# JP 1.7 -- Moving Water from Theory and Farms -- the Colorado Water Bank Experiment

John Wiener (U. of Colorado), reporting work by Howe, Wiener and others, with graphics and map assistance from Tom Dickinson, and a figure from Gates et al.

Powerpoint 97™ slides for pre-print volume, October 2003, for AMS Annual Meeting, Seattle, January 2004

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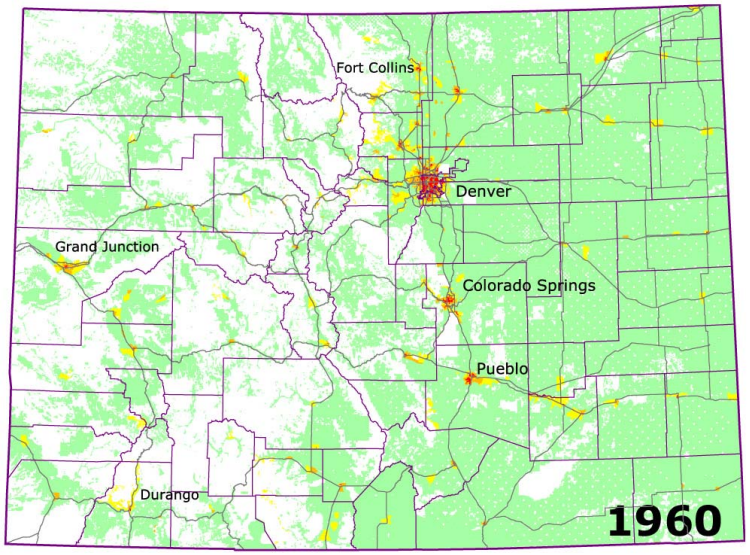
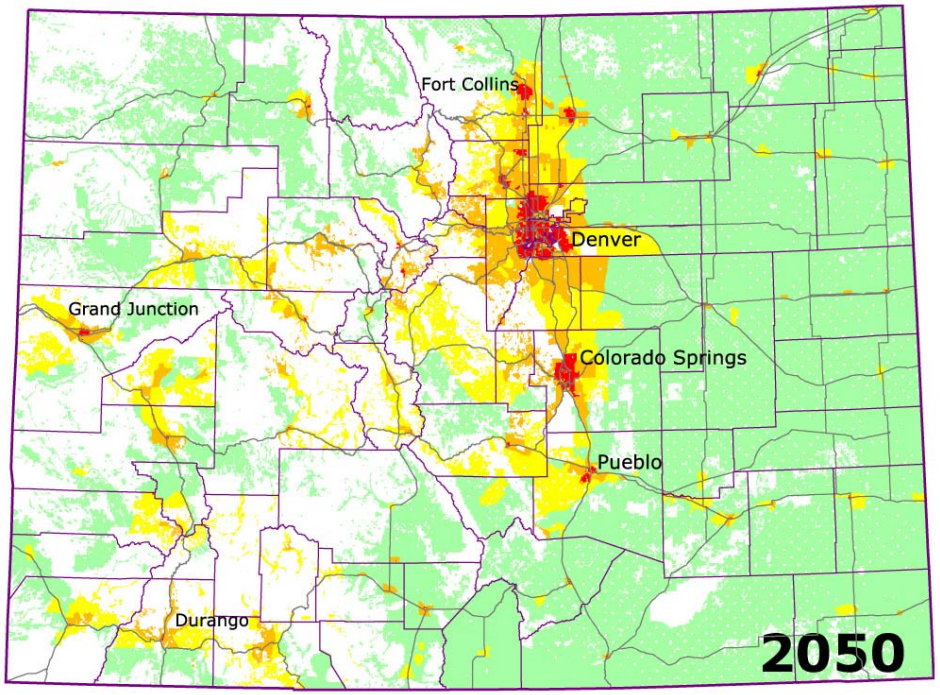
(actual poster presented will be modified, updated)

# Housing Density Change
# 1960 - 2050

(Tom Dickinson, C.U. Center for American West, and IBS Social Sciences Data Analysis Center)




Municipal demand for water is growing -- where will the water come from? This is a worldwide problem with urbanization in arid and semi-arid areas

*It seems so simple in the U.S. -- just buy the water from the farms… But the water is used many times. Water not consumed is returned to the stream and claimed by others. Traditional water law protects them, but makes transfers slow and costly -- can we do better? And can we ease the change and sustain farming and rural life?*

"*It is frequently argued that a reallocation of just 10 percent of agricultural water to municipal uses could augment municipal supplies West-wide by 50 percent.*" (Nichols et al. 2001: xii-xiii: Water and Growth in Colorado, C.U. Natural Resources Law Center).

"*Irrigation agriculture continues to be the focal point of discussion on sources of water to meet growing demands. Calls for conservation have come from several sources, apparently prompted by assumptions that the magnitude of agricultural water use is associated with inherent inefficiencies in current use and that minimal efforts toward conservation could yield the water required for alternative uses.*" (Smith et al, 1996, Irrigation Water Conservation: Opportunities and Limitations in Colorado, C.S.U. Water Resources Research Institute.)

# Our Case: Where does Arkansas River water go?

- Municipal Use versus other use -- average withdrawals by owner before the 2002 drought

| | | |
|---|---|---|
| CITIES | | |
| Colorado Springs | 76,000 acre-feet | |
| Pueblo | 38,659 | |
| Aurora | 35,459 | |
| Canon City | 5,703 | |
| Pueblo West | 3,100 | |
| Florence | 2,067 | |
| Lamar | 900 | |
| Municipal Use Total | 161,888 | (11.97% of CO use) |
| Kansas State Line Flows | 192,358 | |
| Rocky Mountain Steel | 76,779 | (5.68% of CO use) |
| Agriculture, Irrigation | 1,113,647 | (82.35% of CO use) |
| TOTAL used from Arkansas River | 1,544,672 | |

(Frying Pan-Arkansas Project, and other trans-mountain diversions provide average 69,200 acre-feet used by Southeast Colorado Water Conservancy District; SEWCD Annual Reports; city figures compiled by Pueblo Chieftain, 19 Dec 1999 from figures from Office of the State Engineer.)

# Another problem: social and environmental impacts on rural areas from removal of agricultural water

- The loss of crops, replaced by “weed farms”
- The loss of employment and families
- The “loss of future” if water transfer is permanent -- lost opportunity no matter what else comes along
- Even if water is “leased-back” temporarily, asset value is lost
- The secondary impacts on local economies -- backward linkages to suppliers of inputs to agriculture, and forward linkages to consumers and users (in Colorado, especially the livestock industry), “rippling” through everything from school finance to employment on and off the farms

- More information: See Howe and Goemans, Dec. 2002, “The nature and impacts of market transfers of water in the South Platte and Arkansas Basins”, Colorado Water, on-line <http://cwrri.colostate.edu>

# The Legislative Goals in the Colorado Water Bank Experiment

- *Simplify* and improve approval of leases, loans and exchanges, including interruptible supply agreements for stored water
- Reduce *costs* of transactions
- Increase availability of water-related *information*
- Assist farmers and ranchers to *realize the value* of their water rights assets *without forcing severance* from land
- Avoid material injury to other water rights users
- Make no other changes to water law
- Get State Engineer's report in 2005 on pilot program -- but in 2003, state-wide authority to establish "water bank" without "sunset" clause
- Arkansas River Water Bank Pilot Program: HB01-1354 (CRS 37-80.5-101 et seq.); rules effective 2002; website and operational date January 2003, operated by Southeastern Colorado Water Conservancy District
- HB03-1318: Water Banks in other basins, but no out-of-basin transfers
- Other bills in 2003:  Interruptible Supply Contracts can be out-of-basin, but are limited in duration and conditions of use; emergency supplies OK

# Two ideas of a "Water Bank"

- Historically, two kinds: ground-water *storage* with traded rights to use, (AZ, NE, etc.) and *this kind*, *transfer* use of water stored in reservoirs or for interruptible supply/dry-year options, use of flows to come
- Experimental for Non-"Project" water and surface water (Trans-basin "project" water can be free of water rights to return flow, so much more easily transferred (see Howe and Goemans, supra., Wiener, AMS 2003)
- Temporary transfers become practical because can be quick
- Big reduction in costs of transfers
- Makes possible many small changes otherwise too costly
- Makes experiments possible to involve many interests now very expensive to organize
- The interruptible supply/dry year options idea, in Colorado, can be pursued with "water bank" in-basin, or short-term out-of-basin under different authority
- Agriculture-to-agriculture transfer and agriculture-to-other uses
- Big controversy still (late 2003): What about out-of-basin transfers?
  - Pro: Highest prices likely from out-of-basin, even for lease transfers
  - Con:  Any transfer out of basin is threatening

# Skip water court? Critical for working "water bank" -- But, very threatening to many Coloradans

- Why is not using Water Court critical??
  - Because it saves time -- some deals only work if fast enough
  - Because it saves money -- costs can't exceed benefits or no deal
  - Because it makes many changes possible -- where transfer is fast and cheap, average size of deals is small -- the opposite of the Arkansas and West Slope experience (Howe and Goemans, supra)
- Why do people fear allowing this?
  - Because it might reduce the protection for others
  - Because it reduces the time for them to evaluate the change
- Resolution? Maybe…
  - If compromise on notification and burdens not unfairly shifted -- the issue is "who has to prove what" -- that's what costs! Does opposer have to prove injury? Or does changer have to prove no injury?
  - Is there agreement that State Engineer can administer on "good enough" basis? Legislature says yes, but… no deals as of October 2003 -- and drought continues...

# The idea of Interruptible Supply Contracts or “Dry Year Options”

- A commitment to lease water under conditions that the parties specify -- timing, annual fees,... many possible terms of deals; long duration likely
- Water rights “stay on the farm” -- avoid permanent transfer
- Transferable amount limited, of course, so no injury to others
- Cities seem most likely to use dry-year options, but uses for high-value agriculture and industry are not yet known (e.g., new hydroponic tomato farming in Pueblo announced -- feasible because of reliable city water)
- Should be attractive if normal supply is sometimes insufficient, and the optioned water does not require new infrastructure
- Early exercise to save costs; later, require higher payment -- set fees to cover costs to maintain soil and farm management as well as other expenses (warning: some claim this is a bad choice for farmers)
- There is strong public support; “Colorado 64 Principles” (adopted by all counties as [soft] policy) and Dept. of Interior “Water 2025” initiative
- Question for the cities: How much need can be met this way, and how much must be permanent water rights transfer? Are cities now using conditional rights where this might work?

# The Potential Benefits Are Substantial

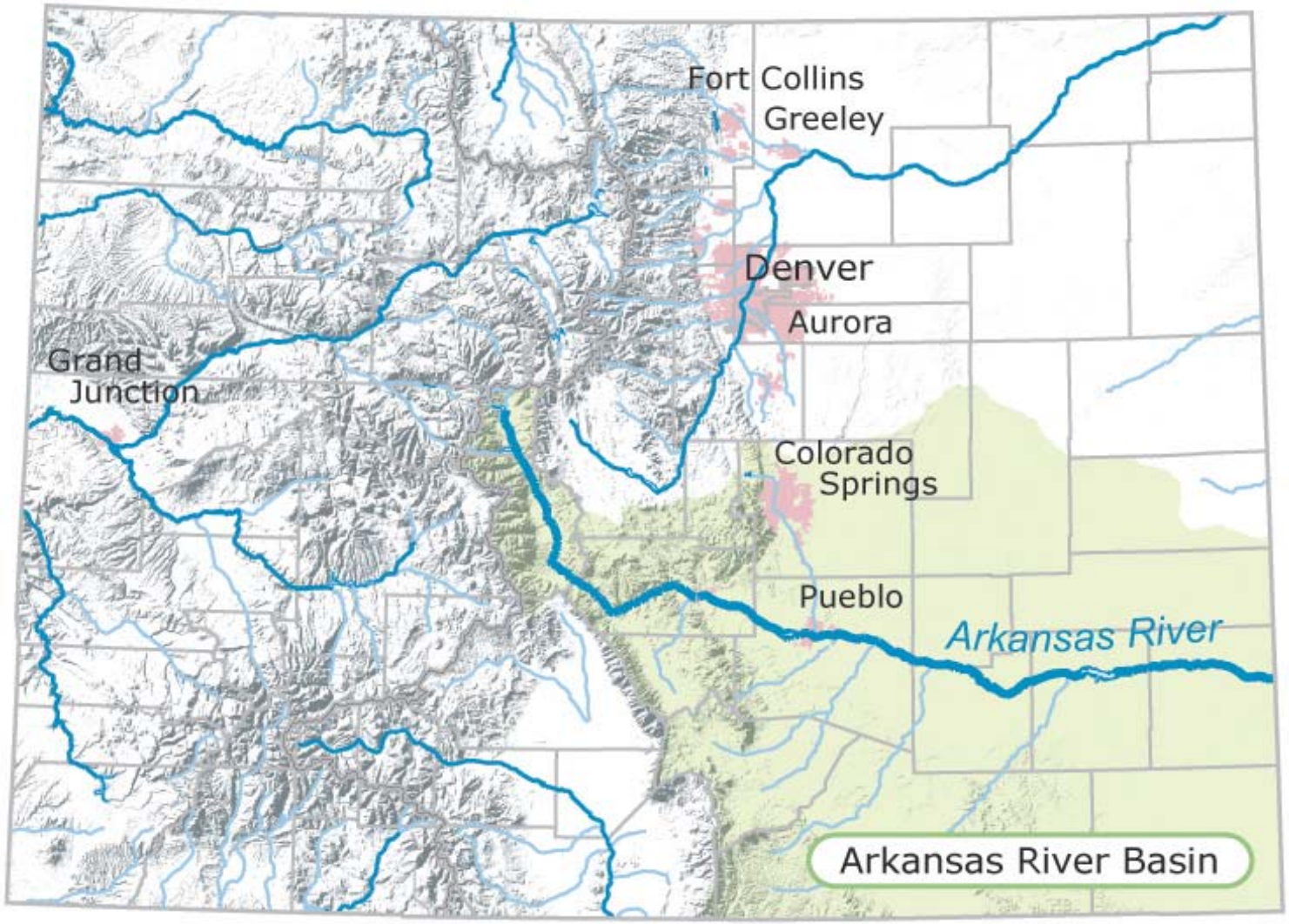
- Ag to Ag AFFORDABLE transfers: good water on good soil, in good time -- use climate, market, weather info, for:
  - New capability of responding to the annual/seasonal situations
  - New capability of responding to the in-season case
- Agriculture to Municipal Use transfers:
  - New long-term dry-year options - farmers may get better deals!
  - Water can be aggregated from small amounts or not -- individuals and ditches have flexibility in how they manage their water
  - Short-term “spot market” leases are also allowed
- Chance to experiment with bringing in **public $$ for public interests**:
  - Recreation -- local, hunting, fishing, tourism
  - Salinity reduction by irrigation rearrangement
  - Environment and amenity -- species, wetlands, etc…
- Resilience -- Make farms, ranches and cities better off, not just restoring arrangements that failed after drought relief arrives, but allowing more efficient arrangements equitably (or at least happily) achieved

# Special Features of Arkansas Water Bank

- *Legally stored* water can be used -- not limited to foreign/trans-basin water -- but no direct flow water rights can be used -- problem?
- Allows contracts and actions in response to *climate information*
- Allows wide range of transactions:
  - *interruptible supply contracts (dry-year options)*
  - changes in place and kind and time of use of the transferable portion of the water
- Compromise in rules between notification and delay versus making much faster transfers possible than before… but still, months...
- Can use State Engineer's *estimates* of historic consumptive use, and administration of the remainder to maintain historic patterns of return flow (no extra cost) or prove other figures (at your own expense)
- *In-basin preference* in Pilot Program; now, *no* out-of-basin transfers
- As of May 1, HB03-1318: Extend the opportunity to all basins, on request of a conservancy or conservation district
- But… was 2002 the worst time to try the experiment? Many think it couldn't have been worse, given the drought and the politics.

# Arkansas River Basin in Colorado

Map by Tom Dickinson, SSDAC, IBS, University of Colorado



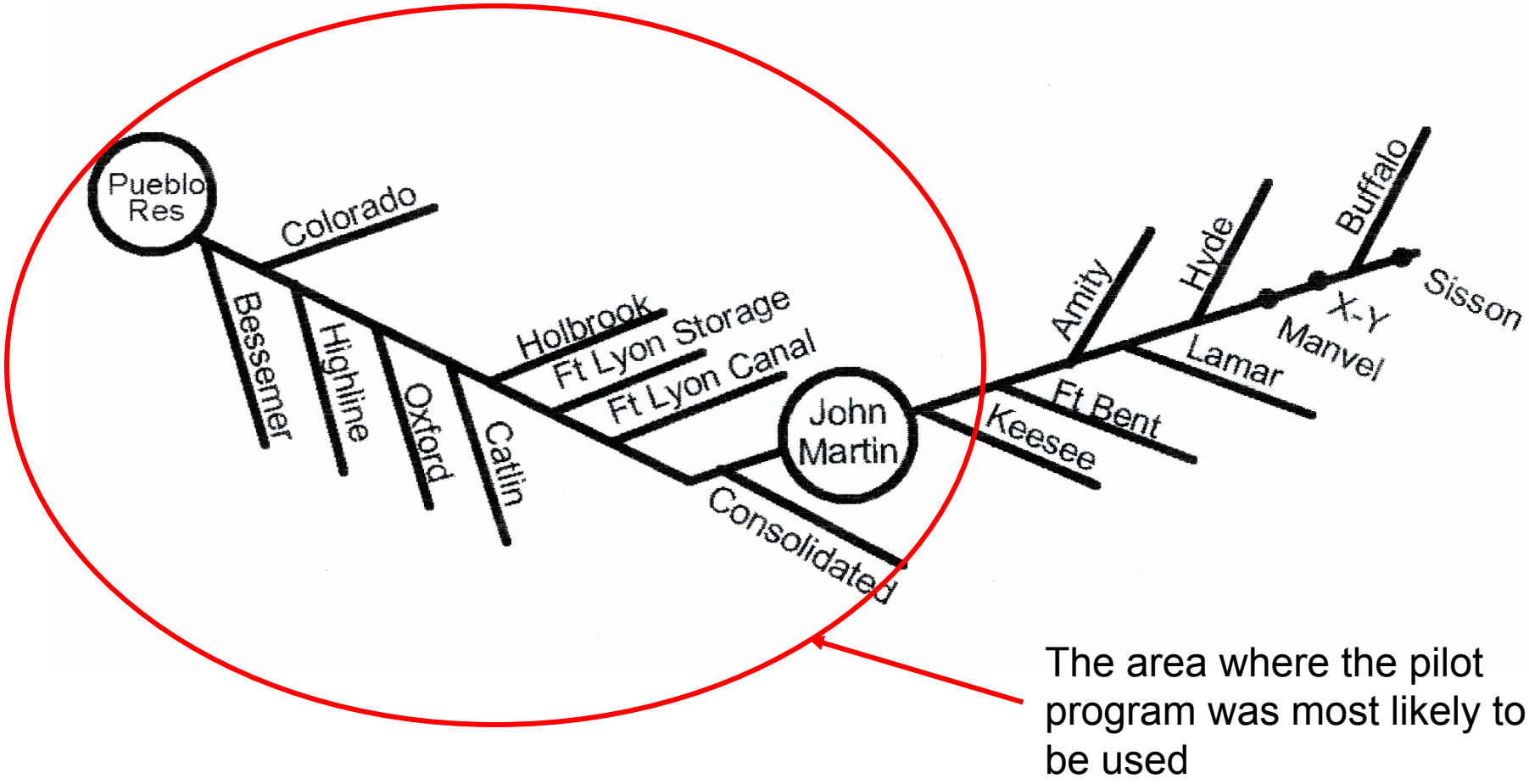
# Why was it tried first in the Arkansas Basin?

- Simplicity of the situation -- relatively few major water users -- help or hindrance?
- Depth of available information on wells, augmentation,and water rights, from Kansas v. Colorado hydrologic modeling
- Very serious consequences in the past from status quo -- “big changes only” in the past, as effect of high transactions costs:
  - Arkansas Valley followed South Park as an infamous case of high secondary economic impacts from several very large sales
  - The Rocky Ford sale of very senior water rights and loss of farming in the Valley attracted public concern in 1990s and 2000s
  - The Valley is still remarkably dependent on agriculture and hurting!
- [And the academic view? In the competition over water between marginal agriculture and growing cities, is small agriculture doomed? Perhaps better rules can help uses continue and co-exist. There are easy transfers in the Northern Colorado Water Conservancy District, and much richer agriculture. Comparing counties and complicated situations is difficult - there are no simple answers! (See Howe and Goemans, December 2002 Colorado Water, supra)]

# Lower Arkansas Valley -- Schematic of Major Ditches Shows Relative Simplicity of the Arkansas --

A similar map for most basins looks much more like a spaghetti accident...

(Figure from Office of State Engineer)



# Objections to the Arkansas Water Bank -- Economic Impacts? (What we learned interviewing potential users)

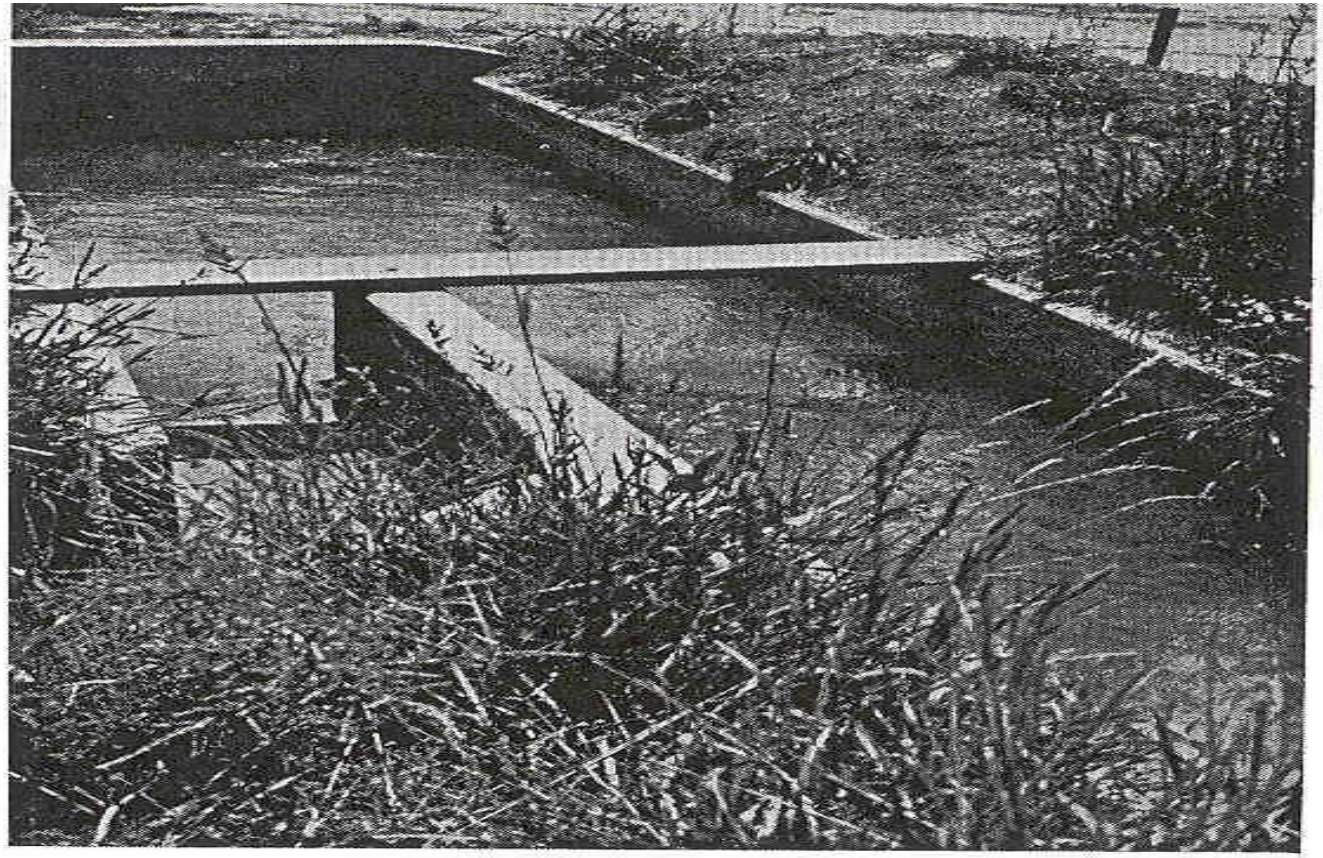
- Fear of price effects on permanent water rights sales -- will water rights be worth less if water is more freely transferable?
- Answer: Don't know!
  - May be depressing, if same market
  - May not impact, if dry-year options or spot-market short-term transfers are actually different segments of the market
  - Important that we don't know, since it has been so easy, until recently, for cities to acquire conditional water rights, or buy water rights and "lease back" unneeded water to agriculture until needed. Municipal ability to pay is much higher than agricultural return on water, so there has been little difficulty for growing municipalities
  - Increased transferability may increase value because of new potential uses
- Needed: further inquiry and better information on prices
- Also need more effort to engage municipal policy makers… so far, so good, but will the first one have to go to Supreme Court at high cost?

# Objections to the Arkansas Water Bank -- Management Difficulties for the Ditch Companies

- Ditch Companies face problems in:
  - (a) Decision-making:
    - do the by-laws impose limits on transfers of water? Limits on transfer out of the ditch are common
    - Do the by-laws require a vote or board of directors approval of transfers? Are there special procedures for out-of-ditch transfers?
    - Accounting can be complex -- Whose water? Whose $? How to allocate additional expenses from lower flows?
  - (b) Internal water management:
    - If there are long distribution laterals, is the minimum decision-making unit for a transfer too big?
    - If the ditch uses “splitter boxes”, high infrastructure rigidity
- Answer? It is their business and their private property
    - Some financial aid is available, and information from Co-operative extension -- but, we still need an active market!

The Problematic “Splitter Box” -- Water Management “set in concrete” so no more management is needed. Now, this may put some ditches at a competitive disadvantage.

(photo from Colorado State University)



# Objections to the Arkansas Water Bank -- Long-term impacts and fears

- Dry-up? the Problem of Irrigation Efficiency
  - Dry-up is simple, traditional, observable and not very efficient!
  - Hurts local economy, soils, weed problems, and farm management (e.g. labor, rotations, market niches)
  - Reduces incentive for short-term water transfer, reduces long-term resilience for both farmers and the water management system
- Answer? Can we get "close enough"? This involves:
  - Complicated politics - the new institution needs social acceptance
  - Complicated engineering - *How much*? What's "good enough" is a question not usually asked of engineers and lawyers
  - Institutional coordination and private sector involvement will be needed -- not a trivial task
  - May need legislative push for administrative support
  - Agricultural efficiency needs more research on how to fairly "save" water and allocate it without losing production and with lower salt loading from deep percolation if possible
  - Aggregating individuals' small amounts, and supporting the ditch too

# Constraints and Stumbling Blocks to Use of New Information -- A Synthesis from the Literature

- In the individual receiver of the information
  - Ability to evaluate, understand, or relate the information to projects?
- In the content of the information (see Wiener, AMS 2003, AMS 2004 pre-prints)
  - Is it what is wanted or close enough to be adjusted?
  - Does use require other information or technique?
- In the form or delivery of the information
  - E.g., older farmers don't use internet; many can't get good quality service
- In the associated decision-making group
  - If collective act needed, can group act?
  - Does individual interest conflict with others or collective interest?
- In the formal authority or physical or financial capacity to respond
  - Inability to move water defeats application of climate information! So we "need" the water transfer bank as modification of western water law
- In the economic organization of the activity (linkage or markets limiting?)
- In the informal, cultural or personal characteristics of the receiver or the associated decision-makers? (More discussion and application: see http://sciencepolicy.colorado.edu/wwa/ - presentations archives, Wiener)

## Climate and Weather Forecasts to the Rescue? Applications for long-term forecasts, long term planning and increased value of water rights might be the added incentive wanted

- Interruptible Supply Contracts or “dry year options” for intermittent needs: more certainty about increased variability
- Agriculture to City: “firming” supply for unusual needs
  - Does not replace permanent water sales for permanent growth needs
  - May replace water sales for needs not always appearing, such as drought years (higher outdoor use in cities just as supplies shrink)
  - Attractive if new infrastructure needs are reduced
  - Popular support and endorsed by federal and state agencies
- Agriculture to Agriculture: Support investments in higher yield
  - Assured supply even in competitive market, with controlled price
  - Support high-value farming (fruit, vegetables, organics, direct sales)
  - Payments for option support increased efficiency in lower-value commodity production or reduced debt loads

## Climate and Weather Forecasts to the Rescue? Annual, seasonal forecasts for pre-season planning and better results

- Planning the coming year -- mix of crops best suited for expected water supply and other inputs to production
  - Different crop cultivars (e.g. 80-day corn to 150-day corn)
  - Different crops -- timing of critical water need differs between crops
  - Different rotations of crops or fallowing
  - All choices may be improved by earlier land treatments
  - Earlier decisions may save money on seed orders
- Vegetable markets are very complex; information wanted for own farm, regional and for competitor regions -- especially important for marginal crops and farming areas!
- Pasturing -- when and where to move animals, lease pasture
- Little crop switching without this incentive, so far
- Threat management and resource allocation
- (More detail: see Wiener, AMS 2003, 2004 pre-prints)

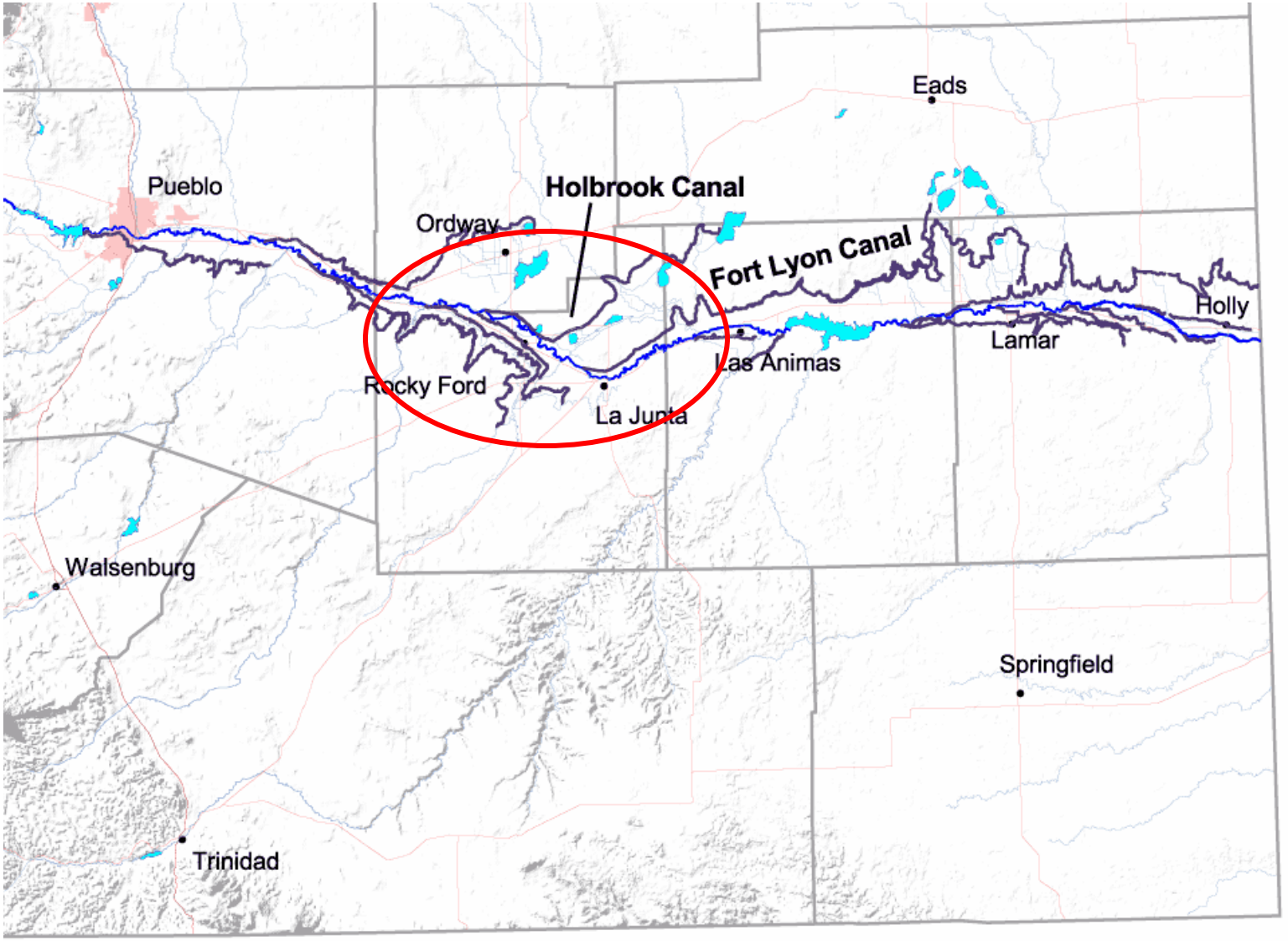
# Climate and Weather Forecasts to the Rescue? In-Season forecasts will soon be much better used

- Manage shortages by crop stress timing
  - Because crops differ in time of critical need, in-season forecasts can help adjust plans especially on which crops to "short" when…
  - Irrigation scheduling tools are available, and can be or will soon be easily adapted to use with forecasts as well as current and recent weather information
  - Colorado's "crop flex" model <http://ccc.atmos.colostate.edu/~crop/>
  - For Kansas, and more background on information wanted and used:
  - <http://www.oznet.ksu.edu/pr_irrigate/CPIA.htm> -- the Central Plains Irrigation Association (California and other states have a great deal of information available as well…)
- Manage the water assets by transfers if warranted
  - The near future (already partly here -- see DTN, Inc. commercial source) will include market information, water price and demand information, and weather and climate forecasts -- own and competitor's regions

# Public Interests Fostered by Improved Management Using Climate and Weather Forecasts

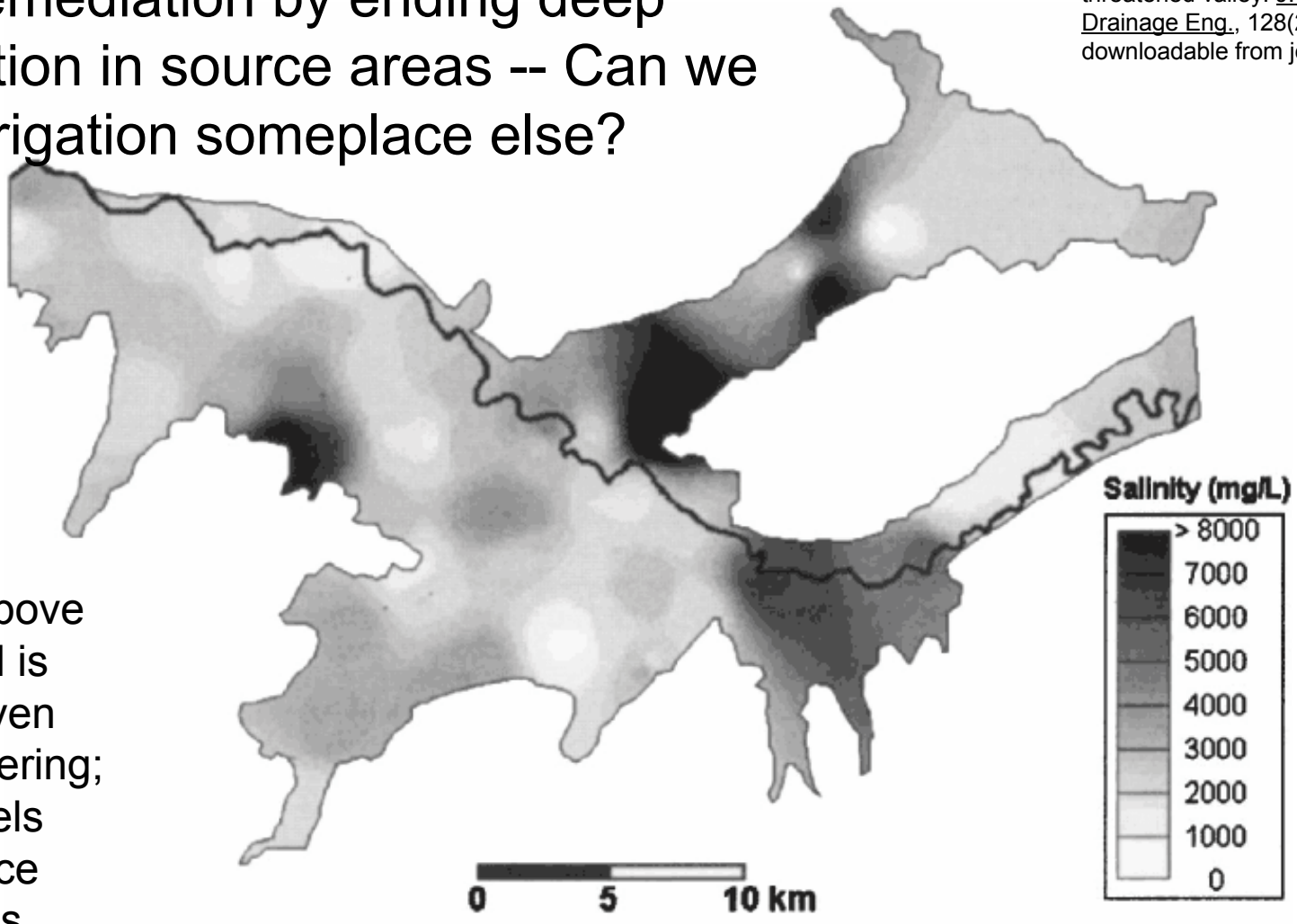
- All water users are affected by salinity, through reduced crop yields and increased costs of water treatment for drinking… moving irrigation may cut deep percolation on saline marine shale sources (see Gates et al.)
- Restrictions and uncertainty in resource management due to Endangered Species, Wetlands conservation, and other environmental issues are costly, increasing the benefits from flexibility to increase or establish buffers and reserves to avoid or manage problems; these are climate-sensitive for aquatic and riparian concerns.
- Rural sustainability and economic growth is highly dependent on amenity values for local residents, dependent in part on agricultural viability (USDA ERS, see below); tax and real estate values are also affected, and thus basic government and services.
- Every state, the federal and many local governments have enacted programs to conserve farmland and many foster small agriculture as well, for many reasons; these programs demonstrate widespread interest (USDA ERS, various sources, available on internet; see especially Agricultural Economics Reports Nos. 765, 778, 781,803, 815)

Locator Map for Two Canals (see schematic) in the Valley -- note wishbone shape here and in salinity map from Gates et al. (Map by Tom Dickinson)



# Inhomogeneity of salt loading suggests remediation by ending deep percolation in source areas -- Can we move irrigation someplace else?

Figure from Gates et al., 2002, Monitoring and modeling flow and salt transport in a salinity-threatened valley. J. Irrig. And Drainage Eng., 128(2): 87-99; downloadable from journal site.



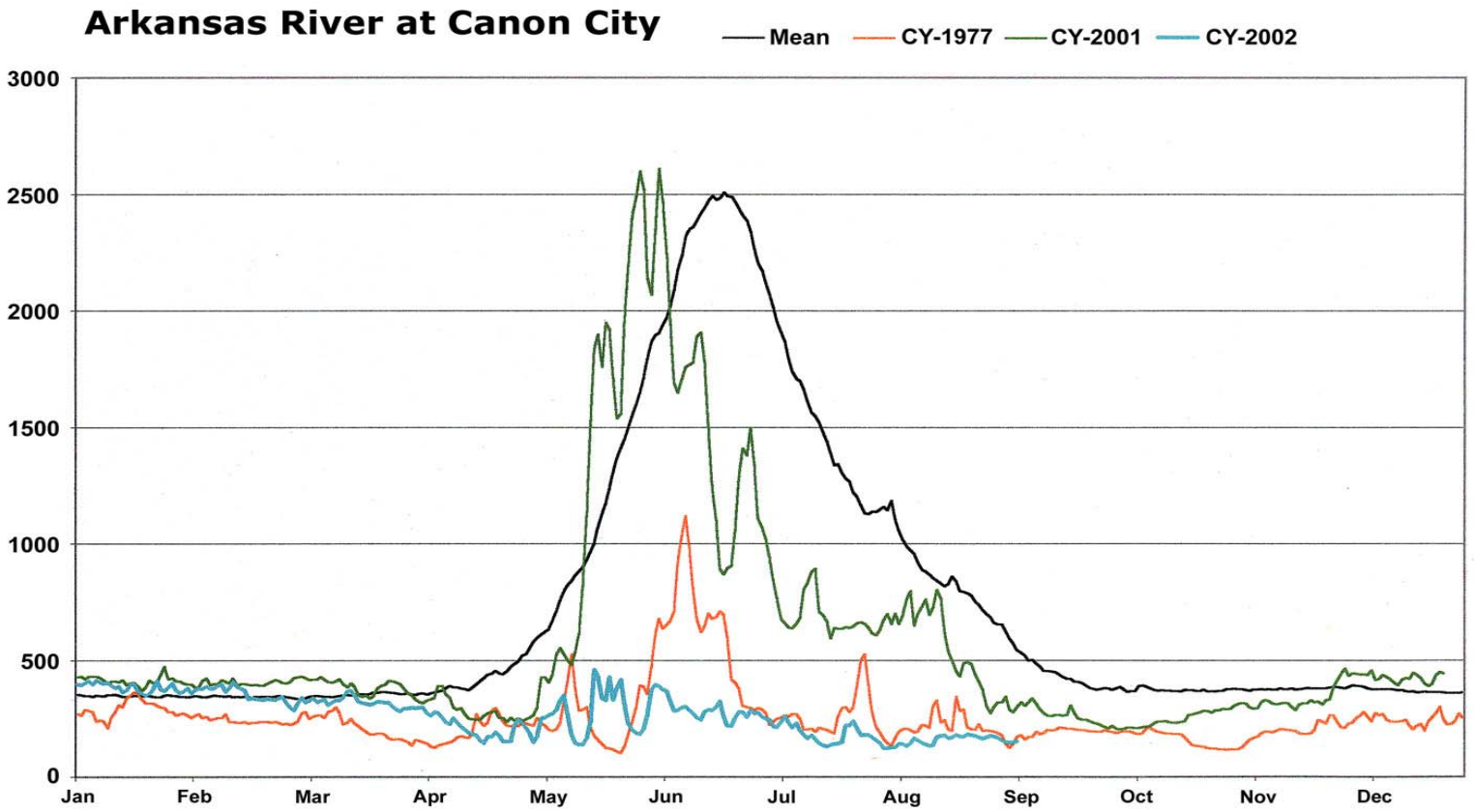

Salinity above 1500 mg/l is bad for even stock watering; these levels also reduce crop yields.

Estimated contours of water table salinity based upon specific conductance readings in observation wells for July 14±17, 1999

# Arkansas River Hydrographs (Canon City)
## Mean, 1977, 2001, 2002
(Office of the State Engineer)

Flows were very low all year long in 2002 and after

Flow in cfs; note early peak in 2001 - low soil moisture as well going in to 2002



# Fort Lyon Storage Canal Headgate

Almost no inflows! The biggest ditch in the Valley ran dry in 2002, and sales of options begun in 2001 continued in 2002 and in 2003



2001 was a more normal year

# Holbrook Canal Headgate Works -- May 2002

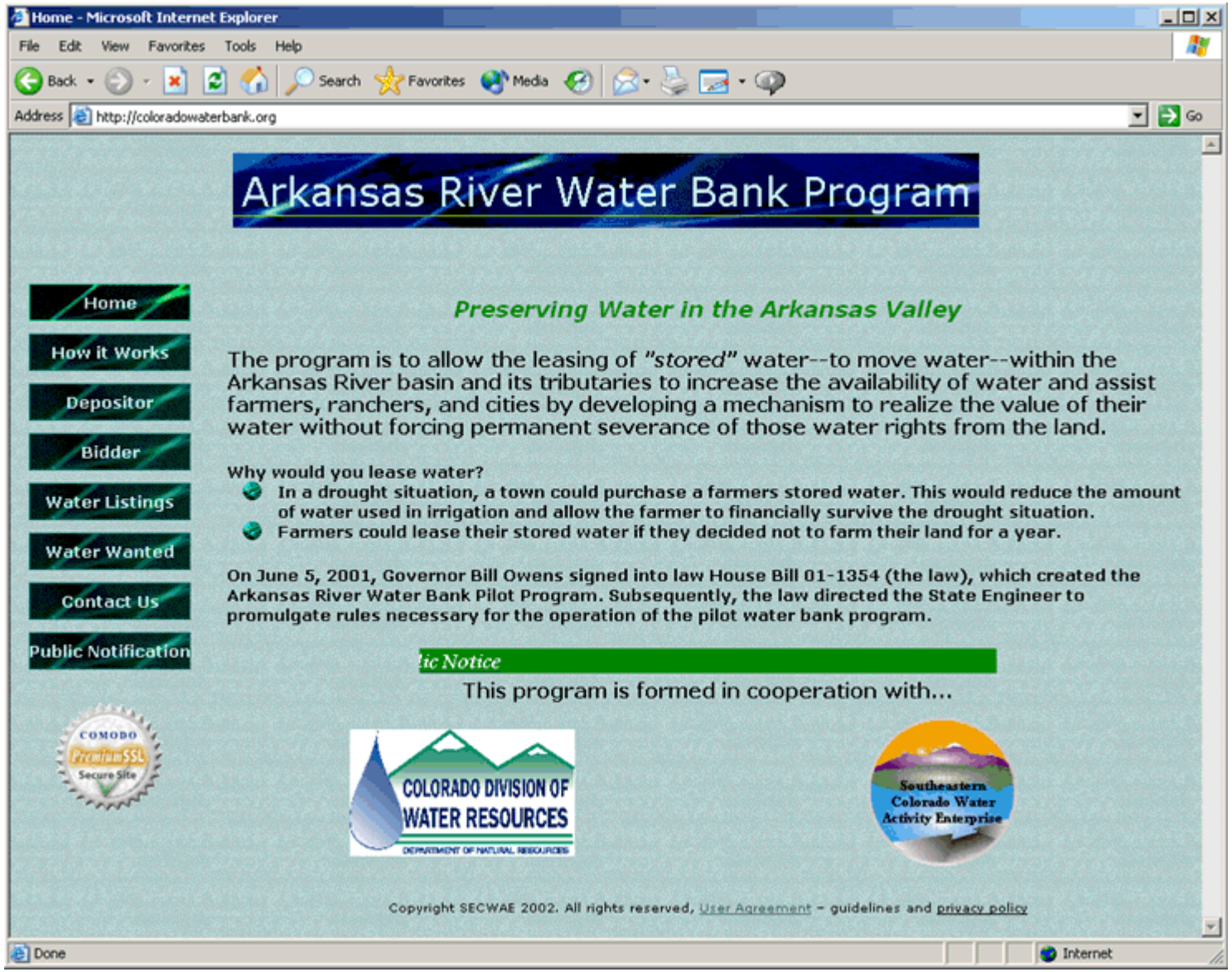
Note that these are substantial investments with significant effects on the environment and positive as well as negative effects on the ecology

# Holbrook Canal, May 2002

# Perspective of the Water Bank Operator -- Why has there been no use of the new opportunity yet?

- Restriction to “stored water” only limits what can be transferred -- only some have storage
- Need for acre-feet, not shares or allocation % may limit use - delays listing until amount certain -- too late for some uses?
- Consent of private systems may be problem (see objections notes on internal ditch issues)
- Necessity for dry-up of proportional acreage may impose threat of unknown costs (see objections notes)
- Notice requirements also impose delay
- The Drought of 2002 -- came at the worst time! No one had water to trade when the bank became operational (Jan 03)
- (Interpretation of presentation and other discussion by Mr. James Broderick, SE Co. Water. Consy. District General Mgr. , by Wiener)

# http://coloradowaterbank.org



# SOCIAL PRESSURE: Arkansas Valley public opinion when the Water Bank Pilot Program was becoming operational

(Ciruli Associates Survey reported by Arkansas Valley Water Preservation Group)

- 90% Disapproved of out-of-basin water sales
- 89% Important for State to deal with drought
- 84% Important to keep water in farming and ranching for future economy
- 82% Approved forming new conservancy district
- 78% Favored tax increase to raise $ for it
- CRITICAL PROBLEM -- Many of this strong majority believed the water bank would increase out-of-basin transfers of water that would "never come back" -- do some farmers think it just "wrong" to transfer water? If so, how will this constraint be overcome?

# More Problems (hindsight or insight?)

- No market history -- no realistic price expectations for small transfers -- and too small a set of potential transferors? Previous sales all too big; no leases...
- Social pressure from fear, misgivings despite stated purposes of water bank -- just don't believe...
- Endless distractions from "water raids" and sales to speculators as well as out-of-basin cities buying, with lots of public concern
- Serious in-Valley conflicts over water issues, between the big cities of Colorado Springs and Pueblo, worse with pressure of drought
- Local water supply and quality issues for small cities and farms have been dramatic in some cases involving changed enforcement of well regulations, especially in the South Platte Basin, with implications for the Arkansas as well.

# So far… (end of October 2003)

- Rules done, Arkansas water bank “in operation”… but no uses -- no publicly known negotiations on price
- Basin water politics not settling down much -- some issues being settled but many still very contentious; “water raid” speculation buying continues, too -- plenty of fear and anger to go around!
- Drought of 2002 is probably continuing… with poor prospects for much of Colorado and the Southwest and Plains as of October 2003
- State legislation: extended water bank opportunity statewide, provided separate out-of-basin transfer authority but it is short-term and limited; now there is a hotly argued referendum asking for up to $4 Billion bonding debt without specified projects; Statewide Water Supply Initiative study process has begun: first water planning by Colorado.
- The interest in using climate and weather forecasts is growing, especially with the surge in interest in paleo-climate information and the dramatic “odd weather” events.
- The potential competitive advantages of using the new climate and weather forecasts are slipping into public discourse… We’ll get there!