Colorado Water

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Highlights

In Every Issue

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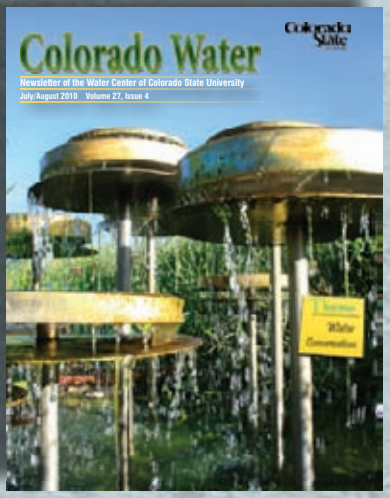

Cover photo: Water spills from gold mining pans in a xeriscape garden in Greeley, Colo. Photo by Lindsey A. Knebel.

This page: Blue Mesa Reservoir. Courtesy of Bill Green Images.

COLORADO WATER is a publication of the Water Center at Colorado State University. The newsletter is devoted to enhancing communication between Colorado water users and managers and faculty at the state's research universities. This newsletter is financed in part by the U.S. Department of the Interior, Geological Survey, through the Colorado Water Institute. The contents of this publication do not necessarily reflect the views and policies of the U.S. Department of the Interior, nor does mention of trade names or commercial products constitute their endorsement by the U.S. Government.

Editorial

Reagan Waskom, Director, Colorado Water Institute

Working on a college campus provides a different point of view- while it may not completely reflect the pulse of our society, one certainly benefits from a youthful view of contemporary issues. One perspective I clearly note in listening to students is widespread interest in water and energy conservation. Water conservation is also much on the mind of the water management community in Colorado as we debate ways to meet the looming "gap." By definition, water conservation refers to the efficient delivery and use of water resources. Beneficial use without waste is a foundational principle of Colorado water law. However, in a system built upon the use of return flows, defining what this means in practice is complicated and often doesn't make sense to students or the general public.

Water is increasingly spoken of as the "oil of 21st century," but somehow I doubt that. Water and oil are two very different natural resources –we have built a world economy around one of these resources, while the other is absolutely essential for human survival. Perhaps an even more interesting distinction is that water in our rivers and alluvial aquifers is a renewable resource, coming anew each year with the melting snowpack. With a renewable resource, the goal should be to not outgrow the sustainable yield and to leave enough in the system to meet environmental needs.

One of the dominant trends in water resources planning is the enhanced focus on the demand side of the equation as opposed to a more traditional focus solely on water-supply enhancement. Water conservation will have a significant role in managing future water supply gaps, both in meeting temporary drought and long-term growth needs. The question is how to best utilize conservation savings in building a robust and resilient water supply portfolio.

Part of the calculus water providers must reconcile is the need for a reserved capacity to quickly reduce demand in times when drought diminishes water availability. Drought restrictions are a critical tool that must be reserved for these unpredictable but certain-to-occur future events. Recall the drought of 2002 when our rivers provided only 25% of average flow – reservoir storage saved us, but would not have done so had the drought persisted for one or two years longer. Short-term conservation measures reduced demand by up to 30 percent in some municipalities during 2002 and 2003. These water conservation savings have moderated somewhat in recent years, but still persist to a surprising degree. In response to the prolonged drought in Australia, Melbourne's per capita daily use has been reduced to less than 40gpcd, less than a third

of our demand. This was achieved by a complete ban on all outdoor urban water use – landscapes, lawns, car washing, everything – not exactly what most people hope for in Colorado. The question of conservation persistence and sustained savings (also penetration of implementation across sectors and communities) is an important research question with more than academic implications for Colorado, as articulated in the article by Stone and Goemans in this month's *Colorado Water* newsletter.

When asked about water conservation, it is surprising how often people mention turning off the faucet while brushing teeth or shaving- obviously a wasteful practice, but one of little magnitude. While also non-consumptive, but of a much more significant magnitude, the EPA has estimated that 17 percent of treated water in the U.S. is lost to leaky pipes due to aging infrastructure. It seems a no-brainer to save water by upgrading these systems, but of course this would require large capital expenditures to rectify. The wisdom of using almost half of our treated drinking water to water our lawns and landscapes also suggests how far we have yet to travel in reducing our water footprint.

The importance of water conservation in Colorado's future is certain. The extent to which we employ it to satisfy growth versus meeting temporary shortage needs to be carefully analyzed as we seek to meet human and environmental needs. Like most sea-changes, it will likely require generational change to fully embrace and implement a sustained conservation ethic. It's reassuring to note that this generational mindset change is already underway.

The Complexities of Conservation: Identifying Conservation Research Needed to Incorporate Conservation Savings Into Utility Water Supply Planning

Janine Stone, Graduate Research Assistant, Department of Agricultural and Resource Economics, CSU
Christopher Goemans, Assistant Professor, Department of Agricultural and Resource Economics CSU

"Conservation." Intuitively, this word has a simple definition: use less. In the context of water resources planning, conservation is a way to decrease residential consumers' water use so that utilities don't need to further augment water supplies to meet demand. The Colorado Legislature, Colorado Water Conservation Board (CWCB), and municipalities throughout the state all agree that water conservation needs to play a major role in the state's future. However, to effectively incorporate conservation savings into long-run planning efforts, an understanding of the effectiveness of particular conservation measures is necessary. One needs information regarding the effectiveness of demand management to not only identify which policies to implement, but also to determine the extent to which conservation can be counted upon to reduce future demand.

For most of the past 50 years, literature on water demand has focused on estimating consumer responsiveness to changes in price, while analyzing the effectiveness of non-price policy measures has only gained prominence in the past ten or fifteen years. In part, this is because non-price policies (and their impacts) are more difficult to measure given the data typically available. Nevertheless, several themes have emerged from the water use literature on non-price policies. First, research has found that policies aimed at promoting conservation do not always have the effects we expect or intend. Furthermore, communities themselves have unique baseline water demands and water supply portfolios, so a policy aimed at increasing conservation will have a differing impact depending upon where it is implemented, the characteristics of its service population and other demand-reduction policies that are in place. For example, informational campaigns have been found to increase the effectiveness of price increases. Lastly, researchers note that the short-term impact of a policy may differ from its long-term effects, though few studies have looked at the long-term impact of conservation policies. The combination of these factors makes it difficult for an individual utility to incorporate conservation into water planning efforts.

> "To Resident X of Colorado Springs, "wise water use" might mean watering three times a week instead of every day; however, he now waters for twice the time."

Early-morning watering, as this site in Greeley, Colo., demonstrates, is an example of individual efforts to conserve water. Photo by Lindsey A. Knebel.

The CWCB defines "conservation" as "water use efficiency, wise water use, water transmission and distribution system efficiency, and supply substitution." What does this mean to the typical consumer? To Resident X of Colorado Springs, "wise water use" might mean watering three times a week instead of every day; however, he now waters for twice the time. And to Resident Y in Aurora, "water use efficiency" means Y installed a low-flow showerhead; the only problem is she now runs the water longer to rinse her hair. Resident Z of Fort Collins, on the other hand, took "water distribution efficiency" to mean he should perform a home water audit and fix all leaks; however, he uses a portion of his savings for watering new plants.

Uncertainty regarding how consumers will react to conservation policies complicates estimating potential conservation savings. For example, estimating the

demand impact of, say, a low-flow showerhead incentive program is not just simple accounting. We can't merely add the number of residents who installed the devices and multiply that number by average water savings for that specific device, and this is true for one major reason: the "Resident Y" factor. Like this hypothetical Aurora resident, some consumers who install water-efficient appliances or take other actions to "conserve" end up using more water as a result of behavioral changes made in conjunction with the conservation action. Thus, we use regression analysis to estimate these behavioral responses, to examine how consumers think, and to tease out how policies like price increases, water-use restrictions, and informational campaigns impact consumers' choices and actions. This approach utilizes data to compare household behavior before and after a particular policy has been implemented.

As the above paragraphs explain, totaling the impact of a conservation policy is difficult because it depends on two factors: consumers' initial reaction the policy, and how those reactions/behaviors change over time. Figure 1 shows a timeline of water demand before and after a conservation policy is put into place. As illustrated, research has found that water demand typically falls when a conservation policy is implemented. However, consumer behavior may change—and resulting water savings erode—over time, as can be seen by the increase in demand in the post-conservation period in Figure 1.

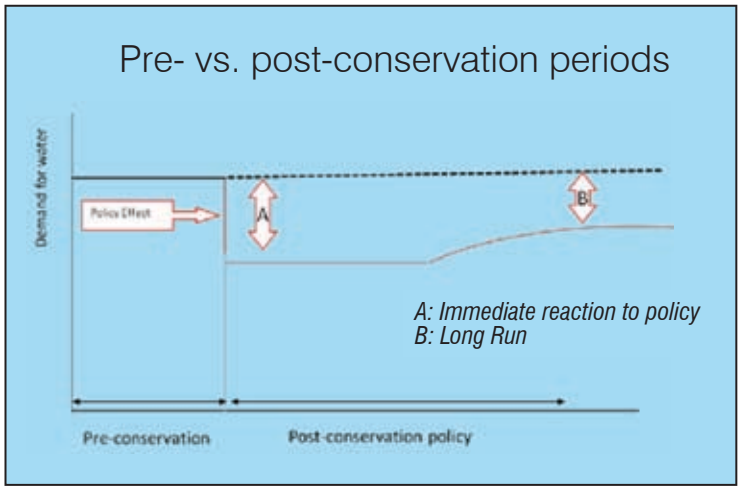

Figure 1. The chart indicates that initial response to conservation policy may be greater than long-run response and that long-run demand is more elastic, as households can switch to low water usage technologies and landscapes.

In order to incorporate savings from conservation into water supply plans, policy, utilities need to know both the short and long-run impacts of conservation policies. Thus, the data we use needs to span a long enough time horizon to capture these changes.

Lastly, we must consider the impact of drought. Previous research has found that consumers are more responsive to utility policies when they perceive a crisis situation. For this reason, using data from a drought period to estimate the impact of a conservation policy may overestimate that policy's effects. Second, Colorado utilities have observed decreases in demand in the post-drought period, and these decreases have remained even after temporary drought programs ended. The question is, will those demand reductions become permanent, or are they merely a "drought shadow," the lingering impact of the drought on consumer behavior? If the drought inspires consumers to adopt more water-efficient technologies, how far can we expect such technology to penetrate (i.e., how many total households can be induced to install low-flush toilets, drip irrigation systems, and so forth in any given community)?

Researchers at CSU are teaming with the Colorado Water Conservation Board and Colorado water providers to assess the feasibility of future research into the permanency and penetration rates of water conservation savings and measures. This research project is designed to jump-start the process of collecting the information utilities needed to build conservation into water supply plans. We are working with both large and small utilities throughout the state to identify the information they require and to determine what types of data need to be collected in order to obtain this information. Specifically, we will examine existing data and processes of providers; examine data needs and processes needs; examine constraints and barriers to assessing water conservation potential; and create a needs/opportunities matrix which highlights current informational shortcomings. This will be followed by a demonstration analysis in which we work with utilities to illustrate the types of analysis that can be done given the data they currently collect, and what could be done if more data were available.

We expect to find large differences in the types of data collected by different utilities, as well as differences in the types of conservation programs currently used and/or integrated into present water resources planning. However, these differences between utilities are not necessarily negative; they are merely the result of the fact that every community has a unique mix of water supply resources, and its residents hold varying preferences for water consumption. As such, studying these differences—and seeing what utilities can learn from each other—is an integral first step in incorporating conservation into Colorado's water supply future. To use a metaphor, studying the policies and data collection policies used by utilities is like staring at the drifts of snow that supply the Front-Range's water—at first glance, it all looks the same, yet if you look closer, every flake is different. Our goal is to look closely at these differences and, in doing so, add new dimension to the process of incorporating conservation into water supply planning.

A Water Conservation Strategy for Colorado

Kevin Reidy
Water Conservation Technical Specialist, CWCB

As the State of Colorado faces future water challenges, water conservation will play an increasingly important role in countering increased demands, and water conservation will be responsible for meeting a portion of the unmet demands of the future. In order for water conservation to be an effective planning tool, the potential of water conservation must be clarified in terms of how much water savings can be expected, how much savings can be counted as permanent, when the savings will occur during the planning period and finally, how water conservation integrates into overall water resource planning.

The Office of Water Conservation and Drought Planning (OWCDP) within the Colorado Water Conservation Board (CWCB) is addressing these questions in the near term and building a body of knowledge of water conservation in Colorado through a number projects and initiatives that comprise a Water Conservation Strategy. The OWCDP is confident that the Water Conservation Strategy will better define the role that urban water conservation will play in statewide water resource planning.

Current OWCDP Water Conservation Research Projects

In addition to reviewing water conservation plans and funding water conservation projects, the OWCDP projects that make up the Water Conservation Strategy (Figure 1 on page 6) will lay the foundation for assessing urban water conservation potential in Colorado. These projects are necessary for optimizing local water conservation efforts in terms of prioritization and effectiveness, defining water conservation's role in local and state water resource management and assessing the impact of water conservation on the future demand needs.

Statewide Water Supply Initiative (SWSI) Water Conservation Levels Analysis

The SWSI is a reoccurring CWCB planning effort that attempts to verify Colorado's future water supply needs and future water demand levels as well as identifying potential strategies to meet those future water supply needs. There have been two iterations of this planning effort—SWSI I in 2004 and SWSI II in 2007. In SWSI I, five levels of conservation measures were defined and savings were associated with each level. Level 1 was defined as "Passive Conservation." Passive water conservation savings are those savings that occur outside of a water provider's scope of influence, e.g., the replacement of higher volume toilets with lower volume toilets by way of a national or large scale plumbing code change thus affecting the market for those plumbing fixtures. The purpose of the SWSI Water Conservation Levels Analysis is two-fold; first, to reassess the conservation levels classified in SWSI I and the conservation measures associated with each classification; and second, to reassess the passive conservation savings used in SWSI I.

Dillon Reservoir's marina rests on the lake bottom instead of water in 2002. Courtesy of Bill Green Images.

The forthcoming document created a new prioritized framework of conservation measures and developed estimates for passive water conservation savings. By creating a prioritized framework of conservation measures and using the aforementioned BP guidebook, water providers can better plan their conservation activities based on sound research. A crucial aspect of this project is formulating realistic water conservation passive savings estimates based on regulatory decisions and market behavior. Passive water conservation estimates will inform water provider conservation programs in terms of extent and duration of fixture replacement programs. The SWSI Water Conservation Levels Analysis will be finalized by early July 2010.

SWSI Update-Water Conservation Section

This project will update the conservation section of the SWSI report for 2010 by analyzing and updating the projected conservation savings and penetration rates from SWSI II and developing conservation scenarios for meeting Colorado's water demand needs out to 2050. The update will integrate the Best Practices Guide for Water Conservation in Colorado and the SWSI Conservation Level Analysis, as well as supporting literature to ground future conservation scenarios in proven science. This will be the first time that realistic water conservation scenarios are extended out to 2050, creating an opportunity to discuss what role water conservation will play in future water resource planning efforts.

Water Conservation Permanency and Penetration Rate Feasibility Study

Finally, this project will assess the feasibility of researching the permanency and penetration rates of water conservation savings/measures with Colorado urban water providers. Through this reconnaissance-level study, the OWCDP will be able to assess what challenges and opportunities exist at the provider level in order to carry out future water conservation savings permanency and penetration rates research. Ultimately, the next stage of research will support the previously described research efforts and provide another much needed piece to help define what the future water conservation potential is for Colorado.

Colorado Statewide Water Conservation Best Practices (BP) Guidebook

Colorado WaterWise is developing the BP Guidebook is being developed through a grant awarded by the CWCB's Water Efficiency Grant Program. This project is discussed in another article in this issue, entitled "Colorado Water Wise Develops Water Conservation Best Practices Guidebook" by Peter Mayer, page 14.

Looking forward

As the OWCDP lays the foundation for future conservation efforts through its Water Conservation Strategy, a couple of additional initiatives will shape and support this strategy in the coming years.

Water levels drop in Colorado's Ridgeway Reservoir during the drought of 2002. Courtesy of Bill Green Images.

Water Conservation Technical Advisory Group

The OWCDP has convened a technical advisory group to advise on the current research projects and assist in defining future directions for water conservation efforts. This group will ensure that statewide water conservation efforts are consistent, effective and avoid duplication of efforts. At present, the group consists of conservation technical staff from Aurora Water, Colorado Springs Utilities, Denver Water, Northern Water, Pueblo Board of Water Works and the Southeastern Colorado Water Conservancy District as well as representatives from

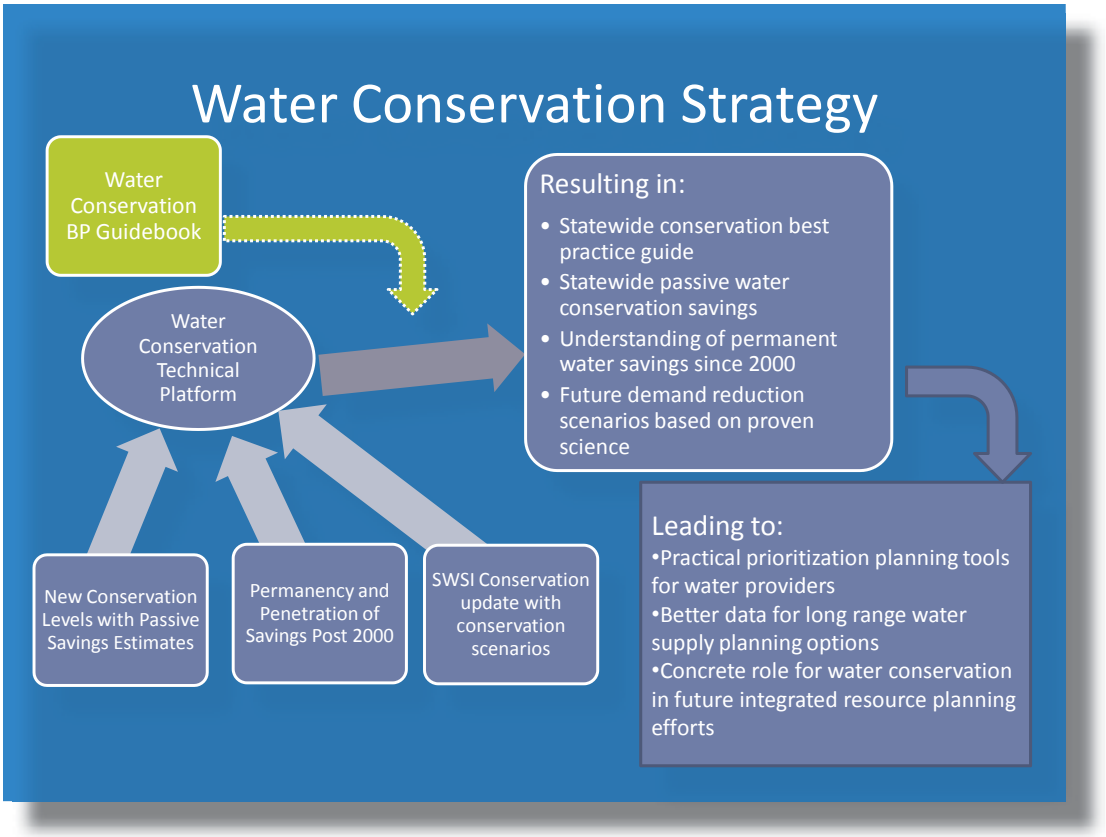

Figure 1. Water Conservation Strategy. Courtesy of Kevin Reidy

Colorado State University, Western Resource Advocates and private water conservation consultants. Through the work of the technical advisory group, statewide water conservation efforts will be grounded in the best available science and local experience.

HB-1051

In 2010, the Colorado legislature passed HB-1051 (aka the data collection bill) to standardize data collection routines for water conservation activities in Colorado. The aim was to collect consistent data on water conservation programming to support future water conservation planning efforts. The current Water Conservation Technical Advisory Group (WCTAG) will be expanded in early 2011 to accommodate a more diverse set of water providers such as mid- and smaller sized water utilities as well as more representation from the west slope and southwestern Colorado.

Through this collaborative effort, water conservation data collection will become more standardized, water providers will help define how they collect this information in the future, and the OWCDP will have more current and consistent data by which to plan for statewide water needs.

Conclusion

The big question for water providers is, How much can we count on from water conservation? To answer the question, the OWCDP has initiated a water conservation strategy in the form of research and partnerships. As stated earlier, the potential of water conservation must be clarified in terms of finding out how much water savings can be expected, how much water savings can be counted as permanent, when these savings will occur during the planning period and finally, how water conservation will integrate into overall water resource planning. As the Water Conservation Strategy moves forward, the OWCDP is building collaborative relationships with urban water providers to fashion a unified direction in water conservation planning. With much work and productive partnerships, the foundation for a viable water conservation strategy for Colorado will be built and will lead to a more comprehensive statewide water resource planning process.

Water-Conserving Cropping Systems: Lower South Platte Irrigation Research and Demonstration Project

Neil Hansen, Associate Professor, Soil and Crop Science, Colorado State University
Tom Holtzer, Professor, Bioagricultural Sciences and Pest Management, Colorado State University
James Pritchett, Associate Professor, Agricultural and Resource Economics, Colorado State University
Bruce Lytle, P.E., Lytle Water Solutions, LLC

Figure 1. The specialized linear-move research sprinkler system pictured above was constructed at the Iliff research location to control irrigation on nearly 150 individual plots. Courtesy of Neil Hansen.

Introduction

In 2007, Parker Water and Sanitation District (PWSD) and Colorado State University (CSU) partnered to create a comprehensive field study to develop profitable irrigated cropping systems that reduce historic consumptive water use. The study explores reduced irrigation practices as alternatives to drying up irrigated land to meet growing municipal and industrial water demand. The site near Iliff, Colo. is funded by PWSD and the Colorado Water Conservation Board and takes a systems approach to water saving including agronomic and economic considerations. A specialized sprinkler was constructed on a 35-acre site to allow irrigation control at the plot scale for nearly 150 individual plots (Figure 1). The site is designed for a detailed water accounting including a fully-automated weather station that has been integrated into the Colorado Agricultural Meteorological Network (CoAgMet, Iliff station) The weather station monitors soil moisture, depth to ground water and the controls of all applied irrigation. Water conserving cropping systems include rotational cropping, limited irrigation and partial season irrigation.

Rotational Cropping

Rotational cropping systems save water through combinations of irrigated crops and non-irrigated crops or fallow periods. Fallowing was included in the study because there is precedence for administering transfers of saved consumptive use from fallowed land. However, the drawback to fallowing is the absence of economic return to offset costs of land, equipment and management (i.e., weed control). Other concerns include that fallowed fields may not produce as well when returned to irrigation. Alternatively, rotating irrigated crops with dryland crops can improve efficiency because the non-irrigated crop scavenges water and nutrients left by the previous irrigated crop. Four rotational cropping systems are compared for water use and yield to a historical reference of continuous corn with sprinkler irrigation in the study with several interesting results (Table 1). On average, the evapotranspiration (ET) for the dryland crops (winter wheat, winter triticale, or hay millet) averaged eight in. per year compared to seven in. per year of ET during a year with clean fallow. Surface evaporation makes fallowing an

inefficient approach to water savings and similar amounts of annual water savings can be achieved while producing a low-cost, dryland crop. Another important result is that there was no yield loss in irrigated corn after a one year fallow period (Table 1). In fact, corn yields are higher in rotations with either fallow or dryland crops than when produced continuously. The rotational cropping systems reduced average annual irrigation by 50-65 percent and reduced average annual ET by as much as 40 percent relative to continuous corn.

Limited Irrigation

Limited irrigation practices are a major emphasis in the study. The practices are being evaluated for corn, soybean, sunflower, canola, triticale and hay millet in three alternative crop rotations (Table 2 below and Figure 2 on p. 9). Changing the cropping mix to decrease the magnitude of consumptive use within a growing season is one alternative to drying up land. Corn, alfalfa and grassy hay crops dominate the existing irrigated acreage in the South Platte. These crops have high water demand because they are produced during the warmest period of the year, they have long growing seasons, and they are produced under conditions of complete canopy cover for most of their growing season. Adjusting the crop mix to decrease the length or alter the timing of the growing season can reduce consumptive water use while minimizing loss of farm income and the exposure of soil to erosion. Changing fully irrigated corn, alfalfa or vegetable cropping systems to include winter annual crops has the greatest potential to decrease consumptive water use. Winter annual crops that have a high potential for reducing consumptive use include winter wheat, forages, and oil seed crops.

Crop Sequence	Irrigation (in)	ET (in)	Yield (units)
Historical Reference –			
Continuous Corn	19	24	146 (bu/ac)
System Annual Average	19	24	
Corn	10	20	155 (bu/ac)
Sunflower	8.5	20	1137 (lbs/ac)
Winter Wheat	6.5	15	42 (bu/ac)
Winter Triticale	6.7	13	3.2 (T/ac)
System Annual Average	8	17	
Corn	10	21	152 (bu/ac)
Soybean	6.7	16	38 (bu/ac)
Winter Wheat	6.5	14	57 (bu/ac)
Winter Canola	4.4	15	failure
System Annual Average	8	16	
Sugar Beet	7	17	33 (T/ac)
Hay Millet	4.4	12	1.6 (T/ac)
System Annual Average	5.8	15	

Table 2. Irrigation, evapotranspiration (ET), and crop yield for limited irrigation cropping systems.

Crop Sequence	Irrigation (in)	ET (in)	Yield (units)
Historical Reference –			
Continuous Corn	19	24	146 (bu/ac)
System Annual Average	19	24	
Corn	19	24	171 (bu/ac)
Fallow	0	8	--
System Annual Average	9.5	16	
Corn	20	27	169 (bu/ac)
Fallow	0	7	--
Dryland Winter Wheat	0	10	54 (bu/ac)
System Annual Average	6.8	15	
Corn	19	23	167 (bu/ac)
Sunflower	13	19	1887 (lbs/ac)
Dryland Winter Wheat	0	8	38 (bu/ac)
Dryland Winter Triticale	0	7	2.9 (T/ac)
System Annual Average	8	14	
Corn	19	24	173 (bu/ac)
Soybean	10	17	38 (bu/ac)
Winter Wheat	0	11	48 (bu/ac)
Winter Canola	8	18	failure
System Annual Average	9	17	
Sugar Beet	14	22	35 (T/ac)
Dryland Hay Millet	0	7	1.6 (T/ac)
System Annual Average	7	15	

Table 1. Irrigation, evapotranspiration (ET) and crop yield for rotational cropping systems.

Limited irrigation is based on timing irrigations to crop growth stages and managing crop water stress to improve water use efficiency. Average annual irrigation for the limited irrigation systems was 7.5 in., compared to the reference of 19 in., and ET averaged 15 in. compared to the 24 in. per year for continuous corn. The 40 percent average savings in ET for limited irrigation systems is similar to the water savings for the rotational cropping systems. Compared to the rotational cropping approach, limited irrigation has lower yields of corn (-15 bu/ac) and sugarbeet (-2.0 T/ac), but higher yields of wheat (+5 bu/ac) and triticale hay (+ 0.3 T/ac). Whether a rotational cropping or limited irrigation approach is the preferred way to save water will depend on the production costs and commodity prices. Sugarbeet appears well-suited to limited irrigation.

Figure 2. Limited irrigation sunflower, soybean, and sugarbeet are being evaluated in limited irrigation cropping systems. The study has shown sugarbeet (right) to be well-adapted to limited irrigation. Courtesy of Neil Hansen.

Partial Season Irrigation of Perennial Hay Crops

Another portion of the study is evaluating water use of cool-season perennial grass hay crops. The cool-season grasses are typically harvested two times per year with an early harvest in early June and a late fall harvest. Cool season grasses do not produce as much during the heat of the summer. This growth pattern is of interest because the peak irrigation demand of the crops differs from that of summer annual crops like corn. Reducing water consumption during summer months could be offset by irrigating cool season crops. Fourteen different species of perennial grasses including various wheatgrasses, fescues, bromes, and orchard grass are being evaluated for biomass production potential under full and partial season irrigation. Partial season irrigation means that the hay crops are irrigated to meet full crop demand during part of the season with no irrigation during other times. The two partial season irrigation treatments are spring-only irrigation (no irrigation after first harvest in early June) and spring/fall irrigation (irrigation stops after first harvest but is resumed in mid August). While the immediate interest in these crops is for hay and pasture production, there is also interest in the potential use of these grasses as bioenergy crops. Biomass yields for the first harvest period ranged from 2.0- -3.5 T/ac among the grass species with highest yields observed for several varieties of wheat grasses. Irrigation during the summer has had little effect on yields of the fall harvest.

Adoption Potential

The study has identified a variety of cropping systems that can conserve water and reduce ET, but could agricultural water conservation help address changing water demand in Colorado and would farmers adopt water saving systems if a water lease markets materialized? A producer survey was conducted with the objective to gauge potential adoption of limited irrigation strategies, the amount of water that might be made available in water leasing arrangements, the necessary compensation needed for farmers to participate and their perceptions of lease arrangements. The results of the survey suggest that more than 60 percent of the respondents are willing to lease garnering between 50,000 and 60,000 acre-feet of potential water supplies and preferred compensation ranges from $300-$500 per acre of irrigated cropland. Most farmers would prefer not to lease their entire water portfolio, so these respondents are likely to remain in agriculture and generate positive economic activity. The next step in this research is to uncover the barriers to adopting limited irrigation practices noting where they might be overcome with cost shares and technical assistance.

Visitors to the site can look at individual plots and compare the crops with different irrigation management. Courtesy of Neil Hansen.

Summary

A controlled research site was established in Iliff, Colorado with a linear-move sprinkler irrigation system customized for research with an on-site weather station. The site facilitates research on approximately 150 small plots where a water balance approach is used to determine evapo-transpiration (ET) and drainage, crop yield, and water use efficiency for rotational cropping, limited irrigation, and partial season irrigation systems. Rotational cropping systems that alternate irrigated crops with fallow or dryland crops were effective at reducing ET, with average ET reductions of 30-40 percent compared to continuous corn. Rotating irrigated crops with dryland crops was a much more water-efficient approach than rotating with a non-cropped fallow because of high evaporation and drainage during fallow. Annual forage crops such as triticale are good choices for the dryland phase of these rotations because they use residual water and nutrients from irrigated crops and have lower production risk than dryland grain crops. Corn produced after a fallow period or a dryland crop had a higher yield and water use efficiency than continuous corn, illustrating the benefits of crop rotation to maximize water use efficiency. Limited irrigation cropping systems reduced ET by an average of 30 percent. Both rotational cropping and limited irrigation of sugarbeet and an annual forage crop saved 40 percent of the continuous corn ET. Sugar beet is drought tolerant and shows good adaptability to limited irrigation. Soybean had moderate yield but is a lower water use crop than corn even under full irrigation. Its growth and performance suggested that soybean may be a good alternative crop for water conserving cropping systems in the South Platte River basin.

Better understanding of these concepts of agricultural water conservation can be the foundation of a new approach to meeting changing water supply and demand issues in Colorado while maintaining a viable agricultural and rural economy in Colorado. Beyond the farm level issues are questions about how different models of water leasing would affect local and regional economies. The economic portion of this study is evaluating this question using a variety of techniques including enterprise analysis, state of the art economic forecasting models and models that project farm level changes to community and regional scales. We welcome input on this project.

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or call: 970 491-6804

Colorado State University - GRAD592
Interdisciplinary Water Resources Seminar

Fall 2010 Theme

Moving from Conflict to Collaboration in Water Resource Issues

Mondays at 4:00 PM, Natural Resources Building - Room 109, CSU Campus

8/23	**Communicating and Managing Conflict about Complex Environmental Issues** Jessica Thompson, Assistant Professor, Warner College of Natural Resources, CSU
8/30	**An Overview of Water Law and How We Have Historically Handled Water Conflicts in Colorado and the West** Greg Hobbs, Colorado Supreme Court Justice
9/6	Labor Day — No class
9/13	**Resolving Water Conflict in Colorado and Internationally: Tools and Tales** David Freeman, Professor Emeritus, Department of Sociology, CSU
9/20	**Conflict Stages and Approaches to Resolution--from Litigation to Arbitration, Mediation and Collaboration** Joseph P. McMahon, P.E., J.D.
9/27	**Colorado's Interbasin Compact Committee and the Basin Roundtables Process—Does it Promote Stakeholder Collaboration on Colorado Water Issues?** Alexandra Davis, Colorado Department of Natural Resources, IBCC Chair; Melinda Kassen, Trout Unlimited, IBCC Member
10/4	**Resolving Water Conflicts Between States through Interstate Compacts** Tanya Heikkila, Associate Professor, University of Colorado Denver, School of Public Affairs
10/11	**Case Study: The Arkansas River Dispute** David Robbins, Water Attorney, Hill and Robbins Law Firm
10/18	**Case Study: The Republican River Dispute** Dick Wolfe, State Engineer, Colorado Department of Natural Resources
10/25	**Shared Vision Process—How the Army Corps of Engineers is Using Computer-Aided Dispute Resolution in Northern Colorado's Halligan-Seaman Deliberations** Bill Werick, Werick Solutions
11/1	**Interest Based Negotiation vs. Positional Bargaining—How Things Could Have Played out Differently on the South Platte** P. Andrew Jones, Water Attorney, Lind, Lawrence and Ottenhoff
11/8	**Demonstration of Interest Based Facilitated Dialogue on Poudre River Flow Issues** MaryLou Smith, Facilitator, Colorado Water Institute
11/15	**Public Deliberation as a Conflict Resolution Tool** Dr. Martin Carcasson, Director CSU Center of Public Deliberation
11/22	Thanksgiving Break — No class
11/29	**Participation/Facilitated Deliberation on Poudre Flow Issues** Martin Carcasson and Leah Sprain, CSU Center of Public Deliberation
12/6	**Continued Class Participation/Facilitated Deliberation on Poudre Flow Issues** Martin Carcasson and Leah Sprain, CSU Center of Public Deliberation
12/13	Final Exams — No class

All interested faculty, students, and off-campus water professionals are encouraged to attend.

For more information, contact Reagan Waskom at reagan.waskom@colostate.edu or visit the CWI web site.

Resilience: An Untapped Reservoir

Paul W. Lander, Ph.D., ASLA and University of Colorado, Boulder

What if western water providers could tap in to a source of water representing 25 percent of their current supply at less than a third of the cost of new supplies? What if this source had the extra benefit of leveling out revenue streams and reducing the peak use of water that drives expensive system treatment capacity?

A largely untapped "reservoir" for urban water providers is that of fully developing the capacity of citizens (the water users) to draw on their reserves of resilience and will, a concept adopted by water providers in Australia. Much like the millions of individuals who have adapted to new economic conditions, western citizens can learn to live with greater resilience. But they can't do it alone – they need the full support and commitment of their communities.

Developing and managing this citizen source is a new way of doing business for most western water providers, but it delivers multiple benefits, including increasing Colorado citizens' abilities to adapt to the new climactic future facing all of us. It compliments and optimizes the other necessary water sources we'll all need: smart storage, reuse and recycling, and direct use of rainwater and raw water.

This "reservoir," when developed, acts much like any other, providing a means for balancing out the highs and lows of resource availability. It reminds users to focus on the services they get from water, not simply on using more water. With an increased capacity of will and adaptability, citizens add a dimension to the supply-demand equation currently underutilized by most urban water systems. With encouragement to diversify their expectations, they become more adaptable and provide, as needed, flexibility on the demand side that compliments the diversity of sources on the supply side.

What does this look like in practice? It looks like the high-level professional design utilized to plan the proposed Sterling Ranch in Douglas County. Houses there will use 25 percent less than current averages, utilizing efficient appliances, water-wise landscape techniques and appropriate price signals in the cost of water.

It looks like Civano, Arizona, where 10-year old homes use less than half the energy and water of standard homes built today. It looks like homes built following the U.S. Green Building Council's Leadership in Energy and Environmental Design Neighborhood Development (LEED ND) standards or those of the U.S. Environmental Protection Agency (EPA)'s WaterSense program, each reducing indoor usage by at least 25 percent and outdoor demand even more.

The key to ensuring long-term reliability for these and all water-wise efforts is the full development of the reservoir of users' capacity to think and adapt to water issues. Technology helps tremendously, but it would not result in long-term resilience without the rest of the practice: continuous education of the cost and value of water through traditional means and through water rates, regulations that guide the use of only efficient techniques and practices, and the incentives – financial, environmental, and cultural – that continuously reinforce actions that benefit a community water system.

While hugely rewarding, building this "reservoir" will be hard work, and it will require an appropriate allocation of resources. In the energy world,

Granby Dam shows signs of drought. Courtest of Bill Green Images.

the development of this reservoir of capacity is believed to require at least 1.5-3 percent of annual utility revenues. Colorado water providers, with a few commendable exceptions, spend less than 1 percent of revenues developing this resource. In comparative costs, economists estimate that water "sources" from citizens' efficiency and conservation, when including long-term and environmental costs, are three to four times more cost effective than the development of standard water supplies alone.

As stated before, smart supply will always be the majority component, and an integral part, of any future water resources portfolio. But, without the investment in users' ability to adapt and respond, they seldom fulfill their full potential as water sources.

The task at hand is to develop the knowledge that comes with living in a semi-arid climate. Settlers to the region selected drought-hardy tree species to plant around their homesteads and shelterbelts; they knew about resilience. Remembering, and exercising, that knowledge today can only make our communities stronger and make our limited water supplies more likely to address the full range of demands before us.

Water Resources Outreach around the State: Western Slope Update

Denis Reich, Water Resources Specialist, CSU Extension

As summer looms and irrigators on the Western Slope clean out their creases, another less-traditional water issue is gaining significant attention in 2010. The western half of the state is proving to be a hotbed for Watershed Groups or stake-holder-driven management of water resources within a drainage area. In the Four Corners area, there are few sub-basins left whose water quality and supply isn't under the watch of a local organization. Recently, Extension Water Resources partnered with a Durango-based consultant (BUGS) to host a Watershed Workshop in Cortez (March 13th). Over 50 attendants from all southwest counties, as well as New Mexico, engaged with panelists on the many obvious and not-so-obvious challenges of making watershed groups impactful.

A recent meeting of the joint Gunnison and Grand Valley Selenium Task Force in Delta, Colo., included attendees from the Uncompahgre Valley Water Users Association, the Colorado River District, the Colorado Water Institute, the National Resources Conservation Service, the U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation, the Bureau of Land Management, the U.S. Geological Survey, Colorado Farm Bureau, Western Slope Environmental Resource Council, and other interested citizens. Courtesy of Dennis Reich.

In Delta and Montrose Counties, Extension Water Resources was recently charged with chairing the Science and Research sub-committee of the Selenium Task Force. Selenium has been a lingering water quality problem with local endangered fish in the lower Gunnison Basin for over a decade. With the release of a Programmatic Biological Opinion (PBO) in 2009, the Department of the Interior will now insist on a plan for endangered fish species recovery. Key to the success of this recovery plan will be research projects overseen by this sub-committee.

In Garfield County, Extension Water Resources has recently partnered with The Colorado River District and The Sonoran Institute to form the "Middle Colorado Partnership," a new watershed group for all Colorado River tributaries between Glenwood Canyon and Debeque. With extensive oil and gas drilling in this area and maturing watershed activity up and downstream, this group is seen as the missing piece for grassroots management of Colorado River water from the headwaters to the state line.

Colorado WaterWise Develops Water Conservation Best Practice Guidebook

Peter Mayer
P.E. Partner Aquacraft, Inc.Water Engineering and Management Boulder, Colorado

Experience in developing and implementing water conservation programs over the past decades has resulted in a body of knowledge in Colorado and across the United States. This knowledge combined with experience, research and analysis has resulted in the development of "best practices" (aka best management practices), which are water planning, management, and efficiency measures and policies designed to deliver proven water savings and improved water management.

The Colorado WaterWise Guidebook of Best Practices for Municipal Water Conservation in Colorado is a planning tool prepared for the purpose of improving and enhancing water efficiency in Colorado, and was made possible by a grant from the Colorado Water Conservation Board (CWCB). The Best Practices Guidebook for Municipal Water Conservation in Colorado (Best Practices Guidebook for short) offers a detailed description of specific water conservation measures, program elements, regulations, policies and procedures that can be implemented by Colorado water providers to help ensure reliable and sustainable water supplies for future generations.

Colorado WaterWise (CWW) envisions that this Best Practices Guidebook will be used by water professionals including water providers, local governments, consultants, building managers, design engineers, irrigation professionals and others throughout the state to help select the most sensible and cost-effective water conservation measures and programs to implement. Utilities can use the Best Practices guide to help select water conservation program options to include in their own conservation plans to be submitted to the Colorado CWCB. Building trade professionals may use the Best Practices Guidebook to determine the most sensible water efficiency practices to implement in new construction projects and existing buildings. Others may find the Best Practices Guidebook a useful tool to increase water efficiency in their local community.

The Guidebook of Best Practices for Municipal Water Conservation in Colorado is an essential companion to the water conservation planning resources developed by the CWCB and can be used by water providers big and small to help select appropriate, cost effective water conservation program measures.

What is a "Best Practice?"

In this guidebook, prepared specifically for Colorado, the best practices (BPs) are designed to assist water providers of all sizes to develop effective water conservation programs that deliver real demand reductions among existing customers and ensure new customers join the system with efficiency already "built in".

Your city's water department can perform evaluations and surveys to help determine the best sprikler settings for water conservation. See Best Practices on pages 16-17. Courtesy of Ruth Quade.

A BP is intended to encompass a broader range of actions and activities than a best management practice, although at the end of the day it is only a relatively minor semantic distinction. The authors have chosen the term "best practice" or BP rather than "best management practice" because not all of the best practices described in the guide are directly related to management of water. Some of the BPs included descriptions of methods to improve efficiency of water use, while others describe a regulatory framework that can be used to manage the demand of new and existing customers.

These Colorado-focused water conservation BPs were developed to fit into the Colorado Water Conservation Board's guidelines for preparing a water conservation plan. Each BP is structured similarly with a clear definition that describes the practice itself as well as implementation techniques, scope, potential water savings, water savings estimating procedures, cost-effectiveness considerations, and references to assist in implementation.

What is Included in the Guidebook?

The Guidebook of Best Practices for Municipal Water Conservation in Colorado includes the following elements:

Detailed information on 14 selected BP options including: implementation approach and methods, likely costs, anticipated water savings, barriers and challenges;

Guidance on prioritizing and selecting appropriate water conservation program tools and measures for different communities and situations;

Descriptions of appropriate utility BPs for water management including conservation-oriented rate structures and utility water loss programs;

Descriptions of appropriate end user (customer) indoor and outdoor BP options for urban water conservation in Colorado;

A resource guide for anyone seeking water conservation information, assistance, and financing in Colorado;

A literature review of urban water conservation best management practices and best practice guidance documents developed in Colorado and elsewhere.

The best practices included in the guidebook were selected and carefully reviewed by a project advisory committee and a stakeholder committee each comprised of Colorado water conservation, water management and landscape experts from all areas and sectors in the State. The authors and the review committees worked to ensure that the descriptions, information and data provided in this guidebook are as accurate and complete as possible.

What Practices are Reviewed Guidebook?

The Guidebook of Best Practices for Municipal Water Conservation in Colorado includes 14 best practices that impact all municipal water users and target indoor and outdoor use and municipal water loss. Many of the best practices included are multi-faceted and include several related practices such as metering and rates.

Few water providers will have the time and money to implement all 14 best practices covered in this guidebook, although the authors encourage the effort. When developing a water conservation program tailored to the needs of the community, it is anticipated that a utility will start with the foundational best practices and add selected additional relevant best practices from among the best practices described here and from the list of practices not included in this guidebook.

A list and summary of the 14 best practices included in the guidebook is provided in the tables below. The guidebook document includes detailed descriptions and relevant examples for each best practice included.

About Colorado WaterWise

The mission of Colorado WaterWise (CWW) is to promote and facilitate the efficient use of Colorado's water.

CWW is the voice for water conservation in Colorado. In 2000, CWW was created by combining Metro Water Conservation, Inc. and Xeriscape Colorado, two non-profits formed in the mid-1980s to promote water wise practices among homeowners, businesses, and water providers.

Colorado WaterWise provides support to water professionals, water providers and communities across Colorado empowering them to offer more responsive, effective programs to their own customers, clients, and citizens.

WaterWise Best Practices

Outdoor Landscape and Irrigation

Landscape water budgets, information, and customer feedback

Landscape water budgets address landscape water use and encourage efficiency. Comparing actual metered consumption against the legitimate outdoor water needs of the customer based on landscape area, plant materials and climate conditions. The customer is provided powerful information about the irrigation practices and efficiency at the property.

Rules and regulations for landscape design and installation and certification of landscape professionals

This best practice (BP) supports sustainable and water efficient landscaping design, installation and maintenance practices. Creating rules for new landscape and irrigation system design and installation is a relatively inexpensive way to affect landscape water use. Proper installation and maintenance are needed to create and maintain water-efficient irrigation. A second powerful tool is minimum training requirements and certification for landscape irrigation professionals. These requirements can function in concert as trained and certified professionals are in the best position to design, install, and maintain water efficient landscapes and irrigation systems that meet mandated standards.

Water efficient design, installation, and maintenance practices for new and existing landscapes

Design, installation and maintenance of landscapes and irrigation systems can greatly impact water use. This best practice maximizes water efficiency through water budgeting and the proper design, installation and maintenance of new and existing landscapes and irrigation systems. This BP is largely based on the work of the Green Industries of Colorado (GreenCO) published in their 2008 BMP guide.

Irrigation efficiency evaluations

The efficiency of an irrigation system can greatly impact the amount of water used in the landscape. Over time, even a well designed and properly installed irrigation system becomes less efficient unless it is well maintained and operated for maximum efficiency. This BP describes key considerations for maximizing water efficiency through the use of regular irrigation efficiency evaluations.

Water System and Utility

Metering, conservation-oriented rates and tap fees and customer categorization within billing system impact the way utilities charge new customers when they join the system, bill their existing customers for the water they use, and understand who customers are and which customers might benefit from improved water efficiency. This category can also include advanced metering systems that provide leak detection and real time use data for customers.

Integrated resources planning, goal setting, and demand monitoring

Integrated resources planning (IRP) is a comprehensive planning effort that incorporates water conservation programs as another option for meeting future needs. IRP encompasses least-cost analyses of demand and supply options that compare supply-side and demand-side measures on a level playing field and result in a water supply plan that keeps costs as low as possible while still meeting all essential planning objectives.

System water loss control

Water loss control is the practice of system auditing, loss tracking, infrastructure maintenance, leak detection and leak repair for water utilities. Leak detection and repair are familiar water agency practices, but true water loss control is more pragmatic than simply finding and fixing leaks. Auditing a water distribution system for real and apparent losses and evaluating the costs of those losses is the foundation of water loss control. Cost and benefit considerations drive implementation actions in the recommended methodology, described in detail in the American Water Works Association M36 Manual (2009).

Conservation coordinator

A conservation coordinator is critical for every utility aiming to reduce water demand. A "go-to" person for water conservation is essential to the successful implementation

and management of water conservation programs. For large water utilities, the job of water conservation coordinator is a full time job. Small utilities may not have sufficient resources to have a dedicated conservation coordinator. Small agencies should select a staff member who has other primary assignments to be the designated conservation coordinator – the person responsible planning and implementing water conservation efforts.

Water waste ordinance

A water waste ordinance is a local regulation that explicitly prohibits the waste of water. Waste includes things such as irrigation runoff, irrigation that occurs on a prohibited day and/or time, leaks, use of inefficient fixtures and appliances, or use of wasteful commercial or industrial processes (e.g., poorly controlled cooling towers).

Public information and education

Public information and education encompasses social marketing, school education, public outreach and education and other information efforts aimed at raising awareness and fostering a culture of conservation and behavior change. An element of public information and education is required in nearly all other best practices (BPs) in this guidebook. Central components of this best practice include effectively communicating the value of water, and delivering consistent and persistent messages. This BP also includes measures to provide customers with timely information on their water consumption and alerts if unusual usage or leakage is detected.

Indoor Non-Residential

Rules for new construction

Water conservation measures that are "built in" to new buildings can help slow the growth of new water demands. This best practice (BP) describes water efficiency specifications that water utilities can make voluntary or mandatory for new non-residential developments within their service areas.

High-efficiency fixture and appliance replacement for non-residential sector

The goal of this BP is to increase the installation rate of water efficient fixtures and appliances and to remove inefficient and wasteful devices from the service area in favor of efficient products. Various means are used to spur customers into replacing products. In some programs, customers are simply given hardware that is more water efficient. For the commercial sector more generalized incentives may be appropriate as fixtures and equipment vary from site to site. A low-cost alternative is required for retrofit on reconnect - fixtures and appliances must be upgraded as a condition for re-joining the water system after a real estate transaction.

Specialized non-residential surveys, audits, and equipment efficiency improvements

Specialized non-residential surveys and equipment efficiency improvements reduce water demands in the commercial, institutional and industrial (CII) sector. This BP specifically excludes toilets, showers, and faucets (i.e. fixtures found in residential and non-residential accounts); however, part of the survey process involves identifying all domestic fixtures that should be upgraded to improve efficiency.

Indoor Residential
(Single and Multi-family Residences)

Rules for new construction

Water conservation measures that are "built in" to new buildings can help slow the growth of new water demands. This best practice (BP) describes water efficiency specifications that water utilities can make voluntary or mandatory for new residential development within their service areas.

High-efficiency fixture and appliance replacement for residential sector

The goal of this BP is to increase the installation rate of water efficient fixtures and appliances and to remove inefficient and wasteful devices from the service area in favor of efficient products. Various means are used to spur customers into replacing products. In some programs, customers are simply given hardware that is more water efficient. Faucet and showerhead replacement programs often take this tact. Rebates and vouchers are also important tools for coaxing customers to replace devices with more water efficient models. A low-cost alternative is a requirement for retrofit on reconnect where fixtures and appliances must be upgraded as a condition for re-joining the water system after a real estate transaction.

Residential water surveys and evaluations, targeted at high demand customers

Water surveys and evaluations (frequently referred to as "audits") that identify water savings opportunities and educate customers are a fundamental component of residential water conservation programs. Although often offered to all customers, high-volume customers should be targeted first to maximize water savings and minimize program expenses.

The 2010 Colorado Drought Mitigation and Response Plan: A Comprehensive Revision for the 21st Century

Taryn Hutchins-Cabibi, Drought Specialist, Water Conservation & Drought Planning, CWCB

In 1981, a first class letter could be mailed for less than 20 cents, the first space shuttle was launched, the Celtics won the NBA championship, packman mania had swept the nation and the first woman, Sandra Day O'Conner, was sworn into the Supreme Court. Also in 1981, the State of Colorado broke new ground when they developed one of the nation's first drought mitigation plans. A lot has changed since the early 1980s – Packman has been replaced by Wii, women may soon make up a third of the nation's highest court and you would be hard pressed to buy anything for less than 20 cents. Yet there continue to be a few constants – the Celtics are still playing in the NBA Finals, and drought continues to be a natural and very real occurrence in Colorado. In order to prepare the state for times of drought, the Colorado Water Conservation Board (CWCB) is in the process of revising the Colorado Drought Mitigation and Response Plan, and much like the plan of 1981, we are again breaking new ground.

While the drought plan revision will meet all specifications and requirements for both the Federal Emergency Management Administration (FEMA) and the Emergency Management Accreditation Program (EMAP), it will also go beyond those requirements by providing a multitude of planning tools and resources for local water managers, an improved new mechanism to assess vulnerability to drought by sector and an overhaul of the indices used to monitor drought statewide. The plan will also, for the first time, look at how potential climate change may influence the frequency and intensity of droughts. These additional resources will help local communities and the state better prepare for and respond to droughts when they occur.

The 2010 plan has three major improvements over its predecessors that will promote better use of indices, improved evaluations of drought vulnerabilities and improved tools to facilitate better planning statewide.

Indices

In order to quantitatively monitor drought, the state relies upon three primary indices: the Colorado Modified Palmer Drought Severity Index (CMPDSI), the Standard Precipitation Index (SPI) and the Surface Water Supply Index (SWSI). For the most part, these indices have not been updated or even evaluated since the mid 1980s. Many people had reached the conclusion that only two of the three indices remained valid and that the CMPDSI should find its end in a deep dark hole. But before we took out the shovels, we decided to take a look at what the indices, including CMPDSI, really tell us. We found that CMPDSI actually does do a good job assessing drought in the short term and in fact, it does better than SPI, which remembers drought events for an extended period and consequently, does a better job long term.

As for the SWSI, Colorado was the first state to develop a methodology for calculating the SWSI in the 1980s, but in the early 1990s, the Natural Resource Conservation Service (NRCS) refined the SWSI calculation to address the subjectivity of the original computation. The use of streamflow forecasts in the NRCS updated SWSI is an objective, statistical assessment of the data relating to snowmelt runoff. Additionally, the revised methodology provides a more stable month-to-month transition and utilizes a higher spatial resolution, improving from four digit hydrologic units (seven values statewide) to eight digit hydrologic units (37 values statewide). This shift enables more detailed evaluation of the regions that are most effected by drought at any given time. The revised SWSI calculations are now available for western Colorado, and statewide figures will be available on a monthly basis beginning in the spring of 2011.

Vulnerability Assessment

While a drought vulnerability and risk assessment are required elements of any FEMA-approved natural hazard mitigation plan, the state has typically relied upon qualitative data to complete this. As part of the 2010 drought plan revision, a methodology for completing a vulnerability assessment of natural resource & economic sectors that is both quantitative and qualitative has been developed and performed. This allows planners to rank sectors within the state or a region that are most vulnerable to drought impacts and concentrate their mitigation efforts accordingly. This information will also help in the development of an improved mechanism for tracking drought impacts. Colorado is the first state in the West to carry out such a comprehensive assessment. Perhaps more remarkable is the vulnerability tool that was created in tandem and will be included as part of the drought planning toolbox, discussed below.

Colorado's future vulnerabilities may go beyond our historical reference. Many believe that the southwest will be faced with more severe droughts as a result of climate change. Consequently, we must prepare for a future that may not look like our past. Climate change has the potential to influence the frequency and intensity of droughts throughout Colorado and, given this potential, it is appropriate to examine what changes in our climate might mean to the state and to water availability. The work completed as part of the drought plan revision builds on the CWCB's Colorado River Water Availability Study, applying data to examine possible changes to frequency and duration of droughts statewide. This is the first time climate change has been factored into drought planning at the state level in Colorado.

Drought Planning Toolbox

Comprehensive drought planning is new for many providers who have historically relied upon irrigation restrictions to respond to drought. The CWCB recognizes that the state as a whole is better prepared for drought when the sum of its parts — i.e., the individual water providers, counties and communities — have taken steps to mitigate and respond to drought. Yet getting started on this path can be overwhelming, so the CWCB has developed a how-to guide for dealing with drought from "prior to the onset" through "conclusion of the event." This guide, or planning toolbox, is Web-based and offers a detailed guidance document on drought planning complete with worksheets that will help entities develop their own drought mitigations and response plans from the ground up. In addition to the guidance document, the toolbox provides sample documents such as drought declarations and drought-related ordinances as well as resources such as funding sources for drought planning, regional information on current drought information and impacts and links to federal resources such as the National Integrated Drought Information System (NIDIS) Drought Portal. Perhaps the most innovate aspect of the toolbox is the vulnerability tool. This interactive database enables providers to complete their own vulnerability assessments to determine which sectors and areas within their service area are most vulnerable to drought impacts. This information enhances the overall planning process as mitigations actions can be tailored specifically to those aspects found to be most vulnerable — saving resources and increasing response time.

It isn't about being the best in the west that drove CWCB to embark upon such an ambitious overhaul of the state's Drought Mitigation and Response Plan; the CWCB overtook the change to provide the best possible technical resources to those the CWCB serves, to prepare the state to mitigate and to respond to this inevitable, destructive and economically-distressful natural hazard.

Signs of the 2002 drought were apparent that year at the Antero Reservoir. Photo by Bill Green.

Tools for Planning Cost-Effective Water Conservation Programs

Liz Gardener
Suburban Conservation Coordinator, Denver Water

A billboard displays watering schedules. Courtesy of Denver Water, June 21, 2010.

Water providers all around the country are working on developing and/or improving their water conservation assumptions, plans and programs. Since water conservation is still more art than science, this effort can be difficult without help from those who have been down the path before.

Colorado water utility managers and other decision-makers are facing the issue of finding cost-effective ways to provide enough water for the growing needs of population and figuring possible impacts of climate change on water supplies.

Several Colorado water providers, organizations and businesses have found needed help from the Alliance for Water Efficiency, known as AWE (www.a4we.org), based in Chicago. The alliance provides not only technical assistance to members on water efficiency questions but also offers a newsletter, a legislative liaison in Washington, D.C., and a new EXCEL-based conservation tracking tool that assists water providers in planning and evaluating conservation programs.

The issues facing our state are so complex that many Colorado decision-makers cannot keep up with all the latest research or policies being decided outside the state much less the interwoven interactions of these issues with one another.

One way to help Coloradoans deal more effectively with these issues is to link with others who are also working toward solutions and to share accurate information quickly and effectively. Through its research efforts, participation in development of codes and standards, education and outreach programs and coordination of the WaterSense and water-efficient products, AWE helps all of us to make better, more informed decisions about water use efficiency.

AWE provides thorough and regularly updated Web resources on water conservation topics. It is easy to stay on top of what's going on in Washington, Los Angeles and Denver with the Water Efficiency Watch Newsletter. The website offers current news of water conservation developments around North America, which helps practitioners avoid re-inventing the wheel. Since very few Colorado water providers or organizations have any money to throw around these days, leveraging the knowledge developed by a much larger group helps everyone save money and time.

The comprehensive resource library is a tremendous resource on just about any topic related to water conservation. One of the resources listed is the Handbook of Water Use and Conservation, which offers both case studies and widely accepted assumptions about savings from various conservation technologies.

Colorado decision-makers looking to file their water conservation plans with the Colorado Water Conservation Board can find information on the AWE website about various topic areas mentioned in the law (HB 04-1365). Then, these water providers (also called "covered entities" if they serve more than 2,000 acre-feet of water per year) can use the AWE Water Conservation Tracking Tool to design and monitor their conservation plans.

The tracking tool, available only to members, is an exciting new tool that helps plan water conservation programs, forecast future demands under different demand reduction scenarios and track the impacts on any conservation program. It's written in Excel and easy to use. The software alone is worth the membership fee, according to Peter Mayer, AquaCraft Engineering in Boulder and AWE member.

The tracking tool can also be a mechanism to track long-term water savings. It is fully customizable to each water provider, so if someone finds the default assumptions to be irrelevant, then that user can create his own assumptions. For example, some water providers have no industrial water use; rather, they use only residential and commercial water with perhaps some government water. The tool can be used to focus only on the sectors relevant to that provider or covered entity.

On March 31, 2010, the city of Greeley hosted a one-day workshop on how to use the tracking tool. Attendees came from all over the state and ranged from water providers to business owners, all learning from Mary Ann Dickinson, CEO of the Alliance for Water Efficiency. Attendees saw how the tool can be used in planning and forecasting, then how the tool can formulate understandable graphic outputs for presentations to boards, management, and customers. Six other tracking tool workshops have been held around the U.S. in the last 12 months with more on the horizon.

Colorado Water Conservation Board staff have expressed interest in finding a way to make the Tracking Tool available to all the covered entities in Colorado. This would establish a level playing field for assumptions, methodology, reporting and updating. As of this printing, talks are still in progress.

Another valuable service to Coloradoans is the legislative liaison in Washington, D.C. Since obtaining water efficiencies from national standards due to market share is cheaper for water providers, AWE helps make changes at the national level. For example, if the only toilets that can be sold flush only 1.28 gallons or less, then water providers can make better predictions about water use in the future. This information helps Colorado as a headwaters state calculate more accurately what new supplies will be needed after conservation and water reuse have been optimized. Whether planning for filling the 40 percent gap between current supplies and those needed for the future or building scenarios about coping with the impacts of climate change, good, science-based national standards for water use will be helpful. Ms. Cece Kramer, AWE's person in Washington, stays on top of these issues, educating legislators and their staff members about the benefits of water efficiencies and providing frequent reports to AWE members on her progress.

On another level, AWE maintains a presence on codes and standards-setting boards and committees to be sure that water efficiency is included or at least represented correctly when these codes and standards decisions are made.

A guiding principle of sustainability as applied to water is that we should solve water conservation issues without causing other environmental problems. One of the concerns expressed by school districts in the Denver Metro Area has been the potential for mass installation of high-efficiency

"Use only what you need." Courtesy of Denver Water, June 21, 2010

toilets (flushing only 1.28 gallons per flush) to cause sewer pipe backups. When many school districts are facing tremendous financial pressures, they cannot afford to risk replacing all the high-water-using toilets and urinals with high-efficiency ones if they believe the sewer pipes will not properly evacuate the reduced flow. To address this issue for Colorado and for others around the country, AWE is sponsoring a research project on "Drain Line Carry" after installation of high-efficiency toilets. There are many variables, so this study has to be extremely comprehensive to account for the number of other water using devices in a building, daily uses, age of water and sewer pipes, slopes of the pipes to the main sewer line, etc. The results of this research will be extremely helpful to all decision-makers, both here in Colorado and around North America.

Another valuable service offered to small utilities in Colorado and elsewhere is the national conservation messaging campaign being started later this year. With a grant from the Home Depot Foundation to do a scoping study, AWE will create a plan for a template for this national message campaign. The goal is to offer a tool for water providers who don't have the funds to create their own water conservation messaging to customers.

All of us in Colorado need to be concerned about providing safe, clean, adequate water for our grandchildren and their grandchildren. Water efficiency is one of the ways to help meet that challenge. Obtaining and using ever-more precise information about water-saving technologies, behaviors and practices is the most important step in water conservation in Colorado. Sharing research and tools with other water conservation professionals is one way to improve the science of conservation, and learning from other disciplines is can also help improve the overall science toward a sustainable future. The Alliance for Water Efficiency is one of those resources available to Colorado decision-makers.

Resources:

Alliance for Water Efficiency. www.a4we.org.

Amy Vickers. Handbook of Water Use and Conservation. WaterPlow Press. 2001.

"Use only what you need." Courtesy of Denver Water, June 21, 2010

Denver Parks Conservation

Jill Wuertz
Water Conservation Program Administrator, City and County of Denver Parks and Recreation Department

Debrah Binard
Irrigation Specialist , City and County of Denver Parks and Recreation Department

DENVER PARKS & RECREATION
Mission: As stewards of Denver's legacy, the Department of Parks and Recreation is dedicated to customer satisfaction and enhancing lives by providing innovative programs and safe, beautiful, sustainable places.
Vision: To be a nationally recognized leader providing model programs and dynamic public spaces.
Values: Accountability . Honesty . Respect . Service . Stewardship . Teamwork . Trust .
Water Conservation Mission: Coordinate sustainable water management and improved water quality for the Department through work plans driven by the DPR GamePlan, GreenPrint Denver & Executive Order 123, DW Tap + Smart Plan and DPR's Water Conservation Plan.

Urban water issues are often discussed from the supply perspective, as should be the case since supply and management of drinking water, wastewater, stormwater and floodplain management are of vital importance to running a city. However, Denver Parks and Recreation Department (DPR) has a Water Conservation team that is able to focus specifically on demand-side (or customer-side) water management. Seemingly simplistic, this discipline is fraught with uncertainties, challenges and opportunities. For those of you not overly familiar with park issues, especially in Colorado, it is fairly safe to say that the recent economic downturn has hit many Park and Recreation Departments hard. Colorado Springs has been receiving national attention on the severe cuts to the City's Parks, Recreation and Cultural Services Department. (For more information about this, see site link at end of article.) Denver has fared better but has still seen budget reductions of approximately $5 million in 2010 and $4 million in 2011.

For DPR, water costs comprise roughly nine percent of the overall budget and 20 percent of the Parks operational budget. The primary use of the approximately 2 billion gallons of water is park irrigation; therefore, the majority of the DPR Water Conservation team effort is spent on this issue. The DPR Water Conservation program benefits from being a twenty-year-old program with a longstanding relationship with its supply-side partner, Denver Water. The DPR Water Conservation mission is to coordinate sustainable water management and to improve water quality for the Department. However, it is also important to remember that as a division within Parks and Recreation, its overall mission is to be a steward of the land for citizens of Denver.

Key components of the Water Conservation work plan focus on improving aging infrastructure and irrigation efficiency, responding to and preparing for weather and drought events, improving staff education on water management, finding opportunities for non-potable supplies and reducing park water requirements though landscape changes. Taking large objectives like these and applying them to a 4,100-acre urban park system with over 350 park sites is challenging to say the least. Often, opinions vary greatly on how Water Conservation should respond.

Denver Parks and Recreation uses Geographic Information System (GIS) maps like this one to share and collaborate their data between offices. Courtest of Jill Wuertz and Debrah Bernard.

So how are these challenges being met? The Water Conservation team's current philosophy looks something like this:

The Art of Partnerships + Science + Technology= Successful Water Conservation Program

The Department's biggest advantage in this battle are continued partnerships and collaboration with the water community. Lending the majority of assistance is Denver Water. However, communicating between two large organizations such as the City and County of Denver and Denver Water can be difficult, including aspects ranging from organizational structures down to lingo. The Water Conservation team benefits greatly from having a liaison throughout this process in the way of a Local Government Conservation Coordinator, Donna Pacetti. The coordinator spends her time divided between Denver Water and GreenPrint Denver, an initiative of the Denver Mayor's Office. As a liaison, Pacetti understands the mission of each organization and works to align what at times appear to be disparate goals. On occasion, as with many partnerships, the two organizations reach an impasse and it is during these challenges that the science, research and technology arenas help to bridge divides. The following examples are just a highlight of the many ways in which this is occurring.

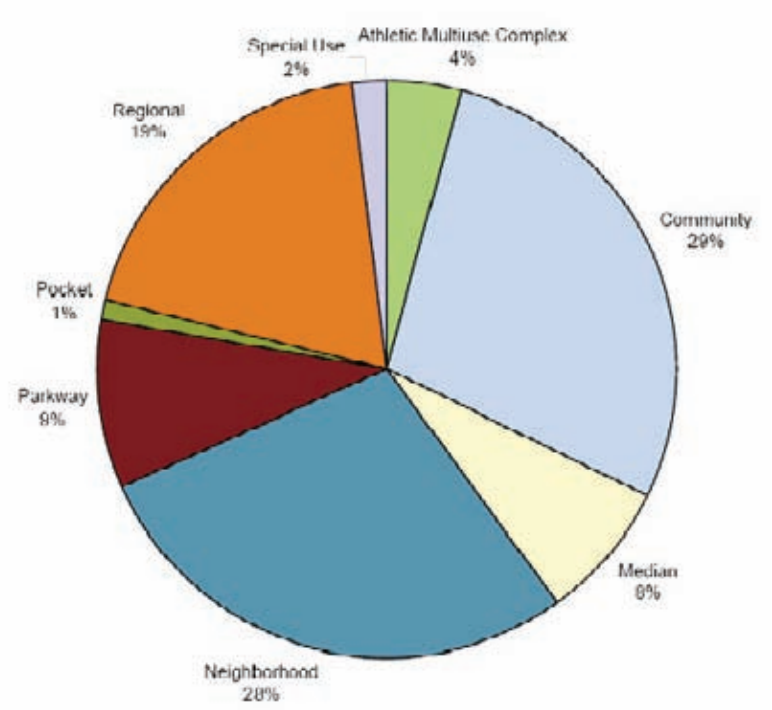
Although recycled water has been available for many years outside of Denver, the Denver park system only began converting parks in 2004. Uncertainty of site-specific management techniques, a lack of understanding of hidden costs and public confusion has made this transition complex. In order to bridge this divide, Denver Water has initiated a follow-up report on Yaling Qian's "Soil Baseline Study on Landscape Water Reuse Sites" in pairing with a new report from Steve Day, Plant Pathologist and Consulting Arborist, on tree health results. The hope is that this research will provide some specific recommendations for Denver Parks to meet the goals of being good stewards of the land and using water resources wisely.

Technology is also assisting with meeting goals and bridging divides by providing sound information with which to make informed decisions. With such a vast system of parks and infrastructure, Water Conservation also utilizes this technology to gain an understanding of priorities. DPR currently maintains a robust Geographic Information System (GIS) of park layers to aid in analysis. Water Conservation has initiated the creation of layers that include information on irrigated acres, water accounts, water budgets, historical water consumption, irrigation infrastructure information and irrigation controller locations. This data has allowed improved communication with Parks field staff on water consumption information by sharing data through the use of a Web-based GIS intranet application. GIS data is also utilized by Water Conservation to provide accurate monthly consumption reporting to field staff in order to reach water budget goals and to record baseline data for the Department's Irrigation Central Control Master Plan.

Drought readiness, whether reservoir-initiated, weather-initiated or even budget-initiated, is a key component of the Water Conservation work plan. On this issue, the department is not only focusing on irrigation infrastructure but also changing plant palettes. DPR utilizes its own greenhouses to assist with maintaining horticultural resources within the parks. The department has recently chosen to align this program with Water Conservation in an attempt to more holistically address plant/water relationships. The May/June 2010 Colorado Water publication featured an article titled "Impact of Limited Irrigation

on Health of Four Common Shrub Species" that truly hit home. It surmised that opinions and visual observation, not scientific research, has determined water use of frequently used plant species in urban landscapes, and the article reached some interesting conclusions. This type of research will be essential for making informed decisions as DPR prepares new park designs and planting plans, replaces existing plant material or converts high water-use areas for lower water-use landscapes.

As DPR's Water Conservation Program works towards both near-term and future goals, we look forward to maintaining our current partnerships and collaborating with new partners. If you're interested in working with us, or happen to find yourself in the unique discipline of Parks and Recreation Water Conservation, please feel free to contact us and continue the art of relationship building.



Irrigation potable and recycled consumption by park definition. Courtesy of Jill Wuertz and Debrah Binard.

For more information on DPR Water Conservation,
visit us at: www.denvergov.org

USGS

Recent Publications

Comparison of Mercury in Water, Bottom Sediment, and Zooplankton in Two Front Range Reservoirs in Colorado, 2008-09 by M.A. Mast and D.P. Krabbenhoft pubs.usgs.gov/sir/2010/5037/

Effects of High-Flow Experiments from Glen Canyon Dam on Abundance, Growth, and Survival Rates of Early Life Stages of Rainbow Trout in the Lees Ferry Reach of the Colorado River by J. Korman, M. Kaplinski, and T.S. Melis pubs.usgs.gov/of/2010/1034/

Final Report: Baseline Selenium Monitoring of Agricultural Drains Operated by the Imperial Irrigation District in the Salton Sea Basin, California by M.K. Saiki, B.A. Martin, and T.W. May pubs.usgs.gov/of/2010/1064/

Relations Between Rainfall and Post-fire Debris Flow and Flood Magnitudes for Emergency Response Planning, San Gabriel Mountains, Southern California by S.H. Cannon, E.M. Boldt, J.W. Kean, J. Laber, and D.M. Staley pubs.usgs.gov/of/2010/1039/

Short-Term Effects of the 2008 High-Flow Experiment on Macroinvertebrates in Colorado River below Glen Canyon Dam, Arizona by E.J. Rosi-Marshall, T.A. Kennedy, D.W. Kincaid, W.F. Cross, H.A.W. Kelly, K.A. Behn, T. White, R.O. Hall, Jr., and C.V. Baxter pubs.usgs.gov/of/2010/1031/

Utility of Microbial Source-Tracking Markers for Assessing Fecal Contamination in the Portage River Watershed, Northwestern Ohio, 2008 by C.M. Kephart, and R.N. Bushon pubs.usgs.gov/sir/2010/5036/

Estimated Withdrawals and Use of Water in Colorado, 2005 by T. Ivahnenko, and J.L. Flynn pubs.usgs.gov/sir/2010/5002/

Saltcedar (Tamarix spp.) and Russian Olive (Elaeagnus angustifolia) in the Western United States: A Report on the State of the Science by P. Shafroth pubs.usgs.gov/fs/2009/3110/

Saltcedar and Russian Olive Control Demonstration Act Science Assessment by P.B. Shafroth, C.A. Brown, and D.M. Merritt pubs.usgs.gov/sir/2009/5247/

U.S. Geological Survey Colorado Water Science Center: co.water.usgs.gov

City of Durango and Colorado State Forest Service Protect Watersheds

Ryan Lockwood
Public and Media Relations Coordinator, Colorado State Forest Service

The water winding its way down Junction Creek, a scenic tributary of the Animas River to the north of Durango, Colorado, doesn't end its journey there. After the waterway meanders past the ponderosa pine forests of Durango's Dalla Mountain Park, it transports runoff to the Animas River, which in turn flows into the larger San Juan River.

This watershed provides recreation, irrigation and fresh water to many Four Corners communities. As a result, forest management activities conducted near Dalla Mountain Park have in part focused on minimizing negative impacts to the watershed. To protect a forested watershed, catastrophic wildfire must be prevented; this can be a challenge in an area primed for just such a fire.

"Dalla Park is in a historic high-frequency fire regime, but we've missed a lot of fire cycles there," said Craig Goodell, fire mitigation and education specialist for San Juan Public Lands. Despite a history of regular, low-intensity fires, he says no large wildfires have burned in the area for over 125 years.

Intense wildfires lead to severe runoff and soil erosion due to the resulting lack of ground cover, soil water repellency and sterile soils. These high rates of runoff and erosion can greatly lower water quality in nearby streams and ultimately clog reservoirs downstream with sediment.

Yet the risk for heavy post-fire runoff and sediment erosion into Junction Creek—not to mention the immediate wildfire risk to Durango residents—has recently been reduced thanks to funding from Colorado's Forest Restoration Pilot Program administered by the Colorado State Forest Service (CSFS).

A High Risk for Wildfire

Dalla Mountain Park provides Durango residents with open space for hiking, walking dogs, mountain biking and rock climbing. Sandwiched between Bureau of Land Management (BLM) acreage to the northeast and private land to the southwest, the 176-acre park sits in a classic wildland-urban interface zone. Until recently, the park was cloaked in a thick understory of flammable Rocky Mountain juniper and Gambel oak—vegetation that could have set the stage for a catastrophic wildfire.

Officials with the City of Durango Parks and Recreation Department, which manages the park, knew they needed to implement fuels reduction projects in the park to protect the community and water supply. The city began fuels reduction efforts in the park using two BLM grants in 2006, but it was only able to treat approximately 16 of the targeted acres. The next year, the city applied for Forest Restoration Pilot Program funding through the CSFS and in 2008 received a Community Forest Restoration award to reduce fuels in the park along its trail system. With additional grant funding received in 2009, the park used more than $46,000 in Forest Restoration grants

Craig Goodell of San Juan Public Lands points out scarring on an ancient stump as evidence of the frequent fires that burned through the area hundreds of years ago. Courtesy of Ryan Lockwood.

Beneath a ponderosa pine canopy in Dalla Mountain Park, untreated acreage is thick with highly flammable junipers and oak brush. Courtesy of Ryan Lockwood.

in 2008-2009, matched by more than $25,000 from the city and another $10,000 awarded by the BLM (overall, a 43-percent match).

"With the economic downturn heavily impacting local budgets, the City of Durango must leverage local resources with outside funding in order to continue to undertake fuels reduction and healthy forest initiatives around the community," said Kevin Hall, the parks, open space and trails development manager for the city.

The Forest Restoration Pilot Program allows the state to fund projects that demonstrate a community-based approach to forest restoration. Projects funded by this program, which the CSFS administers, focus on protecting water supplies and related infrastructure as well as restoring ecosystem function in forested watersheds. Forest management efforts may range from thinning and fuels reduction to replanting trees.

Goodell says one reason Dalla Mountain Park was awarded grant funding was that the project complements an adjacent BLM project, in which 700 acres of forest are being thinned to reduce potential fire intensity. The similar Dalla Park project next door increased the potential effectiveness of this BLM project, according to Goodell. "We get more bang for our buck when we treat across boundaries," he said.

Going Light on the Land

The city contracted the Southwest Conservation Corps to complete the Dalla Mountain Park treatments, employing hand crews to minimize soil disturbance in the watershed. Although non-mechanized thinning is more expensive and time consuming than operations using heavy equipment, CSFS Durango District Forester Kent Grant says that it has a much lighter impact on the ground, which is important when watershed protection is one of the ultimate project goals.

The Corps hand-thinned the scrub oak and juniper beneath the ponderosa pine overstory and pruned or removed some pines. Cut wood was donated to La Plata County's needy, chipped by city workers or assembled in slash piles. The CSFS Durango district burned the piles in a demonstration for the community, with assistance from the Durango Fire & Rescue Authority and San Juan Public Lands.

"This was an important milestone because it was the first time the city had done a prescribed burn on its mountain park or open space properties. The burn went smoothly, so prescribed fire will likely be used again in the future when appropriate to do so," said Grant. In 2008-2009, more than 37 acres were treated at Dalla Mountain Park using Forest Restoration Pilot Program funding. More acreage is slated for treatment in the next one to two years.

A treated area in Dalla Mountain Park no longer has thick ladder fuels in the understory. Courtesy of Ryan Lockwood.

Watershed Now Braced for Fire

"If there is a significant wildfire in Dalla Mountain Park, it should now be less intense and less likely to become a devastating crown fire," said Grant. "Hence, it would have a limited impact on the Junction Creek and Animas River watersheds."

Hall says that the Forest Restoration Pilot Program grants have been critical to completing the Dalla Mountain Park project, and that the City of Durango intends to continue using grant funding to prevent local watersheds from experiencing an excessive build up of fuel. Grant agrees that maintaining a more open, historical forest composition is essential for Durango's rural parkland. "Trees and especially brush will come back in, and dry fuels will keep accumulating on the forest floor," said Grant. "It's important to keep up what we've done to ensure effectiveness over the years."

For more information about funding opportunities for projects that enhance Colorado forest and watershed health, visit csfs.colostate.edu.

—2012 Water—
Rain Gauges for Everyone

Nolan Doesken, Colorado Climate Center, CSU

If you like water, 2012 is going to be a great year here in Colorado...

I can't guarantee there will be a generous supply in 2012, but the water we have will certainly be celebrated. The details are still taking shape and won't be announced for several months. A combination of coincidences and anniversary dates are coming together to make 2012 a year for celebration of Colorado's water resources and our state's water-centered heritage. Stay tuned and be ready to pitch in to make 2012 the year where everyone in the state learns to better appreciate our precious water resources.

While we look to the mountains, the snowpack, the rivers, the reservoirs and our aquifers as the source of our water supplies, the real source is, of course, the sky. Colorado's interior continental location, far from the oceans, means that we are often on the short end of the stick when it comes to precipitation. But still, our high and complex mountain ranges, mid-latitude location, seasonal cycles of changing wind patterns, air masses and storm tracks interact to deliver enough rain, hail and snow to satisfy many fish, fauna and fun seekers as well as providing for our farmers, other businesses and urban dwellers.

Based on many years of measuring precipitation (back to the 1880s in a few places) from Springfield in the southeast to Julesburg in the northeast and from Craig and Dinosaur in the northwest to Cortez and Mesa Verde in the southwest, we have a detailed record of how much water falls from the sky. Averaging about 17 in. of precipitation (rain plus the melted content of snow) statewide, precipitation varies from as little as 7 in. per year near Alamosa and 8 in. in Grand Junction to 12-16 in. across much of the Colorado's eastern plains, increasing to 20-35 in. in the mountains and over 40 in. in a few preferred wet spots like Wolf Creek Pass and Colorado's proverbial snow paradise – Buffalo Pass northeast of Steamboat Springs. There precipitation averages around 60 in. per year including close to 500 in. of snow annually. That is a lot of snow for a location so far inland. Not only does precipitation vary dramatically from one location to another, it also varies greatly from one year to the next. At any given location, precipitation can vary from less than half the long-term average in a dry year to nearly double the average in a very wet year. No wonder water managers have their work cut out for them trying to deliver us a steady supply.

Over the next year and a half, the Colorado Climate Center will be working with many other water organizations to prepare for 2012. We are going to need a lot of help. Here are few things you can do to help.

James Cano displays a rain gauge, used to measure precipitation. Accurate measures will help develop consistent data for the use of water conservation experts. Courtesy of Nolan Doesken.

Plan to measure the precipitation in your own yard. There may be no better way to come to appreciate our limited water resources than to measure what falls from the sky. The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS), started here at Colorado State University (CSU) over ten years ago, makes it easy for anyone to help measure and report precipitation from their own neighborhood. Data from thousands of individuals are combined in an extensive online database that makes it possible to map the rainfall patterns over the entire state and nation. Sign up at http://www.cocorahs.org and click on "Join CoCoRaHS" to get started. We need you. Precipitation is so variable that it would be necessary to have at least one volunteer per square mile to accurately map and track precipitation patterns from our variable storms. We already have over 1,000 volunteers measuring rain and snow here in Colorado, but by 2012 we would like to at least triple that number.

Help sponsor a rain gauge for your neighborhood school. We would like to see every school in Colorado measuring their precipitation in 2012. To help make this possible, we'll need several hundred high quality, high capacity all-weather precipitation gauges. These gauges can be purchased for about $30 each and cost less per gauge if purchased in bulk. If you or your organization would like to help provide rain gauges, please let me know via my contact information at the end of the article.

Help measure evapotranspiration (ET). Second to precipitation, the next largest component of the hydrologic cycle is evapotranspiration. Here in Colorado, except for the snow accumulation areas of the higher mountains, the bulk of the precipitation that falls either evaporates directly or goes into the soil only to be tapped by roots and circulated back into the atmosphere as transpiration. There is a modestly priced instrument called an "Atmometer" that approximates the evapotranspiration process. This instrument can be purchased for about $200. We would love to have about 100 of these instruments distributed across Colorado to help measure and map evapotranspiration during the growing season. In combination with the Colorado Agricultural Meteorological Network (CoAgMet) www.coagmet.com we could demonstrate our water cycle in action and make it easier for students to visualize the water balance. Please contact me if you would like to help.

Watch your calendars and volunteer for 2012 water events. It's still more than a year away, but start thinking now about how you might be able to help in 2012. There will be many children's water festivals, historical commemorations, opportunities to visit schools and probably many other water education activities. Start thinking now of how you might help make 2012 be a very special year for water here in Colorado.

To sponsor a rain gauge, go to www.cocorahs.org and click "Join CoCoRaHS."

CSU Professor Receives Two Awards

Kurt Fausch receives the Colorado-Wyoming Chapter of the American Fisheries Award of Excellence for his work on stream ecology.

Dr. Kurt Fausch, professor in the Department of Fish, Wildlife, and Conservation Biology at CSU, was recently honored with two awards for lifetime achievement. Fausch won the Award of Excellence from the Colorado-Wyoming Chapter of the American Fisheries Society and the 2010 Outstanding Alumnus Award awarded by the College of Agriculture and Natural Resources at Michigan State University, where he earned his M.S. and Ph.D.

Fausch is internationally known for his research, teaching, and outreach on stream ecology, with an emphasis on conservation and management of stream fishes. His work with students and colleagues was recently chronicled in the documentary film RiverWebs, which aired on PBS to more than 70 million homes in 2009 and is currently showing again.

Local Conservation: City of Loveland, Colorado

Lindsey A. Knebel, Editor, Colorado Water Institute
Greg Dewey, P.E., City of Loveland Dept. of Water and Power

According to Greg Dewey, Civil Engineer for Loveland, Colorado's Water and Power Department, Loveland actively participates in multiple efforts to conserve its water resources.

Dewey says that in 1982, the Loveland community was one of the first in this area to be fully metered, and "shortly thereafter," customers reduced their overall water use by about 20 percent. Loveland keeps these meters accurate and up-to-date with an ongoing meter testing program.

Loveland focuses its efforts on education by supporting an annual Loveland Children's Water Festival, which has reached as many as 900 students in recent years. They also distribute educational pamphlets called City News Updates that "reach every customer," according to Dewey. The city also displays two example xeriscape gardens at the city's Civic and Service Centers. See below for a list of Loveland's activities and programs aimed at water conservation and public education.

In addition to outreach programs, Dewey says his staff at the Department of Water and Power and the Loveland Utilities Commission (LUC) are considering certain programs and changes to recommend to City Council for 2011. As of June 23, 2010, no decisions had been made on those recommendations.

Joe Chaplin, City of Loveland employee, uses puppets to demonstrate water conservation and water quality concepts at the 2006 Big Thompson River Revival in Loveland. Courtesy of the City of Loveland.

The proposals included the idea to update and implement water conservation programs because, says Dewey, "using less water while also maintaining the desirable community attributes enjoyed in Loveland" is an ongoing, important issue for the community. The proposal includes updating Loveland's 1996 Water Conservation Plan to find new ways to reduce water use, implementing an ENERGYSTAR® Clothes Washer Rebate, creating a Larimer County Youth Conservation Corps, implementing Commercial and Indoor Irrigation Audits, creating a Garden in a Box demonstration and implementing Irrigation Assessments.

The LUC and Dept. of Water and Power recommended another idea that would save water resources as well – this idea also saves the city from constructing a new water treatment facility. They would encourage water users to conserve via educational and informational campaigns, implement an every-other-day watering for residential, commercial and irrigation consumers and begin using an interconnect with another facility to stream in enough water for high use periods. These changes, if accepted, would take place in 2011.

The Service Center Xeriscape Garden is located at the administrative headquarters of the Loveland Water and Power Department, 200 North Wilson Avenue, Loveland, Colo. Customers are encouraged to observe the various plants year round. Courtesy of the City of Loveland.

Existing Water Conservation Activities

- Low water use landscaping is offered as an option for irrigation meters using xeric types of landscaping and using a water budget. This option lowers water rights requirements and potentially lowers the system impact fees.
- We are conducting a pilot study with the Medical Center of the Rockies to evaluate water use on xeric landscape.
- The city requires appropriate soil amendments in the City's Site Development Performance Standards and Guidelines document for new construction.
- Publications on conservation practices are distributed at the Loveland Public Library, the Utility Billing Office, the Utility Service Center, and on the City's website.
- The importance of water conservation is promoted with information available in the City Update and in public outreach through presentations to service clubs and organizations.
- The Garden In A Box program is offered annually. About 150 xeric gardens are planned and sold annually to citizens to help promote low water use landscapes.
- Two Xeriscape demonstration gardens are promoted and maintained with signage.
- Hose meters are distributed upon request so customers may estimate their irrigation water use.
- Customers are provided with dye tablets to test for toilet leaks.
- We have an ongoing program to repair and replace aging infrastructure to reduce system loss.
- We support a Loveland Children's Water Festival, along with the Northern Colorado Water Conservancy District and the Thompson School District. An important educational goal is to enable every fifth grader in the Thompson School District to participate in the annual Loveland Children's Water Festival.
- We support project WET (Water Education for Teachers) along with the City Stormwater Division Water-based curriculum and ideas for the classroom are provided in this one day training session. The City provides community-specific information on our water resources as well as support for the teachers throughout the year.

A kinetic sculpture acts as a large garden ornament as it adorns the Loveland Service Center Xeriscape Garden. Courtesy of the City of Loveland.

Documenting the Xeriscape Movement

Patricia J. Rettig
Head Archivist, Water Resources Archive, Colorado State University Libraries

A walkway runs through a xeriscape garden in Greeley, Colo. Courtesy of Ruth Quade.

In late fall 2009, the Water Resources Archive received a significant new collection. Contained in a modest five boxes, the collection represents a new area of historical documentation for the Archive, which works to preserve the history of Colorado's water, in all aspects.

Donated in November 2009, the Records of Xeriscape Colorado, Inc. is the Archive's first collection to address the issue of landscape water conservation. It is further significant because Xeriscape Colorado evolved from the organization that created the word xeriscape and began the movement of carefully planning landscapes to reduce water use.

The word xeriscape came into existence in Denver in 1981, as did the Xeriscape Task Force, a group involving both landscapers and water experts. Combining the Greek word "xeros"—meaning "dry"—with "landscape" created one word to embody the concept of low-water-use landscaping along with fundamental practices behind it. The word and accompanying logo were trademarked by Denver Water, a task force partner, to be an easily recognized concept, and thus a good promotional tool.

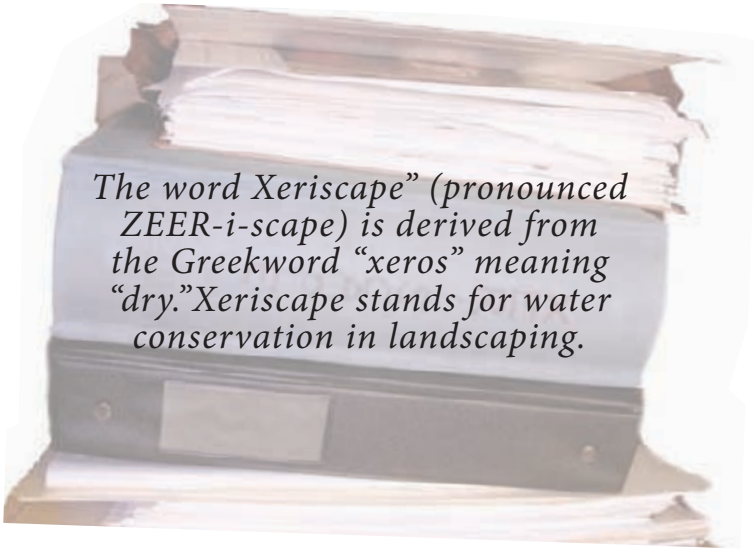
The concept pre-dated the word, but the word began a movement which rapidly spread throughout the arid west during the 1980s. The task force employed educational activities and demonstration gardens to spread the concept, and in gaining a more solid footing, the task force changed into Front Range Xeriscape in the mid-1980s and finally into Xeriscape Colorado in 1989.

The Xeriscape Colorado records, donated by the Colorado WaterWise Council with which it is now affiliated, contain the details of its history. However, the five boxes arrived with only a partial inventory of the unorganized binders, folders, envelopes, and loose materials, so the details are still waiting to be uncovered

The materials appear to date back to 1982, the year that xeriscaping made its public debut, primarily as a demonstration garden on the grounds of Denver Water, but also through promotional materials. Meeting agendas and minutes in the collection contain an outline of the organization's activities and concerns; however, since these are scattered throughout the boxes, it is not yet known how complete the set is. Additionally, the organization produced various newsletters over the years, but, again, they are scattered throughout the boxes, so the comprehensiveness of those publications is not yet known either.

Beyond records documenting Xeriscape Colorado's activities, the collection contains materials showing the spread of xeriscape across the country. This is evidenced through such diverse items as magazine and newspaper articles, extension reports, pamphlets, brochures, and calendars. Once this material is brought together and organized, a clearer picture of the movement will emerge.

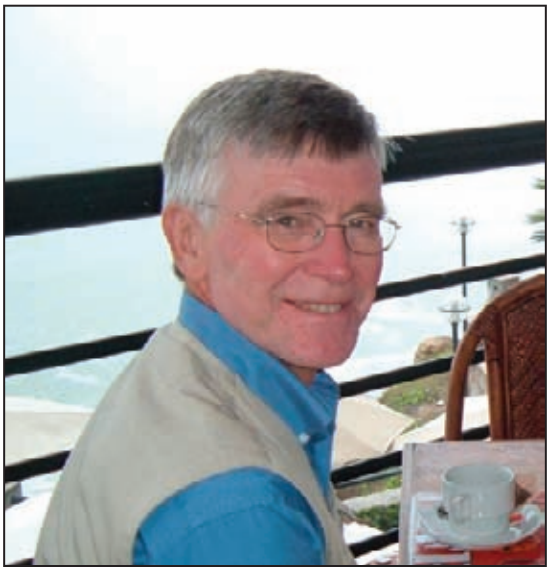
Archivists will thoroughly organize and inventory the five boxes later this year. In doing so, the various material types will be brought together, so researchers can examine meeting minutes, news-letters, publications, or various other materials in a more orderly fashion. Once the contents of the collection are thoroughly known, organized, and inventoried, archivists will then explore digitizing portions of it. Efficient access to these historic materials will enable researchers to investigate and learn from the origin and growth of xeriscape.



The word Xeriscape" (pronounced ZEER-i-scape) is derived from the Greekword "xeros" meaning "dry."Xeriscape stands for water conservation in landscaping.

For more information about the Xeriscape Colorado collection or others in the Water Resources Archive,
visit: lib.colostate.edu/archives/water
or contact the author: (970) 491-1939; patricia.rettig@colostate.edu

Former CWI Director Robert Ward Receives 2010 Elizabeth Jester Fellows Award



Dr. Robert C. Ward, retired professor and director of the Colorado Water Institute at Colorado State University, is the recipient of the 2010 Elizabeth Jester Fellows Award. This award recognizes individuals for outstanding achievement, exemplary service, and distinguished leadership in the field of water-quality monitoring. Dr. Ward is dedicated to improving the state of the science of water quality monitoring through the delivery of quality education, development of coherent water monitoring systems, and promotion of the development of water quality information that the public and decision makers can understand, trust, and use to further improve water resources. He taught two generations of students in operations research, engineering design, and water quality monitoring during his 35-year tenure at CSU and through his "Short Course on Water Quality Monitoring Network Design." His seminal text on this topic and the monitoring network design he helped develop in New Zealand stand as testament to his work. His profession of goal-oriented monitoring was reflected in the Interim Task Force on Monitoring products, as well as the National Water Quality Monitoring Council's (NWQMC) Framework for Water Quality Monitoring. Internationally he has served on the scientific Organizing Committee for four Europe-wide conferences on water quality monitoring.

Southwest Colorado Basin Tour, June 9-11, 2010

Julie Kallenberger, Research Assistant, Colorado Water Institute

2010 CFWE Tour group photo: Southwest Basin Tour attendees gather at the McPhee Reservoir Overlook. Courtesy of Kristin Maharg.

Colorado Foundation for Water Education's (CFWE) annual river basin tours provide an opportunity for water professionals, educators and legislators to visit basin sites and hear from expert speakers who focus on past, present and future problems and solutions facing Colorado's river basins. This year's tour took place June 9-11 and visited the San Juan and Dolores River basins, located in southwest Colorado. A number of water-related topics and issues were presented and discussed, including interstate compacts, energy and water rights, tribal water use, environmental and recreational flows, river protection and planning for municipal growth.

The San Juan River's headwaters begin in the San Juan Mountain Range and collect water from several tributaries including the Mancos, La Plata, Animas and the Navajo Rivers. The upper stretches flow through two Native American Reservations – the Ute Mountain Ute Reservation and the Southern Ute Indian Reservation. The Dolores River originates south of Telluride near Lizard Head Pass and travels more than 230 miles before its confluence with the Colorado River in Utah. The primary uses of both basins include agriculture, recreation, wildlife preservation and municipal use.

The trip began with three pre-tour activities: whitewater rafting the Lower Animas River, a tour of Mesa Verde National Park and a field tour of the Animas-La Plata Project (A-LP). The day closed with a reception hosted by the Southwestern Water Conservancy District with guest speakers Senator Bruce Whitehead, who gave a basin overview, and Andrew Gulliford (Fort Lewis College), who presented a slideshow on paddling the Dolores River.

Day one's first stop was the Anasazi Heritage Center where Mark Varien (Crow Canyon Archaeological Center) discussed the Village Ecodynamics Project, Mike Preston (Dolores Water Conservancy District) presented on the history of transbasin irrigation from the Dolores River, and Ken Curtis (Dolores Water Conservancy District) presented information on the Dolores Project delivery system.

The group then visited McPhee Reservoir where John Porter (Southwestern Water Conservation District) shared information about the Dominguez-Escalante Expedition of 1776. After lunch, Chuck Wanner discussed the Dolores River Dialogue and Marsha Porter-Norton talked about the Lower Dolores Plan Working Group which was created for greater community collaboration and land management planning. Additionally, Peter Mueller (The Nature Conservancy) spoke on tamarisk removal along the Dolores River, and Jim White (Colo. Division of Wildlife) talked about native fish restoration. Next, the group traveled to Ute Farm and Ranch Enterprise on the Ute Mountain Ute Reservation, where they heard from Paul Evans on farm operations and Scott Clow on tribal water quality standards. The day closed with a dinner and entertainment at Blue Lake Ranch. Evening speakers included Mike Preston, Chairman of the Southwest Basin Roundtable, and Nicole Seltzer (CFWE).

Day two began at Durango's Santa Rita Park where Peter Butler and Steve Fearn (Southwestern Water Conservation District) spoke about the Animas River Stakeholders Group and Cathy Metz (City of Durango) and Senator Whitehead spoke on the city of Durango's recreational in-channel diversion water right. Next, the group traveled to Lake Nighthorse where Barry Longwell (Bureau of Reclamation) discussed operations of the A-LP project and Senator Whitehead spoke on the A-LP compact. In addition, Chairman Ernest House Sr. (Ute Mountain Ute Indian Tribe), Lina Atencio and Chuck Lawler (Southern Ute Indian Tribe) talked about the Indian water rights settlement and tribal water use. The group then traveled to Pagosa Springs where Peter Kasper (Colo. Division of Water Resources) and Phil Starks (town of Pagosa Springs) discussed the town's geothermal resources and operations. The last stop on the tour was the San Juan Chama Diversion Project where Scott Brinton (Colo. Division of Water Resources) and Mike Hamman (Bureau of Reclamation) discussed trans-mountain water diversions.

2010 CFWE Tour ALP Project: Senator Bruce Whitehead discusses the A-LP project and compact at Lake Nighthorse. Courtesy of Julie Kallenberger.

Several speakers discussed water-related topics while we traveled on the bus. Dick Wolfe and Rege Leach (CO Division of Water Resources) discussed energy and water rights; Chris Treese (Colorado River District) and Steve Harris (Harris Water Engineering) spoke about the Colorado River Compact and water bank initiative; Jack Burk (Mancos Conservation District) talked about the Mancos Valley Watershed Mangement Project; Brice Lee (La Plata Water Conservancy District) and Eric Bikis (Bikis Water Consultants) talked about the Long Hollow Reservoir project; Steve Harris (Harris Water Engineering) and Sheila Berger (Pagosa Area Water & Sanitation District) talked on municipal water planning in a resort community; John Gerstle (Trout Unlimited) discussed the Dry Gulch Reservoir case; Scott Brinton (CO Division of Water Resources), Chuck Wanner (Trout Unlimited), Ann Oliver (Conservation Representative), John Taylor and Steve Fearn (Southwestern Water Conservation District) discussed the San Juan River Protection Workgroup; Sharon Whitmore (U.S. Fish & Wildlife Service) talked on the San Juan River and Upper Colorado River Recovery Implementation Program; and Wanda Cason of Senator Udall's office talked about the Good Samaritan legislation (H.R. 4011) that amends section 402 of the Clean Water Act by creating a permit for Good Samaritans cleaning up abandoned mine sites.

2010 CFWE Tour: Peter Mueller with The Nature Conservancy discusses tamarisk removal along the Dolores River. Courtesy of Kristin Maharg.

Thank You CFWE Staff For An Outstanding Educational Tour!
We Look Forward To Next Year's Visit To The Colorado River Basin.

Faculty Profile: Pinar Omur-Ozbej

Research Assistant Professor, Dept of Civil and Environmental Engineering, CSU

I joined the Department of Civil and Environmental Engineering at Colorado State University as a Research Assistant Professor in January 2009. For the past year and a half, I have been conducting research, teaching and pursuing outreach efforts in the area of drinking water to understand its aesthetical and health-related issues. I received my Bachelor's degree in environmental engineering from Middle East Technical University in Ankara, Turkey in 2002. In 2003 I came to United States to pursue graduate studies in civil and environmental engineering at Virginia Tech. I received my master's degree in 2004 studying taste and odor problems related to algal metabolites in source waters and their relation to human perception of tap water.

In 2008, I obtained a Ph.D. as a National Science Foundation Integrative Graduate Education and Research Traineeship (NSF-IGERT) associate, conducting interdisciplinary research to investigate the metallic flavor of drinking water caused by iron and copper. My research evolved from sensory analyses of metallic flavor to biomedical approaches to understand the effects of iron and copper ions on the oral epithelial cells.

Throughout my graduate studies I have received several national and international awards and fellowships, such as the Best Paper Award from American Water Works Association in 2008, Best Poster Award and Scholarship from International Water Association in 2008 and 2005 respectively, Best Mentor Award from the NSF Summer Undergraduate Research Program (SURP) in 2008, and the Edna Bailey Sussman fellowship in 2003. I have been actively attending and presenting at both national and international conferences and publishing my research.

Pinar Omur-Ozbej. Photo by John Eisele - CSU Photography.

Research

My research focuses on drinking water and branches out to related areas to study the aesthetical and health-related issues. Seasonal taste and odor problems due to algal metabolites have been an issue for the drinking water utilities throughout the world and billions of dollars are spent each year to tackle this problem. I apply sensory and analytical methods to understand human perception of the off-flavor compounds found in drinking water and removal of such compounds by non conventional techniques such as activated carbon adsorption. Even though off-flavor compounds are generally not a health concern, the public perceives the tap water as unhealthy when it has off tastes and odors. This may cause a lack of trust to the water utilities and lower consumption of tap water. Hence, it is essential for the utilities to effectively remove these compounds and respond properly to consumer complaints. Another issue related to algae is algal toxins, which are an emerging issue. As a consequence of climate change, algal blooms and hence algal metabolites are occurring more commonly in the source water. I am planning to steer my focus in this direction and collaborate with the faculty in biomedical engineering as toxins directly impact humans and animals exposed to them in the source and finished waters. Another pathway that humans are exposed to drinking water contaminants is through skin or inhalation. I am also interested in understanding the detection of off-odors in tap water while humans are taking a shower. This also leads the way to modeling and predicting exposure to harmful contaminants that may also be present in the tap water.

Teaching

I believe teaching is the most meaningful aspect of academia. I try to make my classes more interesting and engaging by including news and research articles on contemporary issues and visual components (such as video clips) related to the topic covered. My goal is to improve the analytical and critical thinking skills of my students. At CSU I have been teaching Environmental Engineering Concepts (CIVE/ENVE 438) and Water Quality Analysis (ENVE 441). I enjoy teaching these two classes very much as my background is mainly in environmental engineering. We cover almost all of the topics related to environmental engineering field in the Environmental Engineering Concepts and it is very fruitful to see the students' reactions when they realize the environmental and health problems related to pollution and how society,

economy and environment are interrelated when seeking solutions for pollution. Water Quality Analysis gives the environmental engineering students the knowledge and analytical skills they need to characterize the contaminants found in source waters and wastewater. Then, they apply this knowledge to select proper treatment units for a small design project at the end of the semester. I continue to attend workshops on teaching to improve my skills to better respond to the learning needs of the students of today that grew with technology. I am looking forward to developing a graduate level course in environmental engineering in the upcoming years.

Outreach

As a part of my graduate studies, I have utilized sensory methods to identify the contaminants that may be present in drinking water. One of these methods is the well-known "Flavor Profile Analysis" created by the food and beverage industry, which was adapted to drinking water in early 1980's. During my studies, I developed an odor standard to be used with this method to improve panelist training and sample analysis. I have been conducting sensory analysis workshops to train water utility personnel to quickly and efficiently detect certain compounds in their source and finished water to be able to take proper action before consumers complain about the off-flavors of tap water. Since I started at CSU, I have conducted flavor profile analysis workshops for the City of Fort Collins and City of Loveland Water Treatment Facility personnel. Using the same techniques (smelling and tasting) as the consumers, utilities may better connect with the public and show that they care about their perceptions.

I also enjoy interacting with and teaching to students in grades K through 12 as well as undergraduate students. I have acted as a laboratory and science camp instructor to attract students to science and engineering fields since 2003, and last semester I conducted a half-day seminar to recruit undergraduate students to the Engineers Without Borders program. Being a scholar citizen, I understand the value of sharing and applying the knowledge we pass onto the new generation.

I am very excited to be a part of the CSU family and I am looking forward to meeting people and establishing collaborations.

Pinar Omur-Ozbej, Ph.D.
Research Assistnat Professor

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Water Research Awards

Colorado State University (May 15 to June 15, 2010)

Berrada, Abdelfettah, Southwestern Colorado Res Ctr, National Sunflower Association, Boosting Sunflower Production in SW Colorado with Supplemental Irrigation, $9,000

Bestgen, Kevin R, Fish, Wildlife & Conservation Biology, Wyoming Game & Fish Department, Big Sandy River Larval Dispersal, $85,340

Bestgen, Kevin R, Cooperative Fish & Wildlife Research, Colorado Division of Wildlife, Eastern Plains Native Fish Investigations, $7,374

Bestgen, Kevin R, Fish, Wildlife & Conservation Biology, DOI-Bureau of Reclamation, Monitoring Effects of Flaming Gorge Dam Releases on the Lodore and Whirlpool Canyon Fish Communities, $61,211

Bestgen, Kevin R, Fish, Wildlife & Conservation Biology, DOI-Bureau of Reclamation, Evaluating Effects of Non-Native Predator Fish Removal on Native Fishes in the Yampa River (Project No. 140), $85,976

Bledsoe, Brian, Civil & Environmental Engineering, CDM, Mapping Geomorphic Settings in the Colorado River Basin for Environmental Flow Analysis, $12,117

Brick, Mark A, Soil & Crop Sciences, Colorado Department of Agriculture, Irrigation Efficiency of Three Water Delivery Systems on Diverse Dry Bean Market Classes of Dry Edible Bean, $44,000

Chavez, Jose L, Civil & Environmental Engineering, Regenesis Management Group, Crop Water Stress Index and Evapotranspiration Monitoring using Remote Sensing Techniques, $78,836

Davies, Stephen P, Agric & Resource Economics, New Mexico State University, Afghanistan Water, Agriculture and Technology Transfer Program (AWATT), $338,545

Fausch, Kurt D, Cooperative Fish & Wildlife Research, DOI-USGS-Geological Survey, Tools to Assess Effects of Uncertain Climate Change Scenarios on Colorado River Cutthroat Trout, $35,000

Fiege, Mark T, History, FRICO-Farmers Reservoir and Irrigation C, A History of Farmers Reservoir and Irrigation Company, Brighton, Colorado, $14,335

Grigg, Neil S, Civil & Environmental Engineering, Water Research Foundation, Retrospective Analysis of Performance of Dual Distribution Systems, $150,000

Grigg, Neil S, Civil & Environmental Engineering, Water Research Foundation, Integration of Cost of Failure with Asset Risk Management, $150,000

Holder, Curt, Department of Geography and Environmental Studies, Leaf hydrophobicity and canopy storage relationships of common species in semi-arid environments of the western United States, $97,831

Johnson, Brett Michael, Fish, Wildlife & Conservation Biology, DOI-Bureau of Reclamation, Chemically Fingerprinting Nonnative Fishes in Reservoirs (Project No. C-18/19), $46,597

Laituri, Melinda J, Forest Rangeland Watershed Stwrd, The Nature Conservancy, Mapping Irrigation in the Colorado River Basin Potential Uses for Water Sharing, $9,200

McKay, John K, Bioagric Sciences & Pest Mgmt, NSF-Biological Sciences, A Course in Plant Breeding for Drought Tolerance - June 14-23, 2010 at Colorado State University (CO), $23,435

Oad, Ramchand, Civil & Environmental Engineering, New Mexico State University, Afghanistan Water, Agriculture and Technology Transfer Program (AWATT), $586,711

Pearson, Calvin H, Western Colorado Research Ctr, DOI-Bureau of Reclamation, An Automatic Gate Valve Actuator for Gated Pipe to Increase Efficiency of Furrow Irrigation, $24,993

Rathburn, Sara L, Geosciences, DOI-NPS-National Park Service, Hydrologic & Sediment Transport Monitoring: Planning for Channel Restoration Along Lulu Creek & Colorado River,?, $6,505

Reardon, Kenneth F, Chemical & Biological Engineering, OptiEnz Sensors, LLC, Multichannel Optical Biosensor for Detection of Contaminants in Water and Food, $50,000

Roesner, Larry A, Civil & Environmental Engineering, Water Environment Research Foundation, Linking Stormwater BMP Systems Performance to Receiving Water Protection to Improve BMP Selection and Design, $153,169

Sale, Thomas C, Civil & Environmental Engineering, US Department of Defense, Basic Research Addressing Contaminants in Low Permeability Zones, $973,748

Sanford, William E, Geosciences, Regenesis Management Group, Quantifying Changes in Irrigation Return Flow Due to Limited Irrigation & Other Crop Optimizing Techniques, $102,622

Schneekloth, Joel, CSU Extension, Monsanto, Response of Drought Genetics to Water Stress, $54,258

Sharvelle, Sybil E, Civil & Environmental Engineering, Water Environment Research Foundation, Innovation and Research for Water Infrastructure for the 21st Century, $195,000

Thornton, Christopher I, Civil & Environmental Engineering, Tetra Tech, Inc., Hydraulic Model Study: River Training Works at M&T Pumping Plant, Sacramento River, $256,000

Winkelman, Dana, Cooperative Fish & Wildlife Research, DOI-Bureau of Reclamation, Population Dynamics Modeling of Introduced Smallmouth Bass, Upper Colorado River Basin, $60,641

Calendar

August

1-5 **StormCon 2010; San Antonio, Texas**
The world's largest storm water pollution prevention conference
www.stormcon.com

5-6 **New Mexico Water Law Conference, Santa Fe**
Water efficiency – should the state regulate increases in consumptive use?, State and Federal Adjudications in New Mexico
www.cle.com

7 **Pine Valley Ranch River Festival; Pine, Colo.**
A celebration of rivers and watersheds featuring interactive activity stations set up along the banks of the North Fork of the South Platte River
www.jeffco.us

8 **Colorado Foundation for Water Education Running Rivers 5k Fun Run; Littleton, Colo.**
Spend a day doing good for your body and the state of Colorado as you break a sweat for Colorado's rivers.
cfwe.org

9-13 **Principles and Practice of Stream Restoration Part II Seminar**
Intended for those who wish to understand and apply the principles of channel design
cnr.usu.edu

25 **Water Availability Task Force Meeting; TBD**
www.cwcb.state.co.us

25-27 **August 25 - 27: Colorado Water Congress Summer Conference; Vail**
Where water professionals go to stay well-informed on the most important issues, current legislation, and latest developments that impact water users in Colorado and other western states.
www.colowc.com

30 **IBCC Meeting; Loveland, Colorado**
ibcc.state.co.us

September

1-4 **2010 Annual Water Symposium; Tucson, Ariz.**
This year's theme is "Dryland Hydrology: Global Challenges Local Solutions."
www.hydrosymposium.org

5-11 **World Water Week; Stockholm, Sweden**
The leading annual global meeting place for the planet's water issues
www.worldwaterweek.org

12-15 **Distribution System Symposium / Water Security Congress Conference; Nashville, Tenn.**
www.awwa.org

12-15 **Annual WateReuse Symposium; Washington, D.C.**
The world's preeminent conference devoted to water reuse and desalination
www.watereuse.org

13-14 **North American Geology in the 21st Century: Today and Tomorrow; Lake Buena Vista, Fla.**
Various presentations and field trips
www.aipg.org

16 **Colorado River Water Conservation District Annual Water Seminar, Two Rivers Convention Center, Grand Junction, Colo.**
www.crwcd.org

24 **2nd Annual Colorado WaterWise Conference; Denver, Colo.**
"Using tools and policy to make every drop count."
www.xeriscape.org

25 **Ag Day 2010; Fort Collins, Colo.**
The 29th Annual Ag Day at Hughes Stadium is hosted by agricultural organizations and associations.
www.agday.agsci.colostate.edu

October

5-7 **CWAS Sustaining Colorado Watersheds Conference; Vail, Colorado**
5th Annual Watershed Conference with the theme "Learning from the Past to Protect the Future"
www.coloradowater.org

12-21 **1st Water Management, Operation and Maintenance, International Seminar and Study Tour**
Self-improvement workshop for personnel who are directly responsible for the technical details of operating and maintaining water systems.
www.usbr.gov/

18-21 **River Watch Training Workshop**
Monitor water quality and other indicators of watershed health and utilize this high quality data to educate citizens and inform decision makers about the condition of Colorado's waters.
wildlife.state.co.us

20-21 **2010 South Platte Forum; Longmont, Colorado**
21st Annual South Platte Forum with the theme "High Stakes Games."
www.southplatteforum.org

22 **Colorado Water Congress Federal Affairs Committee Meeting**
Federal Affairs Committee general meeting.
www.colowc.com

27 **Groundwater and Fractured Rock Virtual Conference**
info.ngwa.org

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A sculpture commemorating Greeley's founders, who had the foresight to ensure plenty of fresh water supplies, stands in a xeriscape garden in Greeley, Colo. Photo by Lindsey A Knebel.