrigation companies. These four companies either owned the 12 reservoirs or managed them for reservoir stockholders. The four large companies still operate today and are the Cache La Poudre Irrigating Company (1878) and its affiliate reservoir company, the North Poudre Irrigation Company (1901) and its system of "plains reservoirs," the Water Supply and Storage Company (1892) with its system of "plains and mountain reservoirs," and the Larimer and Weld Irrigation Company (1879) with its two primary reservoir affiliates. Figure 9 shows the main water storage and canal features in the lower portion of the Cache La Poudre Basin along with the location of these four enterprises.[31]

THE DEVELOPMENT OF WATER EXCHANGES

Ultimately, it may be of only historical curiosity to document water exchanges that were developed primarily for agriculture one hundred years ago. However, present-day irrigators in the basin are concerned that this water management option is losing ground to changes occurring in the basin and that something important still may be learned from the past.[32] In some localities in the basin, exchanges are being modified as a result of new operational priorities of exchange partners. Elsewhere in the basin, older exchanges that are no longer in use are being explored for their potential application today. Some of the new interest in water exchanges derives from a growing concern by agricultural water supply entities that the migration of C-BT Project supplemental water from agricultural to urban ownership will terminate many exchanges (Figure 3a). Again, present water exchanges are often greatly dependent upon C-BT project water owned by agriculture.

FIGURE 4 – Lower Cache La Poudre River Basin



Despite important contributions, pre-1900 water development was still insufficient to secure reliable water supplies for an increasingly diversified agriculture with late season water requirements. Many ideal storage sites were quickly exploited, leaving little further water development opportunities until a long-discussed trans-mountain diversion project could be built through some kind of public financing (i.e., the C-BT Project).[33] Until then, problems of supply, and particularly the timing of this supply for mid and late season irrigation, had to be addressed through other means. This supply problem was ultimately addressed through the development of water exchanges, or what in the early years were

[31] Supra note 26. Dates associated with these enterprises are for dates of incorporation. All of the enterprises generally had various private individual or group owners slightly earlier to their date of incorporation. Some construction on the New Cache-Greeley No. 2 canal began as early as 1871; for the North Poudre system, 1878; for the Water Supply and Storage Company system, 1880 (the Larimer County Canal); and for the Larimer and Weld Irrigation Company system, 1878.

[32] Personal interviews conducted with agriculturalists as part of the study.

[33] R. Anderson, Irrigation Systems in Northeastern Colorado, in A. Maass and R. Anderson, *…and the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments.* Robert E. Krieger Publishing Co., Malabar, Florida (1978). See also D. Tyler, *The Last Water Hole in the West: The Colorado-Big Thompson Project and the Northern Colorado Water conservancy District*. University of Colorado press (1992).

called “trades on the river.”[34] In short, the development of water exchanges was all about addressing late season watering needs, addressing differences in the growing season in the upper and lower portions of the basin, and addressing the historical process of settlement that produced a complex array of frequently ill-positioned junior and senior decree holders under the prior appropriation doctrine.

It is insightful to listen to the comments of a past observer concerning the role of these exchanges in contributing to community cooperation, trust and creativity. It is a message that communicates the spirit and logic of local “social capital” applied to water management, whether through water exchanges, water markets, interruptible supplies, water banks, or pressurized secondary supply systems. E.S. Nettleton, a major source of information on early agriculture in the Cache La Poudre Basin states:

> The plan of exchange or “trading around” of water was conceived, agreed to, and carried on by the people themselves without legislative enactments, court decrees, or legal council or advice. It was simply the outcome of the necessity to dispose of water profitably that could not be utilized on lands in one locality by transferring it to another, thus benefiting one and often both of the parties to the exchange. It was first brought about by practical men, getting together in a friendly, neighborly, and businesslike manner, and consolidating the rights that each might have under existing laws into one common interest in the storage of water. The result has been that there has been no quarreling or litigation over the division and exchange of water from reservoirs.”[35]

The historical filing, and therefore priority, of river decrees on the Cache La Poudre River is generally found to be from the bottom of the river basin, where it meets the South Platte River, to the top of the basin at Cameron Pass. In other words, the earliest diversion decrees are for canals and irrigated lands at the lower reaches of the river near Greeley, Colorado. This meant that as reservoir systems were built by junior decree holders at lower elevations along the river, which was largely the case, winter and spring flood waters captured in these reservoirs could be “traded” for high priority diversions located in the lower basin as well. The early emphasis was generally on seasonal “trading” only. The legal standing of decrees were not changed or compromised in any way through these exchanges, although as more and more of these trades developed, it eventually became necessary to file them in water court.[36]

There was yet another small but important factor that played into the development of these exchanges. This was the existence of variations in the growing season between the upper and lower portions of the basin. Even today, the management of the river’s complex exchange program must take into account the fact that senior decree holders in the lower basin also require water somewhat earlier than junior decree holders irrigating in the upper portions of the basin. If junior decree holders, by emptying their low-lying reservoirs winter storage, can build up the river quickly for senior decree holders early in the Spring, junior decree holders can then take late Spring flows from the river to replenish these early reservoir releases. In effect, this difference in growing season due to elevation provides an additional impetus for exchanges between the upper and lower basin and between junior and senior decree holders. Additionally, senior decree holders can also benefit from return flows emanating from upper basin irrigation later in the season, providing yet another reason to bring senior and junior decree holders together in cooperation. It is a complex and very fungible river basin, one that is highly adapted to innovativeness and cooperation of this nature.[37]

In numerous instances, junior decree reservoir storage can be brought in at several desirable points along the main canal of some neighboring senior decree trading partner below it. For instance, the Windsor (Big Windsor) Reservoir (Figure 4) is largely owned by water users served by a carrier canal that goes by the name of the Larimer

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[34] Supra note 16, at 37

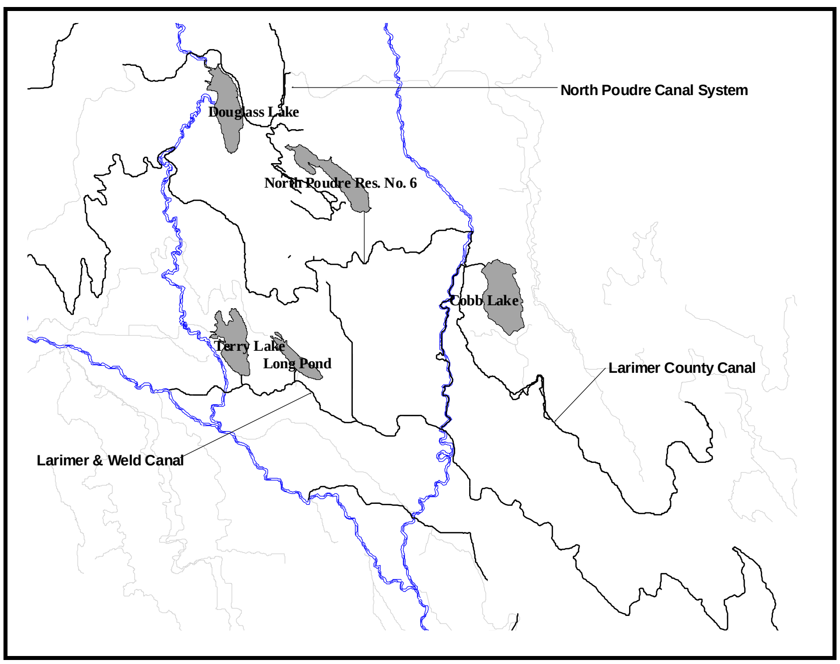
[35] Supra note 16, at 37.

[36] By 1904, the Water Commissioner of District No. 3 was reporting to the State Engineer the extent and importance of exchanges in the Cache La Poudre River basin (Supra note 6, at 37).

[37] To this day, return flow rights are protected in the basin. For instance, purchase by municipalities of canal company stock is restricted to the consumptive use of the water stock in question. This minimizes the impact of transferring water out of canal companies that would ultimately move through the hydrologic system downstream to other users.

and Weld Canal, owned and operated by the Larimer and Weld Irrigation Company. Windsor Reservoir is located below the Larimer and Weld Canal, so cannot be used by irrigators under this carrier canal without pumping stored water up to the main canal, an expensive proposition. However, Windsor Reservoir is valuable for exchange purposes. It can deliver water just east of the headworks of the Greeley #2 Canal, a more senior decree neighbor immediately below it to the south.[38] This has been a very active exchange over the years. It is referred to as a river exchange, because Greeley #2 Canal pays back irrigators under the aforementioned carrier canal by allowing the carrier canal to divert river flows a few miles upstream that are destined for the Greeley #2 Canal headgate. It should be noted that the New Cache La Poudre Irrigating Company, who owns and operates the Greeley #2 Canal, traditionally has been highly sought after by junior decree holders throughout the basin because it has all the qualities of a good trading partner. These include ample and early priority decrees in the lower portion of the basin, as well as ample storage in the lower portion of the basin. New Cache La Poudre Irrigating Company has its own storage in Timnath Reservoir, along with storage rights in Fossil Creek Reservoir. Fossil Creek Reservoir is owned and operated by North Poudre Irrigation Company whose service area is located in the upper portion of the basin (Figure 4; see also Figure 9).

FIGURE 5 – Cache La Poudre River Exchanges



Similar configurations were found with regard to Long Pond (1892) and Cobb Lake, the former owned by the Water Supply and Storage Company stockholders while the latter being owned by the Windsor Reservoir and Canal Company, an affiliate of the Larimer and Weld Irrigation Company (Figure 5). Long Pond can deliver water through exchange or trading to the head portion of the Larimer and Weld Canal, while Cobb Lake in return can deliver water to the tail portion of the Water Supply and Storage Company canal (the Larimer County Canal). Thus, both companies are benefited, the exchanges being used to equalize the canal flows of the two systems. The Larimer and Weld Irrigation Company is an ideal trading partner for the Water Supply and Storage Company which lays just above it, due to the 100 mile length of the latter's main canal which ends out east on the plains. Many opportunities for exchange are afforded along this 100 mile stretch, much of which finds these two canals in relatively close proximity to each other.

In later years, other storage facilities owned by the Larimer and Weld Irrigation Company, particularly Douglas Reservoir, were added to this same exchange to serve the head portion of its neighbor above, the Water Supply and Storage Company canal (the Larimer County Canal). In these early years, the Water Supply and Storage Company also benefited by withdrawing a proportional amount of Larimer and Weld Irrigation Company's senior decree at its headgate some eight miles farther up the river from the Larimer and Weld Irrigation Company headgate. In fact, the first such trade on the Cache La Poudre River may well have been between these two

[38] Big Windsor Reservoir is owned by the Windsor Reservoir and Canal Company, an affiliate of the Larimer and Weld Irrigation Company. The Windsor Reservoir and Canal Company owns six other storage facilities and a major canal (the Poudre Valley Canal). No lands are irrigated by the Poudre Valley Canal; its major function being simply to divert water from the river for storage in the reservoirs it serves.

companies; between Larimer County Ditch Company (now known as Water Supply and Storage Company) and the Larimer and Weld Irrigation Company. This would have been for storage water in Long Pond Reservoir, in exchange for direct flow from the river destined for the Larimer & Weld Canal. The exchange is still occasionally practiced today.[39]

The first "three-way exchange" appears to have been conducted in 1894. In this instance, the Water Supply and Storage Company discharged water from some of its previously mentioned reservoirs into the Larimer and Weld Canal immediately below it. This latter company then discharged water from the Big Windsor Reservoir into the Greeley #2 Canal immediately below it (Figure 4). In return, the Water Supply and Storage Company took the same amount of water from the river destined for the very senior Greeley #2 Canal decree, an exchange representing a distance of about 20 miles between these two company headgates.[40]

Yet later, in 1900, a "four-way exchange" commenced between the then recently formed North Poudre Irrigation Company, the Water Supply and Storage Company, the Larimer and Weld Irrigation Company and the New Cache La Poudre Irrigating Company. This exchange amounted to a forty mile transfer of water; the North Poudre Irrigation Company headgate (the North Poudre Canal) being that distance above the Greeley #2 Canal headgate located lower down the river. This exchange had both a direct and delayed, or "paper transfer" aspect to it. Upon withdrawing water from senior decree holders on the North Fork of the Cache La Poudre River through its North Poudre Canal, the North Poudre Irrigation Company used its Reservoir No. 6 to fulfill its debt, releasing water whenever it was desired by the other entities in the exchange (Figure 5; see also Figure 9).[41]

The building of Fossil Creek Reservoir by the North Poudre Irrigation Company, and some 40 miles below its main North Poudre Canal headgate, greatly facilitated the expansion of water exchanges throughout the basin (Figure 4).[42] In effect, it was an early "water bank" for the basin. Fossil Creek Reservoir had an ideal location, situated immediately upstream of the headgates of many senior ditch company trading partners in the lower portion of the basin. These included Greeley #2 Canal, Whitney Ditch, Ogilvy Ditch, and several smaller ditches just west of Greeley, Colorado. In later years, Fossil Creek Reservoir became a central pooling place for Colorado-Big Thompson units of water owned by many canal companies and individuals throughout the basin. Fossil Creek Reservoir virtually acted as a water bank for several canal companies and individuals. In addition, it captures and stores much of the City of Fort Collins storm drainage water. Today, Fossil Creek Reservoir is highly coveted by county and municipal government for its recreational and open space value. Throughout the basin, urbanization is gradually placing more pressure on the use of such facilities for exchanges, particularly boating and other recreational uses that desire more constant water storage levels, although reservoir owners have no legal obligation to accommodate recreational needs.

A very important feature of these exchanges, perhaps somewhat more in times past than today, was that it was not necessary for an exchange to be completed by both parties simultaneously. In other words, one entity could deliver several thousand acre-feet of water to an exchange partner in early July, but not call upon a repayment until later in the irrigation season when its own irrigators needed the water to finish off late season crops. Of course, the debtor had to hold water somewhere in its reservoir system to repay the debt, much in the way a loan would be secured by a savings account or certificate of deposit. These delayed exchanges were generally more characteristic of wet years than they were of dry years.

This accounting issue has traditionally required the Water Commissioner to maintain careful records of these exchanges. At the turn-of-the-century it was observed that "the water commissioner is expected to be the bookkeeper, and he certainly needs to be very handy with the pencil!"[43] The situation does not appear to be much different today, according to the viewpoints of a more contemporary Water Commissioner. As in the past, the Water Commissioner in the Cache La Poudre Basin is in charge of managing the river decrees—informing water users of who can divert and who can exchange each day. The State legislature created the office of Water Commissioner in

[39] Supra note 16, at 41.
[40] Supra note 16, at 42.
[41] Supra note 16, at 42.
[42] Supra note 14, at 37.
[43] Supra note 14, at 37.

1879.[44] Colloquial language in the basin refers to this individual as the "river czar" or "river cop" not for an autocratic attitude–which would not secure his job for very long–but for the respect and leadership he must win and exercise to achieve a common good.

The Water Commissioner oversees diversions for direct flows and for storage purposes, as well as overseeing the exchanges on a daily basis. During the direct diversion season (i.e., the irrigation season), the right to store water in reservoirs throughout the basin is generally junior to the taking of water out of the river for irrigation or other purposes. This means that reservoirs can be filled only when there is surplus water in excess of the senior decreed rights for direct river flows, or when these senior rights are not being "called." Most reservoir storage in the basin, even after the building of the Colorado-Big Thompson Project, has occurred during the non-irrigation season; generally from early November to late February or early March.

In the 1930s, one of the former Water Commissioners contributed yet another innovation in the basin. This involved obtaining agreement from water users and water supply entities to fill basin reservoirs beginning at the highest elevation first, then gradually moving down the basin to fill reservoirs at lower elevations. This contributed to the benefit of all water users in the basin by ensuring that storage flows were secured as high in the basin and as early as possible in the water year. This policy served everyone, including the many exchange partners that depended upon these reservoirs to complete their exchanges. Again, the use of "social capital," intimate knowledge of the hydraulics of the river and trust between water users, obviated the need for a large reservoir storage project on the main stem of the Cache La Poudre River.

A final and important feature of this river basin is that return flows and seepage from canals and reservoirs contribute significantly to seasonal river flows and irrigation system network operations. In 1920, it was estimated that the total amount of annual seepage from the river and water spreading onto irrigated lands and plains reservoirs was on the order of 84,000 acre-feet.[45] Return flows from irrigation seepage through soils may take several years to migrate to their point of potential reuse, either returning to a lower canal, withdrawn by pumping, or returning to the river. This reuse capability of water flows has contributed significantly to the cooperation, trust and creativity exhibited in the river basin. Water users know that they are part of an intricate hydrological system, changes in the management of which must be carefully thought through before action is taken.

One of the canal company managers interviewed for this report indicated that upwards of 30 percent of the flows in his main canal at almost any time during the mid to late irrigation season can be attributed to return flows from a neighboring canal company irrigating lands immediately above his canal. It is commonly believed that water in the river basin can be used as much as five or six times before it leaves the basin. Such hydrological characteristics have contributed in no small way to the cooperation, trust and creativity found among water users. However, this can be disrupted by the removal of water from irrigation to other uses, such as that occurring today with increased municipal demand; the negative impacts on return flows not showing up until several years after the fact.

We may summarize the discussion to this point:

< The basin is historically unique in many respects, particularly with regard to water development. Water is a very exchangeable or transferable resource in the basin. "Social capital," represented by local knowledge, cooperation, trust and creativity has been the cornerstone of this water development.

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[44] H.N. Haynes, *The Distribution of Water: Powers and Duties of Irrigation Officials in Colorado*. Colorado Agricultural Experiment Station, Bulletin No. 67 (1901)

[45] Supra note 26, at 10.

< Water exchanges have played a central role in the development of agriculture in the basin, and primarily to accommodate the late watering requirements of specialty crops and differences in upper and lower basin climate.

< Agricultural Producers feel there still may be lessons to be learned in how these exchanges were practiced in the past, particularly prior to the construction of the Colorado-Big Thompson Project. Urbanization is clearly a threat to the continuance of these exchanges, although the degree and nature of this threat is often not well understood. Of particular concern is the migration of Colorado-Big Thompson Project water out of agricultural ownership and into municipal ownership. This fact may require a renewal of older exchanges practiced prior to the supplemental irrigation supply provided by the C-BT project.

< Such concepts as water markets, interruptible supplies, water banks, the expansion of conveyance facilities and secondary or dual system water supply management are untried or often potentially expensive innovations, whereas water exchanges have been known for many years to be an inexpensive and beneficial means of achieving basin cooperation and reliable water supplies.

< Reliance on an experienced and dedicated individual, such as the local Water Commissioner, is necessary to provide an inexpensive and reliable way of ensuring that all water users are served in an equitable and timely fashion. Such an individual may be better suited-- perhaps with an occasional helping hand--to manage a basin water bank than the most sophisticated computer modeling program, as evidenced through more than one-hundred years of experience with water exchanges.

< The basin traditionally has shown a very diverse and profitable irrigated agriculture. Approximately $300,000,000 from irrigated crop production alone is generated in the basin.[46] How the loss of water exchanges would effect this cropping pattern is unclear, but casual observations suggest that many specialty crops might well have to be discontinued without the late season watering that is made possible through these exchanges.

WATER EXCHANGES, AGRICULTURE AND URBANIZATION

In the basin of study, agricultural water suppliers originated the practice of water exchanges, and some of the earliest water exchanges in Colorado and the West occurred in the Cache La Poudre Basin. For the most part, agricultural water suppliers, such as canal companies and water storage companies, are the most active entities involved in present-day water exchanges. However, in recent years, municipalities have become involved in exchanges, and may even assume a primary role in exchanges, as the shares of stock in agricultural water suppliers have gradually come under the ownership of municipalities.[47] This transfer of ownership has occurred primarily by way of the requirement imposed on subdivision developers to transfer water rights over to municipalities in order to ensure a potable water supply for the developed land. Until recently, this municipal "water turnover requirement" was often three acre-feet per acre of developed land. As a result of this turnover requirement, municipalities have secured large ownership shares in local mutual canal companies throughout the basin.

Along with water rentals, it is clear that agricultural production in the basin depends upon traditional water exchanges to meet seasonal water requirements. There is concern about the potential negative effects of the interruption or loss of traditional water exchanges to farm income, cropping patterns and overall cooperation between agricultural water suppliers in the basin. The supply of agricultural water in the basin is very limited, as can be shown by the drought of 2002. Each unit of water transferred out of agriculture potentially disrupts existing water exchanges, along with potentially reducing the supply of water for agriculture. The disruption or loss of water from agriculture to municipal ownership is only potential, of course, since change to municipal ownership may be ameliorated by the rental of water back to agriculture. The same applies to water exchanges. Historically successful

[46] The figure of $300,000,000 is based on computing the economic value of crops shown in Figure 7 and 8, and utilizing farm income values derived from regional farm budgets for these crops.
[47] This issue is important to the Cache la Poudre Basin. Presently, two major players in basin water exchanges, the North Poudre Irrigation Company and the Water Supply and Storage Company, are approaching majority ownership by municipalities.

water exchanges between agricultural water entities have in certain instances evolved into exchanges between agricultural and municipal entities, and to the benefit of both. This would be an encouraging trend if it were to continue. However, municipalities must consider potable water needs first, and the requirements of potable water delivery may often conflict with the requirements of irrigation water, both in timing and quantity. This fact often reduces the value of water rentals back to agriculture, since municipalities are prone to hold onto their water supplies so late in the summer as to preclude addressing the needs of agriculture. Water exchanges are prone to the same conditions. Municipalities tend to view them as less important to their overall needs.

In addition, there is considerable market pressure in the basin, as well as elsewhere in the West, to transfer water permanently out of agriculture. This fact can have important economic benefits to growers who own water rights and sell them to developers or municipalities. However, potentially severe costs can set in under more scarce water conditions associated with drought. The big downside to water transfers out of agriculture is the potential disruption to important water exchanges in the river basin that were specifically designed to meet crop production needs and maintain a balance in canal flows. These exchanges are often foregone because a cooperating exchange partner can no longer be found due to changing philosophies of canal company boards now represented by municipal interests and planners.

Farming at the urban fringe has many challenges and tradeoffs. Maintaining the availability of inexpensive, reliable and timely water supplies to irrigated farms, in the face of urbanization, is an overarching concern of agricultural producers. Irrigators are clearly trying to adapt to the seemingly inevitable trend toward urbanization of prime irrigated lands throughout the West. Municipalities are acquiring canal company stock and/or irrigation district lands throughout the Rocky Mountain region at an alarming rate.[48] It is believed that minimizing, or at least transitioning, the impact of this urban development on water exchanges may help prolong the period in which irrigated agriculture can accommodate itself to urbanization before agricultural production is clearly no longer possible or desirable.

Urbanization pits old water exchange cooperators against one another. Some irrigators question the need to worry about protecting agricultural water supplies at all. Irrigators holding this perspective are developing their farmland into houses, and bristle at the thought of land use controls and the comments of water and land preservationists at community meetings. Other farmers are deeply concerned about current trends in the disruption of water exchanges, water supplies and the pressures for reallocation. In other words, the agricultural community itself is divided over the issue of future land and water use. Urbanization can be shown to impose costs on irrigated farm operations, while at the same time increasing equity value in agricultural land and water rights.

In the face of urbanization, water exchanges may have to be clearly shown to effectively reduce farm operational costs while at the same time maintaining, or even enhancing farm equity value, in order for them to remain viable in the basin. Canal company operations are a farm production cost. Irrigators pay annual assessments on their water stock to hire ditch riders and finance maintenance programs. The “social capital” represented by these exchanges helps to keep canal company operational costs down, thereby reducing the annual assessment paid by irrigators to operate and maintain irrigation facilities, and thereby improving the spread (net farm income) between gross farm sales and crop production costs. If it can be shown that traditional water exchanges can reduce the cost of water to agriculture via these and other transaction or delivery mechanisms, these traditional exchanges may well continue to be highly favored for their economic value to agricultural producers since they require such little cost and trouble to perform.

In interviews conducted for this report, some growers stated that sentimental attachment to traditional water exchanges should be avoided if they are no longer needed. Water exchanges may be clever or ingenious in their implementation but may well have outlived their usefulness. Other growers have indicated real concern that the loss of existing water exchanges might terminate their ability to irrigate effectively in certain times of the year. These concerns are linked to supplemental water supplies from the U.S. Bureau of Reclamation’s C-BT Project. These supplies are often the sole basis of some of the water exchanges in the basin. It has been suggested that (1) the disruption of water exchanges due to agricultural--to--municipal water transfers and (2) supplemental water supplies

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[48] One of the local canal companies in Larimer County is now said to be predominately owned by millionaires.

provided by the C-BT project being transferred out of agricultural ownership, may force irrigators to adopt cropping systems to a water regime characterizing the Cache La Poudre Basin prior to the C-BT project itself.

Finally, the “farm impermanence syndrome,” defined by a declining interest in farming due to disruptions in farm practices and increased liability due to urban encroachment, is an important factor in assessing the future of traditional water exchanges.[49] The impermanence syndrome tends to define the conditions and overall willingness of irrigators to continue capitalizing their farms and to remain in business. Declining interest in farming among board members of canal companies may be expected to further de-emphasize the importance of traditional water exchanges for agriculture in the future.

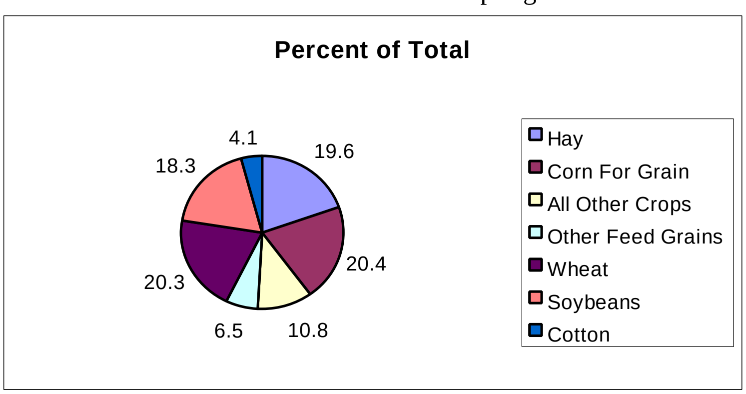
Outside of agriculture, there are other significant economic interests surrounding these water exchanges. There appear to be important considerations for municipalities and environmental-recreational entities, since these entities can potentially make beneficial use of traditional water exchanges to meet a variety of needs. These include maintaining more desirable water quality and in-stream flows along selected reaches of the river, flood control, and aesthetic goals. Water exchanges can conceivably adapt to new needs as well as addressing traditional agricultural needs. However, this involves a better understanding on the part of potential exchange partners regarding how this traditional “social capital” can be most effectively used.[50]

LOCAL AGRICULTURAL ASSETS SUPPORTED BY WATER EXCHANGES

It is important to look at what is potentially at risk if such exchanges can be linked to agricultural production. At the present time, there does not appear to be any particular benefit associated with urban water use deriving from these exchanges, other than what has briefly been mentioned. In fact, the argument has been heard from local municipalities in the basin that the present water exchanges tend to complicate the utilization of water rights for urban and recreational use.

Even if the loss of these exchanges could disrupt agriculture, would these disruptions be major or would they be modest, and with what consequences for the local economy that is supported by agriculture? If we cannot easily dismiss the overall importance of these consequences, then we must logically proceed with the task of better understanding how interference with these exchanges might be minimized.

FIGURE 6
1993 National Harvested Crop Figures



Currently developed irrigated lands in the Rocky Mountain region are very unique, and the crops produced on them represent an important and, some say, irreplaceable sector of national food production. For instance, the removal of developed irrigated lands in the Rocky Mountain region from production through urbanization tends to more directly affect the 10.8 percent of national specialty crop production represented by “all other crops” shown in Figure 6. The Rocky Mountain region is responsible for the production of many

[49] A.C. Nelson describes the farm impermanence syndrome as “characterized by farmers believing that agriculture in their area has limited or no future, and that urbanization will absorb the farm in the not too distant future. It is manifested through disinvestment in farming inputs, sale of tracts of land for hobby farm or acreage development, shifting of crop selection from those that are labor or capital intensive to those that require little or no labor investment, and farmers becoming themselves speculators on land conversion.” A.C. Nelson, A.C., *Economic Critique of U.S. Prime Farmland Preservation Policies*, in Journal of Rural Studies (6:2:1990).
[50] M.D. White, *Water Exchanges: A New Fracas East of the Divide*. Proceedings of a Symposium, American Water Works Association, Colorado Water Resources Research Institute, Colorado State University (1993)

crops in this category. Many of these crops, such as vegetables, fruits, berries, sugarbeets, beans, potatoes and barley can be grown in other parts of the nation, but historically for limited farm sales value. The removal of 1,000 acres of wheat, soybean or feed corn in other areas of the nation might not have the same negative impact on overall national harvested crop production as 1,000 acres removed from specialty crop production in the Rocky Mountain region.

In addition, some of the major field crops, such as alfalfa and small grains, should not be discounted simply because direct farm sales from these crops are lower relative to, say, produce crops. Hay and small grain production must be valued in the context of the important role they play in the region's red meat and dairy production. Livestock and livestock product sales are a major component of farm income in irrigated agriculture. The Rocky Mountain region has several states in the top ten nationally in diary production due to cooler annual temperatures for the animals. Idaho now ranks 3rd in milk production, behind Wisconsin and California.[51] A recent Census indicated that 71 of the 100 counties in the United States leading in total sales of agricultural products are in the 21 States where irrigation is substantial. On the average in these 71 counties, sales of livestock or livestock products account for a full 50 percent of the market value of all agricultural products sold. Thus cattle feedlots are typically located in or adjacent to intensively irrigated areas for easy access to feed supplies.[52] Irrigated agriculture in the Rocky Mountain region is characterized by a fully integrated crop and livestock agricultural system.

Figure 7 and 8 show that Larimer and Weld counties exhibit cropping systems similar to the more productive areas of the West. These two counties are the principal counties in the Cache La Poudre Basin. They are very characteristic of counties in the West representing the specialty crop production seen in Figure 6, as well as the integrated crop and livestock production of hay and grain for local dairy and livestock feed lots.

In order to more fully understand the potential significance of the disruption of water exchanges to agriculture in the basin, it is important to see the overall relationship between the urbanization process, water exchanges, continued investment in improving irrigated agriculture, changes in crop production and ultimately farm income. All five of these factors are closely linked, and in a somewhat descending order. Most major agricultural problems in the region, outside of commodity prices, appear to be related to urban encroachment, including the potential discontinuance of water exchanges.

The effects of urbanization are felt in the rates of investment in irrigated agriculture and water conservation. Crop production is affected through the feeling of impermanence that some growers have in urbanizing areas. The feeling of impermanence can lead to reductions in farm investment and improvements, and may result in a choice of cropping systems that are less capital intensive and/or labor intensive, and therefore potentially less profitable. Meanwhile, as a result of urbanization, disruption in the timing and supply of irrigation water is likely to contribute to a feeling of impermanence. If disruptions in water exchanges affect the availability and timing of water supplies, a direct linkage can thus be made between agricultural production, water supply and farm income. In the final analysis, reduction in farm income from any source continues the cycle of under-investment or disinvestments in farming.

Not only the water exchanges, but irrigation infrastructure is affected by urbanization. Western irrigated agriculture is characterized by upwards of 8,500 associations of farmers and ranchers in incorporated or unincorporated mutual organizations, water associations, commercial canal companies and irrigation districts. These associations play an important intermediate role in the Western irrigation economy, between the individual farm irrigators and the river basin itself. A recent regional study on canal companies and irrigation districts estimated that in the five state area represented by Colorado, Wyoming, Utah, Idaho and New Mexico, the value of present irrigation infrastructure facilities managed by these entities alone was estimated at $1.4 billion dollars in 1995.[53] Again, this does not include the larger reservoir storage facilities in the region that are designated for multiple purpose uses; such as for power production and recreational uses, as well as for irrigation. The $1.4 billion

[51] B. Godfrey, State of Agriculture in Utah. Presentation at the Utah Water Users Association, St. George, Utah (2001).
[52] U.S. Census of Agriculture (1997).
[53] J. Wilkins-Wells, *Irrigation Enterprise Management Practice Study*, U.S. Bureau of Reclamation, Science and Technology Program (1999).

only includes the primary canal system used to provide water to irrigated farms. It is this infrastructure that is often disrupted by urbanization, leading to a grower's feeling of impermanence.

Irrigation districts and canal companies in the western United States appear to be under considerable stress from challenges to their water rights, urbanization of their service areas, and the modern environmental requirements of irrigating and operating a nonprofit water supply entity. The ability of agricultural water suppliers to adapt to these challenges depends in no small way on the soil, water, environmental, and project-level conservation investments of the irrigators who demand water from, and are served by, these associations. Extensive investments by federal agencies in environmentally related, or water conservation-related cost share and grant monies may be negated by urbanization.

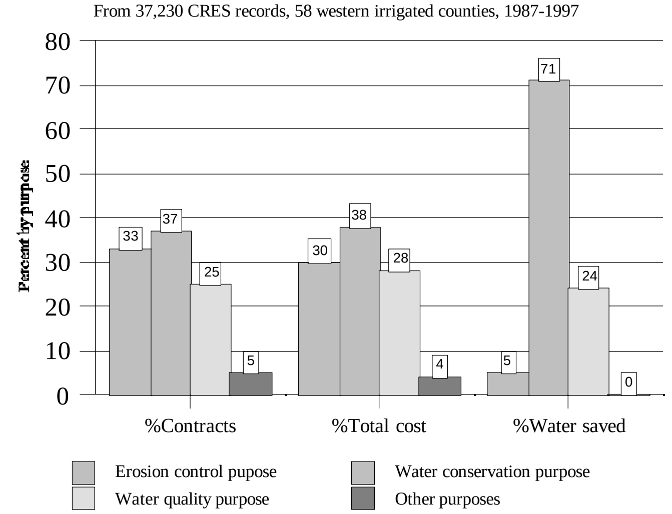
In recent literature, much emphasis has been placed on the fact that agriculture uses eighty percent of the West's water supply.[54] It is therefore assumed that it is appropriate for agriculture to relinquish some of its water to accommodate urban needs, and to further minimize the need for more dams and storage facilities. Finally, it is assumed that improved water conservation is needed in irrigated agriculture to allow for this reallocation, and to reduce negative environmental impacts from overuse of water in agriculture.

This issue is important to the discussion of water exchanges primarily because the possible interruption of water supplies may negate the investments that growers have made to improve their irrigated farm operation to meet these water conservation and environmental needs. If this happens, then the efforts made by growers to address water conservation for reallocation to urban uses are in turn negated. Furthermore, federal and state cost share monies allocated to improving farms and water conservation are negated.

Since 1983, farmer and federal agency conservation accomplishments under the Agricultural Conservation Program (ACP), the Colorado River Salinity Control Program, the Rural Clean Water Program and various other authorities and cost share programs have been recorded by the Farm Service Agency for administrative, public information and research purposes. This database is known as the Conservation Reporting and Evaluation System (CRES). Table 2 shows the distribution of conservation cost-share contracts in the eight state Rocky Mountain region. There were slightly over 32,000 cost share contracts for water conservation throughout 58 prime irrigated counties amounting to $238,000,000. Prorating this expenditure across all irrigated acreage in the Rocky Mountain region receiving conservation measures would give a figure of $104 per irrigation conservation acre. Other important information on the contribution of irrigators to water conservation is noted in Table 2.[55]

Table 2 - Percent Distributions of Conservation Activity by Major Purposes

From 37,230 CRES records, 58 western irrigated counties, 1987-1997



The point being stressed relative to assessing the possible affects of disruption of water exchanges in the river basin is that considerable investment in water conservation has been made by irrigators in recent years to improve on-farm water management. These improvements have opened up opportunities for reallocation of water supplies to urban use in many instances. More importantly, investment in water conservation has been accompanied by considerable investment in erosion control and water quality improvements. All of these investments are at stake when evaluating the potential impacts of the disruption in water exchange practices that are designed to meet local

[54] *Water in the West: Challenges for the Next Century*. Report of the Western Water Policy Review Advisory Commission (1998).
[55] Data compiled as part of an on-going study at Colorado State University. Management Practice Study III, U.S. Bureau of Reclamation, Science and Technology Program.

agricultural production needs.

Finally, to conclude our discussion of agricultural assets at stake with the potential disruption of water exchanges by urbanization, there are long-term discounted returns associated with the loss of prime irrigated lands in general. These include substantial environmental tradeoffs in moving agriculture to more marginal lands in the future as urban encroachment forces out crop production in more favorable areas. There is the potential for reduced production per acre, and increased water use per acre, associated with urban encroachment and the displacement of farm enterprises to more marginal locations. There are increased water quality and soil erosion concerns as well. Urbanization of prime irrigated lands potentially reduces flood absorption near urban areas. There is also the reduced effect of air cleansing from open space provided by agriculture near urban areas, as these lands are encroached upon by subdivision development. Finally, there is the overall loss of scenic backdrops provided by agriculture, a feature coveted by many subdivision developers and their inhabitants. The loss of irrigated lands in urban fringe areas due to rural industrial and housing subdivisions may be at odds with the very reasons society favors the open space benefits of irrigated agriculture.

What we do know is that there is a distinctly valuable cropping system in the Cache La Poudre Basin, that it produces upwards of $300,000,000 in farm sales in crop production alone, that there is a local red meat and dairy industry that is heavily dependent on the cropping system, that considerable investments have been made in recent years for improving on-farm water conservation, and that furthermore the agricultural system itself is unique in U.S. agricultural production. Urbanization can be defined as the prime cause of the potential disruption to local water exchanges. In addition, for the most part, urban and recreational interests would find no compelling reason to continue water exchanges for those water rights transferred out of agriculture.

A LOOK INTO THE FUTURE

There is recent reference by water specialists in the basin to the need for expanded water markets. This is largely prompted by the existence of a traditionally practiced and highly flexible rental market for water in the basin initiated by canal companies many years ago.[56] The concept was subsequently adopted in large part by the Colorado-Big Thompson Project in its allocation of project units of water.[57] The rental market was yet another contribution to the innovativeness shown by irrigators in the basin. However, it is uncertain whether income realized from irrigated agriculture could compete in an even more “laissez-faire” water market situation that is emerging today. In a fully open water market, individual farmers would seemingly be competing with general purpose tax districts and subdivision developers over water prices.[58] In addition, the traditional rental market developed earlier by irrigators in the basin had many conditional requirements on its use, including certain restrictions on where and when the water could be used, and what parties could enter into rental agreements; a not too appealing prospect for water markets as they are commonly thought of today.

Other ideas being explored in the basin include the concept of interruptible water supplies for agriculture. To accommodate growing municipal needs for emergency water supplies, water would be transferred voluntarily out of agriculture for a limited period of time, say for an irrigation season, to address drought conditions affecting municipalities. In return, agriculture would receive financial compensation for lost income. It is not known what long-term effect this would have on agricultural production in the basin. Compensation programs of this nature may be expected to affect cropping patterns, irrigation practices and crop production costs in the basin. Clearly, it is not known what the real consequences to irrigated agriculture in the basin might be until the concept of interruptible supplies is implemented on a trial basis.

Yet another option is a basin-wide water bank. This concept amounts to perhaps more efficient pooling of water to accommodate all basin needs during periods of water shortage. A water bank is a kind of clearinghouse for water rights, and is often most talked about in the context of water rights deposited in the bank for use by others. The depositors would receive negotiable script for their deposited water rights, and perhaps an annual dividend of

[56] Ray Anderson
[57] Supra note 33.
[58] Interviews conducted during the research indicate that the price of water has already become so high in the basin that it is virtually impossible for new entries into agricultural production.

some proportion for their deposited rights. Many other forms of water banks are being tried out in the West today.[59] Water banks in the Cache La Poudre Basin have been discussed for decades to do away with what some regard as "dog-in-the-manger" behavior during periods of severe water shortages. Since it is apparent that water exchanges may tend to break down during water shortages, this suggests that a basin-wide water bank could serve to ensure adequate water during times of drought, protect the traditional water exchanges discussed in this study, and accommodate the rather complex factors of priority, elevation, seepage and variable demand in the basin.

Whether water banks might be more efficient in the long run, given the rather complex hydrology of the river basin, is again an empirical question. Certainly the concept can be informed by the cooperation, trust and creativity shown by water exchanges over the years. Answers about improved efficiency in water use will not be available until a water bank is tried on a pilot basis by a group of entities willing to come forward and be creative, as early irrigators in the basin were with water exchanges. Clearly, several entities would have to agree to pool their water for mutual benefit, and ultimately to the benefit of the entire basin, if the concept were to have a chance of success. This was also the philosophy of early irrigators in the basin. Modeling basin supplies, such as was attempted in the 1980s, and now being re-explored by municipalities, could help in building trust for a water bank if approached in the right way.[60]

Developing more water supplies through the expansion and reuse of present delivery systems continues to be discussed as another alternative to securing future water supplies for agriculture and the basin's growth. There are ongoing efforts to expand conveyance facilities of the Colorado-Big Thompson project, including wrap-around systems to bring irrigation return flows backward from east to west within the project area. However, again there is the issue of cost. The economic benefits to irrigated agriculture, barring subsidies in the development of such systems, might be less than simply continuing present water exchanges that show considerable flexibility in water management, and are far less costly.

Another innovation discussed for the basin is the development of pressurized secondary water supply. A secondary water supply system provides a simultaneous but physically separate provision of pressurized raw irrigation water for outdoor landscaping use to a piece of property, along with the normal provision of potable water to the same property. One or more established private or nonprofit water purveyors, or a small homeowner's association, may be involved in the provision of pressurized raw irrigation water to said property.

Where observed in other regions of the West, pressurized secondary water supply systems are usually provided by traditional agricultural irrigation water suppliers (canal companies and irrigation districts), while municipalities or specially formed water districts continue to provide the potable supply to housing or commercial subdivisions. Where this arrangement occurs, the agricultural water supplier still performs its traditional role of supplying water to farms. Raw water delivery for landscaping simply becomes a business sideline for the canal company or irrigation district. Meanwhile, through the provision of pressurized raw water, canal companies can generate a new revenue base over time to gradually pressurize agricultural water delivery, thereby conserving water and improving the timing of water deliveries, reducing labor costs of irrigating, and opening up opportunities for new cropping systems.

Water markets, water rentals, interruptible water supplies, water banks, expanded water reuse capabilities and pressurized secondary supply systems are in part themselves expansions of the concept of water exchanges as they have been practiced in the basin for over one-hundred years. As management practices, they draw from the same attitudes and traditions toward innovation and risk-taking explored by early settlers in the basin, as they developed these exchange systems. As separate practices they are important to the basin's future water management. However, as complements to each other they may be even more valuable.

Water exchanges play a role in all of these new approaches to water management. Water exchanges are the lubricant that create and maintain the possibility for these other practices. If water exchanges are lost or disrupted

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59 L.J. MacDonnell, *Water Banks: Untangling the Gordian Knot of Western Water*, Rocky Mountain Mineral Law Institute (1995).
60 Harza Engineering Study, *Cache La Poudre Basin Study: Final Report*. Colorado Water Resources and Power Development Authority (1987).

due to a misunderstanding about their function or importance, then the entire river basin management program begins to unravel. Whether or not they are central to river basin management today may be questioned, but they are certainly an essential component of this management.

FIGURE 7
County Historical Trends in Harvested Irrigated Crops
Larimer County, Colorado

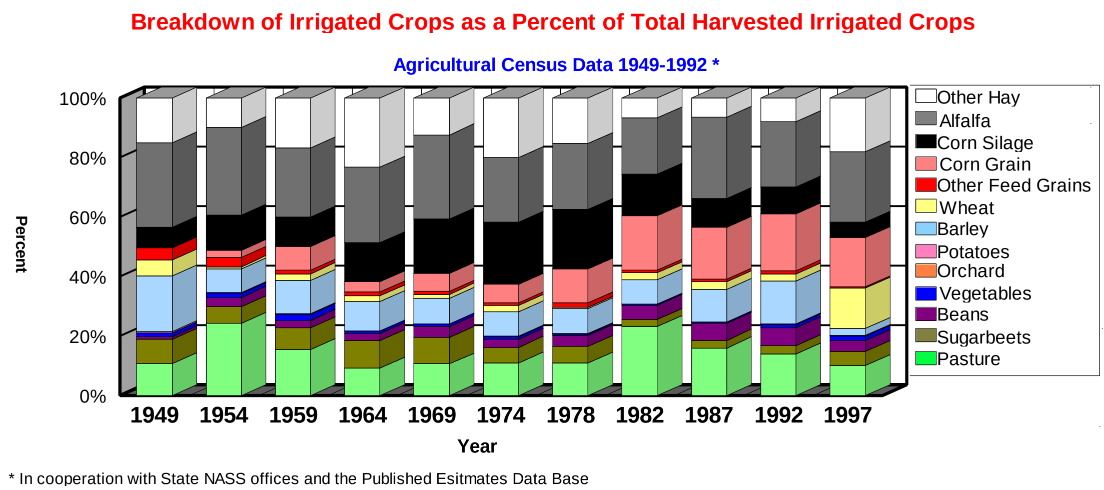

FIGURE 8
County Historical Trends in Harvested Irrigated Crops
Weld County, Colorado

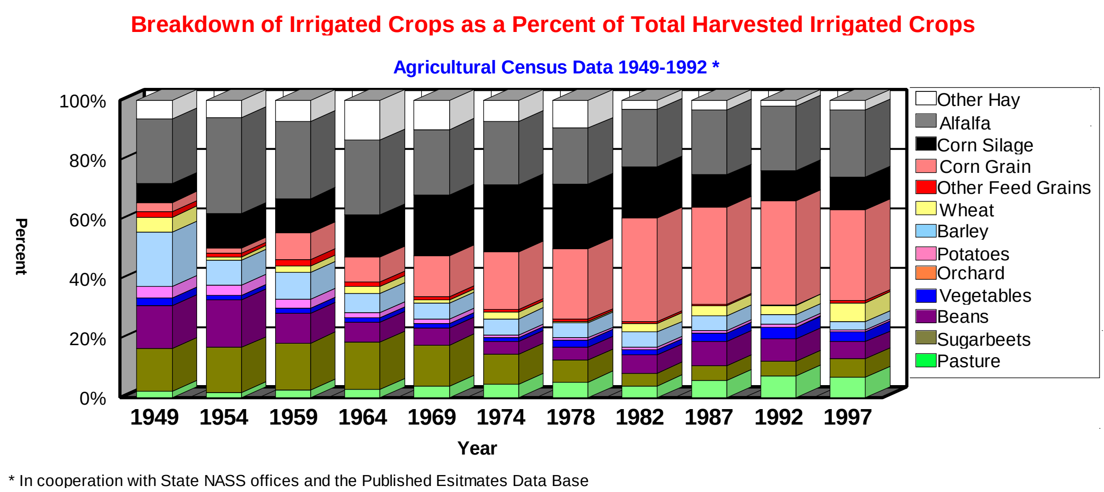

Figure 9: Cache La Poudre River Basin