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COLORADO WATER

Newsletter of the Colorado Water Resources Research Institute, Fort Collins, Colorado 80523

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WATER ITEMS AND ISSUES . . .

November 1989

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A copy of a paper by Russell N. Clayshulte, **Denver South Platte Water Quality and Wastewater Management Study**, is provided as an attachment. The paper was presented at the Colorado Groundwater Engineering and Management Conference.

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CALL FOR PAPERS
COLORADO STATE UNIVERSITY

AWRA - COLORADO SECTION
AND METRO CONSERVATION INC.

SYMPOSIUM ON
WATER CONSERVATION

AWRA Colorado Section will host an all day conference in early February 1990 to explore various aspects of water conservation, including:

MUNICIPAL AND INDUSTRIAL WATER CONSERVATION

- o Drought Contingency Planning
- o Pricing and Rate Structures/Metering
- o Retrofitting with Low Flow Devices
- o Leak Detection

AGRICULTURAL WATER CONSERVATION

- o Techniques for Improving Irrigation Efficiency
- o Legal/Institutional Barriers to Conservation
- o Incentives for Improving Irrigation Efficiency
- o Benefits of Water Conservation

FUTURE DIRECTIONS IN CONSERVATION

- o Public Education and Perceptions
- o Reuse and Recycling
- o Model conservation Programs in Other States
- o Legislative Proposals
- o Water Marketing and Water Conservation

You are invited to submit an abstract for the symposium no later than November 15, 1989 to:

Kate Berry
AWRA Colorado Section
1740 High Street
Denver, CO 80218

Each presentation will be limited to 20 minutes. Abstracts will be published in a proceedings.

RESEARCH TO GUARANTEE COLORADO'S WATER SUPPLY FUTURE

Editorial by Neil S. Grigg

Water supply for the economic futures of all of Colorado's regions is a critical policy issue needing more study than it has received. This is borne out by testimony before legislative committees, editorials and speeches by water leaders. It is a critical issue for each of Colorado's interest groups and geographic regions.

In Colorado, as in other western states, major policy attention has been on planning or opposing new projects and on interstate compact protection. Little attention has been given to making existing supplies go further through better management, except in calls for "conservation" and water use "efficiency." While it is true that because of the appropriation doctrine and compact entitlements supplies must be developed while they are still available, long-term conflicts over allocation between cities, environmental needs and agriculture can only be addressed through better management.

Colorado has deadlocked over which philosophy of water resources "planning" to adopt, and meanwhile it has not done as much as it should to study its strategic problems and opportunities. A central issue in this deadlock is debate over whether the free water market can handle future management needs. But this debate only considers part of the question: the intrusion of the federal government into western water decisionmaking, increasing environmentalism, increasing competition for water and the possibility of climate change all demand a modified approach.

Three general management approaches seem to offer the possibility to make existing supplies go further: sharing and trading arrangements, water banking provisions, and increasing water use efficiency; but none of these methods has been implemented enough in Colorado due to various legal, policy and other constraints. Problems include our lack of understanding of available methods, assessment of benefits and costs, and finding ways to implement the innovations. Each needs data and systematic analysis.

Sharing and trading arrangements include exchanges, pooling and leasing. They can be intrabasin, as in the Poudre Basin, or interbasin, as between the Colorado River and South Platte. The reasons that more of these are not considered include: water law constraints, complexity (difficult to conceive or plan or implement), and institutional barriers, some as basic as relationships between water managers. Water banking provisions include conjunctive use, putting the water away for a short time like in a checking account, and using either artificial or natural recharge; or putting water away for a long time, like in a savings account. Increasing water use efficiency refers to urban, industrial and agricultural uses. The metro area is giving attention to urban water conservation, and Colorado needs to seriously evaluate the possibility of a water salvage law for agriculture. Agricultural water use efficiency is a more complex concept than most realize, as I described in the March 1989 edition of COLORADO WATER.

A water study commission could provide answers to critical questions dealing with these management methods: what is the balance between water supplies and needs for each region and each use category of the state; what methods are needed to improve cooperation in intrabasin water sharing and management; what are ways to meet the long-term water needs of the state's regions through inter-regional sharing and trading; what are the special water needs of the Denver region and how to meet them, including the possibility for inter-regional sharing; how can the state's aquifers be used better for water banking and conjunctive use; what additional water supplies can really be provided through increased water use "efficiency" and how should they be organized; how can water management agencies use their existing authorities to enhance statewide water management and what additional authorities may be needed; and what improvements will the state need to make in data management to prepare for the 1990s and 21st century.

These are broad questions, and initial studies of them could be addressed within the framework of three efforts by a study commission: one dealing with water management, one with institutional questions and one with the metro area. Each study effort would need a technical advisory committee. The study commission could serve as the policy board for the study. Skilled staffing and an adequate budget would be needed to execute the studies using the resources of state agencies, universities and private firms.

A water study commission would be an excellent outcome of the next General Assembly. Members could be appointed by the Governor and the General Assembly. The study commission would need a budget and enough staff capability to integrate its findings into coherent policy recommendations.

Even with better water management, Colorado still will need more storage facilities in the future. Maybe the study commission, by thoroughly investigating management improvements, will also convince Colorado's diverse water interests of the need for more storage; then project planning may proceed more smoothly.

WATER ISSUES TO BE EXPLORED AT DENVER CONFERENCES

Three water conferences will be held back-to-back in Denver, Colorado during the week of February 26-March 3, 1990. They offer an unusual opportunity to study rural water, groundwater issues and water-well contracting.

The Colorado Rural Water Association offers a technical program related to drinking water issues on February 26-27, 1990. Extensive exhibits will be available and the Operator's Exam will be administered.

The Colorado Water Resources Research Institute at Colorado State University (CSU) and the Office of the State Engineer plan a program to evaluate technical and management

methods necessary to solve groundwater problems on February 28-March 1, 1990. Cosponsors of the conference include: Agricultural Experiment Station; Colorado Groundwater Association; Cooperative Extension; CSU Departments of Civil Engineering and Agricultural & Chemical Engineering; CSU's Egypt Water Research Center Project; Groundwater Institute at the Colorado School of Mines; League of Women Voters of Colorado; University of Colorado's Natural Resources Law Center; U.S. Geological Survey, and the Wyoming Water Research Center at the University of Wyoming.

The Colorado Water Well Contractors Association plans a technical program dealing with well construction, the NWWA Certification Exam and how to run a prosperous business on March 2-3, 1990.

These conferences are expected to attract a large and varied audience. For information contact Janet Lee Montera, Civil Engineering Department, Colorado State University, Fort Collins, CO 80523, 303-491-7425.

COLORADO WATER SUPPLY OUTLOOK

*by Sheldon G. Boone
Soil Conservation Service*

The 1989 water year brought generally dry conditions to the State of Colorado. Mountain snowfall was delayed by a warm and dry October, which only helped to deplete soil moisture conditions. The early winter months brought near average snowfall to the mountains, and was highlighted by major storms in February which helped to increase the state's snowpack values to above normal. Snowfall during the critical late-season months of March and April was well below normal across the state. This resulted in sharply decreasing snowpack percentages and forecasted streamflow volumes.

The dry conditions continued through June, having detrimental effects on germination and development of dryland crops, while increasing the wildfire danger. June was exceptionally dry across western Colorado, while the eastern plains received near normal precipitation. July's monsoon rainfall brought relief to the entire state with nearly all locations receiving near to above average totals. Precipitation during August and September was variable across the state, but was generally below average. With few exceptions, total precipitation for the 1989 water year was below normal across the state. The lowest readings were in the Animas, San Juan and Rio Grande Basins.

The below normal runoff and lack of precipitation increased irrigation demands on water stored in the state's reservoirs. Statewide, storage levels are 103 percent of average on October 1. These levels are 94 percent of last year's storage amounts. The most substantial decreases in reservoir storage occurred in the Arkansas and Rio Grande basins. These basins are currently storing only about 60 percent of last year's storage on October 1. The below normal storage volumes have increased the need for an above average snowpack during the 1990 water year.

ROTUNDA WALLS OF STATE CAPITOL ILLUSTRATE IMPORTANCE OF WATER

Entering the rotunda of the State Capitol in Denver, we are instantly reminded of how important water was to the development of the West. Eight murals on the first floor rotunda walls celebrate Colorado's story in picture and verse, through the collaboration of artist Alan True and poet Thomas Ferrill. Each stresses the importance of water. The first panel has no painting, but the mind's eye can create a mural of its own to accompany the following verse by Ferrill:

*Here is a land where life is written in Water
the West is where the Water was and is
Father and Son of old Mother and Daughter
Following Rivers up immensities
of Range and Desert thirsting the Sundown ever
Crossing a hill to climb a hill still Drier
Naming tonight a City by some River,
a different Name from last night's camping Fire.*

*Look to the Green within the Mountain cup
look to the Prairie parched for Water lack
Look to the Sun that pulls the Oceans up
look to the Cloud that gives the oceans back
Look to your heart and may your Wisdom grow
to power of Lightning and to peace of snow.*

The murals, a gift from the Boettcher Foundation, were painted on canvas, then attached to the rotunda walls. They were completed in 1940.

Congress created the Colorado Territory on February 18, 1861, and in 1867 Denver was selected as the permanent site of Colorado Government. Colorado (from the Spanish word meaning ruddy or red) was admitted to the Union in 1876. Our State Capitol, completed around the turn of the century, required more than 20 years to complete.

\$90 MILLION APPROVED FOR 21 COLORADO WATER PROJECTS

A House-Senate conference committee has approved a \$14 billion energy and water bill that includes more than \$90 million for 21 Colorado water projects. The bill includes: \$41.1 million for the Dolores project, \$5.9 million for the Animas-La Plata project; \$4.55 million for a new water treatment plant at Leadville; Grand Valley salinity control project, \$8.24 million; Paradox Valley salinity control project \$2.46 million; Lower Gunnison salinity control \$2.5 million; San Luis Valley closed basin project, \$7.75 million; and Stagecoach dam and reservoir on the Yampa River, \$2.43 million. The balance of funds is for dam site repairs and flood control/operations studies. The committee also allotted \$30,000 for the High Mountain Aquifer Study.

The House-Senate committee also agreed to provide \$1.65 billion for cleanup of the nation's nuclear weapons plants. The amount for Rocky Flats wasn't available, but \$45 million of construction money is earmarked for work at the plant's Building 371, a mothballed plutonium processing facility plagued by problems.

For Utah, the bill includes \$116.17 million for the Bonneville Unit of the Central Utah Project, including \$19 million for environmental mitigation. For New Mexico, Los Alamos National Laboratory will get \$74 million for several projects and Sandia National Laboratories \$17.5 million for research and projects.

Source: Denver Post 9/9/89

DENVER WATER BOARD APPROVES CONSERVATION MEASURES

Mandatory water meters for its customers, rebates for the latest water-saving toilets, and computerized water systems for Denver's parks were approved by a 5-0 vote by the Denver Water Board on October 11. The program is the result of a four-year study by the consulting firm of Peat Marwick Main. Water officials said the restructuring of rates was planned regardless of the fate of Two Forks dam.

The Water Board believes it can save about 10 percent of its current use, or 9.4 billion gallons of water a year, with this strategy. The completion of water meter installation is now targeted for 1993, seven years ahead of previous schedules. Customers will be charged on the basis of "the more you use, the more you pay." Under the current rate structure the more water a household uses, the less it costs. The new rates will establish a 15,000 gallon-per-month threshold for each household, and consumption above that mark would be significantly more expensive. Low water users, however, would see lower rates.

- Water-saving toilets--Homeowners will receive \$80 rebates if they replace 5-gallon or 3.5-gallon toilets with new 1.6-gallon fixtures. The rebates begin January 1. Plumbing contractors, union plumbers and even some city officials, however, said the ultra-low flush toilet may fail. They fear city sewer lines and private service connections could clog more easily. Another consideration is minimum flows. Denver Public Works Manager John Mrozek recommended that implementation of the ultra-low-flow toilet program be delayed until short-term and long-term impacts can be assessed. But the Water Department cited three studies that found no sewer or odor problems caused by the new toilets in Arizona and Wisconsin.

- Denver City Parks--The program will spend \$75,000 on a computerized system to eliminate lawn-watering waste at ten Denver city parks.

- Water Meters--Denver's 60,000 meterless homes will have water meters installed by December 1993. The Water Department estimates that this could save enough water to serve more than 10,000 homes. Property owners will be most affected by the new water rates during the summer months when consumption is estimated at an average of 60,000 gallons per household. Those who have a large lawn, trees, bushes and landscaping (and/or pools) will shoulder higher bills during the summer. Water officials hope the new rates will encourage homeowners to use water-saving landscaping.

Charles Jordan of the Denver Water Department said "There is no precedent for the kind of conservation program we're putting together in Denver. Using conservation to develop water supply is really uncharted territory." The Denver Post reports that most Denver water customers agree that the revised rate system, which rewards conservation, is needed. The Post also reported a story out of Arizona that 32 cities failed to meet state-set water conservation goals last year. Scottsdale, Arizona used 316 gallons per person per day, 35 gallons above its goal. By contrast, Denver residents used 236 gallons per day.

NEW METRO AREA WATER RATES*

Type of customers	Households	Avg. bill	Change
Denver flat rate	60,000	\$170 a year	None
Denver metered	76,000	\$182 a year	About a third of customers will see slight hike
Littleton, Sheridan southeast Englewood	27,000	\$365 a year	10% increase
Wheat Ridge, Arapahoe County southern Jefferson County	28,000	\$341 a year	6.5% decrease, except for high-volume users
Lakewood, Arvada, other wholesale customers	60,000	N/A	6.5% increase

*Aurora, Thornton and several other suburbs have their own water supplies and aren't affected by these changes.

Source: Denver Water Department

Officials of suburban communities served by the Denver water system complained that the new policy places an unfair burden on them. Larry Berkowitz, president of the Metropolitan Denver Water Authority, said suburban users may go to court to block the new rate policy.

CU economist John Morris said water officials should have proposed similar rates discouraging heavy water use by business consumers. The Water Board said it will consider those changes in 1991.

On October 24 the Denver Water Board postponed until Nov. 7 its decision on whether to change water rates and increase fees for heavy users. The board said it needs to examine more closely public comments and concerns aired at its last meeting.

Sources: Coloradoan 10/11/89; Denver Post 9/17/89, 9/20/89, 10/4/89, 10/25/89; Rocky Mountain News 9/20/89, 10/4/89; Reporter Herald 9/29/89.

XERISCAPE CONCEPT ORIGINATED IN DENVER

Xeriscaping - the use of native, low water-demand plants in landscaping - is growing in popularity across the nation. Originating from the Greek word "xeros," or dry, the program's basic idea is to design landscapes that use little water. The xeriscape demonstration gardens at dozens of cities across the nation are direct descendants of a program begun in Denver some seven years ago when landscapers proposed a joint venture with the Denver Water Department, says U.S. Water News.

Wichita, Kansas opened a xeriscape demonstration area this summer at the city's municipal gardens, as did the San Diego Wild Animal Park, using landscape rocks and equipment donated by local firms. In New Mexico, a landscape architect is designing a xeric landscaped subdivision for the East Mountain area of Albuquerque. The New Mexico State Engineer's Office has established limits on developers' water rights, requiring water-conserving plumbing and prohibiting swimming pools.

A handbook, *Landscaping for Water Conservation: Xeriscape!*, covers the step-by-step process of installing a low water-use landscape. Co-published by the City of Aurora and the Denver Water Department, the book can be ordered from: Aurora Utilities Dept., 1470 So. Havana, Aurora, CO 80012. Price: \$5.79. For further information contact Kimberley Knox, Water Conservation Technician, at (303)695-7381.

DENVER GROWTH INEVITABLE BASED ON HISTORICAL TREND

According to the U.S. Census, in 1900 Denver was the second largest regional Western city with a population of 133,859. San Francisco led with a population of 342,782. By 1980 Denver was tenth (population 492,365). Of the cities that grew the most all but Dallas, Phoenix and Denver are coastal cities: first, Los Angeles (2,968,579); second, Houston (1,598,138); third, Dallas (904,078); fourth, San Diego (875,538); fifth, Phoenix (789,704); sixth, San Antonio (786,023); seventh, San Francisco (678,974); eighth, San Jose (629,531); and ninth, Seattle (493,846). These figures reflect core cities and do not include suburbs, which could alter the census statistics. Of these ten cities six were on the list in 1900, including Denver. "What seems undeniable," says Bill Hornby of the Denver Post, "is that the same cities will keep on growing." "The lesson for Denver is that population growth is inevitable," he says, "but...what happens to the human beings behind the numbers can be shaped by foresight."

Source: Denver Post 9/26/89.

AVAILABILITY OF WATER WILL DRAW DEVELOPMENT, SAYS RESOURCE ANALYST

The Fort Collins-Loveland-Greeley area population will grow to 500,000 by the year 2025, with people and industry drawn by the available water supply, says Craig Harrison, owner of Harrison Resources. Harrison's company, located in Fort Collins, specializes in the sale of water rights and farm land.

The three northern Colorado cities will grow together, he says, and must prepare by acquiring more water rights, developing more reservoirs, and building more wastewater treatment plants. Cooperation will be critical to the region, says Harrison. While there is apprehension about some Metro Denver suburban cities looking to the north for water, Harrison says "It might be easier to bring growth here than move water elsewhere."

Coloradoan 9/14/89.

NCWCD WATER STUDY PLANS FOR REGIONAL FUTURE

A study to determine water demands in northern Colorado for the next 50 years and how best to meet those demands is moving into its second year. Financed by the Northern Colorado Water Conservancy District and the NCWCD subdistrict, the study should be completed by this time next year. Included in the survey are Weld, Boulder, Larimer and Morgan counties, cities within those counties, and northern tier cities in Adams and Jefferson counties. Larry Simpson, NCWCD manager, said an eventual plan for the region will be developed in stages as growth occurs. "What we hope to do," said Simpson, "is work in five-year increments and avoid duplication so that we can put together a bulk water system over the next 50 years to provide either raw water, treated water or some combination." He said it is imperative to the future of the area that water treatment facilities not be duplicated.

NCWCD Engineer Karl J. Dreher said the District wants to be prepared for future exchanges and transfers, and hopes that through better planning district communities will not lose valuable water. Recent and gradual changes in the focus of water use from agricultural to municipal, purchase and rental of surplus water, and the likely demand for water from the Denver area prompted the study, he said. Dreher is branch head for engineering services at the District.

Greeley Tribune 10/9/89; Reporter-Herald 10/7-8, 1989

CITY, WATER DISTRICTS DISCUSS SHARING WATER TREATMENT COSTS

The Soldier Canyon Filter Plant, shared by Fort-Collins-Loveland Water District, Elco Water District and Northern Weld Water District, needs to be expanded by about 20 million gallons per day. City and district officials have been meeting since August hoping to merge the expansion into a single project that helps everyone and also lowers expansion costs.

PUBLIC SERVICE COMPANY AND AQUAFARMS INC. JOIN FORCES TO FISH FARM

South Denver will soon have a fresh fish farm that hopes to produce 450,000 pounds of hybrid bass each year. The fish will be marketed to restaurants and grocery stores in the West as "Colorado Mountain Bass." Aquafarms Inc. and Public Service Company have teamed up to create the fish farm and hope to begin marketing their first crop next July. In a green house located next to Public Service Company's

Arapahoe Power Plant, 14 tanks will be heated by steam cooling towers to maintain 75 degree water for the fish. Most of the tank water will be recycled, while wastewater will go into the Denver sewage treatment system. The project is supported by \$2.4 million in industrial revenue bonds being issued by the city of Denver, because "it's a good investment, and we're confident it will succeed," said Mayor Federico Pena. Aquafarms founder, Bob Ashiem, is former president of the Black Hills Power and Light Company in South Dakota.

ARTIFICIAL GROUNDWATER RECHARGE

- York, Nebraska Project - Construction has begun on the York Groundwater Recharge Demonstration Project, which will inject treated agricultural runoff water into the Ogallala Aquifer. The project involves building a dam to create a 55-acre reservoir, using activated carbon filtration and ozone treatment to purify the water, and injecting it into the aquifer through a 200-foot well. Two spreading basins and reservoir seepage will augment direct injection. The primary sources of water for the recharge project are the runoff of approximately 7,400 acres of farmland and cooling water from the York Cold Storage Plant. Nebraska's Upper Big Blue Natural Resource District, sponsor of the recharge project, is the most irrigated district in the state and has sought to maintain current levels of irrigation despite declining water tables. It estimates that the York project will return some 475 acre-feet of water to the aquifer annually. The York Project, part of the High Plains States Groundwater Demonstration Program, is a joint project of the Bureau of Reclamation, the Geological Survey and the Environmental Protection Agency.

- Federal legislation - The Global Environmental Protection Act, under consideration by Congress, provides a federal program for research, development and demonstration of artificial groundwater recharge techniques. A section of the bill states that groundwater resources could be exhausted as a consequence of global climate change, and directs the Army's Chief of Engineers to start a program demonstrating the usefulness of artificial recharge, and to develop techniques for the transfer of surface water to underground sources.

- Research Underway at CSU - A project by Jim Warner and Tim Gates, of the Civil Engineering Department at Colorado State, will investigate the cause of decline in recharge capacity of trenches and wells that has been observed in the field. Two major factors are suspected: the deposition of suspended fines in the recharged water and/or the growth of microorganisms in the aquifer. The project's aim is to determine effective remedial methods to combat the loss of recharge capacity and develop more efficient design and management of the systems. The project is sponsored by the Corps of Engineers.

DRINKING WATER CONCERNS IN COLORADO

In response to a complaint filed last year by six private laboratories, state auditors recommended in early October that routine testing of drinking water be turned over to private companies. Members of the Legislative Audit Committee

which received the report, however, questioned the wisdom of the recommendation. State Senator Dennis Gallagher of Denver said his constituents in Globeville would prefer more, not less, water testing by the State. Senator Bob Martinez of Commerce City rejected the auditors' recommendation, saying his major concern was for "the health of our citizens," and Representative Phil Hernandez of Denver said he thought it an appropriate response for a public health department to test water for its citizens.

Committee members also expressed concern that citizens and local governments would pay considerably more than the \$6 per test charged by the State if the Health Department turns over testing to private laboratories. Representative JoAnn Groff of Westminster, chairman of the committee, said "I don't want to see us take that service away from citizens." Dr. Tom Vernon, Director of Colorado's Health Department, sharply disagreed with the auditors who suggested his agency should phase out routine testing of drinking water. Vernon said the agency must maintain proficiency in order to handle emergencies, such as the testing done to alleviate concerns about drinking water after the Rocky Flats raid last June. Besides the increased cost for testing at private labs, another concern is that they are not regulated. Vernon said the costs to do so would be "enormous," and lawmakers have not reached a consensus that all laboratories should be regulated.

- Adams County - Tests of South Adams County drinking water in August showed levels of TCE (trichloroethylene) at levels ranging from 5.66 parts per billion to 9.01 parts per billion. The affected area is north of 80th Avenue between Colorado Boulevard and the Rocky Mountain Arsenal. Three years ago Army officials acknowledged that the arsenal might be partially responsible for the pollution and agreed to pay \$14 million for temporary and permanent water treatment systems. The permanent system should be in service October 16. The problem with the temporary system seemed to be with deteriorating carbon filters. Larry Ford, water district director, said it would cost between \$100,000 and \$300,000 to replace the filters, and "That's a lot of taxpayer money for just one month" until the permanent system starts. He said the water district would backwash the filters in an effort to redistribute the carbon. The Health Department said it would take water samples every week to make sure the contamination didn't grow worse, and the District also planned to sample several times each week.

The September 14 edition of the Rocky Mountain News reported that shutting down two aging filters in the Adams County public water system stopped the flow of suspected cancer-causing chemicals into the drinking water. Greg Akins of the Colorado Department of Health said "Everything the district has been doing so far has seemed to work in bringing down the (pollutant) levels." Water test results showed only trace amounts of the pollutants in the water.

- Brighton - A \$5 million project is underway to clean up the city's water supply through a water exchange program. The federal maximum for nitrates in potable water is 10 milligrams per liter, and for years Brighton's level has ranged from 12 to 14. Farmers using commercial fertilizers inadvertently introduced nitrates into the groundwater, which feeds the shallow wells that are the city's drinking source. A new system of routing soon will move most of the nitrates

out of the drinking water and into irrigation water, where the nitrates will benefit farmers' crops. The city earlier considered building a water treatment plant or simply abandoning the wells and buying water from Denver. But a treatment plant would have cost about \$15 million, said City Manager Tony Mortillaro, and the initial cost of buying water would have been equally or more expensive. Water rates will increase from \$1.30 to \$2.30 per 1,000 to pay for the bonds sold to finance the improvements. The way Brighton approached its water problems is described as "pretty progressive" by Ken Conright, environmental supervisor for the Tri-County Health Department.

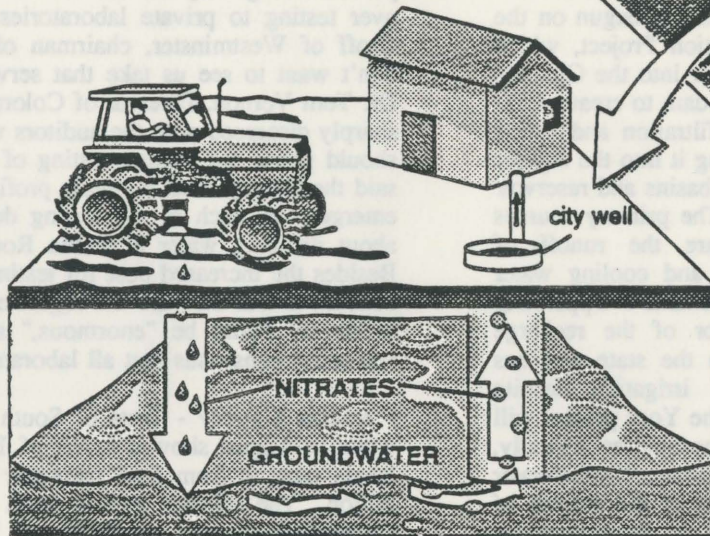
THE BRIGHTON CITY PIPELINE

Construction has been ongoing for the program's first phase, connecting the city's wells to the pipeline that will carry water to the mixing station and Barr Lake.

During the second phase pipelines will be built between the city and Barr Lake and from the Beebe Draw to the mixing station and water storage tank.

The station will also be built in the second phase.

"Hopefully it will be done by August of 1990," says George Kennedy, Brighton Utilities Director.



BRIGHTON'S WATER PROBLEM

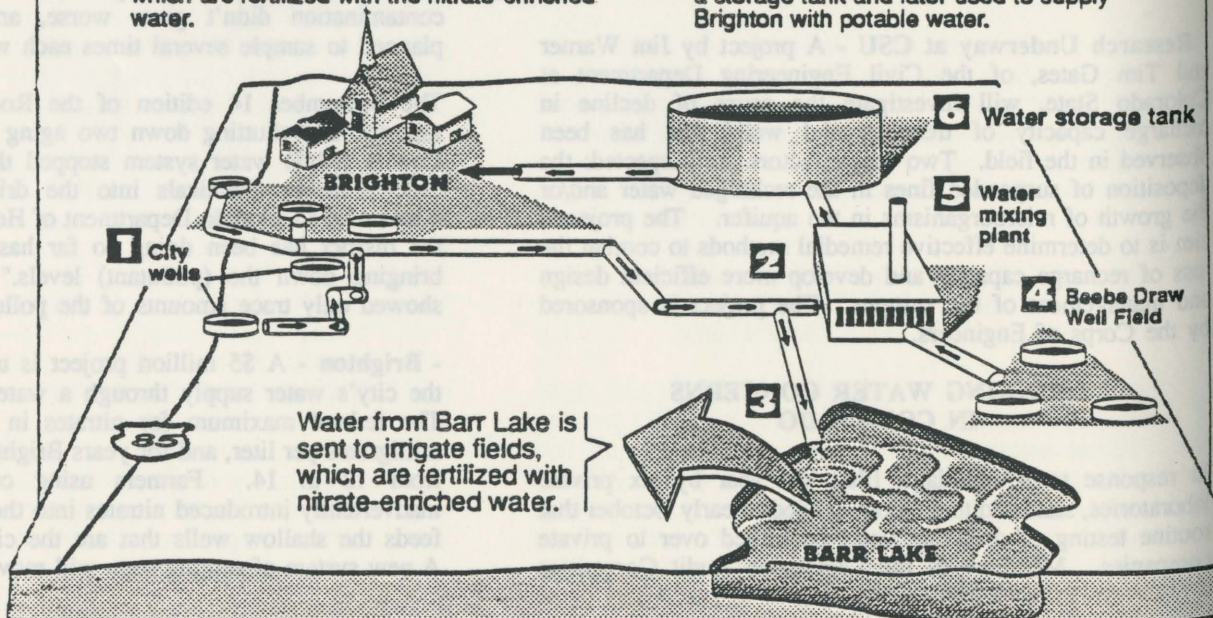
Brighton-area farmers use fertilizers containing nitrates on their fields. These nitrates leach through the soil and enter shallow groundwater. This water also fills wells that supply drinking water to Brighton's 13,500 residents.

This nitrate-laden water is most dangerous to pregnant women and young children because it can cause "blue baby syndrome," suffocation in infants.

BRIGHTON'S WATER SOLUTION

Brighton's solution is a water exchange program. It requires 5 1/2 miles of water pipelines that will reroute half of Brighton's water to Barr Lake and bring in a fresh half from Beebe Draw Well Field. Here's how it works:

- 1 Water is taken from five Brighton city wells.
- 2 One-half of the nitrate-water is left at a water mixing and disinfecting plant.
- 3 The other half is pumped into Barr Lake. Water from Barr Lake then is used to irrigate fields, which are fertilized with the nitrate-enriched water.
- 4 New water is taken from Beebe Draw wells.
- 5 This water is sent to the mixing plant and used to dilute Brighton's nitrate-heavy water.
- 6 The new water mixture then is pumped to a storage tank and later used to supply Brighton with potable water.



- **Canon City** - Contaminated groundwater is being used locally to water livestock and to irrigate gardens and fruit trees, according to a survey of water use conducted by the Cotter Corporation. In 1987 Cotter agreed to clean up the Sand Creek drainage groundwater as part of an \$11 million cleanup of uranium mill contamination. Phil Stoffey, on-site coordinator for the Department of Health, said only a small part of the area has contaminated water, and lab tests over the last eight years indicate a steady decline in contamination. Cotter has agreed to connect three residences using well water to city water lines.

- **Colorado Springs** - Residents of southwest Colorado Springs and Manitou Springs received notice that high fluoride levels in their water could stain and pit the teeth of young children. The notices are required under a new regulation of the U.S. Environmental Protection Agency, which requires that naturally occurring fluoride not exceed 4 milligrams per liter. Usually levels greater than 2 milligrams per liter have little impact on adults. But the notices point out that skeletal fluorosis, a bone disorder, has been linked to high levels of fluoride. Dentists consider 1 milligram per liter an ideal fluoride level. In 1951, Colorado Springs and Boulder participated in a study that showed fluoridated water could reduce tooth decay by as much as 60 percent.

- **Red Feather Lakes** - Tests of soil and groundwater started in early September to measure the extent of petroleum contamination of a municipal well and other drinking wells. Earlier tests conducted in 1985 found that petroleum from several underground fuel tanks located several hundred feet from an abandoned convenience store had created the contamination. The convenience store's owner abandoned the site in 1985, and the bank holding the mortgage has refused to foreclose because of possible liability. Test results will be included in a site assessment report due in December. The Environmental Protection Agency's Leaking Underground Storage Tank (LUST) program funded the tests.

- **Westminster** - Tests of polluted groundwater east of Sundstrand Aviation Plant were scheduled to begin September 13, but concerned area residents were told at a September 1 meeting that the cleanup of any polluted groundwater under an 80-acre tract east of the plant could take years. Sundstrand representatives at the meeting, arranged by the Colorado Department of Health and the local Tri-County Health Department, said leaking underground storage tanks were discovered in late 1987 and they reported the problem to health department officials. Local residents found out about the contaminated water early last year when the Health Department informed the Adams County Commission that a gravel pit and landfill planned for the vacant land couldn't be allowed because of the contamination.

Sources: Rocky Mountain News, 8/24/89, 8/31/89, 9/7/89, 9/13/89, 10/13/89; Denver Post 8/31/89, 9/1/89, 9/20/89, 9/30/89, 10/12/89, 10/13/89.

BYPASS TECHNOLOGY MAY RESOLVE SOUTH PLATTE SEWAGE DUMP PROBLEM

A new technology may provide an alternative solution to the proposed dumping of raw sewage into the South Platte River while the Thornton North Washington pump station is

renovated. The Metropolitan Denver Sewage Disposal District needs to repair its pumping station, and the new alternative would allow all of the sewage usually pumped through the station to remain in the pipeline system while the repairs are made. The process involves tapping into the existing pressurized pipeline and routing the raw sewage around the pump station to the main treatment plant. The Water District Board unanimously voted its approval of the alternative on September 19. The District will have to choose from among only three companies in the nation with the necessary experience and equipment for the job.

WATER QUALITY INFORMATION SYSTEMS

The International Symposium on the Design of Water Quality Information Systems, cosponsored by Colorado State University and the U.S. Environmental Protection Agency with the American Water Resources Association as a cooperating organization, concluded in early June. Forty-four papers, covering a wide range of subjects, were presented at the Symposium. Papers addressed aspects of the water quality information system dealing with data handling, data analysis, reporting, and the utilization of information within management decisionmaking. The thrust of many papers appears to indicate that the field of water quality monitoring is moving toward the concept of "data analysis protocols" and, ultimately, by "information utilization." Such efforts would permit the documented design of a total water quality information system that can be audited in its entirety. For further information, contact Robert C. Ward, Agricultural and Chemical Engineering Department, Colorado State University, Fort Collins, CO 80523.

WQCC TO REVISE GUIDELINES FOR INDIVIDUAL SEWAGE DISPOSAL SYSTEMS

The Water Quality Control Division of the Colorado Department of Health will undertake a comprehensive revision of the State's guidelines for individual sewage disposal systems. The WQCC will establish a work group of interested local health officials and other qualified individuals, which will meet regularly in the Denver area. Several meetings throughout the State also will be scheduled to allow input from those unable to attend the Front Range meetings. Major areas of the Guidelines to be revised include criteria for systems over 2,000 GPD design flow, residuals disposal and greywater use and disposal. Criteria also will be designed for technologies developed since the Guidelines were originally written. Contact Phil Hegeman, ISDS Program Coordinator, at (303)331-4564 if you are interested in participating or wish to submit comments.

AURORA LOOKS FOR WATER SOURCES

With an EPA veto of Two Forks Aurora, like most other Metro Denver cities, is looking for other sources of water. The Aurora Utilities Department wants to buy 350 acre-feet of Tarryall Creek water from a subsidiary of the New Mexico-based Bellamah Community Development Corporation. The city also wants about 60,000 feet of Gunnison River water to pipe into the South Platte River drainage. The city councils of Aurora and Gunnison City plan to meet and tour the sites of Aurora's two proposed reservoirs, at Aurora's suggestion. Dale Howard, Gunnison

City Manager, wants an independent study to determine how much water is available for transmountain diversion before any decisions are made. If a study showed there is water available, Howard said Gunnison would want "absolute assurances" that minimum streamflows will be maintained to protect ranching, recreation, agricultural and municipal interests on the West Slope. Aurora is also trying to negotiate its lawsuit with Eagle County officials over the Homestake II water project in the Holy Cross Wilderness area.

Source: Denver Post 9/18/89

BROOMFIELD POSTPONES WINDY GAP AGREEMENT

The Broomfield City Council has postponed a decision on whether to enter into an agreement to obtain Windy Gap water because of legal concerns about the exchange. Broomfield will not ratify contractual agreements with Harrison Resource Corporation, which is handling the exchange, until it knows what conditions may be imposed by the Northern Colorado Water Conservancy District and what it might cost the city. The Greeley City Council had approved the agreement, under which Greeley would exchange 1,300 acre-feet Windy Gap water for an equal amount of Greeley-Loveland Irrigation Company and Colorado-Big Thompson water. Greeley also would receive more than \$500,000 in cash and be relieved of \$7.35 million in Windy Gap debt, which Broomfield would take over. Larry Simpson, CWCD manager, said he hopes the board can act on the matter when it meets in October. The exchange must also be approved by the District Water Court in Greeley.

Sources: Greeley Tribune 9/27/89; Rocky Mountain News 9/21/89

BERTHOUD RAISES WATER-SEWER RATES

On November 1 Berthoud residents will see their first rate increase in sewer and water fees in 17 years. The minimum monthly charge for water will be \$12.50 for the first 4,000 gallons, plus \$2 per 1,000 gallons for use of 4,001-10,000 gallons; \$1.50 per 1,000 gallons for 10,001-20,000 gallons used, and 80 cents per 1,000 gallons for more than 20,000 gallons used. The rate increase, approved by the Berthoud Board of Trustees at their September 26 meeting, prompted a suggestion from the audience that water fees increase as usage increases to promote water conservation. Mayor Richard Strachan said a future board might want to consider that.

Source: Reporter-Herald 9/27/89

DEFINITION OF FEDERAL ROLE NEEDED BEFORE POUDBRE DESIGNATION, SAYS CITY COUNCIL

The Fort Collins City Council has informally endorsed a plan to support designation of an 18.5 mile segment of the Poudre River as a National Recreation Area (NRA), but called for more studies on what role the Federal Government will play. Kari Van Meter, project manager of the NRA, says the

designation could offer the benefits of creating a comprehensive river management plan beyond the ability of local government as well as opening up access to federal money and resources. But there are continuing concerns about the potential loss of local control along with unknown costs and federal involvement that could affect decisions involving land and other resources in an NRA.

A \$75,000 study of the proposed designation was called for in 1986 legislation adding 77 miles of the upper Poudre to the country's Wild and Scenic River system. At its November 7 meeting the Council is expected to endorse the study's findings, but call for further studies of how it would be managed. Congressman Hank Brown said he will delay introducing legislation designating the 18.5 mile section of the Poudre as a National Recreation Area. Brown says he wants to get all of Fort Collins' concerns worked out first. The delay will also allow him to enlist support for the bill from Colorado's entire congressional delegation.

The Fort Collins Water Board is concerned that potentially more strict federal water quality standards on the Poudre might make it more difficult and costly to operate sewage treatment plants. And some property owners along the river fear the Federal Government would use condemnation to acquire private land if the project were approved. On October 25 the Larimer County Commissioners approved a resolution endorsing NRA designation, with the proviso that condemnation of land within the boundaries of the proposed NRA be prohibited.

"Because this is so complex, it's important people have a feeling everything is answered before we go ahead with it," said Brown. He said he hopes to fashion legislation in which a federal agency such as the U.S. Forest Service would own the NRA property and contract with the city to manage it.

Sources: Fort Collins Triangle Review, Oct. 26, 1989; Coloradoan, October 26, 1989.

UTES GET WATER FUNDS

Colorado's Ute Indians will receive about \$19.5 million for economic development under legislation signed by President Bush. The money is part of the 1986 water rights agreement among the Southern Ute and Ute Mountain tribes, the Federal Government, the State of Colorado, and water users in southwestern Colorado and northern New Mexico. The agreement settled rights for several rivers and is designed to fulfill the tribes' water rights with water from the Animas-La Plata water project. Construction on that project should start next year.

Since 1868 the Ute Mountain Utes have had untreated, inadequate or unsafe water. The current supply comes from an irrigation canal and contains salt, herbicides, dung and silt. The water is poured through a bed of sand and chlorinated, but lab tests show high bacterial count and residents refuse to drink it. Indian families drive to Cortez, 15 miles away, once every two weeks for water. Containers, filled at a city pump or a relative's house, are hauled home and the water is used for cooking and drinking. But now the

McPhee Reservoir, part of the Dolores project, will deliver good drinking water to the reservation in a newly constructed 25-mile pipe to be ready by November. A canal is being built to carry the irrigation water, and if Congress appropriates funds to complete the Dolores project it will provide enough water to irrigate 8,000 acres. If the Animas-La Plata project is completed, the Utes will get still more water.

In 1908 the federal court ruled that reservations must have water to make them fertile, and gave tribes water rights dating to the creation of their reservations. For the Utes that meant unimpeded flows of the Animas, La Plata, Dolores, Mancos and San Juan Rivers which crossed the Indian land. But the rivers were dammed and diverted, and to compensate the United States agreed to give the Ute Mountain Utes \$32 million to develop farm land, and the State agreed to pay \$6 million for the drinking water pipeline. Another \$34 million is needed to finally grow crops with center pivot irrigation systems.

It was the joint efforts of the Indians and white farmers, brought together by Attorney General Duane Woodard, that overcame strong Congressional resistance to new water projects. The Indians had rights to water but needed Bureau of Reclamation projects to get it, so both the Dolores and Animas La Plata were piggy-backed onto the Ute Water plan.

Source: Denver Post 10/15/89

(From Jim Carrier's stories about the Knight family of the Ute Mountain Ute Reservation near Cortez, continuing through the end of November)

SIGNS OF FALL INDICATE LONG, COLD WINTER TO SOME WEATHER WATCHERS

Colorado could face a critical water situation in the next year according to Larry Simpson, Manager of the Northern Colorado Water Conservancy District. He said the Colorado-Big Thompson project has enough water to deliver a 100 percent quota next year, but that is all. We need better than a 120-130 percent of normal snowpack in the mountains to come out even next year, he said. Colorado's snow watchers can hope that those who rely on Mother Nature's hints to predict the weather are right this year, because the signs indicate a long, hard winter. Michael Booth of the Denver Post says the "state's sage veterans have checked the signs - and they're reaching for their snow shovels." Ralph Reiner, who mans the Echo Lake Observation Station for the National Weather Service, says the past August was the coldest he's ever recorded on the mountain: Ground squirrels hibernated in mid-August, weeks ahead of normal; hummingbirds took flight early; and mountain goats and sheep shed their old coats long before the end of summer. Southern Ute Indian leader Everett Burch says animals are coming down from their summer ranges weeks earlier than usual, the alfalfa is freezing and leaves turned early.

The Rocky Mountain Almanac says November will be cold and snowy, 5 to 8 degrees below average, and there will be a strong storm in the latter part of the month. December will be warm and dry early, but heavy snowfall will return late in the month. January and February will be extremely

wet and snowy. Other forecasters, including the National Weather Service, aren't making winter predictions this early.

Rocky Mountain News, 9/21/89; Denver Post 9/30/89

SLUDGE SITE SUPPORTS DIVERSITY OF SEA LIFE

Scientists have found a seabed teeming with tiny plants and animals at the ocean site where New York and New Jersey have dumped their sewage sludge for two years. Researchers from the Woods Hole Oceanographic Institution found a wide diversity of life including fish, shrimp, crabs, sea cucumbers, sea anemones, and many small organisms buried in the sediment. This discovery may raise questions about the wisdom of a national policy to ban ocean dumping of sludge produced as the last stage in sewage treatment. Scientists are completing tests to determine whether animals and plants found at the dumping site are contaminated with bacteria, viruses, heavy metals or other industrial wastes that might enter the food chain.

The New York Times 10/15/89

DROUGHT WATER MANAGEMENT SUMMARY AVAILABLE

Drought Water Management: Preparing and Responding to Drought is a brief summary of key questions concerning approaches to drought and water management lessons learned during recent periods of water shortage. This short document provides initial results of an ongoing project on "Managing Droughts" funded by the Natural and Man-Made Hazards Mitigation Program of the National Science Foundation. Project principal investigators are Neil S. Grigg and Evan C. Vlachos. The summary is available at no cost from: Verdina Johnson, Department of Civil Engineering, Weber Building, Colorado State University, Fort Collins, Colorado 80523 (303)491-5247. A final report and proceedings from a drought water management workshop held in 1988 are forthcoming. For more information contact Neil S. Grigg, Institute director, at 491-6308.

AWWA ORGANIZES WATERTech TO ASSIST DEVELOPING COUNTRIES

WaterTech, a program to assist developing countries with safe water supply projects, was recently approved by the Board of Directors of the American Water Works Association (AWWA), Denver. The project, similar to WaterAid in the United Kingdom and WaterCan in Canada, will organize professionals and volunteers to help provide safe drinking water in developing nations. An AWWA committee is recruiting an administrator for WaterTech and identifying funding sources. The administrator would prepare grant applications/work plans and maintain a roster of AWWA retirees and active members who would volunteer for overseas service. Suggested funding sources include the World Bank, U.S. Government Agencies, foundations, regional development bankers, AWWA members and the general public.

Source: U.S. Water News, October 1989.

CONGRESSIONAL BILLS OF INTEREST IN SUPPORT OF WATER RESOURCES AND WATER RESEARCH

This legislative summary was compiled as a news update for the Universities Council on Water Resources by Jon F. Bartholic, Director, Institute of Water Research, Michigan State, and printed in HYDATA.

A great deal of water legislation has been proposed in the last two sessions of Congress, including two major water resource management and education bills (S203 and HR37). A number of bills involving sections of these two have also been proposed (HR2734, HR978 [Title IV], HR2258 [Title III]; S362 [Title II], S397 [Title IV], and S779 [Title III]). At least a dozen additional water bills are of some interest. Of particular interest are the reauthorization bills for the Water Resources Research Act which will continue the authorization for the water research institutes (HR1101 and S714).

The key water resources research activities bill in the House is HR37, the National Groundwater Research Act of 1989. The bill introduced by Representative Gejdenson is identical to HR791 as it passed during the last session of Congress in December, 1988. HR37 currently has 94 cosponsors. It authorizes a wide variety of activities in the Departments of Interior, Agriculture, and the Environmental Protection Agency. Because of its breadth, HR37 has been referred to several Congressional committees for consideration.

In the Department of the Interior the bill proposes authorization to undertake research investigations, appraisals, surveys and related activities--in cooperation with federal, state and local government agencies, and academic institutions--and to disseminate the results of such research. Further, groundwater contamination risk assessment analysis would be undertaken and programs, training and technology transfer would be established, as well as a national groundwater information clearinghouse.

The Department of Agriculture would be involved in agricultural water quality and use studies, including non-point source management programs and the establishment of an agricultural nitrogen best management practices task force. An additional clause deals with groundwater radium contamination.

EPA would be given additional authority to issue grants to higher learning and research institutions, including consortia, with the establishment of five groundwater institutes in the United States. Cost sharing on a one-to-one basis could apply.

In the Senate a companion bill, S203, "Groundwater Research, Management and Education Act," has been submitted by Senator Burdick with numerous cosponsors. This bill is in the Committee on the Environment and Public Works. S203, in many aspects, is similar to HR37 but leans toward more regulatory and national responsibilities vs. the strong emphasis in the House bill on state level decision making.

Additionally, S203 includes a section (104) which involves the reauthorization of the water resources institutes. HR37 does not include similar language. The "Reauthorization of

the Water Resources Research Act," HR1101, deals with the authorization of the water research institutes. This bill was sponsored by Representative George Miller with 40 cosponsors. It was passed in an amended form on June 6, 1989 by a vote of 336 to 74. The cost-sharing on the House side is one-to-one and evaluation of the institutes is required at least every five years. Section 104 was amended to include a new subsection authorizing up to \$5 million for work on water problems and issues of a regional or interstate nature. A new section, 107, was added which would authorize the Secretary of the Interior, in consultation with the Secretary of Agriculture and the administration of EPA, to enter into contracts to carry out R and D demonstration projects related to contamination of groundwater and toxicological significance. Section 107 is confined to reclamation states and special reference is made to the Los Alamos National Laboratory.

Senate Bill 714 has also been introduced for the reauthorization of the Water Resources Act. This bill, sponsored by Senator McClure and at least 34 cosponsors, has been referred to the Committee on Environment and Public Works. There appears to be an ongoing impasse within the Environment and Public Works Committee as to whether they are willing to act on Senate Bill 714 (my feeling is that this is unlikely), or whether they will try to push the authorization through as part of Senator Burdick's bill, S203. S203 will probably not move this year.

Additional water bills which may be of some interest include: HR980 - Global Environment Research and Policy Act of 1989 for development of a National Global Change Research program; HR1421 - Marine Research Act of 1989. A bill oriented toward the Sea Grant Program; HR2521 - Reclamation States Groundwater Protection and Management Act, 1989; S57 - National Acid Rain Control Act of 1989; S676 -Global Environmental Protection Act of 1989 (similar to HR980).

Developments of the 1990 Farm Bill represent another area of interest from a water resources standpoint. Numerous conservation-oriented sections will probably be added to the ag bill as it evolves and is ultimately passed next year. Already, numerous bills which could ultimately be incorporated into the Farm Bill are being introduced. Among those are Senator Lugar's bill, S1063, and Senator Lawler's bill, S970. Numerous other bills will likely be introduced, allowing hearings on various aspects that could be incorporated as sections into the Farm Bill. Clearly, the increasing concern for conservation and possible impacts of agriculture on ground and surface waters will lead to policies that will attempt to facilitate a more environmentally benign agricultural system.

Inputs for the above comments were obtained from a variety of sources. Of particular importance was the Policy, Legislative and Administrative (PLA) Committee report for the UCOWR Annual Meeting in Minneapolis, August 8-11, 1989.

SENATE OFFERS COMPROMISE ON ACID RAIN LEGISLATION

States that have already installed equipment to reduce power plant emissions would be exempt from rigid compliance requirements of clean air legislation under a compromise proposal by Senate Majority Leader George Mitchell (Maine) and Senator Max Baucus (Montana). The affected states are Kansas, Minnesota, Montana, North Dakota, New Mexico, Utah and Wyoming. The compromise proposal also exempts new plants that burn "clean" or low-sulfur coal from mandatory installation of expensive pollution control devices known as scrubbers. Provisions of President Bush's clean air bill which would require power plants to reduce sulfur dioxide emissions by 10 million tons by the year 2000 are retained.

An Energy Department report indicates that pollutants from old power plants linked to acid rain could be reduced by almost one-half through the use of "clean coal" technologies now under development. The department is conducting a \$5 billion program in cooperation with private industry to develop these technologies, but does not expect that they will be available for commercial use before the turn of the century.

Sources: Colorado Country Life Magazine, Sept. 1989 and the Denver Post 9/23/89.

ARKANSAS RIVER AGREEMENT SIGNED

Governor Romer and Cy Jamison, Bureau of Land Management Director, signed an agreement on October 27 for joint state-federal management of a 148-mile segment of the Arkansas River. The agreement establishes the Arkansas Headwaters Recreation Area between Leadville and Pueblo Reservoir. Under the agreement, the State will manage river recreation and the BLM will supervise public lands along the river. In 1987 the legislature passed a bill giving the Colorado Department of Natural Resources authority for the river. The DNR developed a management plan after negotiations between rafting outfitters and fishermen. Fishermen had complained about the six-fold increase in river rafting, with commercial rafting companies taking as many as 150,000 people annually down the river. Chips Barry, DNR Director, said next summer the State will establish a trial period for regulations designating sections of the river closed to rafting during parts of certain days. The BLM and the State will share the cost of upgrading recreation facilities along the river. Colorado has already committed an initial \$400,000 and another \$215,000 after next year.

Source: Denver Post 10/28/89

NASA GRANT WILL SUPPORT SPACE PROGRAMS AT COLORADO STATE

As the nation's space program looks forward to exploration and settlement of worlds beyond earth, one primary research area is the development of support systems able to sustain life in space and on harsh alien lands. This research is the

focus of two new disciplines under development at Colorado State University: space civil engineering and space life sciences. These two educational options will be offered at both the graduate and undergraduate level through existing departments beginning in the fall of 1990.

"Ours is one of the first programs to look at the problems of and potential for the introduction and support of life on the moon and other planets and their moons," said Willy Sadeh. Sadeh is a Professor of Civil Engineering and Director of the Space Grant College and Fellowship Program at Colorado State. "The first disciplines required to support human expansion into space are civil engineering and agriculture, because shelter and food are essential to human survival," he said.

Development of these two engineering and scientific programs is funded mainly through a new consortium of Colorado colleges. Member colleges include Colorado State, the University of Colorado at Boulder and Colorado Springs, Mesa State College, Fort Lewis College and the University of Southern Colorado. The United Space Foundation in Colorado Springs also is a member. CU is the lead institute.

The Colorado Space Grant College Consortium was one of 17 university consortia in the nation to receive NASA grants as part of an innovative national program to further education in engineering and science. The consortium was awarded a four-year, \$850,000 grant August 31. "We will investigate and teach civil engineering techniques to overcome the problems of building in space," Sadeh said. "Additionally, we will examine the problems--present and future--of human being living for extended periods of time in space and on other planets."

COLORADO STATE RESEARCHERS PURSUE SOLUTIONS TO IMPACTS OF GLOBAL CHANGE

by Andrew Schmit, Student Assistant
Public Relations Department
Colorado State University

Colorado State researchers play a vital role in unraveling the interwoven problems of population growth, pollution and global climate change. "Strategic responses to Global Change" was the topic of the Showcase '89 conference held on the Colorado State campus Oct. 12-13. The event was co-sponsored by the University's College of Forestry and Natural Resources and Colorado U.S. Sen. Tim Wirth. The conference provided Colorado State researchers and other participants with the opportunity to discuss issues of global concern.

"Global warming, often referred to as the greenhouse effect, is one of change," said Jay Hughes, Dean of the College of Forestry and Natural Resources. He cited burning of fossil fuels and deforestation as two human activities that contribute significantly to global climate change. "Burning fossil fuels creates excess carbon dioxide in the atmosphere, and the reduction of green biomass from trees reduces Earth's ability to refix this carbon," Hughes said. "Colorado State is particularly focused on the interaction of the atmosphere with the biosphere. We are attempting to understand the integrated nature of these problems."

In a multidisciplinary approach to the problem of global change, Colorado State in April established the Center for the Analysis of the Dynamics of Regional Ecosystems or CADRE. Researchers from the University's Natural Resources Ecology Laboratory and the Cooperative Institute for Research in the Atmosphere study arid and semi-arid regions of North and South America, Africa and Asia to monitor environmental impacts of global climate change.

At the Central Plains Experimental Range Site, located 30 miles northeast of Fort Collins, 15 Colorado State researchers meticulously collect data important to the preservation of the grasslands environment. Their expertise ranges from meteorology to biochemistry. "The problem of global change isn't necessarily faceless," said Marco Rodas Flores, Colorado State director of international forestry programs. "It is an integrated problem of the earth and its inhabitants. Showcase '89 sought to examine the human and social ramifications of these global problems."

For 20 years, sociology professor Evan Vlachos has studied the impact human society makes on the environment. His studies show unchecked human population growth coupled with the overconsumption and misuse of resources like natural gas slowly destroy valuable ecosystems. "We must take action to motivate people to drastically alter their pattern of consumption of fossil fuels," Vlachos explained. "While our careless use of resources has made life easier for us all in the short run, in the long run it has destroyed our harmonious relationship with the environment."

Ongoing work by researchers in the College of Arts, Humanities and Social Sciences examines the value of water resources, explores hazardous waste disposal practices in other countries and scrutinizes environmental policy decisions. As discussion and research of the impacts of global change continue at Colorado State, researchers hope their work one day will bring solutions to problems that now appear overwhelming.

MORGAN LIBRARY'S CAM TO INCLUDE GOVERNMENT DOCUMENTS

This fall the number of online records available in CAM, the Libraries' computer catalog, will nearly double when 200,000 records for U.S. government documents are added to the database. The records represent titles that Colorado State has received since 1976 as depository publications. Adding U.S. government publications will do more than just increase the number of bibliographic records; documents librarian Fred Schmidt says it will "bring into the mainstream an entire class of material that was almost inaccessible to many library users. Ease of accessibility has resulted in a dramatic increase in the use of documents in libraries that have previously loaded the 13-year range of data. Some libraries have reported more than 300 percent increase in the first year of online accessibility.

Colorado State University Libraries' documents collection represents virtually every subject that touches on public policy and public life in the United States. These government publications are an especially valuable source for research, Schmidt adds, because most are considered original sources. The collection's holdings are strong in agriculture,

forestry, engineering, the environment, statistics, management, energy, space sciences, natural resources, political sciences, and water resources.

FROM COOPERATIVE EXTENSION

by Jim C. Loftis, Associate CWRRI Director
and

Paul D. Ayers, Israel Broner and Lloyd Walker
Extension Agricultural Engineers

Summary of EPA Regulations for Underground Storage Tanks - The EPA has recently published a document "Musts for USTs" summarizing new regulations for underground storage tank systems (EPA Document EPA/530/UST-88/008). Fortunately agricultural fuel storage tanks are exempt from the regulation to some degree. Specifically, "Farm and residential tanks holding 1100 gallons or less of motor fuel used for non-commercial use...and tanks storing heating oil used on the premises where it is stored...are not covered by these regulations." The major points of the regulations state that:

- If you install an UST after December 1988, it must meet the requirements for new USTs concerning correct installation, spill and overflow prevention, corrosion protection, and leak detection.

- If you have an UST that was installed before December 1988, it must meet two major requirements: 1) Corrosion protection and spill overflow prevention. 2) Leak detection requirements.

- You must take corrective action in response to leaks.

- You must follow closure requirements for tanks you temporarily or permanently close.

- you are financially responsible for the cost of cleaning up a leak and compensating other people for bodily injury and property damage caused by your leaking UST.

For USTs installed before December 1988, both corrosion protection for steel tanks and piping and devices to prevent spills and overflow are required by December 1998. Leakage detection requirements are more urgent. Here are a list of dates when leakage detection will be required (Date tank was installed: leakage detection is required by December of...): Before 1965 or unknown: 1989. 1965-1969: 1990. 1970-1974: 1991. 1975-1979: 1992. 1980-Dec. 1988: 1993.

The above mentioned document is available from the US-EPA Office of Underground Storage Tanks, Washington, DC 20460. An EPA Hotline (800/424-9346) has been established.

Winterizing Irrigation Systems - includes the regular tasks such as draining pipelines and chlorinating wells. An important step that not all irrigators do is to check over the system for repairs that need to be done before the next irrigation season. By walking through the system during the last irrigation or two, needed repairs can be located and taken care of during the fall. Hal Warner, Extension Irrigation Specialist from South Dakota, has some tips for winterizing and fall maintenance of irrigation systems.

Wells: Chlorinate the well.

Pipelines: (1) Drain all underground pipelines and store aluminum pipeline to prevent damage. (2) Inspect fittings, check valves, and water meter-service as needed.

Pump and Power Unit: (1) Drain water from all above ground parts of the pump. (2) Check coolant on engine and replace annually. (3) Service engine and motors including changing oil, cleaning air filter and lubricating as required. (4) Loosen and grease pump packing-replace if needed. (5) Loosen V belts and note if new belts will be needed for next year. (6) Remove suction line and store to prevent damage. (7) Insure that screens are secure and that motor and control boxes are rodent proof.

Sprinkler System: (1) Remove sand trap and make sure all automatic drains have drained the system. (2) Check gear boxes for moisture and replace grease as recommended by the manufacturer. (3) Lubricate and grease as needed. (4) Check tires and make sure they are inflated properly. (5) Check pipe boots and replace those that leak. (6) Note defective sprinklers and obtain replacements. (7) Note electrical problems and repair as needed.

Other: (1) Retrieve and clean tensiometers. Store in a heated location over winter. (2) Retrieve rain gauge for winter storage. (3) Drain and store chemigation pump to prevent winter damage. (4) Note defective pressure gauges and obtain replacements.

(Taken from South Dakota Irrigation Pipeline, Volume 3, Number 4, October, 1987).

CITY SEWAGE RECOVERY FARM RECEIVES AWARD

The City of Fort Collins has been selected by the Environmental Protection Agency to receive its Excellence Award for Beneficial Use of Sewage Sludge. The award was announced by James Scherer, EPA regional administrator. The city's sludge facility was built in 1983. It uses treated sewage to fertilize and grow crops on site and the sludge is also used by area farmers.

Coloradoan, 9/28/89.

LOVELAND CITY MANAGER WINS TOP ICMA AWARD

Mike Rock, Loveland City Manager, received the Mark E. Keane Award for excellence at the September annual conference of the International City Managers Association held in Des Moines, Iowa. He was chosen as the city manager who has done the most to make local government more effective by a 15-member committee, which made the selection from among city managers throughout the United States and several foreign countries. He is the second Coloradoan to win the award in the past three years; the other was Aurora City Manager Jim Griesemer.

APPOINTEES TO NCWCD BOARD OF DIRECTORS ANNOUNCED

Nancy Gray, former Mayor of Fort Collins, has been reappointed to the Northern Colorado Water Conservancy District board of directors, representing Larimer County. Gray, who has served on the board for five years, was reappointed by Chief District Court Judge John David Sullivan. She will retain her position on the Board until 1993.

Les Williams, Executive Director of the St. Vrain and Left Hand Water Conservancy District, has been selected to replace Milt Nelson, Boulder County representative on the board. Nelson, who served for 22 years, decided not to seek reappointment earlier this year. Williams has served four years as executive director of the SVLH Water Conservancy District, was a member of the St. Vrain board for a year, and has been involved with private ditch companies and the District 6 Water Users Association since the early 1980s.

John Caneva, presently the vice president of the NCWCD Board of Directors and a member of the Board for 11 years, was also reappointed to a four-year term. Caneva, who farms near Fort Morgan, represents Morgan/Washington Counties. He is on the Board of the Riverside Irrigation Company and is active in the Groundwater Appropriators of the South Platte Basin.

Source: NCWCD Water News, Fall 1989

COLORADAN RECEIVES AWRA NATIONAL AWARD

Gilbert White of Boulder received the Henry P. Caulfield, Jr. Medal for Exemplary Contributions to National Water Policy from the American Water Resources Association in September. The award was presented at the association's Silver Anniversary Conference in Tampa, Florida. White is former Director of the Natural Hazards Research and Applications Information Center at the University of Colorado, Boulder, and has contributed uniquely to the interdisciplinary advancement of water resources management over a long and distinguished career.

HARZA EXECUTIVE ELECTED AMERICAN WATER FOUNDATION PRESIDENT

Don Duck, Chairman and President of Harza Engineering Company, has been elected President of the American Water Foundation. Headquartered in Chicago, Harza is a leading U.S. and international engineering company. In accepting the Presidency of the Foundation, Duck said, "There is a great need for an organization which can become a clear voice and formidable advocate in behalf of U.S. trade competitiveness in all water resource development sectors. I intend to do what I can to help AWF fulfill that role. With the support of other engineering, construction and manufacturing firms, we will succeed."

The American Water Foundation is a private, non-profit organization dedicated to the international transfer of U.S. water resources technology. Membership includes officials of private and public sector organizations throughout the

United States. AWF also organizes international seminars and training programs in the U.S. and abroad. The Foundation is headquartered in Denver, with offices in Washington, D.C., and Fort Collins, Colorado.

NEW HEC DIRECTOR NAMED

Darryl W. Davis is new Director of the Hydrologic Engineering Center (HEC), succeeding Bill S. Eichert who retired after serving 16 years as Director. Davis joined HEC in 1970 and was Chief of the Planning Division. He assumes leadership of a staff of 30 engineers and computer scientists that provides support in hydrologic engineering and water resources planning to Corps of Engineers offices nationwide. HEC is located at the COE Water Resources Support Center in Davis, California.

NCWCD OFFICER WILL CHAIR ASCE/WRPMD EXECUTIVE COMMITTEE

Darell D. Zimbelman, associate general manager of the Northern Colorado Water Conservancy District, is the new chairman of the Water Resources Planning and Development Division, American Society of Civil Engineers. A graduate of Colorado State and Arizona State universities, Zimbelman brings many years of experience to his new post.

Source: ASCE News, Vol. 14, No. 10, Oct. 1989

NEW USGS REPORTS

Contact Books and Open-File Reports, Federal Center, Box 25425, Denver, CO 80225-0425 for the reports described below. (303)236-7476.

Urbanization Increases Suspended-Sediment Yields. Suspended-sediment yields from urbanized areas were larger than those from rural areas during synoptic sampling in the Fountain Creek drainage basin upstream from Widefield, Colorado, according to a recent report by the U.S. Geological Survey, Department of the Interior, prepared in cooperation with the Colorado Springs Department of Utilities. Paul von Guerard, author of the report, stated "Increases in storm runoff resulting from urbanization are one reason for increases in suspended-sediment yields, and areas under development also contribute to suspended-sediment load in the streams by producing large areas of bare soil that are subject to rapid rates of erosion during storm periods."

Suspended-sediment load increased in the downstream part of Monument Creek. During the 1985 water year, about 61 percent of the total annual suspended-sediment load transported by Monument Creek was contributed by the downstream 14 percent of the drainage basin.

The report entitled, "Suspended sediment and sediment-source areas in the Fountain Creek drainage basin upstream from Widefield, southeastern Colorado," by Paul von Guerard, is published as Water-Resources Investigations Report 88-4136.

Ground-water Quality at the Pueblo Depot Activity Landfill, Pueblo, Colorado. Chemical analyses of groundwater samples collected at the landfill of the Pueblo Depot Activity have indicated the presence of the organic compounds trichloroethylene (TCE) and dichloroethylene

(DCE). The sampling and analyses were done by the U.S. Geological Survey, Department of the Interior, in cooperation with the U.S. Department of the Army. Seepage of contaminated groundwater from the landfill has not affected groundwater quality in the nearby Arkansas River Valley.

The contamination of the groundwater seems to have two possible sources. One is within the landfill but the other may be north of the landfill. "The solvents are extremely volatile. Once contaminated ground water is discharged at land surface, the solvents rapidly evaporate and are discharged to the atmosphere," Kenneth R. Watts, a U.S. Geological Survey hydrologist and principal author of the report said.

"MEETING THE NEEDS OF 6 BILLION PEOPLE" ASCE Schedules Convention

ASCE has set the theme for its November 1990 national convention - Meeting the Needs of 6 Billion People. This is an important and timely topic in that many global problems in the news today need civil engineering solutions. In developing countries, feeding and supplying water to a growing populace dwarfs other needs.

Dr. Otto Helweg of Memphis State proposed a session theme, "Water and Food for Six Billion People," that the Irrigation and Drainage Division will sponsor. Helweg, Department Chairman of Civil Engineering at Memphis State University, received his Ph.D from Colorado State in 1974. He is initially heading up plans for the session. Anyone wishing to suggest speakers is invited to write to Dr. Helweg at the Department of Civil Engineering, Memphis State University, Memphis, TN 38252.

Source: ASCE News, Vol. 14, No. 10, Oct. 1989

DURANGO WILL HOST NATIONAL IRRIGATION CONFERENCE

Durango, located in the heart of Colorado's San Juan Mountains, is the site chosen for the 1990 National Conference and Watershed Management Symposium set for July 9-13, 1990. The conference is sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers. The watershed symposium, held every five years, will pursue new scientific knowledge and sound watershed management practices through application of planning and analysis tools. The irrigation conference will be held immediately after the symposium's conclusion. Its purpose is to provide an opportunity for presentation of a broad range of topics dealing with irrigation and all phases of drainage engineering. Both conference and symposium will last 2-1/2 days and include a plenary session with invited speakers, concurrent half-day sessions, poster sessions, an awards luncheon and field trips. For further information contact: W. Martin Roche, 1223 Devonwood Dr., Apt. 105, Merced, CA 95348. (209)665-5791.

ASCE News, Vol. 14, No. 10, Oct. 1989

COLORADO WATER CONGRESS SCHEDULES FIVE NOVEMBER WORKSHOPS

Five CWC workshops are scheduled for the week of November 14-17 on the following topics:

Public Speaking for the Professional, Nov. 14 - a one-day intensive working session on public speaking for the professional; **Workshop for Elected Officials, Members of Municipal Water Boards and Board Members of Water Conservancy/Conservation Districts**, Nov. 15 - the focus is how well we deal with various working relationships and how can we make them better; **A Review of Federal Environmental Laws Impacting Water Interests**, Nov. 16 - includes National Environmental Policy Act of 1969, Clean Water Act, Safe Drinking Water Act, and Endangered Species Act; **Workshop on the State Legislative Process: The Law, The Rules and The Practices**, Nov. 17 - Fred Anderson, Former State Senator and President of the State Senate presiding.

For information contact the Colorado Water Congress, 1390 Logan Street, Denver, 837-0812.

SHORT COURSES

1990 Central Plains Irrigation Short Course February 5-6, 1990

This course is sponsored by Cooperative Extension in Kansas, Colorado and Nebraska, and brings current information on new technology to irrigators from the Central Plains of the three states. This year the short course will be held in Wray, Colorado on February 5-6, 1990 and hosted by Colorado State University. The meeting theme is: "to provide a regional forum for information exchange on irrigation technology, practices and policies in the Central Plains." The intent of the organizers is to have interaction between researchers, Extension personnel and farmers to facilitate an information exchange and to take advantage of the knowledge accumulated in the three states. Colorado State Cooperative Extension personnel involved in organizing the meeting are Clyde Richardson, Yuma County (332-4151), Wayne Shawcroft, Washington County (345-2249), Bruce Bosley, Logan County (522-3200) and Israel Broner, (491-5274). Programs and registration materials will be available for distribution in early November 1989.

CALLS FOR PAPERS

Second International Symposium on Gas Transfer at Water Surfaces, Minneapolis, MN Sept. 11-14, 1990. For abstract instructions contact Steven Wilhelms, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180 (601)634-2475 or John Gulliver, University of Minnesota (612)627-4600. Deadline: Jan. 31, 1990.

Twenty-Sixth Annual Conference & Symposium of the American Water Resources Association. Conference: The Science of Water Resources: 1990 and Beyond, Denver, CO Nov. 4-9, 1990. Global climate change, widespread flooding and droughts, hazardous waste contamination, increased water demand, and diminishing

good-quality supplies will continue to be concerns during the 1990s and beyond. This Conference is an opportunity to address these and many more emerging water resources issues. Student papers encouraged. The abstract cannot exceed 200 words and must include the title of the paper or poster, all authors' names and affiliations. Submitting author must include, on a separate page, the full mailing addresses and a telephone number for each author. Deadline: December 1, 1989. Submit three copies of abstract to: Jim Loftis, Colorado State University, Rm. 100, Engineering So., Ft. Collins, CO 80523 (303)491-7923; or Bob Montgomery, Woodward-Clyde Consultants, 4582 S. Ulster Parkway, Suite 1000, Denver, CO 80237 (303)694-2770. Symposium: Transferring Models to Users. Both invited and contributed papers will be presented in poster and oral technical sessions. A computer-poster-type forum is planned as a special event. Submit three copies of abstracts to: Eric B. Janes, SC-325, Bureau of Land Management, Bldg. 50, Box 25047, Denver, CO 80225-0047 (303)236-0170; or Jeffrey E. Miller, U.S. Geological Survey, Box 25046, MS 406, Lakewood, CO 80225 (303)236-5931. Deadline: December 1, 1989.

Challenge Ahead: Flood Loss Reduction Strategies for the '90s. Association of State Floodplain Managers 14th Annual Conference, Asheville, NC June 11-14, 1990. The conference will focus on strategies to further reduce flood hazards in the coming decade. Papers addressing virtually any aspect of this topic are invited. In addition, proposals for short courses, special exhibits or demonstrations that may be of interest to those attending the conference are welcome. For details on preparing abstracts for submission, contact Tim Keptner, Program Chair, Pennsylvania Dept. of Community Affairs, 551 Forum Bldg., Harrisburg, PA 17120. (717)787-7403.

Mapping and Geographic Information Systems (GIS), San Francisco, CA June 21-22, 1990. Submit a 300-500 abstract and ASTM Paper Submittal Form by November 15 to Dorothy Savini, Symposia Operations, ASTM, 1916 Race St., Philadelphia, PA 19103-1187. (215)299-5413. Submittal forms are available from Ms. Savini. The Symposium chairman is Ivan Johnson, 7474 Upham Court, Arvada, CO 80003. (303)425-5610.

Critical Issues for the 1990s: Desalination and Water Reuse, 1990 Biennial Conference, Walt Disney World, Orlando, FL August 19-23. Papers are solicited on topics that deal with advanced water sciences, water reuse, conservation and related subjects. Papers from university students for student section are welcomed. Abstracts (500 words) must include the following: title of paper; authors' names, titles and affiliations; presenter of paper; indication of whether the work has been or will be published elsewhere; and the date of completion of the project being reported. Deadline: December 1, 1989. Send 5 copies of abstract to: O.J. Morin, Post, Buckley, Schuh & Jernigan, Inc., 800 N. Magnolia Ave., Suite 600, Orlando, FL 32803. (407)423-7275 Ext. 330.

POSITIONS AVAILABLE

Director of the Water Center, Institute of Agriculture and Natural Resources, University of Nebraska--Responsibilities: The incumbent will coordinate and provide

administrative leadership for water-related research, extension and teaching activities. Responsibilities include the planning, coordination and review of water-related research and extension programs funded through the Water Center including P.L. 98-242 funds. Will provide primary leadership and management for the University of Nebraska Water Science Research Initiative which is part of a \$20 million State-supported initiative to enhance the research base at the University of Nebraska.

Qualifications: Requires Ph.D degree in applicable discipline. Adequate professional experience in some area of water-related research and education to qualify for rank of Professor in an appropriate academic department is required. **Salary:** Commensurate with qualifications and experience. **Application:** Submit letter of application, resume and the names and addresses of three references postmarked by December 15, 1989 to: Dr. T. E. Hartung, Associate Vice Chancellor, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Lincoln, NB 68583-0708. Phone: (402)472-2871.

Forest Hydrology-Watershed Management, University of Connecticut--Teaching and research faculty position, tenure track, 9-month appointment as Assistant Professor. Salary commensurate with qualifications and experience. Starting Date January 1990.

Qualifications: Ph.D degree in Forest Hydrology, Watershed Management, or closely related field. Demonstrated research and teaching competence in some aspect of the physical-chemical environments of forest and agriculture lands such as water quality, soil pollutant cycling, acid deposition, or water supply. Candidates lacking a degree in Forest Hydrology or Watershed Management will be considered providing they can demonstrate a strong educational background and/or experience in a related field.

Submit letter of application, resume, and names, addresses and telephone numbers of three references to: Dr. Hugo H. John, Department of Natural Resources Management and Engineering, College of Agriculture and Natural Resources, The University of Connecticut, 1376 Storrs Road, Box U-87, Storrs, CT 06269-4087. Applications will be received until October 1, 1989 or until a suitable candidate is found.

Student Research Assistant, South Dakota State University-- pursuing a Master of Science degree in a Water Science-related discipline at South Dakota State University in cooperation with the Water Resources Research Institute. Part of the Engineering and Environmental Research Center (EEERC), College of Engineering at South Dakota State University, Brookings, South Dakota 57007. Application closing date: Dec. 15, 1989 or until a suitable candidate is selected. Position and semester starts on January 10, 1990.

Job Description: This person will have the opportunity to work on a Rural Clean Water Project (Agricultural Chemical Leaching Study) in South Dakota. The thesis will concentrate on using water quality and quantity data collected from a computer-controlled automatic soil-water monitoring and sampling system to determine if differences between moldboard plow and no-till tillage treatments on a corn-oats rotation system affect soil solution and groundwater quality.

If you are interested in the effects of agricultural management practices (BMP's) on ground water quality, this would be an ideal opportunity to become acquainted with the state of the art methods in soil-water sampling and monitoring. The Rural Clean Water Program is a joint effort between the U.S. Department of Agriculture (USDA) which includes the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS), the U.S. Environmental Protection Agency (EPA), the S.D. Dept. of Water and Natural Resources, SDSU's Water Resources Research Institute, and local Conservation Districts.

Qualifications: B.S. Degree in a physical science area, preferably a water-science related discipline; Valid driver's license; acceptance into graduate school at South Dakota State University-must have a 3.0 GPA or better overall; desire to pursue a Master's Degree in a water-related physical science; must be self-motivated and enjoy working with others; prefer agricultural background.

Salary: A forty-nine percent time graduate research assistantship is available for 10 months at \$9,000 per annum. Two-thirds of tuition is waived for resident and non-resident students. Resident and non-resident applicants are expected to pay for \$17.10/credit-hour.

Contact: John H. Bischoff, Water Resources Research Institute, SDSU, Box 2120, Brookings, South Dakota 57007, 605-688-4910.

Water Resources Engineers, South Florida Water Management District--The Basin Planning Division of the South Florida Water Management District is seeking qualified applicants for five professional and supervisory engineering positions. The Basin Planning Division is responsible for performing Level of Service reviews for flood protection for 16 counties along with developing basin plans for selected watersheds. The five positions are: Supervising Professional Water Resources Engineer; Senior Water Resources Engineer (2 positions); Staff Water Resources Engineer; and Water Resources Engineer.

The positions involve numerical model development, application and engineering design in one or more of the following areas: watershed hydrology, groundwater/surface water systems, hydraulics, sedimentation, and/or coastal/estuarine hydrodynamics. Requirements are a BSCE, AgE or related water resources degree and from two to five years of responsible civil or hydraulic engineering experience, including sophisticated water resources modeling experience on a basin scale. Advanced education may be substituted for experience. Send resume to: South Florida Water Management District, Personnel Office, 3301 Gun Club Rd., West Palm Beach, FL 33416 or call (407)687-6349.

NATIONAL SCIENCE FOUNDATION: Applicants for the following positions should submit an SF-171 Application for Federal Employment, and Letter of Recommendation (a resume may be submitted for rotational/temporary assignment) including current salary to NSF, Personnel Administration Branch, Room 208, 1800 G Street, NW., Washington, DC 20550. Attn: Catherine Handle, 357-9529. Hearing impaired individuals should call: TDD 357-7492. NSF is an Equal Opportunity Employer. These positions are excepted from the competitive civil service and will be filled on a permanent basis. The type of job appointment is indicated in the job

announcements. For additional information and/or to obtain the closing date for the announcement, call 357-9529.

The per annum salary is as follows: *Program Director Level IV-\$48,592 to \$75,473; *Associate Program Director Level III-\$41,121 to \$64,778; *Assistant Program Director Level II-\$28,852 to \$53,460.

*NSF's Divisions of Cellular Biosciences and Molecular Biosciences (BBS Directorate) are seeking qualified applicants under the provisions of NSF's Visiting Scientist Program for the following positions: Assistant Program Director, Associate Program Director, and Program Director. Since responsibilities include research proposal evaluation, budget development and scientific planning; broad knowledge and specific research accomplishment are key qualifications. The positions are excepted from the competitive civil service and will be filled on a one- or two-year rotational/temporary basis. The positions become available periodically and will be filled beginning in the summer or fall, 1990.

Requirements include Ph.D or equivalent experience plus two or more years of research experience beyond the Ph.D. In the Division of Cellular Biosciences there are openings in Cell Biology, Developmental Biology, Cellular Biochemistry, and Physiological Processes. In the Division of Molecular Biosciences there are openings in Biochemistry, Biophysics, and Genetics. For further information, call Dr. Bruce Umminger, Cellular Biosciences, 357-7905 or Dr. James H. Brown, Molecular Biosciences, 357-9400.

* NSF's Division of Ocean Sciences (GEO Directorate) is seeking qualified applicants for a position which is available immediately for Associate Program Director, Marine Geology and Geophysics, Ocean Sciences Research Section. Primary responsibilities involve proposal evaluation, project development and support, program planning and budgeting, and related administrative duties.

Applicants must have a Ph.D or equivalent experience in marine geology and geophysics or related disciplinary fields. In addition, four or more years of research experience beyond

the Ph.D, broad understanding of the current status of the relevant U.S. academic scientific community and its interrelationships with NSF, other Federal agencies, and international planning efforts. For technical information about the position, call Dr. Bilal Haq, 357-9639.

* NSF's Division of Chemistry (MPS Directorate) is seeking qualified applicants for rotational (one- or two-year) positions as Program Officers in the Visiting Scientists Program. The positions are for the following programs: (1) Inorganic, Bioinorganic, and Organometallic Chemistry; (2) Organic Synthesis; (3) Organic Reaction Dynamics; (4) Experimental Physical Chemistry; (5) Theoretical Physical Chemistry (6) Analytical and Surface Chemistry; and (7) the Special Projects Office. (The Special Projects Office handles proposals for special initiatives including chemistry of Life Processes, and Materials Chemistry; the Postdoctoral Research Fellowships in Chemistry; and the Research Experiences for Undergraduates program.) For technical information about the positions, contact Dr. K.N. Houk, Division Director, 357-7947.

* NSF's Division of Materials Research (MPS Directorate) is seeking qualified applicants for program director positions under the Visiting Scientists Program which periodically become available in several of its programs. These positions will be filled on a permanent, one- or two-year rotational or temporary basis. At this time, the Division is especially interested in filling positions in condensed matter physics. For technical information, contact Dr. W. Oosterhuis, 357-9787.

* NSF's Division of Mathematical Sciences (MPS Directorate) is seeking qualified applicants for positions under the Visiting Scientists Program which periodically become available. Incumbents will be responsible for planning, coordination, and management of basic research activities primarily through Federal grants and contracts to academic institutions and non-profit, non-academic research institutions. A broad, general knowledge of the field and some administrative experience are required. For technical information, contact Dr. Judith Sunley, 357-9669.

CONFERENCES

- Nov. 8-10 INTERNATIONAL SYMPOSIUM ON LAKE AND RESERVOIR MANAGEMENT, Austin, TX. Contact: No. American Lake Management Society, P.O. Box 217 Merrifield, VA 22116.
- Nov. 12-17 NATIONAL SYMPOSIUM ON WATER QUALITY, Orlando, FL. Contact: Vivian Olcott, U.S. Geological Survey, R.B. Russell Federal Bldg., 75 Spring St., Suite 772, Atlanta, GA 30303. (404)331-5174; fts 242-5174.
- Nov. 16-17 7TH ANNUAL RED RIVER BASIN LAND AND WATER INTERNATIONAL SUMMIT CONFERENCE, "WATER QUANTITY: TOO MUCH - TOO LITTLE," Grand Forks, ND. Contact: The International Coalition, Box 127, Moorhead, MN 56560. (218)233-0292.
- Nov. 17 WATER MARKETING 1989: COLORADO IN THE WAKE OF THE TWO FORKS DECISION. Contact: Institute of Advanced Legal Studies, University of Denver College of Law, 7039 E. 18th Ave., #140, Denver, CO 80220.
- Nov. 19-21 102ND ANNUAL MEETING, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES, Washington, D.C. Contact: NASULGC, One Dupont Circle, Suite 710, Washington, D.C. 20036-1191. (202)778-0850.
- Nov. 27-28 AIR QUALITY PROTECTION IN THE WEST, Boulder, CO. Contact: Katherine Taylor, Natural Resources Law Center, University of Colorado at Boulder, Campus Box 401, Boulder, CO 80309-0401. 303)492-1288.

COLORADO WATER RESEARCH

A summary of water research awards and projects recently initiated is given below for those who would like to contact the investigators to receive information.

Colorado State University, Fort Collins, CO 80523

- Technical Support and Peer Review for Ongoing Groundwater Characterization Efforts**, Frederick W. Smith, Civil Engineering.
- An Evaluation of the Leachability of Heavy Metals from Fly Ash Liner Materials**, Charles Shackleford, Civil Engineering.
- Biomass Resource Assessment in the State of Colorado**, Muhammad N. Karim, Agricultural & Chemical Engineering.
- Water Quantity and Quality as Affected by Grazing in a Mountainous Riparian Zone**, Milton J. Trlica Jr., Range Science.
- Rocky Mountain Arsenal Exposure Study**, John S. Reif, Environmental Health.
- Process Control in Solid Substrate Fermentation**, Vincent V. Murphy, Agricultural & Chemical Engineering.
- Modeling of Intermittent Hydrologic Processes**, Jose D. Salas, Civil Engineering.
- Land Condition/Trend Analysis on U.S. Army Lands**, Robert B. Shaw, Range Science.
- The Climatological Effects of Convective Cloud Systems**, David A. Randall, Atmospheric Science.
- Program Coordination & Atmospheric Deposition Chemistry Analysis NADP & NTN**, James H. Gibson, Natural Resource Ecology Lab.
- Floriculture Research**, Joe J. Hanan, Horticulture.
- Analysis of Weather as a Determinant of Grasshopper Outbreaks**, Thomas O. Holtzer, Entomology.
- Population Modeling**, Gary C. White, Fishery & Wildlife Biology.
- Irrigation Management Project (IMP) Redesign in Nepal**, Ramchand Oad, Agricultural & Chemical Engineering.
- Evaluation of Surface Thermal & Moisture Characteristics, & Terrain Configuration on the Initiation and Development of Convective Clouds**, Roger A. Pielke, Atmospheric Science.
- Reaction Steps & Mechanism for Chemical Vapor Deposition of Tungsten**, Carol M. McConica, Agricultural & Chemical Engineering.
- The Role of Clouds in CO₂-Induced Climate Change**, David A. Randall, Atmospheric Science.
- Conservation Tillage in a Furrow-Irrigated Arid Environment of Western U.S.**, Calvin H. Pearson, Agricultural Sciences Department, Western Slope-Fruita

University of Colorado, Boulder, CO 80309

- Reduce Uncertainty in Projection of Future Sea-Level Change Due to Ice Wastage**, Tissa Illangasekare, Civil, Environmental, and Architectural Engineering.
- Economics and Psychology Policy Research for Environmental Management**, William Schulze, Economics-Center for Economic Analysis.
- Topographic Controls on Primary Biological Productivity and Organic Carbon Deposition, Oman Arabian Sea Coastal Upwelling Region**, John Brock, Cooperative Inst. for Research in Environmental Sciences.
- Static and Dynamic Pile Performance by Centrifuge Testing**, Frank Barnes, Civil, Environmental, and Architectural Engineering.
- Greenland Ice Sheet Program (GISP II) Data Management**, Roger Barry, Cooperative Inst. for Research in Environ. Sciences.
- Composition of Bromine Aerosols Related to Ozone Destruction in the Arctic**, Patrick J. Sheridan, Cooperative Inst. for Research in Environ. Sciences.
- Climatology of the Arctic Planetary Boundary Layer and Temperature Inversion**, Jonathon Kahl, Cooperative Inst. for Research in Environ. Sciences.
- Effects of Climate Change on Plant-Herbivore Interactions**, Alcinda Lewis, Environmental, Population and Organismic Biology.
- A Genetic Analysis of Photosynthetic and Biomass-Partitioning Adaptation in *Cleome serrulata* Along a Topographic Moisture Gradient**, Russell Monson, Environmental, Population and Organismic Biology.
- Development and Application of the Thermoluminescence Technique to Date Arctic Deglacial Marine Sediments: A Case Study on Western Spitsbergen, Svalbard**, Steven Forman, Inst. of Arctic and Alpine Research.
- Field Demonstration of Biological Denitrification of Polluted Groundwater**, Joann Silverstein, Civil, Environmental, and Architectural Engineering.
- Hydrologic Aspects of Revegetation Following Water Transfer from Irrigated Farmland**, J. Ernest Flack, Civil, Environmental, and Architectural Engineering.
- Development and Laboratory Verification of Models of Surface-Subsurface Water Quality Interaction**, Tissa Illangasekare, Civil, Environmental, and Architectural Engineering.
- Enhanced Microbial Reclamation of Water Polluted with Toxic Organic Chemicals**, Steven Schmidt, Environmental, Population and Organismic Biology.
- Investigation of the Impact of Forest Fires on the Chemistry and Water Quality of Groundwater in Yellowstone National Park**, Donald Runnells, Geological Sciences.

Denver South Platte Water Quality and Wastewater Management Study

by Russell N. Clayshulte
Principal Water Resources Planner
Denver Regional Council of Governments

The need for a comprehensive water quality study involving all of the municipalities and special districts in the northern metropolitan region of Denver has been recognized since the mid-1970's (CH2M Hill Inc., 1977). Although there have been several water quality related and wastewater management studies completed for portions of this area, these studies did not provide solutions acceptable to all affected agencies or develop a regional plan. The Denver South Platte (DSP) study was developed as a regional plan by the Denver Regional Council of Governments (DRCOG) at the request of the Colorado Water Quality Control Commission (DRCOG, 1989). The Commission was concerned about the lack of information on long-range water quality trends, anticipated development forecasts and wastewater service planning for this northern metropolitan region of Denver (Figure 1).

The DSP Task Force was established to oversee and assist the DRCOG staff in the DSP study. Participants in the DSP Task Force represented both municipalities and special districts within the study region. The involved cities and towns included Northglenn, Westminster, Thornton, Broomfield, Brighton, Lochbuie, Aurora, and Commerce City. The special districts and other agencies were Metropolitan Denver Sewage Disposal District No. 1 (Metro District), Beebe Draw Water and Sanitation District, South Adams Water and Sanitation District (South Adams), Barr Lake Metropolitan District, Bromley Park Metropolitan District, Third Creek Metropolitan Sewage District, Adams County and the City and County of Denver.

The DSP task force determined those essential issues which needed to be investigated as part of a long-term water quality and wastewater management plan. These issues were divided into initial, future and special topics. Initial topics which were addressed in the management plan included: Population, employment and wastewater flow projections; a defined decision making process; criteria for establishing development in new service areas; a mechanism to address 'leap frog' development; how to make maximum use of existing facilities; interim water quality effects on receiving waters; an evaluation on institutional alternatives; management agency institutional roles; and a determination of the ability of operating and management agencies to provide new wastewater service. Future topics would assess the regional wastewater facility goal and define triggers and staging for construction of this facility. Special topics required separate assessments and included: the proposed new Denver airport wastewater service and water quality; existing water quality in Barr Lake; groundwater quality; and non-point source loadings.

STUDY CRITERIA

The DSP water quality and wastewater management provides a regional strategy for interim wastewater service through 2010 and a goal for long-term service. Planning level cost analyses were used in the process of determining the more cost effective alternatives, while eliminating the least effective alternatives. Cost analyses does not establish actual customer costs, but it does develop estimate wastewater service costs which could provide a basis to establish future customer costs. The DSP study also recognizes there are other factors which can affect the selection of a preferred alternative. Therefore, the DSP study does not replace the need for specific wastewater facility plans which are necessary to implement a preferred alternative.

Hydrological and geographical features establish natural drainage basin boundaries (Figure 1). Generally, service area boundaries should coincide with these basin boundaries. However, there are socioeconomic, political and water quality considerations which can alter these service area boundaries. Therefore, service areas are defined as complex hydrological systems composed of orderly hydrologic units and their man-related aspects, such as the use, treatment and reuse, and disposal of wastewater and municipal annexations.

Hydrological systems were used to develop initial service areas. These areas were further defined on the basis of municipal annexations and accounted for the new Denver airport land use. The Beebe Draw hydrological system was separated into a subregion. The remainder of the region was split along the South Platte River with alternatives evaluated for areas west of the river and east of the river. No wastewater flows were planned to cross the South Platte River. In each subregion (Beebe Draw, East and West), a series of alternatives were prepared which provided the most likely wastewater service opportunities.

A set of criteria was used to design a system of services areas and define a process for changing and updating these service areas over an interim planning period. The process was intended to be flexible to allow for changes as development patterns or other assumptions changes with future growth in the region. This process provides a "road map" to allow regulatory and designated agencies to follow development of wastewater systems within this region.

REGIONAL GOAL

A large regional wastewater treatment facility, which would replace existing facilities, becomes more cost effective and feasible after 2010. However, there is a potential to initiate a "seed facility" prior to 2010. This seed facility could be built at a location near Fort Lupton by the new Lower South Platte Management Association in coordination with other existing management agencies. This seed facility could be initiated between 1996 and 200 to replace the existing Brighton wastewater treatment facility. If the Brighton facility does not need to be expanded or relocated, then Metro District could also initiate a seed facility to process

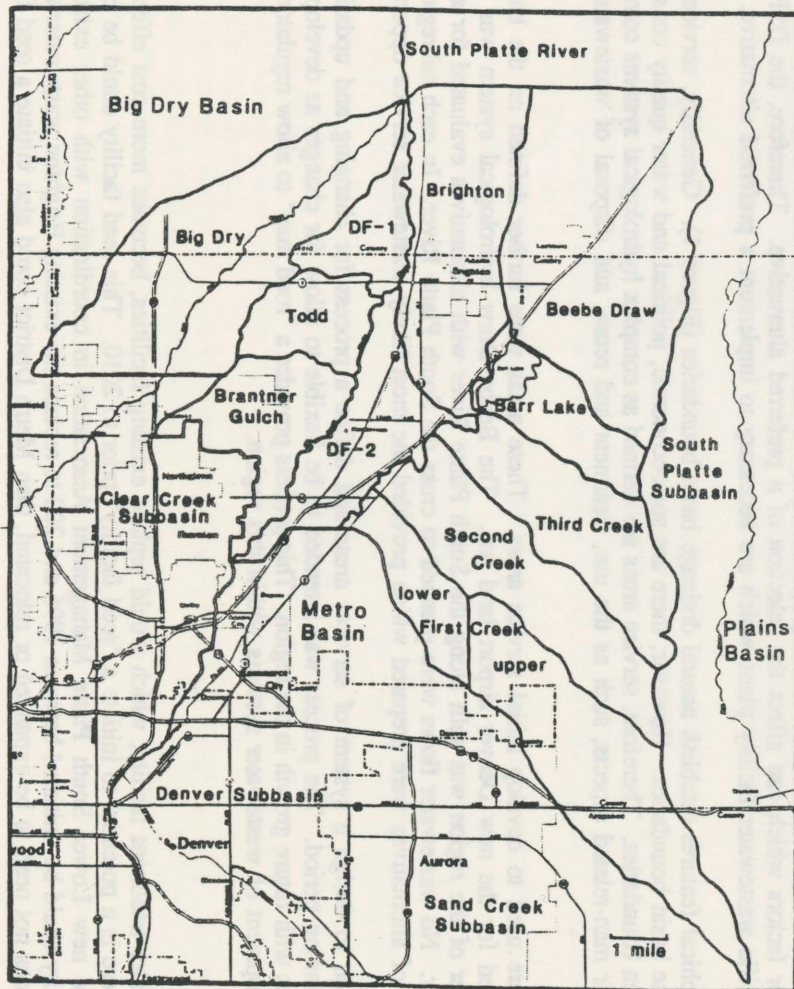


Figure 1. Location of DSP study area and hydrologic systems

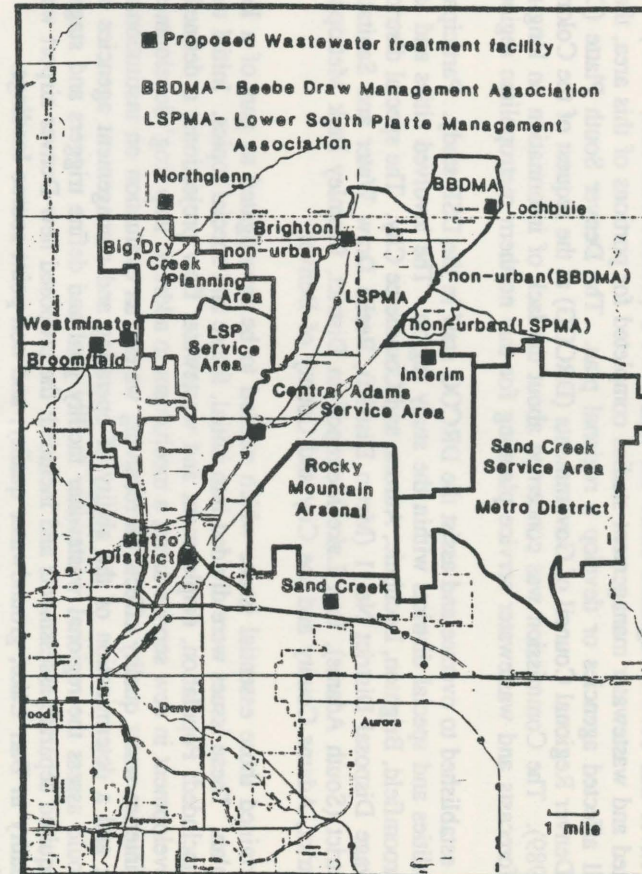


Figure 2. Service areas, management agencies and wastewater treatment facilities through 2010.

wastewater flows from the existing Brantner Gulch interceptor system when this system reaches capacity near the year 2010. The combination of these options could also initiate a regional facility.

Existing facility use would be maximized before sending wastewater flows to the regional facility. The only expansion of facilities would be those which occur in the interim planning period. Flows which are in excess on existing facility rated capacity will be sent to the regional facility after 2010 as shown in the future developed facility plans. This will allow existing facilities to continue operation through their design life.

The total capacity of an existing facility would be diverted to the regional facility once the design life is reached or sooner if it becomes cost effective to send wastewater flow to the regional facility based on annual operation and maintenance costs at the existing facility. Sequencing existing flows to the regional facility would be related to the economic life of existing facilities. Expansions of the regional facility could be done in size blocks of 8 to 10 MGD, as designated in a regional facility plan. Management agencies with three subregions will meet on an annual basis to discuss regional facility construction and timing issues.

SERVICE AREA ALTERNATIVES

Service alternatives were evaluated to determine the most cost effective system for providing wastewater treatment service for an interim planning period of 1988-2010. Water quality considerations did not appear to be significant in relation to alternative selection. The DRCOG Regional Development Framework forecasts were used to estimate development by the year 2010 (DRCOG, 1985). Growth expectations among the northern metropolitan municipalities are high, particularly for single and multi-family land use and commercial development associated with the processed beltway transportation system. DRCOG projects a 68 percent increase in population and employment within existing service areas and a 160 percent increase for new urban service areas by the year 2010. The area east of the South Platte River also anticipates additional commercial development resulting from construction of the new Denver airport complex. Wastewater service area alternatives were analyzed for the three subregions and the most cost effective alternatives recommended for interim wastewater service.

East Subregion

The wastewater treatment facilities belonging to Brighton and South Adams would provide service to a joint service area (Figure 2). The Barr Lake Metropolitan District would be included within this new joint area. An interim on-site wastewater treatment facility would be cost effective for this district. After 2005, this District will send wastewater flows to Brighton and the on-site facility will be removed. The proposed new Denver airport would send wastewater flows to a Metro District facility for treatment.

Institutional mechanisms necessary for implementing the Clean Water Plan (CWP) were developed for the east subregion (DRCOG, 1988). There will be a new shared Central Adams service area which uses Brighton and South Adams facilities and recognizes an interim Barr Lake Metropolitan District facility. The management agency for this service area would be a new Lower South Platte Management Association with a membership of Brighton, South Adams, Adams County, Commerce City and Barr Lake Metropolitan District. Metro District would be designated as the management agency for the new Denver airport.

West Subregion

The most cost effective interim alternative for West subregion would utilize the excess capacity at the Northglenn wastewater treatment facility to provide interim service to portions of the Big Dry Creek hydrological system south of their facility (Figure 2). The Metro District central wastewater treatment facility would continue to process wastewater from the Brantner Gulch area through existing transmission lines. Metro District would expand new transmission lines into the Todd Creek drainage system when wastewater service is required for this area.

The West subregion has not designated a new management agency for the Big Dry Creek and Todd Creek areas. Instead, the existing management agencies will be responsible for service to the annexation areas when they occur. While Northglenn was the most cost effective operating agency for portions of Big Dry Creek, use of this facility will still need to be considered in intergovernmental agreements (IGAs) which are in progress. The IGAs will be developed between the management agency annexing into the Big Dry Creek area and the City of Northglenn. The CWP will not recognize the Big Dry Creek area as a wastewater service area until submitted as CWP amendments with signed IGAs between affected agencies (DRCOG, 1988). Results and recommendations from this study form the basis for ongoing IGA discussions.

Beebe Draw Subregion

The most cost-effective alternative for the Beebe Draw subregion is a single treatment facility located at Lochbuie which utilizes the existing system through 2010 (Figure 2). The Lochbuie facility would need to be incrementally expanded to its maximum design capacity of 1.3 MGD by 2010.

The preferred management system would be a joint agency composed of Brighton and Lochbuie with involvement from Bromley Park Metropolitan Districts, the Beebe Draw Water and Sanitation District, and Adams and Weld Counties. The Cities of Brighton and Lochbuie will negotiate the management agency agreement.

WATER QUALITY ASSESSMENT

Water quality in surface waters, including streams, lakes and reservoirs, is influenced by the character of the hydrological system. Land use patterns in these systems, particularly on a local scale, have been shown to correlate with water quality and quantity trends. Non-point source loading to surface water is correlated with the distribution of land types (DRCOG, 1983). An analysis of land use can estimate the non-point contribution. Additionally, the physical characteristics associated with the hydrological system will not affect water quality trends. These physical factors and land use patterns can define the attainable surface water quality, which is a complex combination of natural conditions modified by human activities.

Regional and subregional water flow regimes and quantities can cause considerable variation in water quality trends. Within region variability can be considerable, while the variability tends to dampen over a larger area. Since general land use development can influence regional water quality trends, land use management was considered in devising a water quality management strategy for the DSP region.

There are a total of 202,460 acres in the 12 hydrological systems. Open space and agricultural lands accounted for almost 193,000 acres in 1986. This land use type is reduced by 28 percent to about 151,000 acres by 2010, but it still remains the dominate land use type. There is a ten-fold increase in single family and multi-family land use between 1986 and 2010. Commercial acres were anticipated to increase from 2,000 to 16,000 areas with the addition of the new Denver airport complex. Large lot usage shows the least change with an increase from 4,500 areas in 1986 to 8,200 areas in 2010.

Water quality issues could affect basin management strategies and long-term service. Water quality issues investigated in this study included: an assessment of wastewater effluent effects on the South Platte River and Big Dry Creek; non-point source pollution loadings; Barr Lake water quality; and groundwater quality.

Water quality in Segment 15 of the South Platte River has shown an improvement in quality within the last five years. This has been caused, to a large extent, by the positive steps Metro District has taken to improve effluent water quality. There have been and still are some water quality problems in Segment 15 from unionized ammonia, dissolved oxygen, metals, total residual chlorine and bacteria (DRCOG, 1988; ERT Inc., 1985; Lewis and Saunders, 1985). Metro District has dechlorinated its effluent and is adding nitrification to the north complex. Monitoring will continue to assess effects from these changes on effluent quality and river water quality. Instream dissolved oxygen exceedances are being evaluated by the Environmental Protection Agency, Metro District and the Water Quality Control Division. Modeled and measured dissolved oxygen sags in Segment 15 are not completely caused by Metro District effluent, but are also influenced by downstream river hydraulics.

Water quality models indicate wastewater discharges from South Adams and Brighton will not significantly affect river quality, based on wastewater flows projected through 2010. There are no significant recent water quality problems identified or modeled in Big Dry Creek; however, limited data has been collected. Currently, the mainstream of Big Dry Creek has only dissolved oxygen, pH and fecal coliform standards.

Barr Lake State Park is an important recreational area in the northern Metropolitan Denver region. Barr Lake is a warm water fishery and is designated as a wildlife refuge area. The Division of Wildlife maintains a nature center in the refuge area and supports other recreational activities. The Lake is an agricultural storage reservoir with discharges into several irrigation systems (Hydro-Triad LTD, 1974).

Barr Lake has received wastewater effluent, industrial waste discharges, urban runoff, agricultural return flows and natural runoff since its construction over 80 years ago. There was some sludge and primary wastewater effluent diverted into the reservoir between 1930 and 1965 by the City and County of Denver. This wastewater discharge reaches the reservoir along with South Platte River flows diverted into the O'Brian Canal. Industrial runoff from refinery operations has been recorded by the Water Quality Control Division of O'Brian Canal discharges. These discharges have produced a eutrophic reservoir which is highly enriched with carbon, nitrogen and phosphorus compounds (Humble, 1979; and USEPA, 1977).

The extent of the eutrophication and enrichment in Barr Lake has not been adequately evaluated in recent years. Therefore, the lake may not be meeting its classified uses as defined by the Commission. The City of Brighton has proposed to use Barr Lake as a potable water source. The lake is not classified for water supply by the Commission. The study recommends not upgrading the classified uses of Barr lake until a more comprehensive water quality data base can be obtained.

The alluvial aquifer is an important groundwater resource in the DSP region. Irrigation practices have affected the water quality in the alluvial aquifer. Generally, the dissolved-solids concentrations increase from agricultural runoff and return flows downgradient in the aquifer. There are also increases of nutrients and other chemicals associated with agriculture in selected portions of the aquifer. Nitrates have periodically been identified by the Colorado Department of Health as a water quality problem in water supplies withdrawn from the alluvial aquifer.

There are numerous public supply systems and individual waterwells which withdraw water from this aquifer and the underlying Denver Aquifer System. More than 25 percent of the water sources in the alluvial aquifer have had dissolved nitrate-nitrogen levels exceeding the national drinking water standards. There have been some waterwells in the east subregion contaminated by hazardous

wastes.

Water quality changes in the Denver Basin Aquifer System are expected to occur at a slower rate than in the alluvial aquifer. These changes will occur primarily along the margins in the upper aquifers. As water is extracted from the deeper non-tributary aquifers, there is an increased potential for water quality degradation. Migration of contaminants from the alluvial aquifer into deeper aquifers will probably be slow (Hearne *et al.*, 1988).

Nonpoint source pollutant loadings from storm events were estimated to determine their effect on receiving water bodies. Land use information submitted by local governments was used in the nonpoint assessment. Data and models derived as a part of the Denver urban runoff program (DRCOG, 1983) were used to predict total phosphorus loading and runoff by land use type. A storm-size distribution and frequency analysis was done to provide rainfall information.

Comparison of relative loading from point sources, baseflow and urban runoff showed municipal wastewater discharges were the greatest contributor of nitrogen, phosphorus and organic carbon to segment 15 on an annual basis (DRCOG, 1983; DRCOG, 1989; ERT Inc., 1985; Lewis and Saunders, 1985). Urban runoff produced a large portion of the total suspended solid and lead annual load which reaches the South Platte River. There are significant quantities of sediments, organic matter, trace metals and bacteria introduced into Segment 15 and into other segments of the river from runoff associated with storm events. These runoff loads can and often do exceed the quantities discharged into the river by municipal wastewater treatment facilities during short duration intermittent flows. There is a lack of information to prove these contaminants have effected classified uses of the receiving water (DRCOG, 1983; DRCOG, 1989).

The DSP management study provides a regional approach and strategy to wastewater management and water quality assessment. The study recommends the development of IGAs which will result in new levels of cooperation among the various management and operating agencies in the region. Although the study has addressed many of the water quality and wastewater management issues, it does not represent the final solution. Management and operating agencies still need to develop institutional mechanisms to implement study recommendations.

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The DSR management study provides a regional assessment of the development of IGA's which will result in a more integrated approach to the development of the region. Although the study has addressed many of the water quality and wastewater management issues, it does not represent the final solution. Management and operating agencies will need to develop institutional mechanisms to implement study recommendations.

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