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Emerging Markets in Water: A Comparative Institutional Analysis of the Central Valley and Colorado-Big Thompson Projects***

ABSTRACT

Water trading is a potential means to improve the productivity of developed water supplies and reconcile competing uses. Economic theory suggests that markets evolve in response to changes in supply and demand. This prediction is at odds with observed disparities in the pace of market development in regions facing similar pressures on scarce water resources. A dramatic example of this disparity is found in the regions served by the California Central Valley Project and the Colorado-Big Thompson Project. This article argues that the differences in market activity in the two areas can be explained largely by the underlying water allocation institutions. The article identifies key institutional features that affect the transaction costs of water trading and examines the roots of the institutional differences. The institutions governing market transactions today are largely a function of pre-existing property rights and political battles to build consensus and obtain federal financing for the projects. The article highlights the path-dependent nature of water allocation institutions and trading, but also suggests that complex inter-regional markets could still develop in California given ever-increasing competition for scarce water resources and advances in information technology that lower market transaction costs.

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I. INTRODUCTION

Water trading is a practice of considerable interest as a means to improve the productivity of developed water supplies and reconcile competing uses. Standard economic theory suggests that markets evolve in response to changes in supply and demand. As a commodity becomes relatively scarce and the gains from trade increase, economists would expect to observe institutional reforms that legitimize or facilitate trading. These predictions are at odds with observed disparities in the pace at which water markets are developing in various regions of the arid western United States. In practice, the rate of transition toward water markets has varied markedly even among regions that face similar pressures on developed water resources.[1]

A dramatic example of this disparity is found between two United States Bureau of Reclamation projects—the California Central Valley Project (CVP) and the Colorado-Big Thompson Project (C-BT). Most CVP water trades are limited to short-term spot, or rental, transactions within the agricultural sector, and a significant number of the trades are informal barter exchanges among families and friends.[2] These latter transactions are more akin to borrowing a cup of sugar from neighbors than true, arms-length market trades. In contrast, C-BT water is transferred in both short-term rental markets and permanent sales markets within and between agricultural and urban areas. Also, there are well-established market prices and water brokers who mediate exchange between anonymous water users.[3]

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1. *See generally* LOYAL M. HARTMAN & DON SEASTONE, WATER TRANSFERS: ECONOMIC EFFICIENCY AND ALTERNATIVE INSTITUTIONS (1970); BONNIE COLBY SALIBA & DAVID B. BUSH, WATER MARKETS IN THEORY AND PRACTICE (1987); Norman K. Johnson & Charles T. DuMars, *A Survey of the Evolution of Western Water Law in Response to Changing Economic and Public Interest Demands*, 29 NAT. RESOURCES J. 347 (1989); K. William Easter et al., *Formal and Informal Markets for Water: Institutions, Performance, and Constraints*, 14 WORLD BANK RES. OBSERVER 99 (1999).

2. *See generally* David Sunding, *The Price of Water...Market-based Strategies Are Needed to Cope with Scarcity*, CAL. AGRIC., Mar.-Apr. 2000, at 56; Nicholas Brozovic et al, *Trading Activity in an Informal Agricultural Water Market: An Example from California*, WATER RESOURCES UPDATE (forthcoming 2001); David Sunding, Economics of Inter-District Water Transfers in California, (presented at American Society of Civil Engineers Annual Conference) (July 1999) (manuscript on file with author).

3. *See generally* Charles W. Howe et al., *Innovations in Water Management: Lessons from the Colorado-Big Thompson Project and Northern Colorado Conservancy District*, *in* SCARCE WATER AND INSTITUTIONAL CHANGE 171 (Kenneth D. Frederick ed., 1986) [hereinafter Howe et al., *Lessons*]; Charles W. Howe et al., *Innovative Approaches to Water Allocation: The Potential for Water Markets*, 22 WATER RESOURCES RES. 439 (1986) [hereinafter Howe et al., *The Potential for Water Markets*];

This article argues that the differences in market activity between the two projects can be explained largely by the underlying water allocation institutions. Four key institutional features are identified—the water district structure, the water rationing mechanism, acreage limitations, and return-flow rules—and the manner in which they affect the transaction costs of water trading in the CVP versus the C-BT is analyzed.

The article then examines the roots of the institutional differences. Did the projects initially adopt similar institutional forms and then diverge over time, or did they adopt different institutional structures from the beginning? The analysis reveals that the two projects chose different institutional structures in their early stages, and those institutions have been relatively impervious to change. The institutions that exist today, and thus the differences in water market development, are a legacy of the initial institutional structures established during the formative stages of each project.

The decisions made then were motivated by the short-term goals of building consensus between diverse interest groups and obtaining federal financing for project construction. The different institutional structures chosen in the CVP and C-BT reflected the nature of the federal-state relationship in California versus Colorado, and the impacts of the projects on landowners with pre-existing water rights. No evidence was found to support the theory that the founders of the C-BT purposefully created an institutional structure that would facilitate an intertemporal and intersectoral water market as has developed. They designed a flexible institutional system because it made easier the task of allocating the initial water supplies to heterogeneous users. The CB-T founders were concerned with the immediate problem at hand, and not the long-term ability of the project to adjust to economic growth.

The institutional environments have remained relatively stable because surface water users and other affected parties, such as adjacent landowners who rely on recharge from imported surface water, have made irreversible investments conditioned on the existing institutions. Some of these asset-specific investments would become unproductive if institutions were to change. Furthermore, compensation of these individuals by those who benefit from institutional change is difficult due to sheer numbers and imperfect information about the magnitude and cause of specific welfare losses.

The framework of analysis in this article, while highlighting the path-dependent nature of water allocation institutions and trading, suggests that major changes could be in store for California's nascent water market. Two developments underway at present, advances in information

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A.M. Michelsen, *Administrative, Institutional, and Structural Characteristics of a Functioning Water Market*, 30 WATER RESOURCES BULL. 971 (1994).

transactions are bilateral and personal toward the adoption of more formal interregional markets. The arguments presented here also suggest that the transition to a more widespread and active water market, when it occurs, might not be gradual but rather rapid and drastic.

The article proceeds as follows. Section II provides an overview of the current state of water trading in the CVP and the C-BT. Section III conducts an institutional analysis of the water markets in both regions. The section begins with a review of the literature. It then analyzes the water allocation institutions in the CVP and the C-BT and their effects on market transaction costs. Section IV examines the historical origins of the institutional differences, and section V analyzes the process of institutional change over time. Section VI provides a summary and conclusions.

II. THE STATE OF WATER TRADING IN THE CVP AND C-BT

A. The Central Valley Project

The majority of water market transactions within the CVP involve internal water district trades.[4] These intra-district trades are relatively routine and only require the approval of the water district in which the transactions occur.[5] Intra-district transfers are short-term "rental" transactions in which the buyer receives the right to use a specified number of acre-feet of water during the current season.[6] Active markets in which permanent water rights are bought and sold do not currently exist. While the local rental markets may help farms adjust to short-run fluctuations in supply and demand, the gains from trade within water districts may not be large if the farms are relatively similar. Especially within small water districts, farms often have comparable water rights and soil types, grow the same crops, and use similar irrigation technologies.[7]

The gains from trade between water districts are potentially much greater due to large variances in farm productivity and water supplies across districts. Because the approval process associated with inter-district trades can be complicated and time-consuming, most of the inter-district trades that occur are negotiated by water district managers on behalf of

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4. David Sunding, *The Price of Water...Market-Based Strategies Are Needed to Cope with Scarcity*, CAL. AGRIC., Mar.-Apr. 2000, at 56, 60.

5. *See* U.S. Bureau of Reclamation, Mid-Pacific Region, *Central Valley Project Improvement Act Final Administrative Proposal on Water Transfers, at* http://www.mp.usbr.gov/cvpia/ltrwt.html (Dec. 14, 2000).

6. *See id.*

7. S. Hatchett et al., *A Regional Mathematical Programming Model to Assess Drainage Control Policies, in* THE ECONOMICS AND MANAGEMENT OF WATER AND DRAINAGE IN AGRICULTURE 476 (Ariel Dinar & David Zilberman eds., 1991).

across districts. Because the approval process associated with inter-district trades can be complicated and time-consuming, most of the inter-district trades that occur are negotiated by water district managers on behalf of their farmers rather than directly by the farmers themselves.[8] Some trades between districts in the CVP and water districts outside the CVP have also occurred but they require additional layers of regulatory approval.[9] Again, most of these trades are short-term transfers of water use as opposed to permanent transfers of water rights.[10]

In addition to failing to allow for efficient responses to short-run supply fluctuations in the agricultural sector, the institutions and laws that govern the CVP inhibit long-run adjustments to changes in economy-wide water demand. The marginal value of water in municipal and industrial uses is typically three to four times greater than the marginal value in agriculture.[11] Nonetheless, when municipalities have faced water shortages, they have been forced to invest in expensive new water projects, such as desalinization plants, instead of purchasing water at a lower cost from marginal agricultural users.[12]

B. The Colorado-Big Thompson Project[13]

In contrast to the CVP, an active water sales market exists in addition to an active rental market in the C-BT. In addition, trades occur not

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8. Interview with Jerry Butcher, General Manager, Westlands Water District, in Fresno, Cal. (1994); Interview with Cliff Trotter, Manager/Engineer, Arvin-Edison Water Storage District, in Arvin, Cal. (1994).

9. *See generally* David Sunding, Economics of Inter-District Water Transfers in California, (presented at American Society of Civil Engineers Annual Conference) (July 1999) (manuscript on file with author).

10. *Id.* Note that because an active market in permanent water rights does not exist, a farm that sells its water rights is making an irreversible disinvestment. Given this irreversibility and the uncertainty about the future value of water, which is driven in the short run by stochastic weather patterns and in the long run by water policy and economic growth, a farm's *option* to sell its water is very valuable. The more valuable the option, the higher the market price must be before a farm will be induced to sell its permanent water right.

11. *See generally* SCARCE WATER AND INSTITUTIONAL CHANGE (Kenneth D. Frederick ed.,1986); Robert E. Howitt, *Empirical Analysis of Water Market Institutions: The 1991 California Water Market*, 16 RESOURCE & ENERGY ECON. 357 (1994); Steven J. Shupe et al., *Western Water Rights: The Era of Reallocation*, 29 NAT. RESOURCES J. 413 (1989). Richard E. Howitt & Henry Vaux, *Managing Water Scarcity: An Evaluation of Interregional Transfers*, 20 WATER RESOURCES RES. 785 (1984).

12. Richard E. Howitt & Henry Vaux, *Competing Demands for California's Scarce Water, in* WATER QUANTITY QUALITY MANAGEMENT AND CONFLICT RESOLUTION: INSTITUTIONAL PROCESSES AND ECONOMIC ANALYSIS 271, 278-81 (Ariel Dinar & Edna Tusak Loehman eds., 1995).

13. In this section see generally Howe et al., *Lessons*, *supra* note 3, at 183-96; Howe et al., *The Potential for Water Markets*, *supra* note 3; Michelsen, *supra* note 3.

just within agriculture but also between agricultural and urban sectors.[14] In the C-BT, trades occur in terms of "allotments," where an allotment is a share of the aggregate project water supply for a given year.[15] If a water user has excess supplies in a given season, he can rent his water to another water user within the Northern Colorado Water Conservancy District (NCWCD), the area served by the C-BT.[16] In addition, while the transaction costs are higher, C-BT water can be rented to users not on the NCWCD delivery system through a system of exchanges and replacements.[17] Rentals of non-C-BT water also occur within and between ditch companies. Non-C-BT rentals entail higher transaction costs than C-BT rentals, however, because conveyance costs are higher and because they involve different liability rules for third-party effects than internal C-BT transfers.[18]

The NCWCD staff facilitates rental exchanges by putting prospective renters in contact. Occasionally an auction of rental water will be advertised, but in most cases the parties to an exchange settle on a price among themselves. In an average year, about 30 percent of the C-BT water delivered to the district is involved in rental transactions.[19] In general, the agricultural sector is a net rentee and cities are net renters of water, although cities have begun to use more of their allotments each year in response to population growth.[20] In recent years, brokers have begun to participate in the rental and sales markets.[21] Some brokers simply link up interested buyers and sellers, but others act as speculator-sellers. The latter type must own agricultural land on which he can demonstrate beneficial use. When opportunities to buy arise, the broker can then either use the water to irrigate crops temporarily or rent it until a buyer is found.

When two parties want to transfer an allotment right, they must submit an application to the district so it can verify that the water will be used beneficially.[22] The approval process is intended to safeguard against speculative purchases of water allotments.[23] Municipal and domestic water

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14. Michelsen, *supra* note 3, at 973. The primary cities served by the C-BT are Greeley, Fort Collins, Loveland, and Longmont. Fred N. Norcross, *Genesis of the Colorado-Big Thompson Project*, COLO. MAG., Jan. 1953, at 29, 36.

15. If a water user owns one allotment, his supply in year t is $1/S_t$ where S_t is the aggregate project water supply in year t. The allotments are defined in terms of "acre-foot units." Michelsen, *supra* note 3, at 974.

16. *See generally* Howe et al., *Lessons*, *supra* note 3, at 183-96; Howe et al., *The Potential for Water Markets*, *supra* note 3; Michelsen, *supra* note 3.

17. Howe et al., *Lessons*, *supra* note 3, at 196-97.

18. *Id.*

19. Michelsen, *supra* note 3, at 979.

20. *Id.* at 975-76.

21. Howe et al., *Lessons*, *supra* note 3, at 187.

22. *Id.*

23. *Id.*

company users are usually exempted from the approval process, presumably because reasonable beneficial use is harder to define for non-agricultural uses.[24] Rental prices tend to be well below water allotment prices, reflecting the fact that rentals carry a higher risk of non-availability than do allotments.[25] In addition to risk factors, unwritten rules of conduct between cities and agricultural renters exist that suppress rental prices. The NCWCD directors have allowed cities to own water allotments in excess of average use under the rationale that cities must have reliable supplies.[26] However, in return for this privilege, it is implicitly understood that cities should not profit from rentals.[27] Most towns simply add a small administrative fee to their variable cost when setting the rental price.[28]

The C-BT's transferable water allotment system has enabled northern Colorado to adjust to short-run and long-run shifts in water supply and demand.[29] In response to urban and industry growth on the eastern slope of the Rocky Mountains, NCWCD water allotments have been transferred from agricultural to municipal and industrial uses. Irrigators owned 82 percent of the water allotments in 1962, 64 percent in 1982, and only 55 percent in 1992.[30] Municipalities and industries have been buying the agricultural allotments to meet their immediate and future needs. Over the period 1962 through 1992, municipal holdings increased from 18 percent of the total to 41 percent and industry holdings increased from less than one percent to four percent.[31] Actual water deliveries to nonagricultural uses are lower, however, because cities and multipurpose users have tended to hoard extra allotments and rent water back to irrigators on a year-by-year basis.[32] For example, irrigators only owned 64 percent of the allotments in 1982, but they used 71 percent of the available water.[33]

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24. *Id.*
25. *Id.* at 191.
26. *Id.*
27. *Id.*
28. *Id.*
29. *See generally* Howe et al., *Lessons*, *supra* note 3, at 183-96; Howe et al., *The Potential for Water Markets*, *supra* note 3; Michelsen, *supra* note 3.
30. Michelsen, *supra* note 3, at 975.
31. *Id.* at 975.
32. *Id.* at 975-76.
33. Howe et al., *Lessons*, *supra* note 3, at 187.

III. COMPARATIVE INSTITUTIONAL ANALYSIS

A. Literature Review

Before analyzing the institutions governing water allocation in the CVP and the C-BT and their effects on market transaction costs, a brief review of the literature is provided. The review begins with a discussion of the new institutional economics literature and the transaction cost economics literature. It then focuses on the water markets literature.

1. *New Institutional Economics*

The new institutional economics literature is perhaps best exemplified by the work of Douglass North.[34] He focuses on two key questions relevant to this research: first, what determines the divergent patterns of the evolution of societies over time? and second, how can we account for the survival of economies with persistently poor performance over long periods of time? In answering these questions, North emphasizes the importance of history. If institutions existed in a world with zero transaction costs, history would not matter because institutions would adjust instantaneously in response to changes in relative prices or preferences. However, since in reality there are positive transaction costs, history matters. North argues that the two main forces determining the path of institutional change are increasing returns to scale and imperfect markets characterized by significant transaction costs.[35]

North describes general stages of market evolution, from local, to regional, to long-distance exchange, involving progressively more specialization and complex trading relationships.[36] The movement from one

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34. *See generally* DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE AND ECONOMIC PERFORMANCE (1990); Douglass C. North, *Economic Performance through Time*, 64 AM. ECON. REV. 359 (1994); EMPIRICAL STUDIES IN INSTITUTIONAL CHANGE (Lee J. Alston et al. eds., 1996).

35. DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE AND ECONOMIC PERFORMANCE 7-10 (1990).

36. In the first stage, there is local exchange characterized by little specialization, strong social networks, informal constraints, and low transaction costs. In the second stage, there is regional exchange with specialized trading centers, growth in multilateral trade, and an increased percentage of the population engaged in trade and commerce. As the size of the market grows, the costs of transacting also increase. Dense social networks are replaced by a greater reliance on anonymous transactions, and more resources are devoted to measurement and enforcement. In the third stage, there is long-distance trade that involves a distinct change in the economic structure. One observes substantial specialization, individuals whose livelihoods are confined to trading, trading centers, economies of scale, and geographical and occupational specialization. Long-distance trade requires the development of standardized weights and measures, units of account, a medium of exchange, merchant-law courts, and a

stage to the next requires institutional and technological innovations that lower the costs of transacting. However, the change necessary for the evolution from one stage to the next will not necessarily occur. The institutional environment will be stable, North says, if the skill and knowledge required for success by organizations and individuals does not induce productive modifications of the basic institutional framework. In such cases of "allocative efficiency," change will occur only if it is stimulated by external forces. In contrast, when there is "adaptive efficiency," sequentially more complex institutional innovations evolve to lower the cost of transacting.[37]

The study of institutional change is closely related to work by Paul David and W. Brian Arthur on the path dependency of technological choices.[38] David illustrates the process of path dependence with an analysis of the history of the QWERTY keyboard system. Although other keyboard systems developed around the same time were shown in speed tests to be more efficient, the QWERTY system became the standard.[39] Arthur describes a similar process of incremental technological change. He argues that if there are large setup or fixed costs, learning effects, coordination effects, and adaptive expectations, there may be multiple equilibria, possible inefficiencies, lock-in, and path dependence.[40] Both David and Arthur focus on technology adoption, but their insights are equally relevant to the process of institutional change in water.

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whole range of other organizations, institutions, and instruments. These developments are necessary to mitigate the transaction costs associated with problems of agency and contract enforcement. In the fourth stage, there are more specialized producers, increasing economies of scale, and urbanization. This stage requires the development of capital markets, manufacturing firms, and political and judicial organizations that can enforce contracts in order to ensure secure property rights. In the final stage, an even larger percentage of the resources of the society are engaged in transacting due to increased specialization. *Id.* at 120-22; Douglass C. North, *Economic Performance through Time*, 64 AM. ECON. REV. 359 (1994).

37. As an example of adaptive efficiency, North describes the development of long distance trade in Europe. Long distance trade became possible due to the development of institutional and technological innovations that increased the mobility of capital, lowered information costs, and spread risk. Douglass C. North & Barry R. Weingast, *Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England, in* EMPIRICAL STUDIES IN INSTITUTIONAL CHANGE 147 (Lee J. Alston et al. eds., 1996).

38. *See generally* Paul David, *Understanding the Economics of QUERTY, in* ECONOMIC HISTORY AND THE MODERN ECONOMIST 30 (William N. Parker ed., 1986); W. Brian Arthur, *Competing Technologies, Increasing Returns, and Lock-in by Historical Events*, 99 ECON. J. 116 (1989).

39. David argues that the adoption and subsequent standardization of an inefficient system was possible due to the following key features of the evolving product system: (1) technical inter-relatedness, (2) economies of scale, and (3) the quasi-irreversibility of investment. He claims that the "QWERTY phenomenon," in which an industry becomes locked-in to the wrong system, is not as uncommon as people may believe. David, *supra* note 38, at 30.

40. Arthur, *supra* note 38, at 126-28.

2. Transaction Cost Economics

The analysis of the CVP and the C-BT also draws from the transaction cost economics literature originally developed by Oliver E. Williamson.[41] Transaction cost economics advocates comparative institutional analysis as opposed to a comparison of the status quo with an unattainable "first best." It analyzes why various governance structures emerge and how they adapt in response to the challenge of mitigating transaction costs. The relevant transaction costs include both the ex-ante costs of drafting, negotiating, and safeguarding an agreement, and the ex-post costs associated with contractual breakdowns and rent seeking behavior.[42]

Transaction cost economics assumes that agents are subject to bounded rationality and are given to opportunism.[43] This theory argues that the most critical dimension of transactions is the degree of asset specificity.[44] Transaction cost economics assumes that uncertainty is present in a non-trivial degree and analyzes the effects of bounded rationality, opportunism, asset specificity, and frequency on the structure of contracts. Transaction cost economics argues that transactions will be organized so as to economize on bounded rationality while simultaneously safeguarding the transactions against the hazards of opportunism. Furthermore, there will be competition among organizational forms, and through an evolutionary process efficient forms should prevail.

Avinash K. Dixit uses transaction cost economics to model the political process in a theory he calls "transaction cost politics."[45] He views economic policymaking as a dynamic game, played under conditions of uncertainty. Rather than thinking of a social planner who maximizes a social welfare function, he envisions multiple agents engaged in a game in which each policy act is a play of the game within an existing set of rules and institutions.[46] In addition, each agent has some leeway to make strategic

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41. *See generally* OLIVER E. WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM (1985) [hereinafter WILLIAMSON, INSTITUTIONS]. OLIVER E. WILLIAMSON, THE MECHANISMS OF GOVERNANCE (1996).

42. WILLIAMSON, INSTITUTIONS, *supra* note 41, at 20-21.

43. *Id.* at 43-52.

44. *Id.* at 52-56.

45. *See generally* AVINASH K. DIXIT, THE MAKING OF ECONOMIC POLICY: A TRANSACTION-COST POLITICS PERSPECTIVE (1996).

46. *Id.* at 8-9, 145-46.

moves that may affect or alter future rules or institutions.[47] Given this framework, Dixit (like North) argues that institutions are not necessarily created to be socially efficient, but rather they are created to serve the interests of those with the bargaining power to create new rules.[48] Out of new institutions arise new organizations that have an interest in maintaining the status quo. As more people make sunk investments based on the current set of institutions, it becomes politically and economically more difficult to change a policy act. Thus, there is a hysteresis of policy acts. With reference to Williamson's idea of the natural selection of efficient organizational forms, Dixit argues that in politics the forces of selection and evolution are weaker and slower than in private business, so the presumption of efficiency must also be weaker.[49] Finally, when evaluating the performance of a policy, Dixit asserts that one should look at efficiency over the life of a project, not just at a given point of time.[50] There is value associated with adaptability.

3. *Water Marketing*

Economists have long argued that markets are an efficient way to allocate water resources. There are by now a large number of theoretical and empirical studies purporting to measure the efficiency gains to various groups and to society as a whole from water trading. For example, Henry Vaux and Richard E. Howitt measure the gain in economic welfare from allowing interregional transfers of water in California.[51] They conclude that the gains are significant, and that only relatively modest transfers of water from agriculture to urban areas (around 10 percent) would be needed to bring the allocation among developed uses into economic balance.[52]

Another benefit of water trading, which is especially important given emerging public preferences for the restoration of American rivers, is the complementarity between water trading and policies to improve environmental quality. In a recent study, David Sunding *et al.* point out that

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47. Dixit distinguishes between policy rules (which he compares to fixed inputs such as capital) and policy acts (which he compares to variable inputs such as labor). Policy acts can be changed in the short run, while policy rules can be changed in the long run and require a lump-sum up-front cost. However, he says the distinction between policy rules and policy acts is one of degree rather than one of kind, since rules are subject to erosion and reinterpretation and acts can create durable institutions. *Id.* at 144.

48. *Id.* at 8-12.

49. *Id.* at 59.

50. *Id.* at 59-60.

51. Howitt & Vaux, *supra* note 11, at 785. *See generally* HARTMAN & SEASTONE, *supra* note 1; RODNEY T. SMITH, TRADING WATER: AN ECONOMIC AND LEGAL FRAMEWORK FOR WATER MARKETING (1988); RICHARD W. WAHL, MARKETS FOR FEDERAL WATER: SUBSIDIES, PROPERTY RIGHTS, AND THE BUREAU OF RECLAMATION (1989); Howitt, *supra* note 11.

52. Vaux & Howitt, *supra* note 11, at 790-91.

water markets can greatly reduce the burden of improving instream water quality by allocating reductions in diversions to users with the lowest economic productivity.[53] Using data from California's Central Valley, they find that economic costs of pre-determined San Francisco Bay/Delta water quality enhancements can be cut nearly in half if trading is allowed between the Sacramento and San Joaquin Valleys.[54]

Economists have also noted that water trading has the potential to allocate other important resources, including risk. H. Stuart Burness and James P. Quirk have shown that by creating differences in water availability over time, the prior appropriation system unequally and inefficiently allocates risk among otherwise similar water users.[55] They argue that water markets can improve economic welfare by reallocating both water and risk according to the productivity of water use and relative risk preferences.[56]

Given the potential benefits of water markets, many analysts have asked why more water trading does not occur.[57] Bonnie Colby Saliba and David B. Bush surveyed water markets in the Southwest and concluded that, actually, quite a few water markets exist, but most are local and informal in nature.[58] K. William Easter *et al.* surveyed water markets in a number of countries, including the United States.[59] Like Saliba and Bush, the Easter *et al.* survey demonstrates that, while many informal water markets exist throughout the world, more formal markets, such as exist for C-BT water, are the exception rather than the rule.[60] Informal local markets are advantaged relative to inter-regional markets since they do not encounter as many legal and bureaucratic restrictions.[61] In local markets, water does not have to be transported long distances and third party effects may be less if water stays in the same groundwater basin. To the extent that transfers generate negative externalities, compensation of third parties may be more likely if the market participants are neighbors (as in local markets) whose long-term reputations are at stake.

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53. *See generally* David Sunding et al., *Measuring the Cost of Reallocating Water from Agriculture to the Environment: A Multi-Model Approach*, NAT. RESOURCES MODELING (forthcoming 2001).

54. *Id.*

55. H. Stuart Burness & James P. Quirk, *Water Law, Water Transfers, and Economic Efficiency: The Colorado River*, 23 J.L. & ECON. 111, 120-21 (1980).

56. *Id.* at 121-22.

57. *See generally* Robert A. Young, *Why Are There So Few Transactions among Water Users?*, 68 AM. J. AGRIC. ECON. 1143 (1986).

58. *See generally* SALIBA & BUSH, *supra* note 1.

59. *See generally* MARKETS FOR WATER: POTENTIAL AND PERFORMANCE (K. William Easter et al. eds., 1998).

60. See K. William Easter et al., *The Future of Water Markets: A Realistic Perspective, in* MARKETS FOR WATER: POTENTIAL AND PERFORMANCE 277 (K. William Easter et al. eds., 1998).

61. *Id.* at 279-80.

Loyal Hartman and Don Seastone point to other reasons why formal water markets have failed to develop.[62] They argue that the physical characteristics of water, namely the stochastic nature of its supply and the complexity of the natural and manmade systems through which it flows, give rise to the special difficulties of establishing markets in water.[63] They analyze the external impacts of transfers with a special focus on return flows and the effects of transfers on local economies.[64] Hartman and Seastone argue that institutional change involving both laws and organizations is necessary for economic growth to occur.[65]

Much of the literature on water trading attempts to define the desirable characteristics of markets. Primary in most papers is a discussion of the need for balance between minimizing transaction costs to encourage efficiency-enhancing transfers and protecting third parties.[66] The debate hinges on the nature of the "right" balance. If there is too much regulation, many desirable transactions will not occur. If there is too little regulation, excessive costs may be imposed on third parties and the net social benefits of transfers may be negative.

Bonnie G. Colby argues that the tension between market-oriented and regulatory approaches to resource allocation stems from disagreements over the appropriate balance between market forces and laws promulgated to protect or enhance broader social values in water.[67] Colby views transaction costs not as the inefficient consequences of regulation but as the costs incurred to comply with policies designed to account for

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62. *See generally* HARTMAN & SEASTONE, *supra* note 1.

63. *See id.* at 119-20.

64. *See id.* at 8-13. For another examination of the potential negative impacts of water transfers on local economies, see LAWRENCE J. MACDONNELL, FROM RECLAMATION TO SUSTAINABILITY: WATER, AGRICULTURE, AND THE ENVIRONMENT IN THE AMERICAN WEST (2000). MacDonnell describes the negative impacts that long-term sales of water rights to Denver metro communities have had on farm communities in the Arkansas River Valley. While the water transfers were welfare enhancing in terms of the creation of jobs statewide, the local farm economies were harmed. *Id.* at 51-60. MacDonnell argues, however, that these Arkansas River transfers do not constitute evidence that water markets do not work. These types of transfers should not be called "water marketing," he argues, because no true market exists in which water is bought and sold. MacDonnell supports institutional reforms that encourage the establishment of well-functioning markets. He states that some portion of already developed and used supplies must shift to new uses. The existing procedures are cumbersome and expensive and often produce undesired results.

65. HARTMAN & SEASTONE, *supra* note 1, at 120-22.

66. *See generally id.*; Howe et al., *The Potential for Water Markets*, *supra* note 3; Bonnie G. Colby, *Regulation, Imperfect Markets, and Transaction Costs: The Elusive Quest for Efficiency in Water Allocation*, *in* THE HANDBOOK OF ENVIRONMENTAL ECONOMICS (Daniel W. Bromley ed., 1995).

67. Colby, *supra* note 66, at 476.

externalities.[68] She says transaction costs reflect the costs associated with gathering information and the need for hydrologic, legal, and economic data to address externalities in an efficient manner.[69] Colby argues that since appropriately structured transaction costs give transacting parties an incentive to account for the social costs of transfers, public policy should not necessarily attempt to minimize transaction costs.[70]

Terry L. Anderson and Pamela Snyder advocate less government intervention.[71] They acknowledge three rationales for government involvement in the allocation of water: monopoly, imperfect capital markets, and externalities.[72] They believe the most legitimate concern is externalities, but they argue that the evolving system of water rights on the western frontier has succeeded in internalizing many of the problems associated with externalities.[73] They argue that much of the government regulation stemming from the reclamation projects in the twentieth century resulted from rent-seeking behavior rather than an attempt to protect public interests.[74]

Along with debating the desirable characteristics of water markets, many researchers describe the evolution of water allocation laws and organizations over time.[75] There seems to be consensus that the institutions necessary to support water markets will evolve in response to greater water scarcity.[76] Indeed, there are examples of what North calls "adaptive efficiency" in which water allocation laws and organizations have evolved to promote more efficient water use.[77] Most change has occurred gradually, but rapid change such as the development of the 1991 California Emergency Drought Water Bank is also possible.[78] However, while examples of

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68. *Id.* at 475.

69. *Id.*

70. For another study advocating water markets combined with a set of strict regulations to protect third parties, see generally BRENT M. HADDAD, RIVERS OF GOLD: DESIGNING MARKETS TO ALLOCATE WATER IN CALIFORNIA (2000).

71. *See generally* TERRY L. ANDERSON & PAMELA SNYDER, WATER MARKETS: PRIMING THE INVISIBLE PUMP (1997).

72. *Id.* at 50-52.

73. *Id.* at 31-44.

74. *Id.* at 47-50. For a viewpoint in opposition to Anderson and Snyder's free-market approach, see Victor Brajer et al., *The Strengths and Weaknesses of Water Markets as They Affect Water Scarcity and Sovereignty Interests in the West*, 29 NAT. RESOURCES J. 489 (1989). Brajer et al. are pessimistic about the prospects of allocating water through market mechanisms and advocate greater restrictions.

75. *See generally* ANDERSON & SNYDER, *supra* note 71; Shupe et al., *supra* note 11; Johnson & DuMars, *supra* note 1.

76. *See generally* ANDERSON & SNYDER, *supra* note 71; Shupe et al., *supra* note 11; Johnson & DuMars, *supra* note 1.

77. NORTH, *supra* note 35, at 80.

78. Howitt, *supra* note 11, at 371.

adaptive efficiency exist, institutional change resulting from rent-seeking behavior does not necessarily promote more efficient water use.[79] Furthermore, as this article demonstrates, some institutions are relatively impervious to change. Thus, markets may evolve more quickly in one area than another, even when water is scarce in each region. In order to understand how and when water market institutions evolve, we need to have a greater understanding of the path-dependent nature of institutional change.

B. Comparison of CVP and C-BT Water Allocation Institutions

This study focuses on four key institutional features that impact the cost of water market transactions in the CVP and the C-BT. They are (1) the contracts between water districts and the Bureau of Reclamation (the Bureau), (2) the water rationing mechanisms, (3) the return-flow rules, and (4) the presence or absence of acreage limitations. These institutional restrictions and their impact on the development of water markets in the CVP and the C-BT are analyzed in the following section.

1. Water Districts and Reclamation Contracts

The Bureau contracts with over 250 entities in the CVP.[80] The contractors include water districts, individuals, and municipalities.[81] Some of the water districts were established long before the CVP was built, with the initial purpose of building and operating local water irrigation projects. Others were established much later with the explicit purpose of contracting with the Bureau for CVP deliveries. The water district entitlements range from a few acre-feet to over a million acre-feet per year.[82] In addition to contracting with water districts, the Bureau contracts directly with riparian landowners that held prior claims to the water diverted by the Bureau.[83]

The contracts between water users and the water districts in the CVP entitled farmers to use a set amount of water on a given piece of land.[84] The contracts did not provide individual farmers with the explicit right to

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79. ANDERSON & SNYDER, *supra* note 71, at 47-50.

80. ARTHUR L. LITTLEWORTH & ERIC L. GARNER, CALIFORNIA WATER 5 (1995).

81. U.S. BUREAU OF RECLAMATION, MID-PACIFIC REGION, WATER SERVICE REPORT 1-12 (Mar. 8, 2001).

82. *Id.*

83. *Id.* at 5-10.

84. The contracts are known as "water service contracts." Water users pay a combined capital and operation and maintenance charge on each acre-foot of water delivered. Capital repayment was amortized over a 40-year repayment period on an interest-free basis. Some capital costs were to be paid by hydropower sales and by municipal and industrial water users. WAHL, *supra* note 51, at 52. For more information on the water service contracts, see the Reclamation Project Act of 1939, 43 U.S.C. §§ 485-485k (1994).

transfer their entitlement to another farmer or even to change the nature of water use on their own land without approval.[85] The Central Valley Project Improvement Act lifted many of the restrictions on water transfers, but trades between water districts require approval by the Bureau and/or the State Water Resources Control Board.[86] The rules that regulate transfers depend on whether the parties to a transaction have riparian, pre-1914 appropriative rights, post-1914 appropriative rights, or more junior contract rights.[87] Transfers are not approved if they will have a significant long-term adverse impact on groundwater conditions within the basin of origin, or if they will unreasonably impact the water supply, operations, or financial conditions of the supplying district.[88]

In contrast to the CVP, the NCWCD is the only water district in the C-BT. It was established in 1937 to be responsible for guaranteeing the repayment of project costs, negotiating solutions to conflicts with the basin of origin, and allocating water among users with various needs.[89] The NCWCD serves agricultural (both individuals and mutual ditch companies), municipal, and industrial users, and is responsible for achieving compromises between these diverse groups.[90] The delegation of power to a single water district provides the C-BT with a more coherent governance structure than the CVP.[91]

In both Colorado and California, transfers between water districts require a lengthy approval process. The cost of trading within the C-BT is lower than in the CVP because one district governs all C-BT water allocations. Since the NCWCD includes both agricultural and urban users, trades between these groups are possible at relatively low cost. In contrast, most of the CVP contractors are agricultural users, so transfers to urban sectors typically extend beyond the project's boundaries and involve additional regulatory complexity.

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85. WAHL, *supra* note 51.

86. U.S. Bureau of Reclamation, Mid-Pacific Region, *Central Valley Project Improvement Act Final Administrative Proposal on Water Transfers, at* http://www.mp.usbr.gov/cvpia/ltrwt.html (Apr. 17, 1998). *See generally* Central Valley Project Improvement Act, Pub. L. 102-575, Title XXXIV, 106 Stat. 4604 (1992).

87. U.S. Bureau of Reclamation, Mid-Pacific Region, *Central Valley Project Improvement Act Final Administrative Proposal on Water Transfers, at* http://www.mp.usbr.gov/cvpia/ltrwt.html (Apr. 17, 1998).

88. *Id.*

89. DANIEL TYLER, THE LAST WATER HOLE IN THE WEST: THE COLORADO-BIG THOMPSON PROJECT AND THE NORTHERN COLORADO WATER CONSERVANCY DISTRICT 61 (1992). The NCWCD was created as part of the Water Conservancy District Act, 1937 Colo. Sess. Laws ch. 266.

90. Michelsen, *supra* note 3, at 974.

91. Howe et al., *Lessons, supra* note 3, at 195-96.

Even if the rules (both statutes and internal district rules) governing transfers were modified to make it easier to obtain approval for trades between districts in the CVP, some trades are restricted by physical factors. Necessary canals may not exist or it may be costly to obtain the rights to distribute the water. If a transfer requires use of distribution networks in multiple districts, permission must be obtained from each. The absence of water metering devices can also limit trades. Some of the districts in the CVP meter individual water use by the acre-foot, while other districts (those with more plentiful supplies) charge their water users a fixed per-acre rate because they do not have metering devices to monitor individual use.[92] The measurement and enforcement costs of trading are high when districts do not meter individual water on a per-acre-foot basis. In addition to capacity, coordination, and metering constraints, districts may have water quality concerns if a proposed trade involves pumping lower-quality water into the distribution system.[93]

2. *Water Rationing Mechanisms*

a. *Priority Rationing in the CVP*

If the supply of water were constant each year, surface water rights would be relatively easy to define. However, water supplies depend on stochastic weather conditions. Therefore, a non-market water allocation system that does not rely on prices to equate demand with supply must develop a rationing mechanism. Water in the CVP is rationed according to a priority system.[94] In the event of a drought, senior-rights holders receive their full allocation before junior-rights holders receive any of their allocation. Land associated with senior rights is said to have "higher priority." Landowners who held riparian rights before the CVP was built, who entered into "exchange contracts" to substitute their original supplies for CVP water, have the most senior rights.[95] Next in line are the irrigation districts that formed in the wake of the 1887 Irrigation District Law and that

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92. The rate per-acre depends on the average water requirements of the crop grown. Suppose, for example, that the Bureau wants to generate $10 per acre on average, and suppose a farm grows 100 acres of cotton. If cotton production in the district requires 4 acre-feet of applied water per acre on average, the Bureau will charge the farm $40 per acre on 100 acres or a total of $4000. The farm will pay $40 per acre regardless of the actual amount of water it uses, as long as the farm's use is not flagrantly wasteful. Interviews with District Staff at Glen-Colusa Water District, Provident Water District, and Richvale Water District (1995).

93. Cal. Dep't of Water Res., *San Joaquin District Drainage Monitoring Program, at* http://wwwdpla.water.ca.gov/sjd/waterquality/drainage/index.html (last modified Oct. 28, 1998).

94. CLAIR ENGLE, CENTRAL VALLEY PROJECT DOCUMENTS PART TWO: OPERATING DOCUMENTS, H.R. DOC. NO. 85-246, at 79-240 (1957).

95. *Id.*

contracted early with the Bureau for CVP water. Junior rights belong to districts that contracted with the Bureau later.

In addition to varying between water districts, user priorities may also vary within CVP districts. For example, Westlands Water District has junior water rights relative to other districts in the CVP, but within Westlands there are also different priority areas, ranked I, II, and III.[96] In the event that full deliveries cannot be met (which has been the norm rather than the exception in recent years), water is rationed first to Area I land and then to Area II land.[97] Land in Area III only receives water in the event that the needs of both Areas I and II have been met.[98]

The priority rationing system increases the transaction costs associated with trading by creating heterogeneous rights that must be quantified and priced for each individual trade. First, the price paid to the Bureau for an acre-foot of water depends on the seniority of the water right. In the Westlands case, users in Area I pay less per acre foot for the same type of water than users in Area II.[99] Second, the likelihood of receiving a full delivery is greater the more senior the water right. Third, the seniority of the right technically is attached to the land where it is used.[100] Thus, if a right is traded to a user with land in a lower priority area, the seniority of the right may change as a result of the trade. Since markets in permanent water rights do not currently exist in the CVP, it is unclear how this issue would be resolved. If the Bureau has to resolve the issue of relative seniority on a case-by-case basis, the costs of trading will remain high.

The higher are the transaction costs, the less is the ability of water users to adapt to short-run supply variations. In the event of shortages, senior rights holders in the CVP may still receive their full entitlements while junior rights holders may not receive any water. Thus, senior rights holders are somewhat insulated from supply shortages and, if they cannot

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96. Priority area I encompasses 337,000 acres of land that were part of the original Westlands Water District. Under a 1963 contract with the Bureau, this area is entitled to 900,000 acre-feet of water in full-delivery water years or 2.6 acre-feet per acre. Area II covers 187,000 acres of land that was annexed by Westlands at a later date from the former Westplains Water District. This area is entitled to 250,000 acre-feet or 1.3 acre-feet per acre. Area III covers an additional 10,000 acres, which was annexed to Westlands after the merger with Westplains. *See CVP Contract Supplies, at* http://www.westlandswater.org/Wtr%20Supply/ws8.htm (last visited May 10, 2001).

97. Westlands Water District, Terms and Conditions for Agricultural Water Service, Article 17: Regulations for the Allocation of Agricultural Water within the Westlands Water District 1-6 (Nov. 16, 1992) (unpublished document, on file with author).

98. *Id.* at 3.

99. *See Current Water Rates, at* http://www.westlandswater.org/Wtr%20Supply/Rates.htm (last visited May 10, 2001).

100. Westlands Water District, *supra* note 97, at 10.

easily sell their water to junior rights holders, have little incentive to cut back their use.

To the extent that senior rights correspond to high-valued uses for which security of supply is crucial and junior rights correspond to low-valued uses for which security is not crucial, the priority system may be an efficient method of allocating scarce supplies. However, such a relationship does not necessarily exist. For example, Westlands Water District is a low *priority* water district, but it is a high *productivity* district.[101] Further, within Westlands, much of the highest productivity land is located in Area II, not in Area I (the area with the highest priority).

In the intra-seasonal spot market, there is no uncertainty regarding supply availability at the time a trade is made. The Bureau announces its deliveries at the beginning of the water year so that all users know how much water they have in their annual accounts. A water district will only approve a rental transaction after it has confirmed that the seller actually has the water in his account. Thus, a buyer should be indifferent between water contract types (*i.e.*, the water seniority), and the market price should be independent of the contract type. However, the seniority of the water right will affect the transfer price, which is the price paid by the buyer to the seller. The market price equals the Bureau water rate plus the proceeds to the seller. Since the Bureau water rate is in general lower the more senior the right, the proceeds to the seller will be higher the more senior the right. Therefore, the price paid by the buyer to the seller is specific to the contract type and the location of the trade. If a trade in permanent water rights were to occur, the buyer and the seller would have to consider the added complexity of supply uncertainty when valuing the right.[102]

b. *Proportional Rationing in the C-BT*

In the C-BT, water is rationed according to a proportional system.[103] The C-BT is designed to deliver a maximum of 310,000 acre-feet per year.[104] The NCWCD divided the water into 310,000 individual allotments that are transferable contracts between the district and the holder, subject to the holder's ability to show beneficial use of the water within the boundaries

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101. David Zilberman et al., *Water for California Agriculture: Lessons from the Drought and New Water Market Reform.*, CHOICES, Fourth Quarter 1994, at 25, 26.

102. The value of 100 acre-feet of water depends on the seniority of the right and the user's expectations about future supply. Clearly 100 acre-feet of senior-right water is worth more than 100 acre-feet of junior-right water, because in a given year the expected supply is greater for the senior-right water. In a drought, the owner of the senior right may still receive full supply while the owner of the junior right may receive nothing at all.

103. Michelsen, *supra* note 3, at 974.

104. *See id.*

of the district.[105] If the C-BT delivers less than the full 310,000 acre-feet in a given year, supplies to all users are cut back proportionally.[106] In April each year the NCWCD board of directors determines the annual quota based on hydrologic conditions and anticipated water demand.[107] The purpose of the C-BT is to supply supplemental water that, when combined with a water user's primary supply, will reduce the variability of supplies across years. Therefore, in wet years the board of directors sets a lower quota in order to store water for use during dry years.[108] This pattern of allocation contrasts sharply with the pattern in the CVP, where supplies increase in wet years and decrease in dry years.

There are four categories of allotment contracts between the NCWCD and the water users, depending on whether the contractor is an individual (Class D), a municipality (Class B), a ditch company (Class C), or a corporation (Section 25).[109] Water users can rent and transfer water from one location of use or class of service to another, and they can buy and sell permanent allotment contracts that are severed from the land. The C-BT's proportional rationing system lends itself more easily to the creation of a water market because the property rights are relatively homogenous. A user's expected supply in a given year depends only on the number of allotments he owns or rents. It does not matter from whom the user buys or rents an allotment or where the water is used as long as it is within the NCWCD boundaries.

3. Acreage Limitations

Another factor that adds complexity to the CVP governance structure is the farm acreage limitation stipulated by the Reclamation Act of 1902.[110] The C-BT is not subject to the acreage limitations of the Act. According to the Act,

> No right to the use of water for land in private ownership shall be sold for a tract exceeding one hundred and sixty acres to any one landowner, and no such sale shall be made to any landowner unless he be an actual bona fide resident on such land, or occupant thereof residing in the neighborhood of said

105. J.M. DILLE, A BRIEF HISTORY OF THE NORTHERN COLORADO WATER CONSERVANCY DISTRICT AND THE COLORADO-BIG THOMPSON PROJECT 28 (1958).

106. For example, if the aggregate supply is reduced by 10 percent to 279,000 acre-feet, then each individual's supply will be reduced by 10 percent. If a user owns 100 allotments and thus receives 100 acre-feet in a full-delivery year, he or she will receive 90 acre-feet.

107. TYLER, *supra* note 89, at 269.

108. *Id.* at 269-270.

109. DILLE, *supra* note 105, at 28.

110. Pub. L. No. 57-161, 32 Stat. 388.

> land, and no such right shall permanently attach until all payments thereof are made.[111]

The acreage limitation was intended to promote small-scale family farming, but the law failed to achieve this goal. First, 160-acre farms that may have been viable in the eastern part of the country were not profitable in the semi-arid West. Second, by the time the CVP was constructed, the majority of the land to be served by the project was already in private holdings larger than 160 acres.[112]

Abuse of the acreage requirement ranged from allowing a husband and wife each to hold 160 acres, and thus increasing a farm's size to 320 acres, to out and out violations.[113] In 1982, the Bureau increased the allowable acreage to 960 acres and, in exchange for relaxing the acreage limitation, vowed to enforce the rule.[114] However, large farms were able to satisfy technical compliance with the law by distributing 960-acre plots to individual family members and creating family trusts or "farm management units."[115]

Even though the federal government has never strictly enforced the acreage limitation law, the law has deterred transfers in the CVP in two ways. First, the law is yet another factor that increases the heterogeneity of water rights because the value of a given right is a function of the size of the farm on which the water is used. The 1982 amendment[116] allows farms to receive project water on land in excess of 960 acres but the farm must pay a higher rate (so called "full-cost") for the water to the excess land.[117] Thus, the acreage limitation, along with the seniority system, forces the buyer and the seller to consider the location of water use in addition to the quantity being transferred.

Second, the law has contributed to the perception among farmers that their rights are insecure. From the CVP's early days to the present, abuse of the acreage limitation has been a focal point of critics of the CVP and other Bureau projects.[118] The stated intent of the reclamation projects was to provide new opportunities for family farming in the West,[119] but,

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111. 32 Stat. at 389.

112. In 1935, the average farm size was just over 200 acres, but 70 percent of the land was in farms of a thousand acres or more. NORRIS HUNDLEY, JR., THE GREAT THIRST 237-38 (1992).

113. *Id.* at 265-66.

114. *Id.* at 380-81. See generally WAHL, *supra* note 51, at 69-126.

115. HUNDLEY, *supra* note 112, at 382-83.

116. Reclamation Reform Act of 1982, Pub. L. No. 97-293, Tit. II, 96 Stat. 1261, 1263-1274.

117. HUNDLEY, *supra* note 112, at 381.

118. *See generally* DONALD WORSTER, RIVERS OF EMPIRE (1985); MARC REISNER, CADILLAC DESERT (1986).

119. *See* Reclamation Act of 1902, Pub. L. No. 57-161, 32 Stat. 388, 390; 35 CONG. REC. 6758 (1902); S. Doc. No. 57-446, at 2, 21 (1902).

instead, critics point out, the projects have provided subsidized water to large corporate farms at taxpayer expense.[120] In the same way that farm lobbies have been able to use political might to ward off enforcement of the law until now, farm lobbies realize that urban and environmental interest groups may be able to wield their increasing power to force changes that jeopardize their water rights. Given this political uncertainty, farmers may be hesitant to participate in water market transactions. Even though the "use it or lose it" rule has been amended to allow farms to sell conserved water, by selling their water,[121] even on a short-term basis, they will be demonstrating that the water is not essential to them, and this could be used against them in the future. Further, in a well-organized market, prices will be publicly available, and the extent of the federal subsidy farmers receive through low water rates will become more obvious to the general public.[122]

4. Return Flow Rules

Colorado state law protects downstream parties from the adverse impacts of changes in upstream water use patterns by placing liability for damages on upstream users.[123] Despite the traditional treatment of return flows in Colorado state law, C-BT water is not subject to the same return flow rule. Rather than again becoming part of the stream as called for under Colorado appropriative law, C-BT return flows were declared to be owned by the controlling water district.[124]

The decision by the authors of the Repayment Contract to grant ownership of return flows to the water district, instead of to downstream users, proved to be instrumental in reducing the transaction costs associated

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120. *See generally* WORSTER, *supra* note 118; REISNER, *supra* note 118; WAHL, *supra* note 51, at 27-46.

121. The California Water Code states, "[t]he sale, lease, exchange, or transfer of water or water rights, in itself, shall not constitute evidence of waste or unreasonable use..." CAL. WATER CODE § 1244 (West Supp. 2001). *See generally* Richard W. Wahl, *Market Transfers of Water in California*, 1 W.-NORTHWEST J. ENVTL L. 49 (1994); Brian E. Gray et al., *Transfers of Federal Reclamation Water: A Case Study of California's San Joaquin Valley*, 21 ENVTL. L. 911 (1991).

122. Many districts in the CVP recently had to renegotiate their contracts with the Bureau because their 40-year contracts were expiring. These districts had additional incentive to demonstrate a need for all of their water. To the dismay of many environmentalists and urban groups, all of the districts successfully renegotiated their contracts. Their rates were increased, but supply levels were maintained. Other districts still face the uncertainty of contract renewal. Westlands Water District's contract expires in 2007.

123. *See, e.g.*, Enlarged Southside Irrigation Ditch Co. v. John's Flood Ditch Co., 183 P.2d 552 (Colo. 1947); Fort Collins Milling & Elevator Co. v. Larimer & Weld Irrigation Co., 156 P. 140 (Colo. 1914); Comstock v. Ramsay, 133 P. 1107 (Colo. 1913).

124. Article 19 of the Repayment Contract with the United States Bureau of Reclamation. For a discussion of Colorado state law dealing with "foreign water," see GEORGE VRANESH, VRANESH'S COLORADO WATER LAW 122-25 (James N. Corbridge & Teresa A. Rice eds., Rev. ed. 1999).

with C-BT water trades.[125] Simple buyer-seller market transactions of C-BT water can take place without having to determine the amount of consumptive use or return flow.[126] Return-flow interdependencies can be ignored because downstream parties have no legal grounds for objection. The return-flow provision frees C-BT water from many of the legal obstacles that stifle transfers in the CVP; however, by ignoring the impacts on third parties, economically inefficient transfers may be allowed to take place.[127]

In the CVP, water users must be much more cognizant of hydrologic connections when contemplating water transfers or other changes in on-farm water application. Several sections of the California State Water Code, taken together, form what is commonly termed the "no injury rule."[128] This rule prohibits water right changes that "operate to the injury of *any legal user* of the water involved."[129] An implication of the no injury rule is that if a transfer of water would affect the availability of water for downstream users then the proposed transfer would not be allowed, regardless of the water right priority of those users.[130] Similar rules apply to groundwater impacts of surface water transfers.[131] To date, the California Legislature has avoided developing statutes that rigorously define the rights and obligations associated with groundwater use. In the absence of such a body of law, the notion that groundwater belongs primarily to the overlying landowner has emerged, including percolated imported surface water.[132]

The protections afforded downstream water users in California also frustrate many potential trades. The no injury rule protects the return flows received by all types of downstream users.[133] The basic implication of this rule is that adjacent and downstream landowners effectively have veto power over proposed trades and other changes in water application. While it is theoretically possible that potential transferors may compensate those

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125. Howe et al., *Lessons*, *supra* note 3, at 185-86.

126. *Id.* at 186.

127. Howe et al., *The Potential for Water Markets*, *supra* note 3, at 441.

128. *See* CAL. WATER CODE §§ 1702, 1706 (West 1971).

129. § 1702 (emphasis added).

130. The no injury rule leads to some contradictions. For example, a user may capture historic return flows from agricultural practices and apply it to land within the originally permitted place of use. However, if the same user wanted to apply this saved water to a new place of use (perhaps through a transfer), then it would not be permissible. In either case, downstream interests are harmed, but the transfer would be prohibited.

131. §§ 1702, 1706.

132. *See, e.g.*, Cal. Water Serv. Co. v. Edward Sidebotham & Son, Inc., 37 Cal. Rptr. 1 (Ct. App. 1964).

133. CAL. STATE WATER RES. CONTROL BD., CAL. ENVTL. PROT. AGENCY, A GUIDE TO WATER TRANSFERS 3-7 to 3-9 (1999).

who would suffer from a transfer, this outcome is unlikely due to the complexities of surface and groundwater flow, the lack of adequate information about the magnitude and timing of these third party impacts, and the large numbers of landowners involved. Alternatively, the transferor may only attempt to sell consumptive use and leave return flows unaffected. While this option is more appealing from a legal standpoint, it makes many transfers uneconomic given average farm-level irrigation efficiencies of 70 percent.[134]

IV. INSTITUTIONAL ORIGINS

The histories of the CVP and the C-BT were similar in many respects.[135] For example, they were both built by the Bureau of Reclamation at roughly the same time. Construction on the CVP began in 1937,[136] while construction on the C-BT began in 1938.[137] Delivery of CVP water to the San Joaquin Valley commenced in 1951,[138] while the first C-BT water flowed through the Continental Divide in 1947.[139] The *stated* intention of each project was to provide supplementary water supplies to land already settled.[140] In the case of California, water was transported from the northern third of the state to the southern two-thirds of the state. In Colorado, water was transported from the western slope to the eastern slope of the Rocky Mountains. The projects required sophisticated technology for the day. In both states, engineers devised pumps to transport water uphill, and in

134. *See* CAL. DEP'T OF WATER RES., BULLETIN 160-98, at 4-21 (1998).

135. The federal Central Valley Project was first authorized by the Rivers and Harbors Act of Aug. 30, 1935, Pub. L. No. 73-409, 49 Stat. 1028, 1038. Secretary of Interior Harold Ickes presented a finding of feasibility to President Roosevelt on November 26, 1935. The CVP was re-authorized for construction by the Department of Interior and made subject to the reclamation laws by the Rivers and Harbors Act of Aug. 26, 1937. The congressional logjam over the Colorado-Big Thompson was broken when Congress passed S. DOC. NO. 75-80 (1937), a plan of development and cost estimate. On August 9, 1937, Congress appropriated an initial $900,000 for the CBT in accordance with S. DOC. NO. 75-80 (1937). In November of 1937, Secretary Ickes presented a finding of feasibility to President Roosevelt and the President approved it on December 21, 1937.

136. *See* ROBERT AUTOBEE ET AL., CENTRAL VALLEY PROJECT: HISTORIC RECLAMATION PROJECTS BOOK 7 (1996).

137. *See* DILLE, *supra* note 105, at 29.

138. HUNDLEY, *supra* note 112, at 274.

139. TYLER, *supra* note 89, at 156-57. Construction of the C-BT was completed in 1956. DILLE, *supra* note 105, at 61.

140. *Interior Department Appropriation Bill for 1938, Hearings before Subcomm. of Comm. on Appropriations*, 75th Cong. 1594 (1938); BUREAU OF RECLAMATION, DEP'T OF THE INTERIOR, SYNOPSIS OF REPORT ON COLORADO-BIG THOMPSON PROJECT, PLAN OF DEVELOPMENT AND COST ESTIMATE, S. DOC. NO. 75-80, at 6-10 (1937).

Colorado, engineers blasted a water tunnel through a section of the mountains.[141]

Despite these common features, markedly different water allocation institutions were adopted for each project. The decision makers at the state and federal levels sought governance structures that would enable them to allocate the initial water supplies at the lowest cost. They required contracts that would provide the water users with secure rights and provide the federal government with a means to recover its construction investments.[142] The decision makers were much less concerned with the long-run ability of the projects to adapt to shifts in the demand for water.

The analysis that follows focuses on the origins of the four water allocation institutions discussed above—the water district structure, the acreage limitation rule, the system of rationing, and the return flow rule. Pre-existing water laws, and the vested interests that grew up around those laws, shaped the choice of institutions in the CVP and C-BT. The feasible set of water allocation institutions also was constrained by the earlier challenges of obtaining political support for the projects and federal funding for construction. Thus, a review of pre-existing water laws and an examination of the struggles to obtain political and financial support for the projects precede the analysis of the four water allocation institutions.

A. Pre-Existing Institutions

The complex and often contradictory nature of California's pre-existing state water rights laws complicated the task of developing the institutions to allocate CVP water. California law accommodates riparian and prior appropriation doctrines (as well as correlative pueblo and Indian rights).

The riparian doctrine, which preceded the prior appropriation doctrine, is the most common form used in the eastern United States. Under riparian law, landowners located along a river or stream can use as much water as they need to irrigate their fields, but they cannot divert water for use on lands outside the original watershed. When the riparian doctrine is strictly enforced, water rights may not be transferred to others for use on non-adjacent lands. Thus, landowners without riverfront acreage are excluded from surface water use. In areas where water supplies are

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141. HUNDLEY, *supra* note 112, at 274; TYLER, *supra* note 89, at 131-40.

142. Article 19 of the Repayment Contract with the United States Bureau of Reclamation, *reprinted in*, DILLE, *supra* note 105, at 27. A satisfactory Repayment Contract was required as part of Amendment 90 of the Interior Department Appropriation Act for fiscal year 1938.

abundant relative to demand, and thus there are fewer conflicts in use, riparian laws apply and usually are not enforced very rigorously.[143]

The prior appropriation doctrine is more common in the western United States, where competition for scarce water resources is greater. In contrast to riparian law, which is based on land ownership, appropriative law is fundamentally a usufructuary right. The appropriative right defines the time and place of water diversion, the place where the water is to be used, and the type of use. If the appropriator wishes to change any dimension of the right, he must apply for a permit change with the state. Under the prior appropriation doctrine, senior rights are granted to the first person or party to put water to "beneficial use" regardless of whether the land on which the water is used is contiguous to a stream. This is expressed as "first in time, first in right." The definition of beneficial use varies from state to state; however, traditional beneficial uses have included irrigation, livestock watering, industrial, and domestic uses. Only recently have state legislatures included recreational uses and fish and wildlife habitat protection in the definition of beneficial use.[144]

Once an appropriative right is established it continues to exist as long as the water is beneficially used. A right may be declared abandoned if the appropriator intentionally discontinues use for several years. Even if the appropriator unintentionally discontinues use for a period of time established by statute, the right may be forfeited. This is commonly called the "use it or lose it" rule.[145]

An extremely important aspect of prior appropriation doctrine is its treatment of return flows. Under the prior appropriation doctrine, return flows again become part of the stream and are subject to downstream appropriation. State laws attempt to protect downstream parties from the adverse impacts of changes in upstream water use patterns, including transfers among users, by requiring that upstream users advertise any proposed changes in points of diversion or types of use. Downstream parties who expect to be damaged by such changes are then permitted to petition the water court for relief. This judicial process is costly and time-consuming and can lead to inefficiency in the transfer process to the extent that it prevents desirable transfers. There may be more efficient ways to address third-party hazards.[146]

California's dual rights system is largely a legacy of the landmark case of *Lux v. Haggin*,[147] which pitted riparian rights holder Henry Miller

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143. *See generally* Brian E. Gray, *The Modern Era in California Water Law*, 45 HASTINGS L.J. 249 (1994).

144. *See generally id.*

145. *See id.*

146. *See id.*

147. 10 P. 674 (Cal. 1886).

(Lux was Miller's partner) against prior appropriation rights holder James Haggin for control of the Kern River. After five years of litigation in the lower courts, the California Supreme Court ruled in favor of Miller and reaffirmed the right of a riparian on private land to demand undiminished flow of a water source. The supremacy of riparian rights over prior appropriation rights was strengthened in the case of *Herminghaus v. S. Cal. Edison Co.*,[148] in which the California Supreme Court ruled that a downstream riparian can command the entire flow of a river to flood-irrigate land. The decision upheld a riparian's right to usurp the claims of an appropriator and use water in an unreasonable and wasteful manner. In response to public outcry over *Herminghaus*, the California Constitution was amended in 1928 to require all water uses, not just prior appropriation uses, to be both reasonable and beneficial. These cases, combined with others pertaining to groundwater rights, pueblo rights, and federal reservation rights, led to the system that has come to be known as the "California Doctrine." The use of this dual system further complicated the already difficult task of establishing well-defined property rights for water.[149] Unlike California, Colorado does not recognize riparian rights. This simplified the task of negotiating with pre-existing rights holders when the C-BT was built.

The laws pertaining to water districts also differed between the two states. In California, the 1887 Irrigation District Law (known as the Wright Act)[150] permitted the formation of irrigation districts. The Act declared that the use of water for irrigation provided a public benefit and thus deserved public funding.[151] The irrigation districts were granted quasi-municipality status, which meant they had the power to levy taxes in order to build public projects.[152] By 1930 there were nearly 90 irrigation districts in California, covering 1.6 million acres.[153]

An equivalent law to the Wright Act did not exist in Colorado. Water users in Colorado organized mutual ditch companies, which are owner-operated and financed irrigation companies that distribute water according to the ownership of shares in the company.[154] Ownership of the water rights and the water facilities of the company are held in common by

148. 252 P. 607 (Cal. 1926).

149. HUNDLEY, supra note 112, at 240-41.

150. 1887 Cal. Stats., ch. 34.

151. *Id.* at 108-09.

152. In reaction to the *Lux v. Haggin* ruling, prior appropriation rights holders formed an anti-riparian league and, in order to remedy their disadvantage against riparian farmers, lobbied for the right to use public funding to fund irrigation projects. HUNDLEY, supra note 112, at 97-98.

153. *Id.* at 237.

154. VRANESH, *supra* note 124, at 282-95.

the shareholders.[155] Colorado also enacted legislation that allowed for the formation of irrigation districts, but the water districts did not have the power to levy taxes.[156] The irrigation districts' main source of revenue for the construction of water projects was through the issuance of bonds.[157]

In the hope of securing funds from the Work Projects Administration (WPA) to build irrigation projects, the Colorado Legislature passed the Water Conservation District Law in 1935. The Law granted a group of irrigators the right to act as a public body and to contract with the WPA. The Law empowered districts to borrow money, pledge revenues as security, accept bids for construction contracts, and collect rents for water service. However, it did not grant them the power to "levy or collect taxes for the purpose of paying, in whole or in part, any indebtedness or obligation...incurred by the district."[158] As will be discussed below, this omission proved to be crucial in determining the governance structure of the C-BT.

B. The CVP's Origins: The State Water Plan

The CVP began as a state project. In 1919 Robert Marshall published an ambitious plan that would have delivered water supplies to the San Francisco Bay Area and Los Angeles, as well as to the Central Valley.[159] Writing about the potential for irrigation in California, Marshall said,

> There are approximately 12,000,000 acres of level land in the Sacramento, San Joaquin, Santa Clara, Livermore, and Concord Valleys, and more than enough water annually passes through the Sacramento and San Joaquin Rivers into the sea unused, lost forever, to put water three feet deep on each of these 12,000,000 acres.[160]

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155. *Id.*

156. Irrigation District Law of 1905, COLO. REV. STAT. ANN. §§ 37-41-101 to 37-41-160 (West 1990 & Supp. 2000); Irrigation District Law of 1921, COLO. REV. STAT. ANN. §§ 37-42-101 to 37-42-141 (West 1990 & Supp. 2000).

157. VRANESH, *supra* note 124, at 298.

158. 1935 Colo. Sess. Laws ch. 145, § 8.

159. At the time, Marshall was the Chief Geographer of the U.S. Geological Survey, but he acted in a private capacity.

160. Robert Bradford Marshall, Irrigation of Twelve Million Acres in the Valley of California 7 (Mar. 16, 1919) (unpublished manuscript, on file with The Bancroft Library, U.C. Berkeley).

Marshall's plan failed to gain approval in the state legislature in 1919 and 1921. Three modified versions went on the ballot as initiatives and were rejected by the voters in 1922, 1924, and 1926.[161]

The State Engineer, Edward Hyatt, introduced a scaled-back State Water Plan to the legislature in 1931.[162] In addition to delivering water from the Sacramento Valley south to the San Joaquin Valley, the plan called for an aqueduct from the Colorado River to deliver water to southern California.[163] Southern California had already begun efforts to secure Colorado River water on its own, however, and believed that involvement with the state would complicate its efforts. Therefore, it asked not to be included in the state project.[164] With the omission of southern California, the state project became almost exclusively a Central Valley project with the goal of supplying water for irrigated agriculture.[165] During the 1930s, it was hard to justify projects that would bring more land into production. Thus, the project sponsors promised that the "immediate initial" project would not appreciably increase the area of agricultural lands in California.[166]

The Central Valley Project Act was passed in the California State Legislature in 1933.[167] Pacific Gas & Electric and other private power interests attempted to block the project, but the voters reaffirmed it in a referendum election later that year. The Act authorized the state water authority to issue revenue bonds in a total sum not to exceed $170,000,000 to finance the construction of the CVP.[168] While project sponsors intended for the CVP to be a state project, the Act authorized the Authority to "accept cooperation" from the federal government in the construction, maintenance, and operation of the project.[169]

Given the bleak state of the economy in 1933, California never attempted to issue the bonds to finance construction of the project. The idea of the CVP as a state undertaking backed by federal financial assistance was surrendered to federal construction of the project. The California congressional delegation painted a picture of desperation to convince the

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161. HUNDLEY, *supra* note 112, at 239.

162. CAL. DEP'T OF PUB. WORKS, DIV. OF WATER RES., BULLETIN NO. 25, REPORT TO LEGISLATURE OF 1931 ON STATE WATER PLAN 33-57 (1930). Hyatt's plan was referred to as the "State Water Plan," but it should not be confused with the State Water Project that was built in the 1960s.

163. *Id.*

164. HUNDLEY, *supra* note 112, at 243.

165. *Id.*

166. See generally MARY MONTGOMERY & MARION CLAWSON, HISTORY OF LEGISLATION AND POLICY FORMATION OF THE CENTRAL VALLEY PROJECT (1946).

167. HUNDLEY, supra note 112, at 248.

168. *Id.*

169. MONTGOMERY & CLAWSON, *supra* note 166, at 81.

federal government to take over the project.[170] It claimed the CVP would provide supplemental water to farmers, who after making large investments in equipment and land improvements, were being driven from their farms due to a decline in groundwater that they could not have foreseen.[171] If the federal government did not provide help, they warned that San Joaquin Valley farmers would be added to the long list of Americans already on the unemployment rolls.[172] In testimony to Congress, State Engineer Hyatt argued that the CVP was not a new-lands project but rather a relief project targeted at areas already under agricultural production in the Central Valley. Without the project he claimed that 50,000 Californias would lose their livelihoods and be forced off the land.[173]

President Roosevelt authorized initial funding of $20 million for the CVP through the Emergency Relief Appropriation Act of 1935.[174] The CVP was not authorized as a federal reclamation project, but the Act clearly stated that the money was to be reimbursable under the Reclamation Act of 1902.[175] The terms of reimbursement under the Reclamation Act included an interest-free loan, a forty-year repayment period, and compliance with the excess lands provision limiting farm size to 160 acres.[176] Because the initial funding for the CVP came through an executive order,[177] the details of the project were not subject to lengthy congressional debate. The CVP's promoters emphasized the benefits and feasibility of the project and downplayed the costs.[178] The federal government accepted the state's cost estimate of $170 million and adopted the state's engineering plans.[179] Congress reauthorized the project in the Rivers and Harbors Act of 1937,[180] again stating that the CVP would be subject to the repayment guidelines of the Reclamation Act.[181] According to the Act, the CVP's top priorities were improvements of flood control and navigation, and saltwater abatement in

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170. HUNDLEY, *supra* note 112, at 251-52.

171. *Id.*

172. Lawrence B. Lee, *California Water Politics: Depression Genesis of the Central Valley Project, 1933-1944*, J. OF THE WEST, Oct. 1985, at 63, 65-66.

173. *Interior Department Appropriation Bill for 1938, Hearings before Subcomm. of Comm. on Appropriations*, 75th Cong. 1590-98 (1938).

174. The amount was later reduced to $4.2 million. The letter from President Roosevelt is reprinted in CLAIR ENGLE, CENTRAL VALLEY PROJECT DOCUMENTS PART ONE: AUTHORIZING DOCUMENTS, H.R. DOC. NO. 84-416, at 559 (1956).

175. *Id.* at 559.

176. *Id.* at 569-71. The statutory requirement for acreage limitation and the repayment terms are contained in 43 U.S.C. § 423e (1994).

177. MONTGOMERY & CLAWSON, *supra* note 166, at 81.

178. *Id.* at 75-76.

179. Letter from Secretary Harold L. Ickes to President Franklin Roosevelt (Nov. 29, 1935), *reprinted in* MONTGOMERY & CLAWSON, *supra* note 166, at 249 app.D.

180. Pub. L. No. 75-392, 50 Stat. 844, 850 (1937).

181. *Id.*

the delta.[182] The goal of supplying water for irrigation and domestic use was next in importance, and power generation was last.[183]

C. The C-BT's Origins: The Grand Lake Plan

Unlike the CVP, the C-BT did not begin as a state project. The idea for a trans-mountain diversion project to transfer water from the headwaters of the Colorado River to the eastern slope of the Rockies dates back to the 1880s. The original project was known as the Grand Lake Plan.[184] However, while the idea originated at the state level, Colorado water managers realized from an early stage that a trans-mountain diversion would require federal aid.[185] Furthermore, Coloradans felt that they deserved a piece of the federal reclamation pie. Other states were using federal money to appropriate water from rivers whose headwaters were in Colorado and which Coloradans felt was rightly theirs.[186]

Colorado had been competing with Wyoming and Nebraska for the rights to the North Platte River and with the lower basin states for the rights to the Colorado River. In 1933 the WPA decided to fund the Casper-Alcova Project, which would enable Wyoming to store North Platte water upstream from Casper and develop 60,000 to 80,000 acres of land for irrigated agriculture.[187] Colorado's defeat in the battle for the Platte River rights, combined with the lingering fight over Colorado River water and four years of below average rainfall, created a panic among Colorado water managers.[188] If Colorado did not act quickly to secure its water supplies, they believed the other western states would appropriate the flows necessary for Colorado's future development. They were especially fearful of California, with its rapidly growing population and strong representation in Congress.

Northern Colorado water managers established the Northern Colorado Water Users Association (NCWUA) in 1934 to promote the idea of a trans-mountain diversion project and convince the federal government to build it.[189] The Association represented 80 irrigation ditch companies in seven counties.[190] The project faced strong opposition from landowners on

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182. *Id.*
183. *Id.*
184. The name was changed to the Colorado-Big Thompson Project in July 1936. TYLER, *supra* note 89, at 55.
185. Norcross, *supra* note 14, at 30.
186. *Id.*
187. *Id.* at 29.
188. *Id.*
189. Tyler, *supra* note 89, at 46.
190. *Id.*

the western slope of the Rocky Mountains (the basin of origin). Representatives from the western slope, most notably Congressman Edward Taylor, argued that the project must provide an acre-foot of water to the western slope for every acre-foot provided to the eastern slope as well as additional storage capacity for western slope users.[191] The National Park Service also opposed the project because it called for a tunnel to be built through a section of Rocky Mountain National Park.[192] Further, senior appropriators and successful ditch companies on the eastern slope opposed the plan because they did not want new acreage to come into production when agricultural prices were already depressed.[193] The project promoters promised that the C-BT would provide supplemental water for future urban growth and agricultural land already under production.[194]

Colorado's initial application for funding from the Bureau for the C-BT was denied in 1936.[195] In order to secure federal funding, the NCWUA needed to overcome opposition to the project and convince Congress that the C-BT would not pit the western half of the state against the eastern half. In addition, the NCWUA needed to convince the federal government that the project was feasible and that northern Colorado was capable of repaying the federal government for its construction.

D. Origins of the Water District Structure

The somewhat ad hoc system of contracting in the CVP is a function of the battle between the state and federal governments for control of the project and the relative lack of attention paid to the project's repayment. The Bureau did not submit repayment contracts for signature in the years immediately following its takeover of the CVP. It required contracts with the water users before water would be delivered, but not before construction could begin.[196] During the early construction period, it was not clear if the water users would contract with the California Water Project Authority or with the Bureau.

When the federal government took over the CVP in 1935, California possessed an information advantage. It had already invested close to a million dollars in surveys, engineering studies, and data collection for

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191. *Colorado Irrigation Men Bury Ax to Get U.S. Cash*, ROCKY MOUNTAIN NEWS, Sept. 28, 1933; Congressional Record, 75th Congress, 3rd Session, 1938, Appendix at 83.

192. TYLER, *supra* note 89, at 48-49.

193. *Id.* at 54.

194. *See generally* J.M. DILLE, COLORADO-BIG THOMPSON AND NORTHERN COLORADO CONSERVANCY DISTRICT (1941).

195. TYLER, *supra* note 89, at 55-57.

196. Lee, *supra* note 172, at 68.

construction of the project.[197] It had also conducted preliminary negotiations for rights-of-way and water contracts with farmers in the Valley.[198] Consequently, the federal government had an incentive to form a cooperative relationship with the state. In the proposed governance structure, the Water Project Authority (the Authority) was to play a joint role with the Bureau in negotiating water contracts and administering the project.[199] The cooperative nature of the relationship is illustrated in the House appropriations bills from 1937 through 1940. Each year the bill read as follows:

> The Water Project Authority of the State of California, created by an act of the legislature, is cooperating with the Bureau of Reclamation in the construction of the Central Valley Project. Under the terms of a contract dated March 25, 1936, the Authority will negotiate contracts, subject to approval of the Secretary of the Interior, for necessary rights-of-way and acquisition of water rights. Contracts for repayment of construction costs will be made under the Reclamation law either with the Authority or with the several irrigation districts before water is supplied for irrigation. A part of the construction costs will be repaid from the sale of surplus electrical energy developed at the Sacramento power plants.[200]

In 1939 the governor of California, Culbert Olson, tried to initiate legislation to enable the Authority to play a more direct role in the administration of the project. In a letter to the Secretary of the Interior, Harold Ickes, Olson proposed that the Authority enter into a contract with the United States under which the Authority would operate and maintain the project upon completion, repay the reimbursable costs of the project to the United States by revenues from the sale of water and electric power, and direct and assist in the organization of public districts to contract with the

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197. MONTGOMERY & CLAWSON, *supra* note 166, at 146-64.

198. *Id.*

199. CLAIR ENGLE, CENTRAL VALLEY PROJECT DOCUMENTS PART ONE: AUTHORIZING DOCUMENTS, H.R. DOC. NO. 84-416, at 433 (1956).

200. *Interior Department Appropriation Bill for 1937: Hearing before the Subcomm. of the House Comm. on Appropriations*, 74th Cong. 72 (1937); *Interior Department Appropriation Bill for 1938: Hearing before the Subcomm. of the House Comm. on Appropriations*, 75th Cong. 281 (1938); *Interior Department Appropriation Bill for 1939: Hearing before the Subcomm. of the House Comm. on Appropriations*, 75th Cong. 348 (1939); *Interior Department Appropriation Bill for 1940: Hearing before the Subcomm. of the House Comm. on Appropriations*, 76th Cong. 421 (1940); *Interior Department Appropriation Bill for 1941: Hearing before the Subcomm. of the House Comm. on Appropriations*, 76th Cong. 493 (1941).

Authority for the purchase of water and power.[201] However, as the federal government's financial commitment to the project increased, it became less, not more, willing to share the responsibility of administering the project with the state. Secretary Ickes responded by stating, "The Central Valley Project is a federal undertaking to be administered in accordance with Reclamation Law."[202]

Reclamation law required that repayment contracts be made only with agencies that had the power directly to assess and to create liens on the property of water users.[203] While the Authority did not have this power, the local water districts did have this power under the Wright Act.[204] The shift toward greater federal control is evident in the 1941 House appropriations bill. It stated,

> The CVP is being constructed by the Bureau of Reclamation and repayments will be provided for under contracts with persons, firms, and corporations, to be hereafter made pursuant to the reclamation law and amendments, and from revenues derived from sale of surplus power to be generated at Shasta Dam.[205]

Unlike the earlier bills, there is no mention of a cooperative relationship with the State Water Authority.

The battle between the state and the federal governments for control of the project directed attention away from the task of contracting with the water users. The first water district contract was not signed until 1945,[206] twelve years after President Roosevelt authorized the initial funding for the project. The majority of the contracts were not signed until the early 1950s.[207] The chosen institutional structure, in which the Bureau created a separate contract for each individual water district, increased the costs of developing markets for CVP water. However, the Bureau was less concerned with the long-run adaptability of the system than with the immediate task of contracting with the water users.[208] The least-cost solution was to contract with the existing water districts. The contracts needed to provide the water users with assurance that their rights would be secure,

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201. MONTGOMERY & CLAWSON, *supra* note 166, at 95-96 (summarizing letter from Governor Olson to Secretary Ickes on Feb. 15, 1939).

202. *Id.* at 96 (quoting Letter from Secretary Ickes to Governor Olson on April 13, 1939).

203. 32 Stat. 388.

204. 1887 Cal. Stat., ch. 34.

205. *Interior Department Appropriation Bill for 1942: Hearing before the Subcomm. of the House Comm. on Appropriations*, 77th Cong. 738 (1942).

206. CLAIR ENGLE, CENTRAL VALLEY PROJECT DOCUMENTS PART TWO: OPERATING DOCUMENTS, H.R. DOC. NO. 85-246, at 79-82 (1957).

207. *Id.* at 82.

208. *Id.* at 79-240.

and they needed to provide the Bureau with a long-run stream of revenues from water sales. To achieve security in rights and in repayment, both sides had an incentive to establish rules restricting water transfers.

Contracts between the Bureau and the C-BT water users were not based on the existing institutional structure, as in California. Rather, a new water district, the NCWCD, was established to contract with the Bureau and the water users.[209] This outcome reflects the fact that the delegation of authority between the state and federal governments and the system of repayment were resolved before construction of the C-BT began. In sharp contrast to its relaxed treatment of the repayment contract in the CVP, the Bureau required that the NCWCD sign a repayment contract before construction could begin.[210] The Bureau's stricter treatment of the C-BT reflected a change in Bureau policy; however, it also stemmed from Colorado's weaker bargaining position.

The CVP promoters had held stronger cards when they obtained federal aid in 1933. First, they could point to the passage of the Central Valley Project Act in 1933 as evidence of statewide support for the CVP. The C-BT, in contrast, had not yet been put before Colorado voters. Second, California had already invested in detailed engineering studies that showed that the CVP was feasible, whereas Colorado was trying to obtain federal aid to conduct the initial surveys.[211] Third, under the Wright Act, California's irrigation districts had the power to levy taxes.[212] Thus, the Bureau could use the *existing* institutional structure to contract with water districts in California. Colorado did not have a law analogous to the Wright Act, and therefore it did not have water districts with the ability to contract directly with the Bureau.

The leaders of the NCWUA had both the opportunity and the need to create a new institutional structure to contract with the Bureau to build the C-BT. Under Colorado's existing institutional structure, each ditch company would have had to contract separately with the government.[213] The ditch company members would have had to mortgage their properties to the NCWUA, which in turn would have contracted with the Bureau for repayment of the project costs. Since the 1935 Water Conservation District Law denied the NCWUA the right to levy taxes,[214] repayment would have

209. TYLER, *supra* note 89, at 58-80.

210. *See* DILLE, *supra* note 105, at 28.

211. The directors of the NCWUA entered into active negotiations with the Bureau in September 1934. Secretary Ickes approved an allocation of $150,000 for a preliminary engineering investigation of the project on July 26, 1935. Norcross, *supra* note 14, at 29.

212. 1887 Cal. Stat., ch. 34.

213. TYLER, *supra* note 89, at 58.

214. 1935 Colo. Sess. Laws ch. 145, § 8.

had to be financed through water and hydroelectricity sales alone. Neither the Bureau nor the leaders of the NCWUA believed this was possible.[215]

Drawing from court-tested legislation in California and Utah, the lawyers for the NCWUA drew up plans that would enable Colorado to form conservancy districts with taxing powers.[216] In May 1937, the Colorado legislature passed the Water Conservancy District Act, which stated that water conservancy districts could be established with the power to tax and contract with the federal government.[217] Two months later the Northern Colorado Water Conservancy District (NCWCD) was established, and it effectively replaced the NCWUA.[218]

In some respects, the Bureau shifted the financial risk of construction to the NCWCD by requiring a repayment contract in advance. However, the arrangement was actually advantageous to the NCWCD because the contract established that the District's share of the total cost was not to exceed $25,000,000.[219] The actual cost was much higher.[220] The NCWCD leaders recognized the advantage of having a well-defined contract. A NCWCD report dated July 1, 1941 stated,

> One main advantage of this plan is that it permits the District to contract the sale, or allotment of the 310,000 acre-feet of water, at a definite predetermined cost, whereas under the usual Reclamation Bureau project, the final determination of costs to be repaid by the water users is not fixed until the project is completed and the construction cost is known.[221]

The existence of the repayment contract also provided the NCWCD with an incentive to begin contracting with the water users as soon as possible. The directors of the NCWCD were concerned that the Bureau would not sign the repayment contract unless they demonstrated that there was sufficient demand for the future C-BT water.[222] To demonstrate demand, the NCWCD began accepting petitions for allotments during the

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215. TYLER, *supra* note 89, at 58-59.

216. *Id.* at 58-59. *See* Metropolitan Water Districts Act, 1935 Utah Laws ch. 110; Act of June 13, 1929, 1929 Cal. Stat. 1613.

217. *The Water Conservancy District Act*, 1937 Colo. Sess. Laws ch. 266, § 15.

218. It was debated whether one conservancy district should exist for the whole state or whether there should be regional districts. Proponents of the regional district plan prevailed, because regional districts were perceived to be more politically palatable; however, conservancy districts had to contain both agricultural and urban landowners and satisfy minimum size requirements.

219. U.S. BUREAU OF RECLAMATION, SYNOPSIS OF REPORT ON COLORADO-BIG THOMPSON PROJECT, PLAN OF DEVELOPMENT AND COST ESTIMATE, S. Doc. No. 75-80 (1937).

220. DILLE, *supra* note 105, at 65-66.

221. DILLE, *supra* note 194, at 7.

222. DILLE, *supra* note 105, at 28.

summer of 1938.[223] The price of allotments was set at $1.50 per acre-foot per annum.[224] By 1957, 2,631 contracts, representing 64 percent of the project water, were signed between the NCWCD and individual landowners.[225] While it was possible for a ditch company to contract for an allotment of water, the NCWCD leaders reasoned that the benefits would be greater and the chance of repayment higher if water were allotted to individual landowners.[226] This preference for contracting with individuals facilitated the development of markets for C-BT water.[227]

E. Origins of the Excess Lands Provision

The way in which the Bureau handled the repayment contract in Colorado versus California impacted the treatment of the excess lands provision in each project. Because the NCWCD had to gain voter approval for the repayment contract in advance of construction,[228] the Colorado delegation in Congress was provided with strong incentive to lobby for exemption from the excess lands provision. It argued that the excess lands provision did not apply to the C-BT because of the supplemental nature of the proposed water project.[229] The C-BT received exemption in May 1938, just one month before the repayment contract was put before the voters.[230] Once large landowners learned that the C-BT would be exempt from the 160-acre limitation rule, they realized the project could benefit them.[231] If the C-BT had been subject to the excess lands provision, it is unlikely that the voters would have approved the repayment contract and ultimately the project might not have been built.

Since the CVP water users were not required to approve a repayment contract in advance of construction, the project's sponsors could downplay the fact that reclamation law required that the CVP would be subject to the excess lands provision. Their main objective in the short-run was to secure funding for construction of the project, and each year they had to lobby Congress for additional appropriations.[232] They may have

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223. DILLE, *supra* note 194, at 8.

224. *Id.* at 7.

225. The remaining 36 percent of the water was allocated as follows: 14 percent to municipalities, 2 percent to ditch companies, and 20 percent to corporations. *Id.* at 58.

226. *Id.* at 28.

227. *Id.* at 64.

228. TYLER, *supra* note 89, at 92-93.

229. At the same time, water users on the Truckee Project in Nevada were able to obtain exemption by arguing that a family farm in the high desert region needed to be larger than 160 acres to be viable. HUNDLEY, *supra* note 112, at 260.

230. 83 Cong. Rec., 6876, 7713, 8323 (1939).

231. TYLER, *supra* note 89, at 95.

232. *See generally* HUNDLEY, *supra* note 112, at 251-52; WORSTER, *supra* note 118, at 243-44.

gambled that they would be able to obtain exemption from the provision later on. Once the canals were completed, they may have believed the Bureau would be in a poor position to deny their use to landowners because repayment contracts were not signed.[233]

In 1943, once construction was well under way, the CVP's supporters in Congress began a campaign to repeal the excess lands provision.[234] They argued, as Colorado's delegation had, that the CVP would provide supplemental water to established farms that were suffering due to drought and depleted groundwater supplies.[235] However, they failed to convince Congress to repeal the provision. As will be discussed below, the C-BT supply really was more supplemental than the CVP supply. Furthermore, the CVP was a much larger project requiring more federal funding. Eastern representatives in Congress would only support such a massive project if they believed the CVP would open up new areas for small family farms rather than benefit California's large landowners.[236]

Having failed to obtain exemption for the excess lands provision, Californians believed they could avoid it by returning control of the project to the state. The following quote from the Central Valley Project Association in its July 1944 newsletter is representative of the sentiment in the Valley at the time:

> One thing is certain and that is a strong fight will be made against further federal encroachment upon the rights and properties of California citizens and that every effort will be made to effect a cooperative agreement whereby the control of the Project operation and management will revert to local authorities.[237]

In 1945, the state attempted a formal takeover. Secretary Ickes stated that the Department of the Interior was prepared to withdraw from the project if the state could prove itself capable of reimbursing the federal government for its expenditures to date and of financing the remaining construction.[238] The Bureau had already invested $157,180,000, and anticipated additional expenditures of $200,000,000 to complete the project.[239] Daunted by a price tag of over $357,000,000, the state abandoned its efforts to take over the project.[240]

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233. Lee, *supra* note 172, at 68.
234. WORSTER, *supra* note 118, at 252-53.
235. *Id.*
236. *Id.* at 254.
237. MONTGOMERY & CLAWSON, *supra* note 166, at 109.
238. *Id.* at 124-26 (quoting letter from Secretary Ickes to Governor Warren, March 7, 1945).
239. *Id.*
240. *Id.* at 127.

F. Origins of Priority versus Proportional Rights

The sponsors of the CVP and C-BT emphasized that the projects would provide supplemental water to land already under production.[241] However, while the water provided by the C-BT legitimately was supplemental, in many cases the CVP water provided a primary supply to its users. The choice of priority rationing in the CVP and proportional rationing in the C-BT was largely a function of this distinction between primary and supplementary supplies.

"Supplemental" supposedly meant that (1) the lands to be served already had an alternative (but inadequate) supply, and (2) no new lands would come into production. In reality, neither of the above conditions held in the CVP. First, some farms that were "already under production" had such pitiful water supplies that they could only operate in the wettest of years.[242] For these farms, the CVP provided a primary water supply. The CVP water also represented a primary supply for landowners that agreed to accept CVP water in lieu of their pre-existing water supplies. Of particular importance were the so-called "exchange contracts" established with Miller & Lux, Inc. and other riparian landowners on the San Joaquin River.[243] For the riparian rights holders to agree to the exchange contracts, they had to be convinced that their water supplies would be secure over time, in drought years as well as wet years. To achieve this, the exchange contractors were granted the highest priority, their water rights were tied to the land and transfers were restricted.

Second, the CVP ultimately did bring new lands into production. The push to expand the CVP was not surprising given the early history of the State Water Project in which Robert Marshall envisioned putting water three feet deep on "12,000,000 acres of level land."[244] During the 1940s, the emphasis of the project shifted back to the view that it should provide both supplemental water and water for land not yet under cultivation. The California congressional delegation argued that the project should be expanded to increase food production to aid the war effort.[245] When the CVP ultimately did deliver water to additional lands, new water districts (*e.g.*, Westlands Water District) were established to contract with the Bureau. The Bureau then granted these new water districts junior rights.[246]

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241. HUNDLEY, *supra* note 112, at 251.

242. CLAIR ENGLE, CENTRAL VALLEY PROJECT DOCUMENTS PART ONE: AUTHORIZING DOCUMENTS, H.R. DOC. NO. 84-416, at 101 (1956).

243. *Id.* at 554-555.

244. Marshall, *supra* note 160, at 7.

245. *See generally* HUNDLEY, *supra* note 112.

246. *Id.*

Unlike the CVP, the C-BT really did provide a supplemental water supply. When individuals and municipalities petitioned for C-BT allotments, they had to prove that they already had an alternative water source.[247] Because the water was supplemental, proportional rationing was feasible. Senior appropriators would not have agreed to a proportional system if they had been expected to substitute C-BT rights for their pre-existing rights as did some of the landowners in California. However, as a supplement to their existing rights, the proportional system was more acceptable. The NCWCD's negotiations with landowners were also simplified by the fact that they did not have to deal with riparian landowners, since Colorado water law was based on the prior appropriation doctrine.

The NCWCD leaders favored proportional rights because they wanted a flexible system of water allocation in which water rights were transferable. It is possible that the NCWCD leaders considered the long-run benefits of being able to transfer water from agricultural to urban areas as the state's population grew. Given their fear of losing water to the other western states (especially California, which had a much larger population and more political might), the NCWCD leaders wanted to secure water for *future* development. While urban areas in California had taken local action to secure water supplies for future growth, Colorado had a smaller urban population base and fewer resources to develop local projects.[248] It would have been logical for Colorado to seek federal aid to develop the water supplies necessary to enable future urban growth.

However, while they may have considered the long-run benefits of a transferable rights system, the NCWCD reports in the 1940s and 1950s do not mention these long-run benefits.[249] The NCWCD directors were primarily concerned with the short-run challenge of allocating the initial water supplies.[250] Due to the wide differences in initial water supplies throughout the District, and the lack of enthusiasm for the project among some landowners, they wanted a distribution plan that would be flexible and voluntary on the part of the users. As stated in a report by J.M Dille, Secretary-Manager of the District,

> The water supplies of the thousands of farms under the various irrigation systems varied widely dependent annually

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247. Most of the original water supply for the district came from mountain streams. Some farms also pumped groundwater. DILLE, *supra* note 194 at 2, 8.

248. By the time the CVP was approved, Los Angeles had already completed the Owens Valley Project, San Francisco had completed the Hetch Hetchy Project, and the East Bay cities had completed the Mokelumne River Project.

249. See generally DILLE, *supra* note 194; DILLE, *supra* note 105; Norcross, *supra* note 14.

250. DILLE, *supra* note 194, at 7.

> on the dates of decrees and the irregular supplies from the local streams and reservoirs. Ownership of water rights or ditch stock in proportion to acreage of farms was very uneven. Management of many systems was in control of the larger stockholders who rarely needed additional water and were opposed to acquiring a "block" of water for their company. Many leading irrigation men were doubtful of the feasibility of the Project. These and other considerations indicated a plan that would be flexible and voluntary and would allow individual farmers to acquire the water they needed.[251]

The District leaders sought a water allocation mechanism that would allow them to spread the benefits of the project as evenly as possible. Before accepting petitions for allotments, District staff collected data on existing water supplies in the region.[252] They only accepted petitions for allotments on land with a present "base" supply. Their policy was to distribute the water allotments so that the C-BT water together with the pre-existing supply would provide each farm with between two and two and one-half acre-feet per acre.[253]

At its 1956 meeting, the board of directors of the NCWCD adopted the rules and regulations for reallocating or transferring allotments.[254] Copies of the "Rules and Regulations" were distributed to the water users.[255] While the board of directors designed a system that would allow transfer of the water allotments, it most likely did not anticipate the volume of transfers that would occur in the future.

G. Origins of the C-BT Return Flow Rule

According to Colorado state law, return flows normally enter the public domain and cannot be recovered by the original appropriator.[256] Despite this state law, the NCWCD argued that ownership of C-BT return flows should be granted to the District instead of to downstream users.[257] The C-BT water was new to the eastern slope basin, and, therefore, the NCWCD did not have to contend with any pre-existing claims to the return

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251. DILLE, *supra* note 105, at 56-57.

252. DILLE, *supra* note 194, at 8.

253. *Id.*; DILLE, *supra* note 105, at 57.

254. DILLE, *supra* note 105, at 64.

255. *Id.* at 64.

256. *See, e.g.*, Enlarged Southside Irrigation Ditch Co. v. John's Flood Ditch Co., 183 P.2d 552 (Colo. 1947); Fort Collins Milling & Elevator Co. v. Larimer & Weld Irrigation Co., 156 P. 140 (Colo. 1914); Comstock v. Ramsay, 133 P. 1107 (Colo. 1913).

257. Article 19 of the Repayment Contract with the U.S. Bureau of Reclamation, *reprinted in*, DILLE, *supra* note 105, at 27.

flows. The NCWCD's primary motive for gaining control of the return flows was to protect the water against future federal interference. Secretary-Manager Dille stated,

> This important provision determines that the return flows shall become part of the streams, subject to state administration, and also forestalls any possible future interference by federal agencies in state control of the water supplies.[258]

While the NCWCD owned the rights, it allocated the return flows to the irrigable lands already being partly supplied at no extra charge. Some officials at the Bureau believed the District should collect revenue from the beneficiaries of these flows, but the District negotiators felt that would conflict with recognized state laws and be difficult to administer and enforce.[259] Thus, the secondary water users obtained the benefits of the return flows at no cost and upstream users were relieved from any liability associated with any water transfers.[260]

IV. INSTITUTIONAL CHANGE

This article highlights the importance of institutional path dependence. The institutional structures adopted in the early stages of the CVP and the C-BT were constrained by pre-existing property rights systems and organizational structures. The choices were motivated by the short-term goals of building consensus between diverse interest groups and obtaining financing for construction, but they have had long-term impacts. The institutions that govern water allocation in the C-BT enable market transactions to occur at a relatively low cost, and have enabled northern Colorado to adjust to short-run and long-run shifts in water supply and demand. The CVP's water allocation institutions have been relatively successful at establishing secure rights and mitigating third-party conflicts, but these achievements have come at the expense of system flexibility.

Why have the water allocation institutions not been altered to allow trading at a pace consistent with increases in scarcity? A principal reason is the web of irreversible investments made by water users that are conditional on current patterns of water allocation. Institutional reforms would reallocate water among competing uses within agriculture and between agriculture and urban areas. These geographic changes in water use patterns would cause numerous types of irreversible investments to

258. DILLE, *supra* note 105, at 27.
259. *Id.*
260. Howe et al., *Lessons*, *supra* note 3, at 185-86.

become unproductive, and force costly relocation of sectors of the agricultural industry. For example, surface water users with senior rights and a high degree of water supply reliability have made substantial investments in perennial crops and specialized vegetable crops. Current patterns of land allocation among crops affect the placement of crop-specific service industries such as equipment dealers, irrigation engineers, and pest management consultants. The agricultural labor force is specialized, and key workers have settled in areas where the crops they know best are grown. More important, though, is the network of processing and distribution facilities that have evolved based on current water use and cropping patterns.

If the CVP's water allocation institutions were to change to permit trading, what would the new system look like? Is the C-BT an appropriate model? As discussed in this article, there are some desirable aspects of the C-BT system, but the CVP is a more complex project, covering a much larger geographic area and delivering much more water to many more users. The existence of one water district, the NCWCD, and the proportional rationing system have facilitated trading within the C-BT. The transaction costs of water trading in the CVP could be reduced if some of the smaller water districts were consolidated to form larger regional districts. Currently the water districts range from very large districts such as Westlands Water District, which serves approximately 700 farmers, to very small districts that serve only a handful of farmers. While a merger of water districts might be feasible, a switch from priority to proportional rationing in the CVP would be a more radical change. The high adjustment costs and potential income transfers associated with such a dramatic shift in property rights make such a change unlikely.

The most important factor enabling the development of water markets in the C-BT may be its unique return flow rule. Critics of the C-BT system may argue, however, that the rules allow trades to occur in which the overall benefits do not outweigh the costs to third parties. Third party effects are the biggest impediment to water trading in the CVP. A return flow rule similar to the C-BT's is unlikely to be adopted in the CVP, but as more trades occur and third-party impacts are resolved, there will be precedent for future trades. Furthermore, as the potential gains from water trades increase, water districts will have an incentive to invest in more accurate water metering devices, and there will be increased pressure to clarify groundwater rights and to meter groundwater use. These developments will reduce the costs of measuring the third-party impacts associated with water trades.

The acreage limitation rule in the CVP has not served its original purpose, which was to promote small family farming. While the rule appears to be enforced, in practice many large landowners get around it by dividing 960-acre units among family members. As discussed, the acreage

limitation rule contributes to the insecurity of property rights, and it increases market transaction costs by forcing market participants to consider the location of a trade in addition to the quantity of water traded. The acreage limitation rule will not, however, disappear easily. Taxpayers understandably object to large landowners receiving federally subsidized water. From the landowners' perspective, the benefits of removing the law may be perceived as small relative to the potentially high costs of bringing the issue once again to the public's attention.

As described by North, institutions may evolve in response to endogenous forces (adaptive efficiency) or exogenous forces (allocative efficiency).[261] Institutional change may be gradual and incremental, or it may occur rapidly and be drastic in its form. The water allocation institutions in the CVP and the C-BT have been relatively impervious to change over time. However, two exogenous forces, growing urban water demand and stress on the environment (combined with greater public support for environmental protection), will continue to create pressure for institutional change that allows the scarce water resources in Colorado and California to be used more efficiently. When these external forces are combined with the unpredictable occurrence of drought, a crisis environment may make dramatic institutional change possible.

Historically, water shortages have been relieved through the construction of new water supply projects rather than through institutional changes that increase the efficiency with which existing supplies are used. However, due largely to environmental concerns, new water projects are politically less feasible than in the past. Without the ability to relieve scarcity through supply-side measures, institutional change is more likely. In California, for example, the extended drought from 1987 to 1991 led to the development of the State Water Bank and contributed to the passage of the Central Valley Project Improvement Act in 1992.[262] More recently, years of above-normal rainfall have dampened pressures for institutional reform in California.

Combined with the increasing scarcity of water, two other forces may stimulate the development of water markets. The first is the tide of deregulation that has swept other regulated industries in the United States, including the airline, telecommunications, trucking, and natural gas industries. Most recently, the electricity industry is undergoing radical restructuring. California was the first state in the United States to enact comprehensive electricity restructuring laws, and many other states have

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261. *See generally* DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE AND ECONOMIC PERFORMANCE 7-10 (1990). Douglass C. North, *Economic Performance Through Time*, 64 AM. ECON. REV. 359 (1994).

262. *See generally* Howitt, *supra* note 11, at 357-71.

followed California's lead.[263] Unlike the above industries, in which services were provided by privately owned regulated firms, the CVP, the C-BT, and most other major water project facilities in the United States are government owned and operated. Nonetheless, while differences exist, the success of deregulation in other industries is creating pressure to restructure the water sector as well.

The second force working to enable the development of water markets is the advancement in information technology. Computerized trading systems have the potential to increase the flow of market information and reduce the transaction costs associated with water trading. In addition, computer networks make possible more complex trades over long distances through improved management of water distribution systems. The first electronic water marketing system, *WaterLink*, was introduced in Westlands Water District in 1994.[264] *WaterLink*, designed by a team of researchers at the University of California through a Challenge Grant funded by the U.S. Bureau of Reclamation, gives farmers in Westlands the ability to obtain water market information and to buy or sell water using their home computers.[265] After a series of meetings with farmers and water district managers, the research team convinced Westlands to test the system.[266] Once Westlands growers and water district managers were exposed to the system, they realized its potential and lobbied for a more advanced trading system.[267] Thus, a process of endogenous change began to occur after the initial introduction of *WaterLink*. The prototype *WaterLink* system has since been expanded to include other water districts in the CVP, and its capabilities have been expanded.[268]

VII. CONCLUSIONS

This article provided a comparative analysis of the water markets in the CVP and the C-BT. The article examined why an active water market, including both rental and sales transactions, has developed in the C-BT, while a similar market, despite a similar degree of water scarcity, has failed

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263. *See generally* Paul L. Joskow, *Restructuring, Competition and Regulatory Reform in the U.S. Electricity Sector*, J. ECON. PERSP., Summer 1997, at 119; PETER FOX-PENNER, ELECTRIC UTILITY RESTRUCTURING: A GUIDE TO THE COMPETITIVE ERA (1998).

264. Janis Olmstead et al., *Water Marketing in the '90s: Entering the Electronic Age*, CHOICES, Third Quarter 1997, at 15, 16.

265. *Id.* at 15.

266. *Id.* at 18.

267. *Id.* at 17.

268. On more recent versions of the *WaterLink* system, see generally Sunding, *supra* note 9.

to develop in the CVP. The analysis showed that four key institutional features—the water district structures, the rationing mechanism, the return flow rules, and the acreage limitation rule—cause the transaction costs of water transfers to be significantly higher in the CVP than in the C-BT.

This research revealed that the two projects adopted different institutional structures from the beginning and the institutions have been relatively impervious to change over time. Thus, the markets today are largely a result of institutional path dependence. The institutions that were adopted were a function of the pre-existing systems of water rights in each state and reflected the short-term objectives of obtaining political support and federal financing for the projects. The founders of each project were concerned with the initial allocation of water rights and with creating security of tenure. They did not appear to be concerned with the ability of the water projects to adapt to long-run changes in water demand through water markets.

The institutions have changed little over time in response to increasing water scarcity. Stress on the systems has been relieved through new water supply projects rather than through institutional change. As new water supply projects are now prohibitively expensive, at least in the near term, we should expect to see investments in institutional change that facilitate water trading and increase the efficiency with which existing supplies are used. Institutional change, when it does occur, is likely to be drastic as opposed to gradual. Given the high costs of achieving consensus among heterogeneous users and affected parties, the trigger event for change may be a crisis event such as drought or a threat to endangered species that increases the cost of maintaining the status quo to the point where the benefits of change outweigh the costs.