California Water Transfers: Gainers and Losers in Two Northern Counties

Proceedings of a Conference Sponsored by Agricultural Issues Center Water Resources Center

University of California
CALIFORNIA WATER TRANSFERS: GAINERS AND LOSERS IN TWO NORTHERN COUNTIES

Raymond H. Coppock and Marcia Kreith, Editors

Proceedings of a conference sponsored by
University of California
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Water Resources Center
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ABOUT THIS REPORT

This document results from a conference held November 4, 1992, in Sacramento, during which speakers described and commented on preliminary results of an 18-month University of California research project. The topic was crucial to water policy and water resource management in California: Impacts of water transfers on those counties where the transfers originate.

More than 200 persons attended the conference, including elected officials, water managers, local and state government workers, representatives of agricultural and environmental interests, academics and many others. The program is on page 72.

This is an intensively edited account of the conference, not a complete and chronologic record. Comments from various speakers on a single topic have been grouped together. Information presented by UC researchers and other principal speakers is in the main text; comments by panelists are inside boxes.

A more detailed and technical report on this UC research project, including final analyses of data, will be published by the Agricultural Issues Center at a later date.
STUDY SPONSORS

University of California Agricultural Issues Center

The UC Agricultural Issues Center serves to focus cross-disciplinary collaborative research on a "mega-issue" involving California agriculture. In addition, it identifies issues central to maintaining a competitive edge for California agricultural industries. Increasingly, the issues confronting agriculture coincide with those facing society—intensified competition for natural resources, internationalized markets, societal and environmental impacts from technologies, and outmoded policies and regulations. Thus, recent Agricultural Issues Center studies have focused on people and resource pressures in the Central Valley, chemicals in the food chain, and the North American Free Trade Agreement. The Center acts as catalyst for University of California collaboration with diverse interests.

University of California Water Resources Center

The UC Water Resources Center is a multi-campus research unit charged with stimulating and coordinating water research on all nine campuses of the University. Founded by legislative mandate in 1957, the Center's mission has expanded from an early focus on the State Water Project to one that encompasses virtually all water and water-related issues in the state. Designated as California Water Resources Research Institute under the federal Water Resources Research Act of 1964 (as amended), the Center coordinates and administers federally supported water research that extends to all state and private universities in California. In addition to its sponsored research, the Center publishes technical and non-technical research reports, maintains a water resources archival library and sponsors conferences on timely issues on water resources for researchers and the general public.
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WHO'S WHO IN THIS REPORT

The names listed here are those of speakers and panelists whose contributions during the conference are reported in these proceedings. For detailed biographical information on all conference speakers, including panel moderators and others who took part but are not quoted here, see pages 74-78.

Paul M. Bartkiewicz, water rights attorney, Sacramento.

Richard A. Berk, professor in the Department of Sociology and Program in Social Statistics at UC, Los Angeles, and director of the Center for the Study of the Environment and Society.

Suzanne Butterfield, special assistant to the manager of the Solano Irrigation District.

Harold O. Carter, director of the UC Agricultural Issues Center.

David R. Dawdy, international consultant in the fields of hydrology, hydraulics and sediment transport.

James F. Eagan, general manager of the Yolo County Flood Control and Water Conservation District.

Kenneth R. Farrell, UC vice-president, Division of Agriculture and Natural Resources

Eyvind M. (Marc) Faye, Jr., farmer, Knights Landing.
Brian E. Gray, legal specialist in environmental quality and water resources law, and professor of law at UC Hastings College of the Law.

Richard E. Howitt, professor of agricultural economics, UC, Davis.

David N. Kennedy, director of the California Department of Water Resources.

Betsy A. Marchand, Yolo County supervisor.

Edward A. McBean, professor of water resources, UC, Davis.

David B. Okita, general manager, Solano County Water Agency.

Glenn Olson, Western regional vice-president for the National Audubon Society.

Norman J. Repanich, president of Solano Economic Development Corporation (SEDCORP).

Elaine Rominger, mayor, City of Woodland.

Joseph L. Sax, specialist in resource and environmental law and professor at Boalt Hall School of Law, UC, Berkeley, and conference keynote speaker.

Henry J. Vaux, Jr., UC associate vice president, Division of Agriculture and Natural Resources, and director, UC Water Resources Center.
Introduction

The UC Research Project

Ken Farrell:

Today, we remain in the grip of one of the worst droughts in California’s recorded history. Simultaneously, we face major issues related to both the availability and the quality of our long-term water supply. Yet, the organizers of this research project elected to focus on the impacts of water transfers that took place nearly two years ago in a pair of medium-sized, semi-rural counties in California.

There is a reason: Timely, relevant and objective information about the impacts of those particular water transfers could be crucially important in developing solutions to the current impasse surrounding water allocation in California.

The State Drought Water Bank of 1991 pioneered a new era in California water management. More than 800,000 acre-feet of water were purchased by the bank and made available for higher-valued uses for which there were no other sources of supply. In general, the water bank has been considered a success; but so far there has been little empirical evidence on the effects, either positive or negative, of the water transfers on the counties of origin.

The Agricultural Issues Center and the Water Resources Center—two statewide research centers within the University’s Division of Agriculture and Natural Resources—identified this as an important opportunity to contribute to the water policy debate. The two centers organized a study project to examine analytically both the direct and the third-party impacts of the transfers on Solano and Yolo Counties.

The UC study teams focused on three important aspects of water transfers as they impacted Northern California during 1991—physical and biological effects; economic and social effects; and water institutions, laws and rights. Our researchers elected to concentrate on a geographical area of manageable size so that specific information about a substantial percentage of real people within real communities could be recorded and analyzed, within reasonable time and budget constraints.

The California Department of Water Resources provided partial financial support and, together with a number of agencies including the US Fish and Wildlife Service and the
State Department of Fish and Game, provided technical information.

Hal Carter:

The study findings are of two general types. First, there are the relatively solid facts about direct and secondary impacts of the water transfers. Some of this was gathered from pre-existing data outside the University. Our researchers also collected entirely new data for this study, and their modeling has produced some interesting results. Much of this information has been entered into a Geographic Information System.

Second, there are the results of scientific opinion surveys. We used this technique to analyze perceptions, opinions and attitudes of several important interest groups—the farmers themselves, allied industries and community decision-makers. One central goal in this opinion survey research was to focus on some of the general uneasiness about water transfers that existed in Yolo and Solano Counties at the end of 1991. What exactly were the key concerns, who held them and how firm were those opinions?

We worked with the Survey Research Center of the Institute for Social Science Research at UCLA. Telephone interviews were conducted by the UCLA Center, and in-person interviews by the AIC staff at Davis. These confidential interviews were both intensive and detailed; each one lasted at least half an hour and often an hour or more.

We talked by telephone to 188 farmers, each of whom farmed 200 acres or more of field crops in Yolo or Solano counties during 1991. About half of them actually sold water during the year; the other half were located so that they could have sold water, but did not. We also interviewed by telephone 108 representatives of associated businesses, including agricultural input industries, processors, trucking firms and even duck hunting clubs.

We talked in person to 58 community decision-makers, including county supervisors, city councilpersons, city managers and public works officials.
directors, water district and reclamation district officials, leaders of farm groups, and representatives of social service and environmental organizations.

Ken Farrell:

We recognize that analyses of real-world events such as the historic water transfers of 1991 inevitably will be complicated by real-world conditions. For that reason, a fundamental requirement of this research project was an attempt to separate the effects of water transfers from the effects of other forces—for example, the drought, the economic recession and even the falling of land under federal farmland set-aside programs. These forces co-existed with the water bank, and we have made every effort to distinguish their impacts from those of the bank.

It is also important to recognize that all of the impacts of water transfers may not be measurable, or even identifiable, at this time because of differing lag times, cumulative effects or other reasons. Thus, this study has dealt with many, but clearly not all, of the effects of water transfers.

Nevertheless, this study is, to my knowledge, the first attempt to develop detailed and comprehensive empirical information on the third-party impacts of water transfers. Thus, the findings include information about the impacts on a broad range of people from different walks of life who did not participate directly in the water bank, but may have been affected by it.

The objective of this project is to provide useful information to those who need it and can put it to work. We will, of course, provide information to decision-makers in Yolo and Solano Counties. But we also believe that the results have relevance, with appropriate adjustments and qualifications, for similar water-exporting areas in Northern California and probably throughout the rest of the state. We hope that legislators and others involved in the debate over water policy in California will find this information helpful in formulating a statewide strategy for managing this state's irreplaceable water resources.
The Water Crisis, The Water Bank
And the Two Counties

The 1991 Drought Water Bank

At the beginning of 1991, the outlook for water supply in California was bleak. Reservoir storage was the lowest since the disastrous drought of 1977. In February, the State Water Project estimated that only 10 percent of its water requests from urban areas could be met, and none from agriculture. The federal Central Valley Project announced plans for water delivery reductions of up to 75 percent.

At mid-February, the Governor set up an Emergency Drought Water Bank, to be operated by the Department of Water Resources. The Department hastily developed procedures to buy water from Northern California sources—farmers, mostly—and to sell it for municipal, industrial and agricultural uses farther south.

There were many potential sellers of water; in fact, more than 300 contracts eventu-
ally were arranged. Still, for a while, it appeared that there might not be enough water in the Bank to supply all the emergency needs in the southern part of the state—but then March storms eased the short-term drought conditions and reduced demand somewhat.

Ultimately, the Drought Water Bank purchased just over 820,000 acre-feet of water during 1991. Delta water quality requirements and technical corrections reduced this to 655,000 acre-feet. The bulk of that water was re-sold and transferred south; about 265,000 acre-feet remained in storage at the end of the year as State Water Project carryover into 1992. The largest single purchaser was the Metropolitan Water District of Southern California, which took 215,000 acre-feet—about one-third of the net total.

Fallowing and Groundwater Contracts

The Drought Water Bank had several kinds of water purchase arrangements. The most common was a “fallowing” contract. In this case, a farmer sold to the water bank the irrigation supply that would otherwise have been applied to a crop—and then either did not plant a crop or did not further irrigate an already planted crop.

With a falling contract, how much water could a grower sell from each acre that he chose to fallow? The answer depended on the water requirement of the crop that previously occupied the land:

- For high water-using crops such as alfalfa, pasture and rice, the amount that a farmer saved by fallowing and therefore could sell to the water bank was set at three and a half acre-feet per acre.

- For medium water using crops such as tomatoes and corn, it was two and a half acre-feet per acre.

- And for irrigated crops that use the least water—beans, for example—it was only two.

Smaller values were used in the Delta, with its special irrigation conditions.
A second type of Drought Water Bank purchase arrangement was a "groundwater exchange contract." In this case, the landowner, in effect, sold his surface supply and pumped groundwater for irrigation.

A third type of Drought Water Bank contract was for water from a reservoir or some other type of storage.

Figure 1 shows the proportions of water from the three different types of contract. Just over half of the water was from fallowing contracts.
Beyond 1991: 
Some Thoughts on Water Transfers

David Kennedy:

Water transfers are here to stay. They are going to get bigger in the future. It's now a question of how we are going to transfer water in a way that meets the needs of those who acquire it and the needs of the communities that will be losing it. This research project will be helpful, but we still have much debate and discussion ahead of us.

Urban people generally have not given enough thought to the way that farming communities view water transfers. It's not just a question of dollars and cents and everybody's happy. There are values here that go beyond what we can deal with just by writing checks.

In Governor Wilson's water policy statement in April, he said that he would support legislation that furthered water transfers if it met five criteria:

• The transfers must be voluntary.

• They must protect fish and wildlife.

• They must protect the groundwater basins—something very important, I know, in the communities that were the subject of this research.

• They must ensure the efficient use of water in the areas that receive the water. Basically, a community cannot continue to have inefficient use and still go out and buy water from agriculture. We're all in this thing together.

• Last, and certainly not the least controversial, transfers must protect the water contract holders and water right holders that have the water today. And they must protect third parties.

Now, we have a new player in this drama. Last Friday, the President signed HR 429, which is the Central Valley Project Improvement Act. (Some people would question that title.) One of the sections of the bill deals with water transfers from CVP users to outside users. During the next few years, the provisions that allow individual farmers to basically convert their existing water use into a water right, and then market it, will be a challenge for us to work out. The bill puts many conditions on any transfer out of the CVP. Some of these provisions, too, look as if they will be difficult to work our way through.
What’s DWR’s role in all of this? We organized the water bank in 1991 and 1992. We have an Environmental Impact Report underway for water banks in 1993 and future years. Interestingly, in spite of all the interest in water transfers, the public hearings on the EIR have been very lightly attended.

We at DWR have an open mind about our role in this question of future water banks. We have no problem if those who want to transfer water directly approach willing sellers and try to work something out. We’re certainly not trying to corner the market. I think that, over all, there will be many different kinds of water transfers. There’s probably a place for a DWR Drought Water Bank in drought years.

Role of the Delivery System

There is, however, an aspect that has not been discussed very much—which is that most water transfers to urban areas are going through the delivery system owned by the state. Very few water transfers to the Bay Area or to Southern California do not go through our system.

Our role is like an escrow company or a paying agent. Suppose the City of San Jose makes a deal with somebody in the Sacramento Valley to buy water, and the state is not involved in the financial transaction. The city cannot get the water directly from the farmer, so we will deliver water to the Santa Clara County area out of our South Bay Aqueduct.

Here’s the part that’s important. We will deliver real water to the city, and presumably real money changes hands in the transaction. But is real water coming into the state system to make up the difference? So far, we’ve found a few proposals that we are not going to sign off on, because we don’t think that they put new, real water into the system.

It’s important to keep in mind that most water transfers are done by exchange. That is, the water that we deliver out of our system to some urban community is not the water that the farmer didn’t use. That water, hopefully, is in some reservoir somewhere, where somebody’s got some control over it.

Our system was paid for by a lot of water users. The water that’s in it is paid for by a lot of water users. Every bit of it is accounted for, down to the last acre foot and the last dollar. So DWR is not going to act as a paying agent to somebody and hand out water unless we know exactly what all aspects of the exchange are. In effect, we’re the title company.

Need for Cooperation

The concept of antagonistic transfers, that is, transfers over the objections of districts, is something we should get into only if we truly have to. This issue has been oversimplified in the legislative process, holding up the district as the bogeyman preventing water transfers. In fact, we are dealing with the need to recognize all interests that are involved—
the local groundwater, the local water supply, the third-party impacts. In the long run, most water transfers must be on a cooperative, truly voluntary basis. If we pursue the idea that somehow urban areas can just run roughshod over those who presently hold the rights, we're going to spend much more time in court than we really need.

We should get all of these issues on the table and deal with them as fairly as we can. If we do that, I think we can make water transfers a very practical part of our future water supply.
The Two Counties

(This information also is presented in a 10-minute video, "Lay of the Land," which is available from the Center.)

Yolo and Solano Counties supplied about one-fourth of the water purchased by California’s Emergency Drought Water Bank during 1991—196,252 acre-feet. Of this, 154,323 came from Yolo County. The fact that Yolo and Solano Counties both occupy portions of the Sacramento-San Joaquin Delta is significant, because the Delta was a major source of supply for the water bank.

Besides the state purchases, additional water transfers resulted from a special program in Solano County. Prompted by the announced cutbacks in State Water Project deliveries, several nearby cities negotiated with the Solano County Water Agency to buy water from Solano Irrigation District farmers and transfer it to urban uses. The Solano County Emergency Water Pool purchased a little over 15,000 acre-feet. Farmers who sold to the Solano Pool were required to fallow their land and not pump groundwater in exchange.

Figure 2 shows the total amounts of water sold in 1991 in Yolo and Solano Counties. The two-county total was 211,309 acre-feet.

Both fallowing and groundwater contracts were used. Figure 3 shows that all the groundwater contracts were in Yolo County. In total, Yolo County transferred about three times as much water as Solano County.

Areas in the two counties from which water was transferred during 1991 are shown in Figure 4. It was concentrated in the Delta region, farther north in Yolo County adjacent to the Sacramento River, and in central Solano County where the Solano Pool operated.
A significant question is how much land was fallowed in the two counties during 1991 as a result of water transfers. After accounting for government set-aside programs, the fallowed acreages due solely to water transfers are estimated at 45,700 in Yolo County and 23,600 in Solano County.

Population and Resources

Solano and Yolo might be described as basically agricultural counties under pressure from urbanization, with growth pressures particularly intense in Solano County because it is closer to the San Francisco Bay Area.

Both counties have more than doubled in population during the past 30 years but, as Figure 5 shows, Yolo County’s population today is about the same as Solano County’s 30 years ago.

The two counties are similar in size, but Yolo County has much more irrigated and non-irrigated farmland, as shown in Figure 6. Solano County has a larger proportion of grazing and native vegetation land, and also includes substantially more urbanized land.

In determining impacts of water transfers, it’s important to consider the amount of water supply within the two counties in “normal” (non-drought) years. An average yearly figure for Yolo County is estimated at about one million acre-feet, for Solano County, about 650 thousand. This supply comes from both groundwater and from surface sources, but most of it is surface water—75 percent in Solano County and 60 percent in Yolo County. In both counties, agriculture uses most of the delivered water. In Solano County, municipal and industrial uses account for about 12 percent; in Yolo County less than 4 percent—and this is almost entirely groundwater.
The Water Supply Network

Major surface supply sources for the two counties are shown in Figure 7. The Sacramento River supplies water through direct river pumping and also through the Tehama-Colusa Canal and through the Colusa Basin Drain which is used as a water source.

Cache Creek, supplied by Clear Lake and Indian Valley Reservoir, is distributed through the Yolo County Flood Control and Water Conservation District system.

The Putah South Canal from Lake Berryessa supplies the Solano Irrigation District system for agricultural as well as urban and industrial uses in Solano County.

The North Bay Aqueduct, part of the State Water Project, supplies the cities of Vacaville, Fairfield, Benecia and Vallejo. Municipal and industrial uses in Solano County also are supplied from local reservoirs (Lake Herman, Lake Fry, Lake Madigan.)

In addition, groundwater is a crucial source of water supply for much of the area. Figure 8 shows the areas of alluvial plains and fans within Yolo and Solano Counties where the most productive aquifers are located. The cities of Woodland, Winters and Davis depend totally on groundwater.
Environmental Effects

Ed McBean:

Estimating the environmental implications in Yolo and Solano Counties of water bank transfers is a considerable challenge. The difficulties arise because of the dynamic character of the physical/biological/environmental system, which is impacted by various forces, including the effects of ongoing drought and changing agricultural markets. Thus, impact of the water transfers is only one force causing adjustments in the system.

Five dimensions of the problem were selected. These were land use and crop production, water use, subsidence, water quality and wildlife habitat. Each of them will be examined in succession.

Effect on Cropping Patterns

Although the water transfers idled a significant amount of irrigated farmland, identifying the actual impacts on countywide land use is difficult because many factors influence crop distribution—for example, crop rotations, market conditions, availability of water supply due to the ongoing drought, and federal set-aside programs.

Cropping patterns in Yolo and Solano Counties throughout the decade prior to 1991 are shown in Figures 1 and 2. In Solano County, with about 200,000 acres planted each year, there is some fluctuation among individual crops but the changes are relatively modest. On the other hand, in Yolo County, there is substantial year-to-year change. In particular, corn and rice acreages diminished, tomato acreage increased, and total crop acreage fluctuated between 300,000 and 400,000.
Thus, there was significant variation in cropping patterns prior to the water bank. Of interest, then, is the degree to which the amount of land fallowed in Yolo and Solano Counties due to the 1991 water transfers compared to that of normal yearly variation.

Tables 1 and 2 show the magnitudes of land acreage fallowed as a result of the water transfers and the differences between actual acreages planted in 1991 and the preceding four year average. There are significant differences between Yolo and Solano Counties, but in both cases it is apparent that forces in addition to the water transfers impacted crop acreages.

In Yolo County, three examples demonstrate the crop adjustments that have occurred:

- A total of 11,600 acres of corn was fallowed due to the water transfers but countywide corn acreage dropped only 4,100 acres, apparently because of increased corn plantings elsewhere in the county.

- The overall countywide decrease in rice acreage (11,000) is substantially greater than the fallowing due to the water bank (6,400). The drought and other factors are causing substantial decreases in rice acreage.

- In contrast, tomato acreage in Yolo County decreased due to the water transfers and yet the total acreage of tomatoes increased by 11,400 acres.

There were similar variations among crop acreages in Solano County, with countywide acreages of grains and sugar beets dropping substantially more than transfer-fallowed acreages; but with corn, as in Yolo County, having more transfer-fallowed acres than the net countywide reduction.

The total cropping figures show a significant difference between the two counties. In Yolo County, despite 45,700 acres fallowed due to the water bank, countywide acreage of the three major crops was only marginally lower by 1,400 acres. In Solano County, the impact of water transfers on cropping pat-
terns was apparently much more significant, with 23,600 acres fallowed and a net countywide loss of 15,900 acres.

In Solano County, irrigable farmland idled by government set-aside programs doubled in 1991 over the previous year, to approximately 20,000 acres. Obviously this represents an important factor in the countywide loss of crop acreage.

The net result is two-fold. In Yolo County, the reduction of crop acreages in 1991 was within the range of average yearly variation. This is evidence that the water bank was only one feature of a dynamic system that is continually changing. In contrast, the reductions in Solano County crop acreage were outside the normal range, indicating the water bank had a more substantial impact.

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**Susan Butterfield:**

Solano Irrigation District grows sold water to the Solano Emergency Water Pool, which is an example of a local agriculture-to-urban water pool that operated successfully outside of the state water bank.

The SID is located in the north-central portion of the county. None of it is within the Delta. We are almost totally dependent on Lake Berryessa water supplies but we do have some groundwater. SID uses 80 percent of the water from Lake Berryessa, mostly to irrigate 60,000 acres of agriculture, but we also serve municipal and industrial uses.

No SID growers sold water to the state water bank. There is no physical connection between Lake Berryessa water supplies and other systems.

In February of 1991, when the City of Benicia was told that it would be getting only 10 percent of its North Bay Aqueduct supplies, the SID had no choice but to assist. The district reacted quickly and notified all land owners of the request to buy water. Out of about 800 landowners, 44 participated. We put a ceiling on the amount of water that we would allow to be sold at 10 percent of our water allocations—about 15,000 acre-feet out of 150,000. That's about 5,000 acres of land, calculating three acre-feet per acre.

We had certain criteria. Water could not be sold from less than 20 acres. We had no restriction on groundwater pumping. However, the land had to be fallowed in order to be part of the pool. We also required that the cities receiving the water must have an urban water management plan that identified 20 percent water savings.

As it turned out, because of the March rains, Benicia, Vacaville and Fairfield did not need to use the water, so it was banked in Lake Berryessa.

There is no emergency water pool this year, but we have it on the books should we need it for 1993. We have made some changes in the guidelines based on public hearings and what our growers and others observed during the 1991 water pool. There is a real concern about groundwater, so the new guidelines do not allow groundwater to be pumped in excess of amounts during the last three to four years. And the city buying the water again must demonstrate that it has an emergency water shortage.

Owners and tenants both must sign the agreement, rather than just owners of the land. And again, we have a 10 percent lid; we will not sell more than 15,000 acre-feet out of 150,000. Our board of directors is very concerned that agriculture stay viable in the county.

We would like to have the cities, wherever possible, go to the state water bank first, and if that doesn't work out, then the Solano Emergency Water Pool could go into effect.
Impacts on Groundwater

Another important environmental effect of water transfers is on groundwater resources. A changeover from surface irrigation using a river or other imported supply to groundwater pumping has two impacts. It eliminates groundwater recharge from imported surface water and it extracts more groundwater from the aquifer. Thus, even land fallowing results in loss of recharge from imported water; however, water transfers by groundwater pumping or groundwater exchange in addition decrease the existing groundwater supply.

In Solano County, all 1991 water transfers were by land fallowing, and the impact on the county’s groundwater resources was only the loss of irrigation water recharge. In Yolo County, the situation was different. Farmers there sold 96,900 acre-feet of water to the drought water bank through land fallowing contracts, and 57,400 acre-feet through groundwater and groundwater exchange contracts.

Of interest is the extent to which these water sales affected actual groundwater usage in Yolo County. Since groundwater pumping is not monitored, it was necessary to develop a water budget model. By specifying alternative inputs to the model—consumptive use of water, surface runoff, deep percolation and other factors—the implications of water transfers in terms of the water budgets of various crops were developed. The areas shown in Figure 3 (DWR’s “Detailed Analysis Units”) were the focus of the study and were used to compare 1991 water usage to 1989.
The results, indicating the changes in groundwater use and the amounts attributable to water transfers, are shown in Table 3. For example, consider the Lower Cache Unit. Compared to 1989, planted acreage in this unit increased slightly (1,400 acres) whereas groundwater use increased by 77,400 acre-feet. Of the total increase in groundwater pumpage, 20,000 acre-feet were attributable to the water bank and the remainder due to other factors such as drought conditions. To the groundwater use must be added the loss of recharge due to the absence of imported surface water. Thus, total depletion of groundwater in Lower Cache Unit was 109,000 acre-feet, of which 40,000 is attributable to the water bank transfers.

Throughout Yolo County, depletion of groundwater during 1991, according to the water budget model, was approximately 140,000 acre-feet. Of this, 36 percent (47,800 acre-feet) is attributable to the water transfers.

A similar analysis was performed for Solano County with the findings of ground-

### Change in Irrigated Surface and Groundwater Use Yolo County 1991 vs. 1989

<table>
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<th>Lower Cache Unit</th>
<th>Delta Unit</th>
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<td>Surface, 1000 acres</td>
<td>-15.3</td>
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<td>97.4</td>
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<td>Depletion of GW, 1000 Ac-ft</td>
<td>139.7</td>
<td>109.0</td>
<td>7.8</td>
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</table>

Box indicates amounts attributable to water transfers

Table 3
water impact being much smaller. This was the result of both the water transfers being restricted to fallowed land, and the Solano County crops being lower water users.

The Problem of Subsidence

As a result of continuing groundwater pumping there is a very real concern with land subsidence, the third component of our analysis. Estimation of subsidence due to groundwater pumping is very complicated, since many forces contribute to subsidence levels. These include the compaction of shallow and deep aquifer systems due to water pumping, gas withdrawal, and tectonic downwarping.

The first two are most important in this particular situation. They are very difficult to establish. One reason is that they involve both elastic and inelastic subsidence. When recharge is available after a period of drawdown, the elastic portion of the subsidence recovers, but the inelastic does not. Pumpage from shallow groundwater will have a lesser impact on subsidence than will pumpage from deep ground water since subsidence from shallow groundwater pumping has a much higher elastic component.

Unfortunately, the mathematical procedures for estimation of subsidence involve many assumptions. In addition, the levels of subsidence vary geographically; thus, what might be measured at one location is not necessarily similar to another location. Examination of a number of different reports, including those presented by West Yost & Associates and Hydrologic Consultants Inc., indicate there is a sizeable range of estimates. One seems to be on the low side, and the other on the high side.

Because of these problems, it is not possible at this time to establish the degree of subsidence resulting from the water bank. Field measurements are essential but the instrumentation has not been in place long enough to allow quantification. Thus, the conclusion at this time is limited to concern about subsidence—con-
cern for protection of levees, for example, and drainage canal slopes. This concern is justified and the situation should be watched very carefully; but the magnitude of subsidence due to water transfers remains to be quantified.

Water Quality in the Delta

Because of the locations at which they occurred, water transfers by Solano and Yolo Counties could not have significantly affected water quality upstream from the Delta. Thus, the focus regarding water quality is in the Delta region. There are about 50,000 acres of Delta farmland in Solano County and about 67,000 acres in Yolo County. Furthermore, the North Bay aqueduct supplies drinking water from the Delta to 150,000 people in Solano County. Of course, water quality in the Delta also is of great concern to many millions of consumers farther south.

James Eagan:

Subsidence is very difficult to recognize. I know landowners in Yolo, Zamora and the Colusa Basin drain area who still refuse to believe that their property has actually settled as much as four feet since their forefathers bought it many years ago. This is why subsidence is so insidious; it is often undetected until too late.

For example, until the Army Corps of Engineers' recent survey, it was not known that the levees in the Yolo Bypass are two to four feet lower in some areas than when they were first constructed. This reduced level of flood protection has made us keenly aware of the problems that could result from continued subsidence.

When proposals were made to transfer water from Yolo County in 1991, we felt strongly that the risks far outweighed the benefits; and the potential for additional subsidence was at the top of our list of issues. When it became apparent that the state water bank was not going to go away, we worked towards a compromise in the form of a monitoring program and some guidelines regarding transfers. Although I feel that the monitoring program is far from adequate, I will concede that the Conaway Conservancy Group was the only participant in Yolo County that cooperated in a monitoring program.

However, the prospect of long-term transfers compelled us to have an independent consultant analyze potential land subsidence impacts of water transfers from Yolo County. An excerpt from this analysis states that "subsidence would be significant if water transfers continue to occur for an extended period of time at the 1991 rates."

There was not a great deal of hard data on which to base this analysis, and assumptions were necessary. Representatives of DWR and Conaway Conservancy don't agree with all of the assumptions that were made. The District, however, feels that the report is a strong indicator that a subsidence problem exists and that further transfers could exacerbate an already serious problem.

The Corps of Engineers has stated quite emphatically that if subsidence is induced by human factors, there will be no federal funding available to correct the problem. So I leave you with this question to ponder: If subsidence is caused by water transfers, who pays to correct the problem?
To interpret changes in water quality in response to water transfers, three standards of measurement for impacts on water quality were utilized:

- For municipal water uses, total trihalomethane formation potential (TTHFMP).
- For agricultural uses, electrical conductivity.
- For fish and wildlife uses, electrical conductivity and the Delta Outflow Index (DOI).

In considering municipal water quality, several contributors to TTHFMP levels must be accounted for. There are inflows from the Sacramento, San Joaquin and other rivers; there are waste discharges from municipal and agricultural sources; and finally, there is tidal intrusion into the Delta, bringing with it bromides from seawater.

In evaluating the impacts of water transfers on TTHFMP levels, waste discharges from agriculture are an obvious factor. Figure 4 indicates the importance of the agricultural drainage component. The lower line shows year-long TTHFMP levels in the Sacramento River while the upper line reflects levels in agricultural drainage. The latter is roughly ten times greater. Thus, by reducing irrigation acreage, the potential exists for improved water quality levels in response to reduced agricultural drainage water.

Agricultural drainage quantities in the Delta peak twice yearly, as shown in Figure 5. The winter peak is the result of rainfall, and thus will not be affected by transfers. However, the summer peak reflects irrigation drainage, and so would be reduced by fallowing.

To explore the degree to which TTHFMP levels would respond to lower Delta island seasonal drainage volumes due to land fallowing during 1991, a water quality budget model was utilized. (Reductions as a result of land fallowing throughout the Delta were explored, not just in Solano and Yolo Counties.) The best case shows a potential 18 percent reduction and the worst case an 8 percent reduction. The difference is due to varying assumptions as to how
much of the acreage lost to fallowing was offset by increased plantings elsewhere in the region.

Figure 6 shows that a slight improvement in TTHFMP levels was recorded in the Sacramento River upstream from the Delta during recent years, including 1991. Figure 7 shows, however, that the TTHFMP levels actually increased at the Banks Pumping Station at the southern edge of the Delta, where the State Water Project takes its water. The Banks Pumping Station results and other measurements show that negative factors—primarily the drought—influenced water quality in the Delta during 1991 more than the potential beneficial effects of land fallowing. Thus, the actual impact of land fallowing, if any, is masked.

Similar findings to those for TTHFMP were obtained for electrical conductivity (EC). As noted above, EC is relevant to agriculture and fish and wildlife. The modeling and the monitoring results, shown in Figure 8, demonstrate evidence of a continuing deterioration over the last decade.

On a positive note, it is noteworthy that, despite the drought, the Delta outflows (as quantified by the DOI) during the summer months of 1991 were at comparable levels to the 1987-1990 average. One objective was to reduce the volume of Delta exports during critical months, in order to benefit fisheries. This was achieved.

In summary, there were potential beneficial impacts of land fallowing on water quality in the Delta, but unfortunately these impacts were overshadowed by the negative effects of the drought.

Effects on Waterfowl Populations

Waterfowl, fish and rare and endangered species also were examined for impacts
of the water transfers. Most of the focus was on waterfowl since more quantified information was available on this component of the assessment.

Varicous waterfowl species utilize the Yolo Bypass—geese and swans, 32 percent; Northern pintail, 26 percent; and other duck species, 42 percent. The impacts of water transfers on those populations are a function of the species as well as the type of alteration to the habitat, where and when it occurs, and its extent and magnitude.

The types of habitats that must be considered include agricultural fields, uplands, tidal and non-tidal marshes, channels and open water, and lakes and ponds. In the Yolo Bypass, agricultural fields are the most common land use, but managed wetlands also are of critical importance.

Although the largest numbers of waterfowl are in the Yolo Bypass during the winter months, smaller numbers utilize the region for summer nesting periods—a very sensitive stage in their life cycle. Thus, the numbers of waterfowl using the region change, and the species using the region at different times of the year also change.

Figure 9 shows that water transfers took place where managed wetlands exist. Because
these wetlands include rice fields and other agricultural fields that are flooded after harvest, land falling clearly impacts waterfowl habitats and populations.

To examine the impacts of the water transfer it is useful first to consider waterfowl population trends. The mid-winter waterfowl inventory for all of California shows a declining trend for the past several decades, although some fluctuations have occurred. In the Yolo Bypass area, the mid-winter inventory shows much more variability, as shown in Figure 10. This is because waterfowl populations in the Bypass are very much a function of water availability and the migratory capabilities of the birds. If conditions are not good in one particular year there will be some impact on populations levels overall and some migration to adjacent habitats. The ramifications of decreased opportunities in the Yolo Bypass are therefore difficult to isolate; however, the declining trend noted for all of California is paralleled for Grizzly Island which has also demonstrated significant declines over the last four decades. The conclusion must be that many factors are contributing to declines in waterfowl populations.

Extensive land falling will exacerbate the rate of decline. For example, rice

Glenn Olson:

About ten million birds come down the Pacific Flyway from Russia, from Canada, from Alaska, and 60 percent of them end up wintering in the Central Valley, where we have lost 95 percent of our wetlands. We are down to the last slice of the pie in terms of natural wetlands for this immense resource of international significance.

Our habitat restoration goals are 200,000 acres throughout the San Joaquin and Sacramento Valleys. Major efforts are underway in Yolo and Solano Counties to restore wetlands. The Yolo Basin is on a fast track. Nearly 4,000 acres have been acquired by the Department of Fish and Game and by Caltrans; and wetland restoration operations are in the design and planning phases. The Army Corps of Engineers, through Congressman Vic Fazio, has received $1.9 million in each of the last couple of years for wetland restoration.

Irrigation districts and individual landowners are probably not the best people to make final water transfer decisions, because of the third party impacts. It's hard to have accountability if the contract is only between the landowner and some entity that is buying the water. As people concerned about natural resources, the biggest handle we have on the problem is the conveying of water. On its way to Los Angeles, the water will go through a state or a federal facility—and therefore we can put restraints on it that are needed to protect local communities.

The historic legislation to reform the Central Valley Project that was just signed by President Bush has language that requires the permitting agency or the Department of Fish and Game to make findings that a transfer of water would not impact the current uses of water for fish and wildlife.

For example, the state wildlife refuge at Gray Lodge gets most of its water from tailwater that drains off rice fields to the north. If you enter into a rice field falling program and sell water and that water doesn't come down to Gray Lodge, there has to be a way to make sure that Gray Lodge has the water it needs.
fields are important to the breeding population, so the loss of 6,500 acres of rice fields in 1991 conceivably could have a significant impact. (The other crucial regional resource for waterfowl is managed wetlands. Coordination by the State Department of Water Resources, State Department of Fish and Game and private landowners allowed the managed wetlands to be flooded earlier than usual. Field operations also were adjusted to minimize impacts on waterfowl nesting.)

Given these considerations, an energy budget model was developed to evaluate the loss of feeding opportunity (waste grain) for the birds as a result of the land falling. In the best-case scenario, 18 percent of the waterfowl population (average midwinter inventory) were impacted by loss of waste grain; in the worst-case scenario, 42 percent. The difference reflects varying assumptions on how many of the birds would migrate elsewhere. These losses are not of the type that would be immediately evident and would affect mostly the wintering-over population.

A number of factors can mitigate the actual impacts of falling on waterfowl populations. Among them are availability of other habitats and management practice—in particular, flooding of fields at the end of the harvest season. Other factors can magnify the impacts: overcrowding and disease, competition, and environmental factors outside the Central Valley (e.g. drought in the Canadian prairies). Nevertheless, the loss of feeding opportunity is certainly a feature about which there must be concern. Adjustments where feasible, such as the earlier flooding of the wetlands noted above, should be explored in order to minimize the potential impacts.

The statement can be made that land falling due to the water transfers resulted in potentially significant reductions in waste grain, but the impact is difficult to distinguish from other forces that are reducing waterfowl populations in the Central Valley.

Findings similar to these but in relation to fish and rare and endangered species were also determined. There was a potential effect of the water transfers on fish
and rare and endangered species but the impacts are difficult to distinguish from those of other forces. Continued monitoring is appropriate.

Conclusions

The most significant negative environmental impact of water transfers by Solano and Yolo Counties during 1991 was increased depletion of groundwater resources in Yolo County.

Other environmental impacts, whether detrimental or beneficial, are difficult to distinguish from the conditions brought on by other forces, including the drought and changing agricultural market conditions. Generally, the impacts are modest and incremental.

Land fallowing may have less negative effect on groundwater levels and subsidence than groundwater pumping and exchange, but even then long-range monitoring is required, particularly for subsidence. However, the potential effects of land fallowing on waterfowl are potentially sizeable.

In conclusion, our findings justify the concerns of community leaders in the two counties: Short-term environmental effects are very difficult to identify; long-term effects may become much more damaging.

David Dawdy:

An important point that should be considered by policy makers is that new wells reduce the resilience of the water supply system. Once a well is drilled, it represents a sunk cost. The only cost of operating it in the future is the marginal cost, mainly for pumping. So when an emergency is over, the new pumps that were installed in response to it usually are operated. That certainly happened after the 1970s drought and it will undoubtedly happen after this one. When the next drought comes, that unused portion of groundwater is no longer there to be tapped. And so there is less resilience in the supply to meet each new emergency.

It would help to have a drought contingency plan, if we start thinking about how to reduce present deliveries by small amounts, we could preclude problems in the future. In 1991, there would have been no need to call for a 75 percent reduction—even if the March miracle had not occurred—if we had planned in advance.

This would seem to call for a law in California to determine how to manage the groundwater, what the constraints on it would be and how third-party costs might be allocated. But the problem with that, as with any law concerning water in California, is that droughts are seen as emergencies. You declare an emergency and the law is suspended—and that’s the only time it’s really needed.
Economic and Social Factors

Economic Effects

Richard Howitt:

Water transfers are now part of California’s water system. There are large efficiency gains to be made from water transfers to agricultural, urban and environmental uses. Today, the question is not whether to transfer, but how to minimize the impacts of transfers on exporting counties to acceptable levels. Minimizing the impact does not mean that they will be zero.

Our study has three components. First, we looked at direct impacts in Yolo and Solano Counties on farm workers and farmer profits. We used two tools. One is a survey of 188 farmers; the other is a farm economic model.

Second, we looked at third-party impacts, which would hit the county as a whole. These include county income and county jobs, particularly in those industries associated with agricultural production. To do this, we took the output from the farm production model and fed it into a county input/output model. The model linkages are shown in the diagram below.
1991 Water Transfers

We also surveyed 108 affiliated industries. We asked them for their perceptions and also for quantitative information, so we could compare their estimates of reductions in payroll with the economic model. In addition, we used economic information from the survey of regional leaders.

In the final component of this study, we asked the model some “what if” questions, comparing restrictions on transfers with totally free water markets.

As shown in Figure 1, for our analysis we divided Yolo and Solano Counties into agricultural production regions based on soil type, groundwater, surface water access and productive capacity. There are substantial differences among the regions.

On-farm Jobs and Profits

In analyzing direct impacts of the 1991 water transfers on farms, we used both the economic model and survey results. The model’s output indicated that:

- On-farm employment dropped by 149 jobs in Yolo County and 87 jobs in Solano County. (Yolo County transferred 154,323 acre-feet of water, compared to 57,309 for Solano.)

- However, the proportion of farm jobs lost was the same in both counties: 4.7 percent.
The model also indicated that impacts on profits to farmers as a result of the water transfers were notable but not excessive. The amounts are shown in Figure 2.

The minus figures show the change in crop income profit to participating farms. The plus figures show the change in their net profit that resulted after the farmers were paid for their water—around 4 percent increase in average farm profit in Yolo County and somewhat above 6 percent in Solano County.

Impacts on average farm revenues in the counties are shown in Figure 3. The decreases are roughly proportional to the numbers of farm jobs lost. Total farm revenues are the chief driving force on the county’s farm economy.

The model also indicated that capital investment in water-related activities increased substantially. (Theoretically at least, farmers would have spent a significant part of the cash received for water transfers on improving their irrigation systems.) This would have two regional economic effects:

(1) Increased irrigation efficiency. As one result, the number of acres in the region actually taken out of production was less than might be expected from the amount of water released.

(2) Increased activity for local businesses.
Survey of Farmers

The other aspect of our study of on-farm impacts analyzed survey responses by farmers who participated in the water bank and also farmers who did not. Figure 4 shows what these farmers reported about impacts on their profits. As expected, most of those who did not transfer water reported no impact of the program on their profits. Of those who did transfer, 30 percent also believed that they came out even.

Almost 60 percent of those who sold water said their profits increased—about the same number as the computer model’s projection. A few farmers who did not sell water also said their profit levels were increased. Possibly they felt that they had benefitted from price effects of the program—on safflower, for example.

A few farmers in both categories believed that their profits had been reduced. About 8 percent of those who sold water felt that the arrangement had not worked to their advantage. Also, about 15 percent of those who did not participate in the program felt that they had lost money. These may have been
farmers who rely on return flows for part of their irrigation requirement, and who believed
that fallowing upstream had reduced that water supply.

(Farmer responses are described in more detail on page 43.)

Third-party Impacts: Agribusiness

When reallocating a scarce resource like water in California during a drought, some
individuals will have to adjust. This is costly and they don’t like it. When is this acceptable
and when is it excessive? As we develop new institutions for water trades and transfers,
we have to come up with a new set of rules for taking third-party effects into account to a
greater or lesser extent.

Norman Rapanich:

Solano is part Bay Area and part Central Valley,
and we’re the fastest growing county in the region.
We’ve doubled the size of each community in Solano
County during the last 10 years. We have a popula-
tion now of just a little over 350,000 and we have
about 150,000 people with jobs. But we have about
50,000 people a day going out of the county to work.
Obviously, they’ve come to Solano County for the
American dream—a home.

As a non-profit economic development organiza-
tion, SEDCORP’s job is to try and shrink the jobs-
housing imbalance in our county. And water plays a
very important role in that scenario.

About 520,000 acres are under agriculture, or at
least agriculturally oriented, in Solano County.
However, the agricultural workforce is only between
7-1/2 and 2 percent of our total, so it isn’t resolving
the problem of jobs. We’re generating about 3,000
high school graduates each year. What should we
do with them? Put them on the road as commuters
or try to bring the companies to us? Again, water
plays a very key role—particularly if we’re going after
the biotech companies, which do need water.

But we have not turned our backs on agriculture
as an economic development activity. Last year we
produced a study through the Graduate School of
Management at UC Davis on grape growing and
wine making in the Suisun Valley.

That valley is under three different constraints.
One is Proposition A, which says that all develop-
ment shall take place within the incorporated cities.
The second constraint is an agreement between the
Solano Irrigation District and the local communities
that, until the year 2010, nothing but agriculture can
exist in the Suisun Valley. And then there’s the
Williamson Act.

With these constraints and with the market for
pears and some other crops that have been predomi-
ant in that valley shrinking, the farmers there are in
a dilemma. So our study asked: “What would be a
higher and better agricultural use?” And we came up
with the fact that wine growing could be a good thing,
given the fact that about 1,000 acres of wine grapes
are there now.

We have the water and the right kinds of soils—
short, it makes sense. But it takes awhile to convince
farmers. It’s their land, and we’re going to be patient.
But we have taken the opportunity to present them
with this idea.
Figure 5 shows losses in agriculturally-related income in Solano and Yolo Counties resulting from the 1991 water sales, as projected by the economic model.

This analysis probably exaggerates the actual negative impacts because it does not take into account:

- The offsetting effect of increased acreage elsewhere in the region of the crop lost to fallowing. This effect was substantial in Yolo County and somewhat smaller in Solano County.

- The natural fluctuations in cropping patterns of recent years.

Agriculturally related jobs—both farm and non-farm—went down 5 percent (404 jobs) in Yolo County and 3.5 percent (191 jobs) in Solano County due to water transfers. Interestingly, these economic model projections are very close to the results of calculations made previously by Yolo County’s analysts.

In addition to the economic modeling we analyzed results of a scientific survey of third-party effects—in this case, a survey of businesses and industries allied with agriculture.

First, we asked about the effects of water transfers on gross annual sales and on after-tax profits. The results are shown in Figures 6 and 7.

In reporting on sales, 62 percent said they had experienced no effect, 31 percent (presumably fertilizer and pesticide dealers, truckers, etc.) reported a decrease, and 6 percent (presumably irrigation equipment, well drilling, etc.) reported an increase.
In reporting profits as compared to sales, substantially more of the agribusinesses indicated no effect from the water transfer program. Relatively few reported a gain; however, 25 percent of those surveyed still indicated that they had lost profits.

Significantly, those who reported losses said that their profits shrank more than their sales, as shown in Figure 8. This is to be expected from businesses with high investment in equipment and fixed capital. The per-acre costs of a crop dusting plane, a grain truck or a combine harvester increase when they are used on fewer acres, and profits suffer disproportionately.

Other reported effects of the 1991 water bank on the average allied business are shown in Figures 9 and 10.

Interestingly, the percentage reduction in payroll reported here by the respondents to the survey (6.8 percent) is reasonably close to the percentage projected by the computer model (4.7 percent). Both the businessmen and the model agree that the impact in jobs and payroll was somewhere in the 4.5 to 7 percent range.

Third-party Impacts: Community Leaders

Another set of survey respondents was made up of community leaders and decision-makers. We sought to learn their concerns about local economic impacts, whether their perceptions were in line with what actually happened, and the degree of concern.

We asked one question about the potential impacts of a permanent, long-term
transfer of water. The responses, shown in Figure 11, were overwhelmingly negative. Apparently, the county leaders regard a permanent shift in water resources very differently than a short-run shift in response to a drought emergency. However, in Yolo County there was a sizable negative reaction even to the 1991 emergency program, as indicated in Figure 12.

We asked opinions of the community leaders about impacts of water transfers on farm workers and on demand for social services. As shown in Figure 13, the majority thought that impacts on farm workers during 1991 had been negative or very negative; few believed that they had been positive. In fact, their opinions on this question were somewhat more negative than the results of the agribusiness survey and the economic model would seem to justify.

In asking the leaders about impacts on social services, we contrasted a permanent shift in water resources with a transitory shift, as in 1991. The results are reflected in Figure 14. There were virtually no positive responses.
The Future: Two Scenarios

In addition to its analysis of the actual 1991 water sales, the economic model looked at the effects of two different possible scenarios:

- Scenario 1: An arbitrary upper limit was placed on water sales of 15 percent of the annual surface water supply in any of the sub-regions shown in Figure 1. The price was set at $85 per acre-foot. (This price reflects the actual $125 paid in 1991, since for most purposes the economic model does not include fixed costs—land, rent, taxes, etc. For these scenarios, a figure of $40 was set to cover fixed costs.)

- Scenario 2: At the same price of $85, no restrictions were placed on the amount of water that could be transferred, with one exception: To protect waterfowl, grain acreage in the flyways could not drop below the historical average. This is the "free sales" scenario.

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Community Decision-Maker Interviews

Of the leaders and decision-makers personally interviewed, 26 were in Solano County and 31 in Yolo County. They included county supervisors, city council members, city managers, water district and water agency officials, and representatives of social service, environmental and farm organizations.

The opening third of the approximately one hour interview consisted of open-ended questions to identify important issues. Interviewees were then asked to choose from a range of answers to more specific questions which could be tabulated.

A common opinion was that repeated future water transfers would bring increasingly negative impacts. For example, the graph below shows that more leaders expect negative effects on farm workers with repeated future transfers.

There were often differences between responses from Yolo and Solano County leaders, with Yolo respondents tending to sound more pessimistic. One reason for this may be that Solano leaders were aware of the 1991 State Drought Water Bank purchases in their county and that the Solano Pool's in-county transfers were seen as locally beneficial. In contrast, in Yolo, all water sales were exports from the county and leaders were very much aware of them.

One difference between attitudes of community leaders in the two counties became evident when they were asked to compare future individual and community benefits. Their responses are summarized in the graph below.

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Local impacts to farm workers due to 1991 transfers and repeated future transfers?

Statement: With repeated future water transfers, individuals who sell water will gain, but communities will lose.
The model produced dramatically different results for the three alternatives (actual 1991 and the two scenarios). Compared to actual 1991, the income reduction in the two-county agricultural sector—not including water transfer payments—was effectively halved by Scenario 1 and doubled by Scenario 2, as shown in Figure 15. The amounts of water transferred, in Figure 16, showed the same pattern of change—219,000 acre-feet in 1991, 107,000 acre-feet in Scenario 1, and 450,000 acre-feet in Scenario 2.

Impacts on agricultural jobs show similar trends, as indicated in Figure 17.

All this reflects the farmers’ knowledge of how much water their crops are using and how much profit the crops are making. When a limited opportunity to sell water arises (Scenario 1), farmers first eliminate the crops that use most water and/or generate the least profit. In most cases, these also are the crops that require the least hand labor and the lowest proportion of inputs per dollar produced—and therefore have the least impact on both county income and jobs.

However, when the opportunity to sell is largely unrestricted (Scenario 2), farmers may eliminate additional, higher value crops with proportionately greater impacts on local jobs and income.
Figures 18 and 19 compare the three alternatives in terms of county income and jobs lost per unit of water transferred. The point here is that the impact per unit of water trans-

**Figure 18**

**Change in County Income**

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**Figure 19**

**Change in County Jobs**

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Betsy Marchand:

In a drought water bank situation, Yolo County is extremely vulnerable. We are a small county, we are located right on the conveyance system and we do not yet have a countywide water agency to speak with one voice for the county. In 1991 a lot of water was to be transferred out of the county. The Board of Supervisors believes that water is a community resource and that we need to protect it, but we soon found that we were on our own. There was no Water Resources Control Board appeals process in 1991.

We knew that we had subsidence. We were very fearful that we could have a depletion of wildlife habitat. Common sense told us these things because we know our county; all of these things are certainly affected by what happens to water.

The Board decided that we needed to try to cooperate with anybody who would cooperate with us. Some of our sellers did cooperate with the county; but some refused. We developed a memorandum of understanding with one of our largest transferors of water, Conaway, who agreed to do monitoring and to pay the county 2 percent of their water sales. The state water bank people did enforce the county's rules in the areas west of the Yolo Bypass, and that is to their credit because they didn't have to.

The county administrator's office was asked to prepare a third-party impact analysis. Early on, we recognized that these transfers could have a big effect on employment, on our social services, and on the underground water resource. We discovered that we could only measure certain third-party impacts with any accuracy. We could measure farm workers and other workers being put out of work. We could measure the effect on our welfare and social services and our health services. But we could not get a handle on impacts to the allied businesses—the truckers, the seed companies, the aerial applicators.

In our impact analysis, we estimated somewhere between 400 and 500 lost jobs. That's basically all we could measure accurately. We developed a claim of $129,000, which was very conservative—based only upon what we could measure. We sent the claim to DWR. They studied it over and I believe they gave it some attention; however, they rejected it. They sent it back and said, "Go to the State Board of Control." But going to the State Board of Control is like going to a bottomless pit; also, this was a new type of claim. It would have cost us more than $129,000 to develop the information they wanted in order to submit a new claim. This isn't fair, folks.
Water is a precious commodity and anybody letting it go is taking a big risk. If the people in Los Angeles decide that we don’t really need as much water in Northern California as we have—that we can get along without it—we may have to do so permanently.

Today, we’re producing more than is needed to feed America; and we’re having a difficult time selling our crops overseas because producers there are getting better and they’re making inroads into our markets. But is it always going to be that way? I don’t think so. For that reason, letting water out of the area of origin is highly risky.

Do I have a right to over-pump groundwater when my neighbor is really supplying it? I don’t think we’re facing that issue yet. We need to talk more about how much water disappears when that pump is turned on, and whose water it is. We need more of these studies before we get too far down the road in transferring water.

Marc Faye

The future wealth of our communities and of our county depends upon the availability and the reliability of water. I don’t think you can put that into a computer model, but I know it is correct. If we lose sight of that fact, we have lost sight of our future. This is California.

We in Yolo County must protect the water resources that we have now; we must do the necessary studies to understand them better; and we must form a county water association so we can all work together to protect and preserve them.

Betsy Marchand

ferred on the local economy—jobs and income—depends on both the total amount transferred and how much it is spread around. There is, however, an offsetting factor. The farmers told us that about 70 percent of the income from water sales was spent within the county. (Much of the rest was for debt retirement.) According to the input-output model, these expenditures will generate, on average, for each 1,000 acre-feet of water transferred (1) $20,000 in agriculturally-related income and (2) three-quarters of a job.

Finally, a crucial analysis is the amount of cropland removed from production, which is a crude measurement of environmental impacts. Figure 20 shows that the impacts during 1991 were concentrated in certain areas of the two counties where the actual transfers took place. Figure 21 shows what happens when an upper constraint of 15 percent of the surface water in any sub-region is imposed. We still get 107,000 acre-feet transferred, but no region goes much over 13 percent change in land use.

We realize, of course, that transfers will be physically easier in some sub-regions than others. However, it is less restrictive to allow theoretical transfers than to arbitrarily disallow some of them. In any case, most transfers involve exchanges of water rather than direct delivery from the point of origin—and such trades are theoretically possible from almost anywhere in the two counties.

The free sales scenario, shown in Figure 22, has a much different impact. Solano County agriculture is greatly reduced, and there is a substantial acreage reduction throughout Yolo County except for the central area.

Conclusion

Almost all farmers in Solano and Yolo Counties who sold water were financially better off as a result of the 1991 water transfers. Except for impacts on groundwater—and, to a certain
1991 Water Transfers

extent, on return flows although there are legal questions here—other farmers were not
hurt.

Third-party effects were relatively low on a countywide basis, but were excessively
concentrated in particular geographical areas.

For the future, we can draw these conclusions:

• Moderate limits can significantly reduce third-party impacts, while still enabling water
  trades to take place.

• Completely free sales, however, could lead to substantial third-party costs, both in jobs
  and in income.
On-Farm Perceptions, Attitudes and Opinions

Richard Berk:

The actual and potential impacts of water transfers on groundwater, on the local economy and on the environment are clearly important; but in addition, perceptions matter. Facts are important, but how people perceive those facts can’t be ignored.

We surveyed farmers in Yolo and Solano Counties who were physically able to transfer water—both those who did and those who did not actually sell water. We focused on farms of over 200 acres, and the interviews were conducted by telephone.

First, we looked at the past. We asked farmers for their views about the actual impacts of the 1991 water bank.

Second, we considered the future. What kind of water bank might farmers be willing to accept later on?

We determined which were typical opinions. The point is not just to represent the differences of opinion but to summarize where the main body of opinion actually lies. Otherwise, decision-makers may be persuaded by those people who talk loudest.

We determined the degree of consensus. One could imagine a situation where perceptions are closely grouped; or, alternatively, a situation in which the public view is polarized. It’s also important to distinguish between positions that are firm and inflexible and those that are soft and presumably available for change. These differences are significant politically.

We asked a series of questions about what farmers in general thought about the impact of 1991 water transfers on their profits and losses. Of course, this required them to take into account not just the effect of the water transfers but changing economic circum-
Effect of water transfers on your profits and losses?

Don't know

Better

No impact

Worse

N = 188

Figure 23

Profits or losses of neighboring farmers who transferred water?

Does not apply

Don't know

Better

No impact

Worse

N = 188

Figure 24

Ability to plan ahead?

Does not apply

Don't know

Better

No impact

Worse

N = 188

Figure 25

stances, the drought, and so on. These are difficult determinations; people have to perform complicated mathematics in their heads, so these judgments should be taken cautiously. The farmers' responses, which have been reported for individual counties by Howitt, are shown in Figure 23.

About 15 to 20 percent said things were worse. That percentage might result from almost any question; you could ask about the Easter Bunny and get that percentage of negative responses. Thus, 15 or 20 percent indicating "worse" is actually a fairly small amount; smaller than the absolute number may imply.

To a question about perceptions of their neighbors' profits or losses, again 15 to 20 percent said "worse," as shown in Figure 24.

A question about ability to plan ahead, as shown in Figure 25, indicated a more serious problem, since the amount of negative responses is now 25 or 30 percent. It's not clear if this is a permanent confusion because of the uncertainty about future water banking policies, or whether this referred specifically to the difficulties of planning in 1991.
Farmers' perceptions of impacts on wetlands and wildlife habitat are shown in Figures 26 and 27. The responses do not reflect widespread concern.

In regard to groundwater, the concerns increase, as shown in Figures 28 and 29. About 30 or 40 percent believed that transferring water had an impact on their own or their neighbors' groundwater level. As to impacts on the quality of groundwater, shown in Figure 30, there was less concern—but it is still a consideration.
Real impact becomes evident when we ask farmers about the local economy. As shown in Figures 31, 32, and 33, almost half thought county tax revenues were worse off during 1991; about 60 percent believed there were fewer farm jobs in the county; and about two-thirds said local agriculturally related businesses had suffered.

To summarize Solano and Yolo farmers' perceptions of the impacts of the 1991 water bank:

- There was relatively little concern about farm profits and losses, and environmental issues.
- There was a moderate level of concern about groundwater.
- The real concern was focused on perceptions of economic impacts to the community.

Farmers who actually transferred water were much less concerned than other farmers. It's not clear whether they anticipated fewer problems and therefore decided to transfer water; or, having transferred, looked at the effects and found them less troubling. But this suggests that there are important differences among farmers.

(For Berk's report on farmer responses to alternative proposals for future water bank arrangements, see page 63.)
Legal and Institutional Issues

Understanding Transfers: The California Water Torture

Joseph Sax:

The question of who has, and who ought to have, what rights in water raises an issue that has been very little recognized in our legal system: the rights of communities. A companion issue is the limit on privatization of water as a commodity.

Unlike almost every other form of property, which we allow to be entirely privatized, water has always been viewed as something in which the community has a stake and which no one can fully own. All the complexity of this point is usually embraced in the phrase “third-party effects” when talking about water transfers.

Third-party effects exist wherever significant resources are allocated or reallocated, but usually they are ignored. When a theater next to a restaurant is sold and turned into a warehouse, the restaurant may go out of business. When General Motors closes a factory in Michigan and opens one in another state or another country, workers may be left in the lurch. These are all third-party effect problems. With rare exceptions, they have no standing in our legal system.

(Of course, the effects don’t go away. They appear in different forms—for example, as increased welfare payments, more unemployment compensation or fewer public services as tax revenues decline.)

But water is and always has been different—certainly in theory and to some extent in practice. Thus, to treat water purely as a commodity, and transfers as two-party transactions only, is to depart from a very deeply rooted tradition in the water field and from consistent intuitions about water as a community resource.
But community right is such an unusual idea in our law that, despite its history and despite its strong intuitive power, we have little experience in giving it content. Moreover, we have virtually no legal doctrine or theory to describe the relation between an owner who wants to sell water and the community from which that water will be exported. Nor is there any clear concept of a “community” entitled to protection against the effects of export transfers. There are all kinds of different communities whose claims could lead, depending on how the community is described, to very different sorts of limitations on water transfers.

Because of strong desires to facilitate transfers, efforts have been primarily directed toward empowering individual sellers, as against community claims, in order to promote transfers. Almost all recent legislation dealing with transfers looks in this direction. This is understandable. If enough interests are involved and each has something like a veto power, transfers will be so weighted down that the whole enterprise is likely to collapse under its own bureaucratic weight and increased transactional costs.

Having set out this background, I will make a few suggestions. My observations are based on two premises: (1) that the claim for a community stake in water is legitimate and is reflected in a wide range of responses to water problems over a very long time; and (2) that legitimate community claims too often have been neglected in the effort to facilitate water transfers.

The Role of Water

First, water in place is a type of wealth. That wealth accrues not only to the owner of a water right, but to many other people in the place where the water is located—in the form of employment, direct and indirect; in lower prices for water because of its relative abundance; and in natural values, such as recreation and fisheries, that arise as a result of water's presence.

Second, when water is sold as a mere commodity, only the formal owner of a water right is compensated. For that individual, there is a transformation of wealth from one form to another—from water to cash. Indeed the seller is likely to be significantly enriched, particularly in ag-urban transfers, since water has been both under-priced and, from the perspective of economic efficiency, underutilized. Payments for water frequently exceed the profits that sellers could have obtained from using the water for irrigation.
Third, while such sales are, for the owner-sellers, transformational—that is, wealth is transformed from water to cash—for everyone else who has been benefiting from the presence of that water, the sales are redistributional. That is, others in the community who have up to that point benefited from wealth in the form of water in place will be made poorer, since the water is gone and they get nothing in return. Moreover, it is likely that the redistribution will be especially adverse to the poorer people in the communities, since they are often the least mobile residents. They are unlikely to move and find equivalent work and amenities elsewhere.

All this suggests to me the existence of a first order conflict between user-sellers—that is, owners of water rights who have been in a position to reap the benefits of a sale—and other interests, natural, economic and social, who have been enriched by the presence of water and will obtain no benefit from its sale.

To avoid wealth redistribution in transfers, the following precepts should be adopted: First, transfers should not be redistributive to the disadvantage of those in the selling area, both in human and natural terms. Second, the price of the water to those acquiring it should take into account all the benefits the water has produced, not just those that have flowed to the holders of formal water rights.

There are several practical ways to promote such goals. One is to favor sales that minimize disadvantages to the community. The most obvious are those that free up water by applying water-saving techniques, so that the same amount of economic activity continues in the selling community.

Another device is the provision of community compensation through a transfer tax. Where sales generate a general decline in the wealth in the community, the concern ought to be for those who remain—those who are least able to leave, rather than for those who can better shift for themselves and leave the community. Taxes benefit those who remain in the community. A tax on water sales, depending on the nature of the sale and its redistributive impact, would be the easiest means to mitigate the redistributive tendency of export sales. A similar approach could be taken to mitigate natural losses—losses to waterfowl habitat for example.

It is true that much of the water likely to be sold does not come from the original place of origin, but rather from a place to which water has been imported. That fact should not affect the
conclusion where a community has been established—whether it is a human settlement or a natural habitat, such as a wildlife refuge. Once such uses are established, the removal of water constitutes a disruption in that community, even if the community is only a few decades old, and thus also constitutes wealth redistribution.

Transactional Costs

The more one enlarges the interests that need to be accounted for, and the more complex or extensive the arrangements to evaluate transfers, the more transfers will be discouraged. This is a transactional cost problem, but there are ways around it. The best way to deal with this issue is to adopt generally applicable formulae that are meant to approximate the losses to the community caused by various types and sizes of transfers. Formulae for taxes on transfers, compensation to instream uses, and prioritization of favored and disfavored types of transfers can be employed to assure mitigation without making transactional costs unduly burdensome. Large and pervasive impacts should be treated differently from small and ephemeral ones.

Of course, a formulaic approach is a second-best solution, and will not produce the appropriate result in every individual case. But the alternative—extensive participation and elaborate public interest hearings—while theoretically appropriate, threatens to make all but the largest water transfers uneconomic and untimely. Certainly some review process is necessary, but the goal should be to make it largely a fall-back device for especially hard cases. For the most part, some sort of formulaic approach will have to be adopted, or I think the whole system is likely to sink of its own weight.

The solution to inadequate water transfers in California is not to ignore community interests in water, but to institutionalize them as part of the price of water—rather than letting all the benefits flow to the formal owners of water use rights and to the buyers of the water.
Water Rights, Laws and Institutions

Brian Gray:

A legal analysis of the issues associated with water transfers from Yolo and Solano County to the 1991 State Emergency Water Bank involves six questions. They are:

• Were the existing water transfer laws, which authorize the transfer of surplus water and water made available as a result of conservation, adequate to facilitate transfers to the water bank?

• Why did the State Water Resources Control Board have so little jurisdiction over the transfers to the water bank, and did the Board’s limited role conform to the requirements of California law?

• Did the Department of Water Resources’ acquisition of the benefits of water held pursuant to riparian rights unlawfully circumvent the place-of-use limitations of the riparian system?

• Should the transfers of the “base supplies” held by the Central Valley Project “water rights settlement” contractors have been subject to the transfer jurisdiction of the SWRCB?

• Did the transfers of surface water made available by the transferor’s decision to use groundwater as a replacement source of supply comply with the surface water transfer laws and the California Water Code’s protections of counties in which groundwater originates?

• Did the transfer process established by the DWR adequately allow for the consideration of potential third-party environmental and economic effects associated with the transfers?

I will consider these six questions and then discuss possible changes to address some of the legal problems. We need to devise a scheme that can facilitate the transfer of water in a future emergency drought, while at the same time providing better and more systematic protection of the various third-party interests—environmental, economic and groundwater—that are potentially affected by such transfers.
Adequacy of Current Law

The first legal question is whether the existing water transfer laws that have been enacted over the last 12 years or so were adequate to allow the water bank to function. My conclusion is that they were adequate and, indeed, that they were essential to the creation of the water bank. The most important were these:

• Section 383 of the Water Code, enacted in 1982, which allows both individuals and water agencies to transfer water that they find to be surplus to their needs.

• Section 1011 of the Water Code, which provides authority to conserve water and to transfer the water made available by such conservation efforts. Section 1011 also tries to assure transferees that by engaging in conservation and transfer they will not jeopardize their water rights. The law does so by (1) declaring that conserving water and offering it for sale is itself a beneficial use and (2) providing that there may be no forfeiture of conserved water during the period of the transfer.

• Section 1244, which states that a transfer may not be used as evidence of unreasonable use or waste on the part of the transferor.

• Finally, Section 1731, applicable to temporary transfers, which provides that at the end of the contract period for the transfer there is a full reversion of all water rights and all interests in the water to the transferor. This addresses the question about the security of water rights that are offered for transfer, and the concern that once the water is released it may be difficult to get back.

These laws do not provide the iron-clad guarantees that some water users who are interested in transferring water would like. But they go a very long way towards assuring individuals who participate in various transfer systems, including the 1991 water bank, that they may conserve water. Farmers may have a surplus that is generated, for example, by
The following of land or by a decision to substitute groundwater in place of surface water. They may transfer that water. And because they engaged in that activity, the state may not—in fact, the state cannot—challenge the validity of their water rights. The state cannot challenge their long-term need for the water by using the fact of a temporary surplus, a temporary transfer, or the ability to conserve on a temporary basis, as evidence that there is no longer a long-term need for the water within that service area.

The legislature enacted several temporary urgency statutes in early 1991 to facilitate the creation of the water bank. The Department of Water Resources has stated that those laws were vital to the creation of the water bank. In my judgment, those statutes, which all expire at the end of this year, were not needed. The existing body of law that has been in place for much of the last decade was more than adequate to allow this water bank and future water banks to be created.

**Jurisdiction of SWRCB**

The existing transfer laws, however, are neither perfect nor complete. One major deficiency is the role of the State Water Resources Control Board which, although well-defined, is rather haphazard. The Board has limited jurisdiction and the limits are based more on historical circumstance and politics than on hydrology or a concern that there should be a thorough, comprehensive evaluation of transfers.

Another problem with the existing transfer laws is that while they provide for the consideration and protection of third-party environmental and economic interests, they apply only in those cases where the Board has jurisdiction—which are very limited. The laws also apply, I believe, in an ill-defined and probably not very workable way, at least in the context of short-term transfers. Those will be the twin themes for the rest of my comments.

The Board played a surprisingly limited role in the 1991 water bank. Of the 351 transfers to the bank, the Board asserted jurisdiction over only two. Both of those were from the Yuba County area—one from the
Yuba County Water Agency and the other from the Oroville-Wyandotte Irrigation District. None of the transfers from Yolo and Solano County were reviewed by the Board. Indeed, the Board went out of its way in a couple of cases to avoid asserting jurisdiction over those transfers.

The Board has authority to review transfers of surface water that is appropriated pursuant to a permit or license that the Board has previously issued. Within that category, the Board’s jurisdiction is applicable only where the transfer requires a change in a term or condition in the permittee’s or licensee’s water right. Specifically, the Board has jurisdiction only over transfers that require a change in the point of diversion, place of use, or purpose of use stated in the permit or license.

This exempts from the Board’s jurisdiction transfers of surface water held pursuant to riparian rights or pre-1914 appropriative rights, other surface water transfers that may be accomplished without changing the transferor’s permit or license, and groundwater.

One example of the category in which a permittee or licensee engages in a transfer not subject to the Board’s jurisdiction would be a transfer that takes place completely within the Central Valley Project—for example, when water is transferred between CVP contractors but remains within the general CVP service area, whether the transfer is from an agricultural-to-agricultural use or even from an agricultural-to-urban use.

Because the permits held by the Bureau of Reclamation for the CVP are multi-purpose and because they cover an extraordinarily broad service area—the Central Valley and portions of the Bay Area—many transfers of this permitted water fall outside the jurisdiction of the State Water Resources Control Board.

Notwithstanding the limited nature of its transfer authority, the Board’s minimal role in the 1991 water bank transfers is striking because there were a number of transfers from Yolo and Solano Counties that would appear clearly to fall within the Board’s statutory jurisdiction.

Transfers of Riparian Rights

During 1991, transfers of riparian rights water were largely concentrated in the Delta, and mostly involved the fallowing of land and the forbearance of the use of the water that normally would be used for irrigation.

On their face, these transfers would appear to violate two fundamental principles of riparian rights law. These are that water diverted pursuant to a riparian right may be used (1) only on riparian land—land adjacent to the watercourse—and (2) only within the watershed in which the water originates. Many of the transfers went from the Sacramento Basin or the Delta to the San Joaquin Basin, to the Bay Area, and to the Metropolitan Water District of Southern California. These transfers would seem to violate both the riparian land and watershed-of-origin limitations.
The Department of Water Resources avoided these problems through what Professor Howitt has called “the most innovative aspect of the 1991 water bank.” According to DWR, in acquiring water from the riparians, the water bank did not actually purchase the water itself, but rather acquired the benefits of that water. DWR used the water without taking title to it and without exerting physical control over it. The Department, in fact, used the water to meet its Delta outflow and salinity control requirements under Decision 1485. That action freed up SWP water which the Department normally would have used to meet the ambient Delta water quality standards. This water then was transferred to the state water bank and distributed to its customers.

In other words, the riparian water that the DWR acquired was left in-stream. There was no use of the water on any land, so there was no violation of the riparian land limitation. There was no violation of the watershed limitation because the water remained in-stream, flowing down the Sacramento River, through the Delta and out into San Francisco Bay.

I agree with Professor Howitt that this was an innovative and useful technique. I also think that under the circumstances it was appropriate as a legal proposition, for several reasons:

• This characterization of the riparian transfers was not done for the purpose of avoiding the jurisdiction of the SWRCB. The Board would not have had jurisdiction over the transfer of water held pursuant to riparian rights under any circumstances.

• The transfers of riparian water were critical to the success of the water bank because they accounted for almost 50 percent of the water sold to the bank. These transfers alone thus represented a very large percentage of the water that was available to other areas of the state.

• The fallowing of land minimized the risk that other riparians in the Delta who were not participating in the program would claim the water sold to the bank. By buying out enough riparians, the Department was able to minimize the risk that those other water right holders would claim the water that it was trying to convey from the Sacramento Basin to the San Joaquin Valley, the Bay Area and Southern California. This was one way in which the Department addressed the problem of ensuring that there was enough water moving through the system to make up for the water being supplied to the purchasers from the water bank.

• Finally, the transfers of riparian water in this context demonstrate that riparian rights can be quantified for purposes of permitting their transfer to non-riparian, out-of-watershed uses. This is a concept that Assemblyman Katz has been struggling with in various versions of his bill, AB 2090. This experience from 1991 provides good evidence that it is possible to quantify riparian rights and to use the benefits of the water acquired, if not the actual water itself, to augment supplies elsewhere in the state. The fallowing formula and groundwater replacement methods of quantifying riparian rights worked well for this purpose.
Questions to be Raised

From this point on, I will be rather critical—from a legal perspective and in the cold light of hindsight—of several decisions by officials of the water bank. I refer specifically to the transfers of water by the Central Valley Project water rights settlement contractors, and to the groundwater replacement contracts.

I want to emphasize that these decisions were made under a perception of an emergency, if not an emergency itself. Everyone involved was interested primarily in moving water from areas of abundance to water-scarce areas of the state, and doing so expeditiously. Even critics of the program have said that while no formal mechanisms were established to protect third-party interests, the administrators of the water bank were more than willing to listen to their concerns and to try to mitigate the harm potentially caused by transfers to the water bank.

The CVP water rights settlement contractors receive water that is appropriated

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David Okita:

In Solano County, we project that, with current growth rates and water supplies, we’re going to be short eventually between 20,000 and 50,000 acre-feet per year. So we’re going to need new water coming into the county. We see water transfers and conjunctive use of our existing supplies as just about the only ways to meet those needs.

Because we have the North Bay Aqueduct, which is a direct pipeline from the Delta, it is easy for us to accept water from transfers. We are north of the Delta, so we don’t have the constraints on the pumping plants south of the Delta.

We are now receiving water from the Glen-Colusa Irrigation District in the Sacramento Valley. We negotiated a very short-term two-month transfer to receive groundwater by exchange. A well in GCID is being pumped and the water is being put to beneficial use in the district and they are in turn giving up an equal amount of surface water supply, which we take through the North Bay Aqueduct.

This two-month transfer was an outgrowth of a one-year deal that we tried to implement, but because of some adverse landowner reaction in the Glen-Colusa District, they suggested two months. We will be negotiating for another one-year deal in 1993.

Part of the proposed one-year deal will be studies and construction of another well that could lead to a long-term transfer program. However, we realize that there are some legal and institutional and political problems.

Another short-term transfer will actually take place next year. This year Putah Creek needed some additional water. With the help of folks in Yolo County, we negotiated a deal with a private land owner there to provide us with some water next year if we provide water from the Solano Project to Putah Creek this year. In the future we hope to enter into some agreements with these Yolo County interests for possibly a long-term program.

These two transfers are not a lot of water, but we think they are a good first step.
under permits issued by the SWRCB to the Bureau of Reclamation. These contractors receive two types of water from the Bureau. The "base supply" delivered to them represents their pre-project water rights. In addition, many of these contractors receive "project water" that is made available to them by the existence of the CVF. In 1991, the Bureau allowed these contractors to transfer their base supplies but did not permit them to transfer project water.

Because the "base supply" technically is appropriated pursuant to permits issued by the Board to the Bureau of Reclamation, the Board would appear to have had authority over these transfers. Nonetheless, the Bureau and the Department of Water Resources persuaded the Board not to exercise its jurisdiction, by characterizing the water transferred as the equivalent of the pre-project riparian or pre-1914 appropriative rights held by these contractors.

There is considerable merit to this analysis, since there is no inherent reason why water rights that predate the CVP should lose their legal character simply because they are incorporated contractually into the CVP system. From the Bureau's perspective, the base supply is not part of the system created by construction of the CVP. Therefore, that water should not be included in the pool of water to be distributed as equitably as possible among the hundreds of CVP contractors during times of system-wide shortage. Similarly, from the vantage point of the managers of the water bank, characterizing the base supply as "pre-project" water has the advantage of allowing the water to be transferred to the water bank in accordance with the Bureau's policies without having to go through the change in water right procedures administered by the SWRCB.

What is curious, however, is the Board's willingness to accede to this characterization—since the consequence of treating the Sacramento River contractors' base supplies as the legal equivalent of their pre-project rights is to relinquish jurisdiction over the transfer of such water.

According to its executive director, the SWRCB did not object to the Bureau's and DWR's legal characterization of the CVP base supply, or attempt to exercise jurisdiction over this water, because the Board sought to implement the Governor's emergency drought policies—to "make the water bank work."

The persuasiveness of this explanation depends on the priority one assigns to two policies that were often in tension. On the one hand, it is undeniable that removal of the sales of the CVP base supplies from the transfer review process administered by the SWRCB facilitated the prompt transfer of that water to the water bank. The contracts could be negotiated and executed without the parties having to justify their actions in a public hearing before the Board. On the other hand, the Board's review and approval of transfers that are subject to its jurisdiction provide the only means by which third parties who claim that they will be injured by a water transfer may formally object to the proposal or seek to condition the transfer on measures designed to mitigate such harm.
Elaine Rominger:

We need to develop and enforce special precautions for groundwater basins. Professor Berk reported that farmers clearly prefer water transfer regulations that strongly protect groundwater supplies. The cities and towns in Yolo County share several large aquifers with the land owners in the unincorporated area of the county. This water supply has not been adjudicated, nor is there any analysis of the extent of the aquifer.

Because of the public concern regarding the transfers from Yolo County, the Conaway Ranch managers agreed to return 2 percent of the sales price to the County of Yolo for water policy development. They transferred approximately 45,000 acre-feet from their area, directly east of our city. I believe these funds should come back not just to the city of Woodland, but should be used in our countywide water planning process.

Also included in the agreement between Conaway, the county and DWR for the 1991 water bank was a groundwater monitoring program. It includes monitoring wells, subsidence monuments and extensometers to determine groundwater levels and to monitor water quality and subsidence. As I understand it, pumping must cease if two tenths of a foot of subsidence occurs within a pumping year. This type of safeguard is necessary to protect our groundwater basin.

Two months ago the City of Woodland discovered that there has been significant land subsidence, four tenths of a foot in the last year—right in the middle of our city. Subsidence has occurred in the past, but not this dramatically. Water experts are still determining the exact cause, and what effect it will have on our infrastructure and drainage. We’re very concerned because of flooding potential. Transfers have not been ruled out as a reason for this subsidence.

Groundwater Transfers

There were a number of transfers of surface water for which groundwater was substituted—that is, surface water was transferred and groundwater was pumped to make up for the difference. These were the most controversial transfers and most of them were from Yolo County.

A number of these “groundwater replacement” transfers involved surface water appropriated under permit or license; but, as with the CVP water rights settlement transfers, the SWRCB did not assert jurisdiction. The administrators of the water bank argued that the transferred water was in fact “groundwater” because groundwater was being pumped to make up for the surface water that was foregone and used for the benefit of the water bank.

At first blush, this treatment of the groundwater replacement transfers would appear to be indistinguishable from the characterization of the transfers of the CVP contractors’ base supplies. It was a reasonable judgment for the Board to accept the characterization of the CVP base supplies as water held pursuant to the transferor’s pre-CVP water rights rather than as water appropriated through the Bureau of Reclamation’s permits for the project. So, too, would it appear to have been reasonable for the Board to view the groundwater replacement transfers as involving groundwater, rather than the surface water for which the groundwater was substituted.

As with the CVP transfers, this may have been justifiable in order “to make the water bank work.” In this case, however, a serious legal problem exists. The characterization of this water as “groundwater” invoked the provisions of Section 1220 of the Water Code, which states that no groundwater may be pumped for export from the combined Sacramento and Delta-Central Sierra Basins, unless the pumping is in compliance with a groundwater management plan adopted by the county board of supervisors.

Nevertheless, DWR determined that Section 1220 was not applicable because, for the purposes of that particular law, the transfers were of surface water,
not groundwater.

It may have been acceptable under the conditions that existed in early 1991 for the SWRCB to have relinquished its statutory authority in ambiguous cases such as the transfer of CVP base supply contract rights. It is disturbingly cynical, however, for DWR (with at least the post hoc acquiescence of the Board) to have manipulated the characterization of the groundwater replacement transfers to the water bank for the explicit purpose of avoiding two important laws—one or the other of which necessarily was applicable to such transfers. After all, the water sold to the bank must have been either groundwater or surface water.

The two laws in question are not simply sterile formalities that can be cavalierly set aside. Rather, these laws provide the only direct protection for an array of third-party interests—including other water right holders, fish and wildlife, instream beneficial uses, local economic concerns, and groundwater users—that might be adversely affected by water transfers.

Before one may be too critical of DWR's manipulation of these laws, however, two caveats must be noted:

- Section 1220 probably does not apply unless and until the county enacts a groundwater management plan, which Yolo County has not yet done.

- The administrators of the water bank were uniformly praised for their willingness to listen to claims that particular transfers might adversely affect third-party interests. Furthermore, the DWR took some actions that were not required by law to consider the effects of certain transfers on both groundwater and the environment, and to compensate, at least partially, for potential harm to local economies.

Third-party Interests

Nevertheless, removing Yolo and Solano County water transfers from the supervisory jurisdiction of the SWRCB eliminated all formal legal means of assessing third-party effects. In the words of one observer, because the DWR never established "a process to invite public
Paul Bartlewicz:

In January and February of 1991, the situation called for extraordinary action. The cooperation and the creativity of many public officials—from the Department of Water Resources, the Department of Fish and Game, the State Water Resources Control Board, the Bureau of Reclamation—as well as the local water agencies and growers who participated in the bank were a phenomenal contribution to the state.

We hear about the March miracle, the rains that came in March. But the real miracle occurred in February, when these people just reinvented the wheel in regard to emergency water supplies. That is an important part of the success of the water bank.

The concern at that time was to have growers make available 800,000 or 900,000 or even 1,000,000 acre feet to meet the emergency water demand within the state—a really critical demand. The lawyers who got together to try to make the water bank work were looking at some of the issues that arise when you have a grower who doesn’t have a water right, but merely an entitlement to a water supply from a water agency. How do you enable that district to allow the grower to transfer water? One of the first issues you must deal with is the definition of water surplus, because all the water district acts say that you can transfer only surplus water.

Professor Gray is right, there is a Water Code section that defines surplus water, and it includes water that a grower agrees to make available from his district allocation. But that section only applies to modern appropriative rights, not to pre-1914 rights. So there was a need for legislation that would include these pre-1914 rights within the definition of surplus water. That was done.

The legislation also addressed another impediment to transfer of water by users. Many water districts had board members who were landowners and were interested in contributing water to the water bank; but there is a prohibition on public officials contracting with the districts they represent. This was, I believe, a legitimate concern, and the legislation addressed it.

The legislation also had some additional water rights protection language. I agree with Professor Gray, that this was redundant to a degree, but when dealing with growers in water districts, to encourage participation in the water bank, there was a tremendous concern about water rights protection. The more statutes you could show them the more it seemed to help. So that was an important aspect of the special legislation.

This two-year legislation has now, in effect, become permanent because Mr. Cotses carried AB 2897 this past session.

Another question involves what kind of water is transferred. A lot of land was fallowed and there were these groundwater substitutions. Aren’t those the types of transfers that result in third-party impacts? When you fallow land, you take it out of production, you affect wildlife habitat, and potentially you affect the industries and businesses that rely on agriculture and support agriculture. You affect the vitality of the community itself. And of course, the substitution of transferred surface water with groundwater raises additional concerns about third-party impacts.

AB 2897 has a provision that says a water user cannot transfer or substitute groundwater for transferred surface water unless the use of the groundwater is consistent with a groundwater management plan that has been adopted under state law. Another chaptered bill, AB 3030 by Assemblyman Costa, facilitates forming groundwater management districts.

The SWRCB has very limited jurisdiction for protecting against third-party impacts. Those impacts are protected under the California Environmental Quality Act (CEQA). Of course, the one-year transfers of modern appropriative rights are exempt from CEQA; but anything for more than a year, as well as pre-1914 rights, is subject to CEQA. And we did have the extraordinary situation in 1991 of an emergency that warranted the CEQA exemption.

I suggest that we focus on the types of transfers that really cause impacts, which I believe are fallowing and groundwater exchanges. Let’s learn more about the third-party impacts from fallowing. Let’s limit the fallowing that’s allowed for transfers. Let’s emphasize the types of transfers that don’t have those impacts. These include transfers of surplus water from storage and conservation projects that make more water available—and also well managed conjunctive use programs.
participation and comment” the transfers remained essentially “private contracts between the transferors and the water bank.”

The consequence of the decisions to minimize the SWRCB’s jurisdiction was to avoid application of the laws that require the consideration of various third-party interests. The laws that were circumvented are the only ones that provide some protection for other water rights holders, in-stream flows, waterfowl habitat, local economies and groundwater.

DWR endeavored to protect fish and wildlife, instream uses, groundwater, and local economic interests in other ways. It agreed with the Department of Fish and Game to move the transferred water through the Delta during periods when the alteration in flows and increased pumping would least interfere with the migration of anadromous fish. Moreover, the falling of land and shifts to groundwater reduced pumping of river water along the Sacramento River and in the Delta, which reduced entrainment losses of salmon fry, striped bass and Delta smelt.

Moreover, DWR abided by Yolo County’s limitations on groundwater pumping, paid for the installation and use of monitoring wells, and contributed a 2 percent surcharge for every $125 per acre-foot of groundwater used to replace surface water sold to the water bank from Yolo County. And the administrators of the 1991 water bank listened to all complaints about the effects of transfers on third-party interests and made sincere efforts to work closely with the Department of Fish and Game.

Notwithstanding these actions, there are three criticisms of the water bank:

• The transfer contracts were solicited, negotiated and signed before anyone other than the farmers, including the Department of Fish and Game, was able to participate. This reflects the general lack of notice provided to potentially adversely affected parties.

• There was no analysis of the transfer effects—particularly of the falling contracts—on migratory waterfowl. Loss of food, lack of brood water, and the reduction in cover and habitat resulted in some nesting failures and altered migration patterns.

• There is great concern in Yolo County that the additional groundwater pumping associated with the 1991 water bank has increased overdraft and created a risk of land subsidence. The groundwater replacement transfers from Yolo County were approved with little understanding of the hydrology of the area, and without a long-term plan regarding groundwater use.

Recommendations

On the local level, Yolo and adjoining counties should enact groundwater management plans that limit exports to the safe, sustainable yield of the aquifer and which protect against subsidence and contamination risks from increased short-term pumping.

On the state level, everyone seems to agree that when there is a perceived short-term water supply emergency, it is vital that the transfers occur expeditiously. That was why all
of the agencies involved made conscious decisions to minimize the role of the SWRCB. When the Board gets involved, it must conduct hearings and it must find that a transfer will not unreasonably affect fish and wildlife, groundwater resources or the local economy. That requires expensive hydrologic and biological analyses, and in some cases an economic analysis—none of which can be accomplished in the 60 to 120 days required for short-term transfers.

The Department is preparing a programmatic Environmental Impact Report to evaluate the broad variety of potential third-party effects. I would propose that this EIR serve as a map, and as a database, to allow the Department in future emergency situations to make rapid, short-term determinations of whether water can be transferred from a particular area without unreasonably harming fish and wildlife, migratory waterfowl, Delta water quality, streamflows, groundwater resources or the local economy.

The virtue of this EIR is that it would provide relevant information about potential third-party effects in advance of an emergency. Future transfers to the water bank would be permissible only if they were consistent with this EIR. Such transfers should not be subject to review by the State Water Resources Control Board. Transferors who want to go outside the bank for some reason would be subject to the Board’s jurisdiction.

Any transfer, whether it goes through the water bank or not, which appears to be inconsistent with the data developed by the EIR would be subject to Board hearings. This would give the parties to the transfer an opportunity to demonstrate that the transfer poses no significant risk to third-party interests.
On-Farm Perceptions, Attitudes and Opinions

Richard Berk:

We focused on the future by (1) describing to the Solano and Yolo County farmers various scenarios of what a water bank might be like and (2) asking them—on a scale of one to nine—how they felt about such a water bank and whether they personally would transfer water in such a situation.

The scenarios had four components:

• **Locus of control.** We asked whether farmers thought decision-making about transfers should rest ultimately with, for example, the county board of supervisors, a county water agency, or themselves.

• **Regulation of groundwater sales and exchanges.** We asked what regulations should exist.

• **Mitigation.** We asked what sorts of economic and/or environmental mitigation should be provided for, and who should pay.

• **Pricing mechanism.** We asked whether the water bank should make use of market forces, or whether there should be a fixed price.

Here, for example, is a typical scenario: Farmers could sell their surface water if they followed guidelines established by the county board of supervisors. Prices for water sold would be fixed by the state. Groundwater could not be exchanged for surface water sold, but groundwater could be sold directly to the bank. Land would have to be fallowed. The county would be allowed to collect a tax on all water transfers, for the purpose of local economic mitigation.

Each farmer we interviewed heard five such scenarios of possible water banks, and reacted to each one. We then disentangled the various components, to determine which made a water bank more or less acceptable to the sample of 188 farmers.

One set of responses to the key issue of groundwater shows that farmers generally preferred, by a substantial margin, water banking in which groundwater could not be exchanged or sold. In responding to all of these scenarios, farmers were particularly concerned that groundwater be protected.

Surprisingly, there was very little concern one way or the other about the cost of mitigation. There can be environmental mitigation or economic mitigation or both, but somebody has to pay for it. We gave choices—the legislature could appropriate money, there could be a statewide tax on water transfers, or a county tax. The difference didn’t
seem to be important to our respondents.

Again, farmers did not seem to care much about administrative regulation, or where the locus of control was—the supervisors, a county agency, or themselves.

The only concern that clearly distinguished successful from unsuccessful water banking options was the question of protecting groundwater. Any water bank that fails to protect groundwater will be unfavorably viewed by our respondents.

A few farmers were substantially divided over water banking in general—with about 15 percent of the respondents refusing to accept it under any circumstances, and another 15 percent at the other extreme who were enthusiastic. This suggests that there is some polarization in the farming community on this issue. However, the overall tendency was indifference—60 percent didn’t care much one way or the other. There probably were more pressing concerns on their minds than the details of one water banking structure versus another.

Farmers who actually had transferred water in 1991 were much more enthusiastic; and farmers in Solano County reacted more favorably regardless of which scenario we laid before them. We found that farmers whose parents had been farmers were substantially more favorable to water banking. Also, farmers who obtained more than 50 percent of their income from farms were more favorable.

Conclusions

There was nothing in the responses to our scenarios suggesting that some particular water banking arrangement will greatly please many people; nor is there a kind of water banking which everybody would oppose. The majority did not seem to care a great deal one way or another about these details of arrangement.

This means there is much room for discretion in designing a water bank to respond to some of the concerns that have been raised. One could propose various water banking structures and not worry too much about public outrage.

Finally, there seems to be some evidence that when farmers get into the water banking business, they like it. They make money and also find that many of the concerns they had before transferring are not as severe as they had anticipated. I take these findings to mean that, with farmers at least, there is considerable flexibility. Not only is there room for innovative possibilities, but as we get farther into the water banking experience, I expect that it will be even more favorably received.
An Overview

Henry Vaux:

A recent nationwide study by the National Academy of Sciences concluded that third-party impacts from water transfers are potentially significant and recommended that state and federal governments develop policies to account for them. The authors also noted that lack of empirical evidence on third-party impacts makes it difficult to identify those which are likely to be significant and which are not.

This conference has presented the results of studies designed to provide exactly that kind of empirical evidence—the physical, environmental, economic and social impacts of transfers during the emergency drought year of 1991 on two counties of origin. We also have heard the results of scientific surveys analyzing the opinions of farmers, business people and community leaders.

There are three especially significant conclusions:

First, forces other than water transfers—in particular, the drought and the economic recession—were at work in Yolo and Solano Counties during 1991, and their effects must be distinguished from those of the transfers. For example, certain changes in the overall hydrologic system as well as some environmental and social impacts have many causes; in at least some of these cases, one year’s water transfers probably played a minor role.

Second, the researchers found that water transfers do have significant impacts on one particular part of the hydrologic system: local groundwater resources. It is important to keep in mind that to some extent the State Drought Water Bank was designed to substitute groundwater resources for scarce surface supplies. However, the experience of 1991 underscores the importance of developing effective groundwater management policies—not only to ensure that transfers do not result in premature exploitation of groundwater, but to protect the groundwater resource even in the absence of transfers. Reasonable groundwater management policies should be developed in any case; but the prospect of heavier reliance on water transfers adds urgency to this issue on the state’s water policy agenda. Furthermore, land subsidence is another potentially significant negative impact of large-scale pumping of groundwater.

A third major finding relates to the economic and social impacts of water transfers on local economies in areas of origin. The local impacts in Solano and Yolo Counties during 1991 were significant, though moderate in intensity. Clearly, however, some jobs were eliminated and some agriculture-related industries lost business. These results suggest that
any comprehensive policy governing water transfers should recognize that adverse effects may occur in areas of origin—and further, that criteria are required to judge whether those impacts are so severe that transfers should be barred, or whether they can be compensated for in some way. (There also may be impacts in areas of delivery, which this study did not consider.)

It should be noted that Howitt’s computer analysis shows that some kinds of limits or constraints on the quantities of water to be exported from any particular location can significantly reduce third-party economic impacts—especially on jobs and on income at the county level.

**Two Qualifications**

Yolo and Solano Counties were excellent case studies. They mirror in many ways the range of conditions that are likely to prevail in other parts of the state that may be subject to water transfers. They accounted for almost 25 percent of the water that moved through the state’s water bank. However, I want to caution against making generalizations to other counties and regions where specific conditions may be different. This is only the first careful examination of the third-party impacts of water transfers, and others will be required before there is enough evidence to permit valid generalizations.

A second qualification has to do with the short-term nature of the 1991 water transfers. The conclusions here are based on one year’s experience and should not be extrapolated to long-term transfers. However, it is likely that most of the water transfers that might occur in California during the next decade or so would be temporary in nature. The results of this conference can thus help to guide development of rules and policies that will permit transfers to be used more widely in combating California’s frequent droughts.

One final point: This UC water transfer study was unique in that, in addition to direct factual analysis, scientific opinion surveys tested the perceptions, opinions and attitudes of all those involved—farmers who sold water, farmers who didn’t, allied businesses, and local leaders and decision-makers.

Significantly, the opinions of these people who have most at stake in the water-exporting counties coincide with the other research findings. They perceive that:

• Transfers involving groundwater put the groundwater resource very much at risk.

• Long-term impacts of continued transfers are likely to be much more severe than short-term.

Clearly, these voices, as well as the other research findings of the UC study teams, deserve attention as California faces historic policy decisions on water resource allocation.

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The Water Study

The Conference Program

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Major Study Project (1991-92)

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THIRD-PARTY IMPACTS OF 1991 WATER TRANSFERS
IN YOLO AND SOLANO COUNTIES

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Ann Thomas, Best, Best and Krieger
Conference Program

CALIFORNIA WATER TRANSFERS:
GAINERS and LOSERS in Two Northern Counties
UC Agricultural Issues Center and Water Resources Center

NOVEMBER 4, 1992  7:00 A.M. TO 5:30 P.M.

7:00-8:15  Registration, Radisson Hotel, Sacramento, 500 Leisure Lane

8:15  Welcome
KENNETH R. FARRELL, UC Vice President
Agriculture and Natural Resources

Video
Sharing Scarcity: Water and Water Use in California

Overview
KENNETH R. FARRELL

8:40
Keynote
Understanding Transfers:
The California Water Torture

JOSEPH L. SAX, James H. House & Hiram H. Hurd Professor, School of Law, UC
Berkeley. A Fellow in the American Academy of Arts and Sciences, Professor Sax is
author of Mountains without Handrails (1981) and co-author of Legal Control of
Water Resources in the U.S. (1991). At the same time as he has published widely in
law reviews, his popular writings on legal and natural resource issues have appeared
Republic.

8:30
Study Design
HAROLD O. CARTER, Director, UC Agricultural Issues Center

Video
Lay of the Land: Solano and Yolo Counties

9:50
Environmental Effects of 1991 Transfers
Actual, Perceived and Anticipated

Moderator
JEAN AUER, Vice Chair, San Joaquin Drainage Oversight Committee and Mayor,
Hillsborough

Speaker
ED McBEAN, Professor, Land, Air and Water Resources
Department, UC Davis
Panel  
SUZANNE BUTTERFIELD, Special Assistant to the Manager, Solano Irrigation District  
DAVID R. DAWDY, Consulting Hydrologist  
JAMES F. EAGAN, General Manager, Yolo County Flood Control & Water Conservation District  
GLENN OLSON, Western Regional Vice President, National Audubon Society and Chair, Central Valley Habitat Joint Venture

11:10  
Audience/Panel Participation

11:45  
Luncheon

Address  
Beyond 1991: Some Thoughts on Water Transfer  
DAVID N. KENNEDY, Director, California Department of Water Resources

1:25  

| Economic and Social Effects of 1991 Transfers  
| Actual, Perceived and Anticipated |

Moderator  
GEORGE HICKMAN, President, Western Farm Credit Banks, retired

Speaker  
RICHARD HOWITT, Professor, Agricultural Economics Department, UC Davis

Panel  
MARC FAYE, Farmer, El Dorado Ranch, Knights Landing  
BETSY MARCHAND, Supervisor, Yolo County  
NORMAN REPANICH, President, Solano Economic Development Corporation (SEDCORP)

2:45  
Audience/Panel Participation

3:20  

| Water Institutions, Laws and Rights  
| Present and Future |

Moderator  
BRENDA W. JAHNS, Attorney, Nossaman, Guthner, Knox & Elliott

Speaker  
BRIAN GRAY, Professor, UC Hastings College of the Law

Speaker  
RICHARD BERK, Professor, Sociology Department, UCLA

Panel  
PAUL BARTKIEWICZ, Attorney, Bartkiewicz, Kronick & Shanahan  
DAVID B. OKITA, General Manager, Solano County Water Agency  
ELAINE ROMINGER, Mayor, City of Woodland

4:40  
Audience/Panel Participation

5:00  
Conclusion  
HENRY J. VAUX, JR., Director, UC Water Resources Center

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Biographical Information

Jean Auer, a member of the AIC Board, is Vice Chair of the San Joaquin Drainage Oversight Committee and Mayor, City of Hillsborough. An independent water consultant, she was formerly the first woman member of the State Water Resources Control Board. She studied the state’s water problems during 20 years with the League of Women Voters and as chairwoman of the Commonwealth Club’s Water Study Section. She was chair of the Commonwealth Club in 1991.

Paul M. Bartkiewicz, is a founding member of the law firm of Bartkiewicz, Kronick and Shanahan, Sacramento, which practices exclusively in the areas of water rights and public agency representation. He has provided legal services in connection with many water transfers, serves on the Water Transfer Task Force of the Association of California Water Agencies and chairs the Water Transfer Task Force of the California Chamber of Commerce. He received his law degree from the UC Hastings College of the Law.

Eduardo Bautista has just received his Ph.D. in Agricultural Engineering (Irrigation and Drainage Engineering) from UC Davis. He was formerly a professor-researcher in the Division of Agricultural Sciences, Technological Institute of Monterey-Queretaro Campus, Mexico, where he taught courses and conducted research in the areas of agricultural water management and irrigation engineering.

Richard A. Berk is a professor in the Department of Sociology and Program in Social Statistics at UC Los Angeles, and is Director of the Center for the Study of the Environment and Society at UCLA. He previously taught at Northwestern University, UC Santa Barbara, and UC Berkeley. As Vice Chairman of the Social Science Research Council’s board of directors, he recently served on a National Academy of Sciences panel on monitoring the social consequences of AIDS. He has published 11 books and over 100 articles in a variety of fields, including applied statistics, program evaluation, time use, crime and justice, AIDS, and the environment.

Suzanne Butterfield has been Special Assistant to the Manager of Solano Irrigation District since 1991. Before that, during 16 years with the California Department of Water Resources, she served among other positions as Chief, Office of Water Conservation; Drought Response Coordinator; and Chief, Division of Local Assistance. She is currently a member of the Dixon City Council. She received a B.A. in Environmental Planning and Management from UC Davis in 1973.

Harold O. Carter is Director of the UC Agricultural Issues Center and a professor in the Agricultural Economics Department, UC Davis. He has served as chair of the department from 1970 to 1976 and 1987 to 1989. He was elected fellow of the American Agricultural Economics Association, served as chair of the UC World Food Task Force, as senior staff economist of the U.S. Council of Economic Advisers, and as co-director of the Economics Project of the UC-Egypt Program. His B.S. and M.S. are from Michigan State University; his Ph.D. is from Iowa State University.

Lawrence D. Clement has been County Director for UC Cooperative Extension in Solano and Yolo Counties since 1990, following nine years as County Director in Solano County. Before that, he was a field crop farm advisor for Cooperative Extension in Solano County (1978-1981), and a staff researcher at the UC Kearney
Agricultural Center (1972-1978.) He received a B.S. in soil science from California Polytechnic State University, San Luis Obispo, in 1968 and an M.S. in soil fertilization and plant nutrition from California State University, Fresno, in 1977.

Ray Coppock, an editor/writer for the UC Agricultural Issues Center, was Communications Specialist for UC Cooperative Extension from 1960 until his retirement in 1987. His work was in the fields of renewable resources and environmental issues, including water policy, as well as communications education. After graduating from UC Berkeley in 1949 with a BA degree in Journalism, he worked for 11 years as a reporter and editor on daily newspapers in the Central Valley.

David R. Dawdy, an internationally recognized leader in the fields of hydrology, hydraulics and sediment transport, is author of the U.S. Geological Survey rainfall-runoff model, and served as research advisor to the U.S.G.S. national research program in the field of surface water. He served as chief hydrologist for Dames and Moore in their role as technical evaluation contractor to the Federal Insurance Administration on Flood Insurance Studies. He developed the current method used by FIA to estimate flooding on alluvial fans, and the manual for implementation of the National Academy of Sciences suggested method for estimating wave height for hurricane flooding. He has served as a consultant on surface water studies and flood protection in Latin America, India and elsewhere. He has contributed more than 80 professional publications in the water resources field, and has been guest lecturer at numerous universities.

James F. Eagan has been General Manager and Secretary of the Yolo County Flood Control and Water Conservation District for 10 and a half years. Previously he served as director of public works in Rohnert Park, projects manager and public works inspector in San Rafael, and as a project construction inspector for the Metropolitan Water District.

Kenneth R. Farrell has served as Vice President, Division of Agriculture and Natural Resources at the University of California since 1987. In this role, he is responsible for administration of systemwide research in the agricultural, environmental and natural resource sciences conducted by the Agricultural Experiment Station on the campuses at Berkeley, Davis and Riverside, and at nine field locations; and for Cooperative Extension programs at the Berkeley, Davis and Riverside campuses and in each of California's 58 counties. He is past president and director of the American Agricultural Economics Association and was elected fellow of that association. Farrell holds degrees in agricultural economics from the University of Toronto and Iowa State University.

Eyvind M. (Marc) Faye Jr. is a farmer in the Knights Landing, Woodland and Grimes areas, producing prunes, pears, walnuts, rice, wheat, safflower and corn. He is a director or officer of numerous organizations, including California Pear Growers, the California State Reclamation Board and the UCD Agricultural Advisory Committee. He was deputy director of the California Department of Food and Agriculture, 1981-82, and is a past president of Yolo County Farm Bureau board of directors. He holds degrees from Stanford, (psychology, 1954) and UC Davis (agricultural economics, 1958).

Eve Picardy Fielder is Director of the Survey Research Center, Institute for Social Science Research, UCLA. She was project director of a Hispanic Immigration Survey by the National Association of Latino Elected and Appointed Officials under a Ford Foundation grant, and also conducted surveys of Mexican-American adolescents for the UCLA School of Social Welfare. She has extensive consulting experience and has received several honors and awards, including the 1990 Ruth Richards Award for Outstanding Student in Public Health. She holds a doctorate from the School of Public Health, Division of Population and Family Health, UCLA.

George Gardner received his MA in Agricultural Economics from UC Davis in 1992 and is now employed by Northwest Economics Associates in Vancouver, Washington. In 1988, he earned his BA in Economics and Mathematics from Northwestern University.

George Goldman is an economist in the Agricultural and Resource Economics Department at UC Berkeley, with an Extension appointment. A UC staff member for 33 years, he works in the areas of rural development, local government finance, local government cost-revenue analysis,
and land and water economics. Most of his work in recent years has involved the use of IMPLAN, a U.S. Forest Service economic model, which has the capability of generating local economic multipliers.

Brian E. Gray, a legal specialist in environmental quality and water resources law, is Professor of Law at UC Hastings College of the Law. He came to Hastings in 1984, having previously been an attorney in San Francisco and a lecturer in water law at Stanford. He has written numerous articles and technical papers on such topics as transferability of federal reclamation water; California water transfer law and water transfers in California; instream appropriative rights in California; and water trading. His law degree was from UC Boalt Hall School of Law in 1979.

George Hickman, a member of the AIC Board, is a financial consultant and a director of Blue Anchor Inc. He is retired past president of Farm Credit Banks of Sacramento, and retired head of the Agribusiness Department, Bank of America. He graduated from UC Davis/Berkeley in 1950. (BS, agricultural economics.)

Richard E. Howitt is a professor of agricultural economics at UC Davis. His areas of research specialization are agricultural economics, land use, water use and development, impacts of water markets, and impacts of air pollution. His degrees include an N.D.A. in agriculture and farm management from Seale-Hayne College, Devon, England; a B.S. from Oregon State University; and an M.S. and Ph.D. from UC Davis.

Brenda W. Jahns, a member of the AIC Board, is with the Natural Resources Practice Group of Nossaman, Guthner, Knox and Elliott in Sacramento where her practice focuses on water rights and environmental law issues. She has represented numerous public and private clients before state and federal agencies in matters such as environmental evaluations of proposed projects, responding to listing proposals on threatened and endangered species, evaluating the validity of water rights for development or transfer, and negotiating transfer proposals for groundwater. From 1983-1988, she was Special Projects Officer for the Bureau of Reclamation’s Mid-Pacific Region in Sacramento and played a key role in planning and implementing negotiation and litigation strategies and legislative initiatives. She received her law degree from UC Boalt Hall School of Law in 1979.

Thomas E. Kearney has been a UC Cooperative Extension field crop farm advisor in Yolo County since 1962, specializing in corn, wheat and safflower. He is a cooperator in the UCD Sustainable Farming Systems Project and a participant in UCD long term research on agricultural systems. He was a member of the Yolo County “Blue Ribbon” Task Force on the Williamson Act. He holds degrees in Agronomy from UCD (B.S., 1959; M.S., 1970).

David N. Kennedy became Director of the California Department of Water Resources in 1983, appointed by Governor Deukmejian. On February 1, 1991, Governor Wilson announced that he had asked Kennedy to continue as Director of DWR. From 1974-1983, Kennedy was assistant general manager of The Metropolitan Water District of Southern California. Before that, he was on the MWD staff and served as an engineer with DWR in Sacramento. He received BS and MS degrees in civil engineering from UC Berkeley.

Marcia Kreith, a program analyst on the AIC staff, is Coordinator of the AIC-WRC Study on Third-Party Effects of Water Transfers in Yolo and Solano Counties. She has extensive experience in organizing UC programs on state water policy issues and on global climate change. She also is the author of the recent Water Education Foundation study on Water Inputs in California Food Production.

Doug Malchow is currently a doctoral student studying California water policy at UC Davis, and is employed as a post-graduate researcher at the AIC, working on the study project to assess impacts of water transfers in Yolo and Solano Counties. He has a MS in Water Science from UC Davis.

Wendy Lou Manley is a staff attorney with Stoel, Rives, Boley, Jones and Grey in Portland, Oregon. On behalf of a large utility client, she participated in a federal administrative process for listing Columbia River salmon under the Endangered Species Act. Formerly, she was a law clerk with involvement in hazardous waste compliance and cleanup issues, and a consultant with an engineering firm involved in land fill design, waste management, etc. Her law degree
is from Northwestern School of Law of Lewis and Clark College (1990).

Betsy A. Marchand was elected to the Yolo County Board of Supervisors in 1972, was recently re-elected to her sixth term, and is currently serving as Board Chairperson. She has a record of involvement in meeting community needs, with special emphasis on water and transportation issues, criminal justice, health care, and child care services. She comes from a pioneer California family in the San Gabriel Valley, and taught high school English and social studies in Southern California. Her education includes an M.A. degree from Vanderbilt University.

Edward A. McBean is a professor of water resources, Department of Land, Air and Water Resources at UC Davis. He joined the UCD faculty in August, 1991, following 17 years with the Department of Civil Engineering, University of Waterloo in Canada. His research specialties include environmental assessment of projects, with emphasis on the environmental engineering components.

David B. Okita has been General Manager for the Solano County Water Agency since 1989. He was hired at the time the Water Agency was reorganized to include representation of cities and irrigation districts in addition to the County Board of Supervisors. He is currently president of the State Water Contractors, an organization of agencies that contract with the California Department of Water Resources for water supply from the State Water Project. A registered civil engineer, he has a M.A. in Public Administration from California State University, Hayward, and a B.A. in civil engineering from UC Davis.

Glenn Olson is Western Regional Vice President for the National Audubon Society, and administers Audubon's program in California, Oregon, Washington, Nevada and Guam. He is Chairman of the Central Valley Waterfowl Habitat Joint Venture, which has as its primary goal the protection and restoration of 200,000 acres of wetlands in the Sacramento and San Joaquin Valleys. He developed the California Wetlands and Waterfowl Program, which has raised over $3.7 million since 1986 to preserve wetlands. A native Californian, he has a B.A. from UC Santa Barbara and a M.A. from UCLA.

Norman J. Repanich has been President of Solano Economic Development Corporation (SEDCORP) for six years. His contact with local decision makers and his national and international connection with a network of business leaders provides insight into those organizations considering Solano County as a possible site for future relocation. He established economic development programs for communities in South Carolina, West Virginia, and Michigan. A native of Sacramento, he has a B.A. in Speech Communications and Political Science from California State University, Fresno, and has performed graduate work in communications at Stanford University.

Elaine Rominger is Mayor of Woodland. She also is Chair of Woodland's Redevelopment Agency Board of Directors, and Chair of the Yolo Water Group. From 1987 until 1992 she was Secretary/Manager of Yolo County Farm Bureau. She has been active as a volunteer in community affairs, in such organizations as Yolo County Farm Bureau, California Women in Agriculture, and the Woodland Farmers' Market Board of Directors.

Joseph L. Sax is a professor at the Boalt Hall School of Law, UC Berkeley and is known world-wide as an expert in resource and environmental law. He has been an attorney in private practice in Washington DC, a professor of law at the University of Colorado and University of Michigan, and a visiting professor of law at several other universities in the U.S. and abroad. He has received many awards in the field of conservation and is author of several books on environmental issues and water law, planning and policy. His law degree is from the University of Chicago (1959).

Connie Sorria has an interest in geography, maps, water and computers and is developing a Geographic Information System (GIS) map for the AIC water transfer study project. Presently a UC Davis graduate student working for an M.A. in Education, she has been involved in industrial engineering design for many years and also has taught high school. She previously worked on an M.A. in Geography at San Jose State University, focusing on California water resources, and holds undergraduate majors in electrical engineering, German and English.
Henry J. Vaux, Jr. serves as Associate Vice President for the systemwide UC Division of Agriculture and Natural Resources. He also is Director of the UC Water Resources Center and is a professor of economics at UC Riverside. For the past two years, he has been President of the National Institutes for Water Resources, a network of water resources research centers located at 54 land-grant universities throughout the U.S. He has authored more than 70 publications on the economics of water resources, and is an expert on the economics of irrigated agriculture and water marketing. Prior to joining UC in 1970, he served on the staff of the National Water Commission and as a water resources specialist in the Executive Office of the President. He holds a B.A. from UC and M.S., M.A. and Ph. D. degrees from the University of Michigan.

Raymond Venner is a research assistant at UC Davis and a Ph.D. student in Agricultural Economics. He was formerly a Peace Corps volunteer in Honduras, where he developed programs in soil conservation and fruit tree orchards and nurseries.

David Whelan is a graduate student in Sociology at UCLA. His interest is in environmental research.