colorado waterwise

GUIDEBOOK OF BEST PRACTICES FOR MUNICIPAL WATER CONSERVATION IN COLORADO

Prepared by

Aquacraft inc
WATER ENGINEERING & MANAGEMENT

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PREFACE

On behalf of Colorado WaterWise, we are pleased to present you with the *Guidebook of Best Practices for Municipal Water Conservation in Colorado*. Colorado WaterWise, *the voice of Colorado's water conservation community*, was formed in 2000 to promote and facilitate the efficient use of water in Colorado. We believe that Colorado should be a water conservation leader because of the critical role water plays in our semi-arid state.

To meet Colorado WaterWise's strategic goal to "participate in the development of urban water conservation policies and integrated resources planning tools," the *Best Practices Guidebook* was developed for use throughout the state. The *Best Practices Guidebook* offers help to those developing water conservation plans with a selection of sensible and cost effective water conservation measures and programs.

This *Best Practices Guidebook* was inspired by an emerging need statewide for utilities large and small to plan for and implement water conservation programs, to comply with Colorado's *Water Conservation Act of 2004*, and to complement the Colorado Water Conservation Board's *Water Conservation Plan Development Guidance Document*.

The *Best Practices Guidebook* was developed through a stakeholder process that allowed for input from local utilities, state agencies, the green industry, water conservancy districts, local non-profits, consultants, and members of academia.

We often hear that, "water is our most precious natural resource." It is Colorado WaterWise's sincere hope that this *Best Practices Guidebook* will not only help to fill the need for a technical resource, but also provide value in the challenge of meeting our state's water needs.

Our sincere thanks go to the Colorado Water Conservation Board for providing a generous grant to fund development of this *Best Practices Guidebook* and for their dedicated support for this project.

Laurie D'Audney and Esther Vincent
Co-Chairs
Colorado WaterWise

FORWARD

The document that you have before you is a testament to the strides that Colorado has made in municipal and industrial water conservation in the past decade. For the first time, Colorado has its own comprehensive *Guidebook of Best Practices for Municipal Water Conservation*. We no longer must rely on our western neighbors for this information. Colorado has taken the best of the best practices and applied them to our State, ensuring that our water providers have proven and applicable water conservation measures to integrate into their water conservation plans.

The Colorado Water Conservation Board (CWCB) is proud to have partnered with Colorado WaterWise on this ambitious and valuable project. It is an example of the State working collaboratively with local water providers in a solutions oriented approach. I hope that it serves as a template for future partnerships.

Colorado has advanced the science of water conservation. Water providers on the east and west slopes are planning for and implementing new and innovative water conservation strategies. But with a forecasted increase in our population, momentum in this area cannot falter. Conservation has great potential to contribute to a water provider's future water supply needs. We need to continue working at being efficient with our water resources as we adopt a culture of using only what we need. Water conservation planning must be fully integrated into water resource planning. To that end, the CWCB will work at supporting the integration of these Water Conservation Best Practices into water providers' planning efforts, including water conservation plans. The CWCB will work to provide the necessary technical support for those efforts.

With the publication of the *Guidebook of Best Practices for Municipal Conservation in Colorado*, we have achieved an important milestone. The CWCB looks forward to continued progress in water conservation.

Veva Deheza
Section Chief, Office of Water Conservation & Drought Planning
Colorado Water Conservation Board

CHAPTER 1. INTRODUCTION

Purpose of Guidebook

The Colorado WaterWise *Guidebook of Best Practices for Municipal Water Conservation in Colorado* (*Best Practices Guidebook* for short) is a planning tool prepared for the purpose of improving and enhancing water efficiency in Colorado. The *Best Practices Guidebook* 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 envisions that the *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. Utilities can use the *Best Practices Guidebook* to help select water conservation programs to include in their conservation plans to be submitted to the Colorado Water Conservation Board (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[1] and can be used by water providers large and small to help select appropriate, cost effective water conservation program measures.

What is a Best Practice?

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.

In this *Best Practices 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."

A best practice 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 this guide are directly

[1] Preparation of the *Best Practices Guidebook* was made possible through grant funding from the CWCB.

related to management of water. Some of the best practices included here describe methods to improve the 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 best practices were developed to fit into the Colorado Water Conservation Board's guidelines for preparing a water conservation plan.[2] Each best practice 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's Included in the Guidebook?

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

- Detailed information on 14 selected best practice 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 best practices for water management including conservation-oriented rate structures and utility water loss programs.
- Descriptions of appropriate end user (customer) indoor and outdoor best practice 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 this *Best Practices 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 have worked to ensure that the descriptions, information, and data provided in this *Best Practices Guidebook* are as accurate and complete as possible. If we missed something or made a mistake, please let Colorado WaterWise know and we'll do our best to fix it in a future edition. It is envisioned that this *Best Practices Guidebook* will be reviewed and updated approximately every five years.

How Were the Best Practices in this Guidebook selected?

The *Guidebook of Best Practices for Municipal Water Conservation in Colorado* was largely written by Peter Mayer, P.E. and the staff of Aquacraft, Inc., but the best practices included were carefully selected by a diverse group of water professionals and industry experts who served on the Project Advisory Committee (PAC) and the Stakeholder Advisory Committee (SAC). A list of all participants on the PAC and SAC is provided in the Acknowledgements section of this document. The best practice selection process went as follows:

[2] http://cwcb.state.co.us/NR/rdonlyres/D3A6FD70-47F2-4208-917B-0CC4A5BD77C1/0/GuidelinesToReviewEvaluateWCPlans.pdf

Literature Review

The project team was well aware of the significant work that has gone into developing best practices guides in other states and regions. To capitalize on these efforts and to effectively incorporate applicable best practices from other areas into the *Best Practices Guidebook*, a detailed literature review of best practices reports and publications was conducted. The consultant team prepared a bibliography and literature review (presented in Chapter 5) on best practices around the U.S. From this effort a "master list" of potential best practices from these sources was assembled.

Selection of Best Practices

Once the literature review was completed, the project team reviewed the master list of best practices and brainstormed for additional appropriate best practice measures to include. Once this was done, the literature review, master list of best practices, and annotated bibliography were provided to the PAC and SAC for review.

Within a few weeks of receiving these work products, a combined PAC and SAC meeting was convened to review the list of best practices and to determine which should be included in the *Best Practices Guidebook.* Approximately 30 members of the PAC and SAC including utility representatives, landscape professionals, water experts, and consultants attended this meeting in Westminster. The meeting included a brainstorming phase, a discussion phase, and an integration phase from which the most relevant and applicable best practices for Colorado were selected.

At the conclusion of the combined PAC and SAC meeting, the final list of best practices for inclusion in the *Best Practices Guidebook* was reviewed and approved.

Review of Draft Guidebook

Once the best practice selection process was complete, Aquacraft prepared the first draft of the *Best Practices Guidebook.* A PAC meeting was convened and the draft guidebook was presented. PAC members were then given three weeks to review the first draft. Project Manager Brenda O'Brien prepared a useful spreadsheet tool to assist the large group of reviewers in coordinating their comments.

Once comments from the PAC were received and incorporated, the second draft of the *Best Practices Guidebook* was prepared by Aquacraft. The second draft was provided to the PAC, SAC, and Board for review. Several weeks were allotted for this review and significant comments were received.

Aquacraft again incorporated comments and changes and prepared a third draft of the *Best Practices Guidebook* which then went through final review from the project manager and the Colorado WaterWise Board. Once final comments were received, the final *Best Practices Guidebook* was prepared and published. It is envisioned that the *Best Practices Guidebook* will be reviewed and updated approximately every five years.

How to use this Guidebook

The *Guidebook of Best Practices for Municipal Water Conservation in Colorado* is intended to be a reference manual for water providers and others developing or seeking to improve their water conservation program. It is envisioned that the *Best Practices Guidebook* will be used by water professionals throughout the state including water providers, local governments, consultants, building managers, design engineers, etc. to help select the most sensible and cost effective water conservation measures and programs to implement. The *Best Practices Guidebook* emphasizes practicality, costs and benefits, water savings, implementation procedures, as well as evaluation methods.

Utilities can use the *Best Practices Guidebook* to help select water conservation program options to include in their conservation plans to be submitted to the CWCB. Building trade professionals may use the *Best Practices Guidebook* to determine the best 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.

At the end of the day, this document is only a guidance document. It is left to individual communities to decide which best practices are appropriate and can be used to meet specific goals and needs.

Funding for Best Practices Implementation

The Colorado Water Conservation Board administers the Water Efficiency Grant program for water conservation planning and measure implementation. The *Guidebook of Best Practices for Municipal Water Conservation in Colorado* can be used as a reference to develop more effective water conservation plans as well as prioritizing implementation of water conservation programs and measures. Utilities that wish to implement measures from this guidebook may be eligible to receive grant funding from the CWCB to assist with implementation. Details for the Water Efficiency Grant Program can be found at:
http://cwcb.state.co.us/Conservation/WaterEfficiencyGrantProgram/

About Colorado WaterWise

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

Colorado WaterWise is the voice for water conservation in Colorado. In 2001, Colorado WaterWise 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, and effective programs to their own customers, clients, and citizens.

Additional information about Colorado WaterWise can be found at www.coloradowaterwise.org.

CHAPTER 2. BEST PRACTICE SUMMARY

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 in this guidebook are multi-faceted and include several related practices such as metering and rates.

Few water providers will have the resources 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. Once these best practices are implemented, utilities may contemplate adding additional programs from the list of practices not included in this guidebook. (A listing of the conservation practices that were considered, but ultimately not selected for the *Best Practices Guidebook* is provided in Appendix A.) Chapter 3 provides "menus" of different best practices selected to meet different budgetary and demand reduction objectives.

Summary of Best Practices

A total of 14 best practices are discussed in this guidebook. For convenience they have been divided into four target categories:

1. Water System and Utility Best Practices
2. Outdoor Landscape and Irrigation Best Practices
3. Indoor Residential (single-family and multi-family) Best Practices
4. Indoor Non-Residential (commercial, industrial and institutional) Best Practices

Summaries of the best practices included in this guidebook are provided on the next four pages.

The best practices in this guidebook are organized using the following category labels:

- **Foundational** - best practices for water efficiency that are considered essential for all utilities to implement.
- **Informational** - best practices that offer useful information on water efficiency to utility customers to foster conservation actions and behavior.
- **Support** - best practices that provide technical information, data, and assistance on water efficiency to customers (closely related to informational best practices).
- **Management** - best practices that offer improved utility management procedures and actions to promote water conservation.
- **Understanding** - best practices that aim to improve knowledge and awareness of water use and efficiency.
- **Operational** - best practices that seek to improve water conservation in everyday utility functions.

Water System and Utility Best Practices

No.	Best Practice	Category	Overview	Estimated Water Savings
1	Metering, conservation-oriented rates and tap fees, customer categorization within billing system	Foundational, Informational, Support, Management. Impacts utility operations and all customers directly.	Impacts 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.	• Metering: 10 – 40% reduction vs. un-metered. • Rate structure: Varies by structure and rates. Reduction range = 0 – 30%. • Tap fees: Varies by method. Efficient buildings have been shown to use 30-70% less water. Linking tap fees to demands will encourage conservation. • Customer categorization: None.
2	Integrated resources planning, goal setting, and demand monitoring	Foundational. Impacts utility operations and customers indirectly.	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 compares supply-side and demand-side measures on a level playing field and results in a water supply plan that keeps costs as low as possible while still meeting all essential planning objectives.	A plan by itself doesn't save water. A utility without a conservation plan doesn't save water either.
3	System water loss control	Foundational. Impacts utility operations only.	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).	Water savings from water loss management programs depend entirely on the ongoing level of loss. It should be the goal of all water providers to limit real and apparent losses to economically efficient levels.

No.	Best Practice	Category	Overview	Estimated Water Savings
4	Conservation coordinator	Foundational, Informational, Support, Management. Impacts utility operations and potentially all customers directly.	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 for planning and implementing water conservation efforts. Staff should be given education or training in conservation as well as authority to affect change.	A conservation coordinator alone doesn't save water, but a coordinator (or someone filling that role) is essential to successful plan and program implementation.
5	Water waste ordinance	Foundational, Operations. Impacts customers directly.	A water waste ordinance is a local regulation that explicitly prohibits the waste of water and clarifies enforcement and penalties. 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).	Savings depend upon publicity and enforcement – much like traffic laws. Having an ordinance provides a legal basis for enforcement and drought management. It also aids in peak demand management.
6	Public information and education	Foundational, Education, Support. Impacts customers directly.	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 in this guidebook. Central components of this best practice include effectively communicating the value of water, and delivering consistent and persistent messages. This best practice also includes measures to provide customers with timely information on their water consumption and alerts if unusual usage or leakage is detected.	Utilities should not rely on any water savings from a public outreach campaign alone. Conservation outreach programs help establish a culture of wise water stewardship which over time results in behavior change and effective action such as replacing inefficient fixtures and appliances. Successful conservation marketing efforts increase participation levels in other utility sponsored programs such as landscape audits or rebates.

Outdoor Landscape and Irrigation Best Practices

No.	Best Practice	Category	Overview	Estimated Water Savings
7	Landscape water budgets, information, and customer feedback	Foundational, Programmatic, Understanding, Informational, Support, and Control. Impacts all customers depending upon implementation.	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.	Varies. Many landscapes are already irrigated at an efficient level and for customers who use less that efficiency levels, budgets have the potential to increase consumption. Efficient irrigation practices have the capability of reducing landscape water by up to 35% in some cases. Water budgets, particularly when linked with an increasing block rate structure, can lead to significant reductions in water use. After implementing budget-based rates, Centennial Water and Sanitation District reported a 25% reduction in demand.
8	Rules and regulations for landscape design and installation and certification of landscape professionals	Programmatic and Control. Impacts all new customers and those who use professionals to re-develop existing landscapes.	This best practice 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. Adopting existing certification programs can help create consistent benchmarks for landscape contractors working in multiple service areas. Utilities may lack authority to promulgate these rules and regulations and may need to work with state and local government to enact.	A 2002 study in Colorado Springs compared water use between a traditional landscape and two landscapes developed using the principles of Xeriscape. The study found water savings ranging from 22% to 63% after implementing the rules and regulations set forth in the 1998 Colorado Springs Landscape Code and Design Manual. Typical savings from landscape regulations range from 15 - 35%. Contractor certification has unmeasured water saving benefits.

No.	Best Practice	Category	Overview	Estimated Water Savings
9	Water efficient design, installation, and maintenance practices for new and existing landscapes	Programmatic and Support. Impacts new and existing customers who install new landscaping.	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) as published in their 2008 BMP guide (GreenCO 2008). Utilities may lack authority to promulgate some rules and regulations and may need to work with state and local government to enact.	Applies to new and existing landscapes. Savings potential of a landscape designed, installed, and maintained for water efficiency vs. standard can be a 35% reduction in annual irrigation use or more according to GreenCO. Designing the landscape to meet a water budget target can establish a savings level. Many landscapes are already irrigated at an efficient level. Proper ongoing maintenance helps preserve water efficiency of the original design.
10	Irrigation efficiency evaluations	Foundational, Programmatic, Understanding, Informational, and Support. Impacts participating customers.	The efficiency of an irrigation system can greatly impact the amount of water that is 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 best practice describes key considerations for maximizing water efficiency through the use of regular irrigation efficiency evaluations.	If recommendations are implemented, savings can range from 5 - 40%. Savings depend upon the severity of problems at each site, the level of over-irrigation prior to the evaluation, and implementation of recommendations.

Indoor Residential Best Practices[3]

No.	Best Practice	Category	Overview	Estimated Water Savings
11a	Rules for new construction	Programmatic and Control. Impacts new residential construction.	Water conservation measures that are "built in" to new buildings can help slow the growth of new water demands. This best practice describes water efficiency specifications that some water utilities can make voluntary or mandatory for new residential development within their service areas. Utilities may lack authority to promulgate these rules and regulations and may need to work with state and local government to enact.	High efficiency homes are expected to use approximately 15 - 30% less indoors than standard new homes. Similar reductions are expected for multi-family properties.
12a	High-efficiency fixture and appliance replacement for residential sector	Programmatic, Support, and Control. Incentive program impacts participants only. Retrofit on reconnect impacts anyone transacting real estate.	The goal of this best practice 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.	HET vs. 3.5 gpf toilet = saves approx. 8,000 - 20,000 gallons per household per year. HET vs. 1.6 ULF = approx. 1,500 gallons per year. HE CW vs. standard top loader = saves approx. 5,000 - 20,000 gallons per household per year. 1 gpm faucets vs. 2.2 gpm faucets saves 2,000 - 10,000 gallons per household per year. 2.0 gpm showerhead vs. 2.5 gpm showerhead saves approximately 0 - 5,000 gallons per household per year.
13	Residential water surveys and evaluations, targeted at high demand customers	Programmatic and Support. Impacts participants only.	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.	Surveys by themselves don't save water, but they often spur savings. Consider impacts to wastewater flow too. Eliminating inefficient water uses should be able to reduce annual consumption by 10 – 20% *after implementing the recommendations* of a carefully conducted site audit.

[3] Applies to both single-family (SF) and multi-family (MF) residences.

Indoor Non-Residential Best Practices

No.	Best Practice	Category	Overview	Estimated Water Savings
11b	Rules for new construction	Programmatic and Control. Impacts new non-residential construction.	Water conservation measures that are "built in" to new buildings can help slow the growth of new water demands. This best practice describes water efficiency specifications that some water utilities can make voluntary or mandatory for new non-residential developments within their service areas. Utilities may lack authority to promulgate these rules and regulations and may need to work with state and local government to enact.	High efficiency non-residential (commercial, industrial and institutional) buildings are expected to use approximately 15 - 25% less indoors than standard buildings.
12b	High-efficiency fixture and appliance replacement for non-residential sector	Programmatic and Support. Incentive program impacts participants only. Retrofit on reconnect impacts anyone transacting real estate.	The goal of this best practice 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 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, including sale or lease.	The savings that can be achieved in the non-residential sector through the replacement of domestic fixtures and through specialized equipment (described in more detail in Best Practice 14) are substantial, but less definitively quantified because of the variability inherent in non-residential demand. The *Watersmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* offers reasonable estimates of water savings that can be achieved in a wide variety of non-residential settings.
14	Specialized non-residential surveys, audits, and equipment efficiency improvements	Programmatic and Support. Impacts participants only.	Specialized non-residential surveys and equipment efficiency improvements reduce water demands in the commercial, institutional and industrial (CII) sector. This best practice 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.	The range of savings will vary greatly and depend entirely on the measures implemented at the site. As part of the 2000 AWWA Commercial and Institutional End Uses of Water study it was estimated that many non-residential sites have the potential to conserve between 15 and 50% of their current demand (Dziegielewski et. al. 2000).

CHAPTER 3. BEST PRACTICE SUITES FOR WATER PROVIDERS

Which best practices in this guidebook make the most sense for a water utility to implement? In Colorado, each water provider has their own specific set of conservation priorities and circumstances based upon their customer base, water supply, and growth potential. Water conservation programs are tailored to meet the needs of each individual utility and there really is no "one size fits all" approach.

To assist water utilities and policy makers in selecting appropriate best practices, three "suites" of best practices have been developed. These suites of best practices are organized around categories of best practices and implementation costs. Suite 1 is the most basic and could be considered a "minimum" package of utility-side conservation best practices. Suite 2 builds on the practices included in Suite 1 and includes low and moderate cost best practices with maximum impact. Suite 3 offers the complete package of best practices described in this guidebook.

Utilities just starting to integrate water conservation into overall water resources planning and those with limited budgets should start with Suite 1 which includes utility-side best practices that are considered fundamental and foundational for the establishment of an effective and low cost water conservation program. Utilities seeking to implement a low to moderate level program with utility and customer-side measures should consider Suite 2. Those seeking maximum cost-effective water savings should consider Suite 3.

Please keep in mind that these Suites are just suggested groupings of best practices. Each provider must decide which best practices make the most sense for their specific situation and conservation goals.

Suite 1: Foundational, No-Excuse Best Practices

Conservation programs are unique, but there are foundational best practices described in this guidebook that make sense for all water providers in Colorado regardless of circumstances. These best practices, found in Table 3-1, form Suite 1 – Foundational, No-Excuse Best Practices. These utility-side best practices form the backbone of a sound water conservation program and set the stage for implementing cost-effective water conservation measures in the future.

Table 3-1: Foundational, no-excuse best practices

No.	Best Practice	Comments
1	Metering, conservation-oriented rates and tap fees, customer categorization within billing system	Measuring consumption with meters, providing regular water bills, and employing a rate structure that sends a strong price signal to customers (including those with high demands) are the most fundamental and effective water conservation practices. All other best practices are aided and supported by this effort. Increasing block rate structures, particularly water-budget based rate structures and individualized rates are the most effective for reducing excessive demands.
2	Integrated resources planning, goal setting, and demand monitoring	Integrated resources planning (IRP) encompasses least-cost analyses of demand and supply options that compares supply-side and demand-side measures (water conservation) on a level playing field and results in a water supply plan that keeps costs as low as possible while still meeting all essential planning objectives. Least-cost IRP ensures customers pay the lowest possible rates while still ensuring adequate water supplies and utility funding.
3	System water loss control	Leadership by example is a powerful component of a successful water conservation program. Utility water loss control is usually the utility-side practice that offers the most water and cost savings. Water loss control is the practice of system auditing, loss tracking, infrastructure maintenance, leak detection and leak repair for water utilities. Auditing a water distribution system for real and apparent losses and evaluating the costs of those losses is the foundation of water loss control.
4	Conservation coordinator	Every utility needs to have someone in charge of water conservation efforts. 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 agencies can select a staff member who has other primary assignments to be the designated conservation coordinator – the person responsible for planning and implementing water conservation efforts.
5	Water waste ordinance	Simple and effective. Water waste should not be tolerated. A water waste ordinance is a local regulation that explicitly prohibits the waste of water either from excess irrigation runoff or from irrigation that occurs at a prohibited day and/or time. The ordinance should outline enforcement and penalties for waste.
6	Public information and education	The public must understand the value of water and the importance of wise stewardship and efficiency. Public information and education is required in nearly all other best practices in this guidebook.

Suite 2: Foundational + Regulatory Best Practices

Suite 2 includes all the best practices from Suite 1, and adds in regulatory best practices that provide substantial water savings at a relatively low cost for water utilities to implement. For utilities with limited staff resources and program budgets, regulatory measures are the easiest and least expensive way to achieve water savings. The conservation best practices in Suite 2, provided in Table 3-2, impact the utility side (Suite 1 practices) and ensure new and re-developed landscapes are as efficient as possible through regulations. Suite 2 also ensures all new buildings in the service area are built to a specified water efficiency standard.

Table 3-2: Foundational + regulatory best practices

No.	Best Practice	Comments
1-6	Suite 1	Metering and rates, IRP, water loss control, conservation coordinator, water waste ordinance, and public information and education.
8	Rules and regulations for landscape design and installation and certification of landscape professionals	This best practice creates landscapes that are "water smart from the start." Creating rules for new landscape and irrigation system design and installation is a relatively inexpensive way for the utility to affect landscape water use. Minimum training requirements and certification for landscape irrigation professionals help ensure that landscapes and irrigation systems meet mandated standards.
9	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 the proper design, installation, and maintenance of new and existing landscapes and irrigation systems.
11	Rules for new construction – Residential and non-residential	Water conservation measures that are "built in" to new buildings can help slow the growth of new water demands. This best practice describes water efficiency specifications that water utilities can make voluntary or mandatory for new residential and non-residential development within their service areas.

Suite 3: Complete Package of Best Practices

Suite 3 includes all best practices from Suite 1 and 2 and adds to them the remaining five customer-side best practices described in this guidebook (see Table 3-3). Utilities that implement all of the best practices in this guide (Suite 3) are taking the most proactive approach to water efficiency. While other conservation program measures beyond these best practices exist, most of the available water savings will be captured and accelerated through the implementation of these best practices.

Table 3-3: Complete package of best practices

No.	Best Practice	Comments
1-6	Suite 1	Metering and rates, IRP, water loss control, conservation coordinator, water waste ordinance, and public information and education.
8, 9, 11	Suite 2	Regulatory measures for new construction, new landscape, and redevelopment of existing landscapes.
7	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, provides powerful information about the irrigation practices and efficiency at the property.
10	Irrigation efficiency evaluations	The efficiency of an irrigation system can greatly impact the amount of water that is 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 best practice describes key considerations for maximizing water efficiency through the use of regular irrigation efficiency evaluations.
12	High-efficiency fixture and appliance replacement for residential and non-residential sectors	The goal of this best practice 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.
13	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.
14	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 best practice 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.

CHAPTER 4. DETAILED BEST PRACTICE DESCRIPTIONS

A total of 14 best practices are discussed in this guidebook. For convenience they have been divided into four categories:

1. Water System and Utility Best Practices
2. Outdoor Landscape and Irrigation Best Practices
3. Indoor Residential (single-family and multi-family) Best Practices
4. Indoor Non-Residential Best Practices

A listing of the conservation practices that were considered, but ultimately not selected for the *Best Practices Guidebook* is provided in Appendix A.

The best practices in this guidebook are organized using the following category labels:

- **Foundational** - best practices for water efficiency that are considered essential for all utilities to implement.
- **Informational** - best practices that offer useful information on water efficiency to utility customers to foster conservation actions and behavior.
- **Support** – best practices that provide technical information, data, and assistance on water efficiency to customers (closely related to informational best practices).
- **Management** - best practices that offer improved utility management procedures and actions to promote water conservation.
- **Understanding** - best practices that aim to improve knowledge and awareness of water use and efficiency.
- **Operational** - best practices that seek to improve water conservation in everyday utility functions.

BEST PRACTICE 1: Metering, Conservation-Oriented Rates and Tap Fees, Customer Categorization Within Billing System

- Foundational, Informational, Support, and Management best practice
- Utility operations - implemented by water utilities
- Customer participation – specific action by customers, not required for implementation

Overview

This multi-faceted best practice impacts the way utilities charge new customers when they join the system, bill their existing customers for the water they use, and understand who their customers are and which customers might best benefit targeted suggestions to improve their water efficiency.

Metering - Measuring use and billing customers for what they use is fundamental to all water conservation efforts. Colorado already has a mandatory metering requirement for systems with more than 600 taps (CRS 37-97-103). Customers who pay for how much water they use, consume less water. Adoption of smart meters, that can be used to notify customers of leaks and provide real time consumption information, is also encouraged.

Rate structure - A number of conservation-oriented pricing systems have been successfully implemented across the US including: water budget-based rates, increasing block rates, and seasonal rates. Utilities in Colorado that have implemented conservation-oriented rate structures include: Denver Water, Durango, Boulder, Fort Collins, Colorado Springs, Glenwood Springs, Aurora, and many others.

Tap or connection fees - Tap fees can be developed based on anticipated future demand. By tying tap fees to more efficient fixtures, developers are encouraged to implement water conserving fixtures and landscapes from the very beginning. Linking tap fees to water budgets will insure that the low demands projected when tap fees are paid will actually be observed over time.

Customer categorization and information - To effectively plan, implement and evaluate conservation more precise categorization of customers is highly encouraged. Residential customers can be categorized as single family or multi-family. Multi-family should include the number of units served by each tap. Non- residential customers can be categorized based on North American Industry Classification System (NAICS) codes. Having this information in the utility billing and customer information system is tremendously useful. This is not a water saver by itself, but is a foundational improvement that benefits a program over the long haul, and makes planning and evaluation more effective. This is very important if water budgets are going to be used.

Why a Best Practice?

Metering – The cliché is true, we cannot manage what we do not measure. Numerous studies have documented the conserving impacts of metering. Meters enable utilities to bill customers based on their actual consumption and provide customers with direct feedback on their water

use. Likewise, submetering also provides valuable information for customers about their water use. Smart meters, which report data at daily or even hourly intervals, can help detect leaks and enhance customer's ability to manage their water use.

Conservation-oriented rate structure – How a utility bills its customers for water impacts utility revenue and demand. Conservation-oriented rate structures serve two fundamental purposes; one theoretical and one practical. Theoretically, conservation-oriented rates can link excess water use to the cost for new supplies (the marginal cost) which provides a strong price signal to the customer. Practically, conservation rates allow the utility to maintain revenue stability even as they encourage conservation by recovering capital costs from heavy users.

Tap or connection fees – An important goal of water conservation programs is to ensure that new buildings and new customers added to a water system are efficient right from the start. Traditional tap fees base system connection charges on the size of the water meter – which may be a reasonable approach if peak demand is the only consideration. Conservation-oriented tap fees base part of the connection charge on the anticipated demand at the site. Developers typically do not use water once construction is complete and therefore they do not see a savings from implementing conservation measures. However, if developers face tap fees based on anticipated water use, they do have an incentive to install conserving fixtures and landscapes. New customers that install water efficient fixtures and appliances will have smaller future demands and as a result should pay a lower connection fee. Under an equitable policy where new customers pay their fair share of water system development costs, anticipated demand is an important parameter to include in tap fee calculations which in turn encourages more efficient use. Linking tap fees to water budgets ensures that the demands used for calculation of the tap fees will be the demands used for future water billing on the property, and that water use over the budgets established in the tap fee process will include the appropriate capital cost for new water.

Customer categorization and information – Targeting water conservation initiatives at the customers who have the greatest potential to save (i.e. to the least efficient users in a customer class) makes sense. But utilities often have precious little information about their customers, particularly in the diverse CII category. Collecting and maintaining basic classification information on each customer served by a utility using the established North American Industry Classification System (NAICS) greatly enables targeting efforts and conservation program design. Coupling an understanding of who customers are (NAICS classification) with measured consumption (metered billing) provides powerful tools for water utilities seeking to improve efficiency. Important customer information extends beyond categorization. Accurate contact information is also critical customer information when communicating water savings suggestions to high water users. Geographic information systems (GIS) are another important element of customer information that can aid in identifying inefficient water use. The customer categorization and information effort is not a water saver by itself, but represents a fundamental improvement in utility management that benefits a program over the long haul.

State Statutory and Planning Requirements

Metering – Metering of all customers is required in Colorado as of 2005 for all systems serving more than 600 taps. Colorado Revised Statutes 37-97-103 "Water Metering Act" has the following key provisions:

- "Every water service supplier providing water in this state shall provide a metered water delivery and billing service to its customers…"
- "Billing of such water services based on the metered service shall begin no later than ninety days from the date of the installation of the meter."

Conservation-oriented rate structure - Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Water rate structures and billing systems designed to encourage water use efficiency in a fiscally responsible manner." [CRS 37-60-126 (4)(a)(VII)].

The statute goes on to state, "The department of local affairs may provide technical assistance to covered entities that are local governments to implement water billing systems that show customer water usage and that implement tiered billing systems." [CRS 37-60-126 (4)(a)(VIII)].

Tap or connection fees – There are no Colorado statutory or planning requirements related to tap or connection fees.

Customer categorization and information - There are no Colorado statutory or planning requirements related to customer categorization and information.

Applicability

Metering – Universal metering as described in this best practice is implemented by water providers on the service lines of their customers. Water meters should be regularly read and maintained on a regular schedule by the water provider to ensure accuracy.

Rate structure – Conservation-oriented rate structures are implemented by water providers. The regular bills sent by the provider are the most direct way in which the provider communicates with its customers. The rate structure impacts both provider and customer directly. Revenues to the utility are determined via the rate structure as are fees paid by all customers.

Tap or connection fees – Tap fees, as described in this best practice, are implemented by the water providers and apply to new customers joining the water system who are seeking a new connection(s).

Customer categorization and information – Collecting customer information is a best practice implemented by the water provider, but one that requires contact with the customer in order to obtain categorical information.

Implementation

Metering – Selecting, installing, testing, and maintaining water meters is standard utility practice that has been implemented in some form since the earliest days of public water supply in

Egypt, China, Babylon, and Rome. The specific details of implementing this practice are beyond this scope of this best practices document. Those seeking to learn more about meters and metering should refer to the AWWA Manual of Water Supply Practice M6 – *Water Meters – Selection, Installation, Testing and Maintenance* (AWWA 1999).

Rate structure – Conservation-oriented rate structures are implemented by utility staff and their designated contractors. Utility rate structures are often formulated with multiple objectives including: revenue adequacy, fairness to customers, understandability, and demand reduction. Typically there is a structured public process whereby utility customers including citizens and businesses can have direct input into the selection and development of the rate structure. The utility billing system software and hardware must be able to accommodate the desired rate structure design. The following resources are recommended as a starting point for those seeking to implement or improve a conservation-oriented rate structure:

- American Water Works Association. 2000. *Principles of Water Rates, Fees, and Charges.* AWWA Manual M1. Denver, Colorado.
- Beecher, J.A. and P.C. Mann. 1991. *Cost-Allocation and Rate Design for Water Utilities.* American Water Works Association Research Foundation. Denver, Colorado.
- Mayer, P.W. et. al. 2008. *Water Budgets and Rate Structures: Innovative Management Tools*. American Water Works Association. Denver, Colorado.
- Raftelis, G.A. 2005. *Water and Wastewater Finance and Pricing: A Comprehensive Guide, 3rd Edition*. CRC Press. New York, New York.
- Western Resource Advocates, et al. 2004. Water Rate Structures in Colorado: How Colorado Cities Compare in Using this Important Water Use Efficiency Tool. Western Resource Advocates. Boulder, Colorado.

Traditional ratemaking for water utilities involves three discrete, logical steps (Beecher and Mann 1991; Raftelis 2005, Mayer et. al. 2008):

Step 1: Identify costs and water agency revenue requirements.
Step 2: Allocate costs to types of water usage.
Step 3: Design rates for each type of water usage to recover costs from customers.

Steps 1 and 2 combined account for the cost of service analysis portion of the rate process and will not be discussed further here. Step 3 is where the rate structure is selected and the actual rates and charges set. Ratemaking is an enormous topic and is a more appropriate subject for a full length book rather than a brief description. A few key concepts related to conservation-oriented rates are presented here.

> Rate structures, like utilities, are unique. It is almost impossible to find two water utilities that have the exact same rate structure and pricing. This is because each utility has its own distinct revenue requirements and objectives for its rate structure.

There are three primary varieties of conservation-oriented rate structure:

- **Increasing block rates** – higher prices are charged as consumption increases as shown in Figure 4-1. Block sizes are fixed for each customer class. For example a residential customer might pay $2 per 1,000 gallons (kgal) for the first 5 kgal each month, $4 per kgal for any usage between 5 and 15 kgal, and $8 per kgal for any usage above 15 kgal. Colorado utilities implementing increasing block rates include: Denver Water, Fort Collins Utilities, Colorado Springs Utilities, City of Glenwood Springs, City of Grand Junction, and many others. This is probably the most popular rate structure form in Colorado.

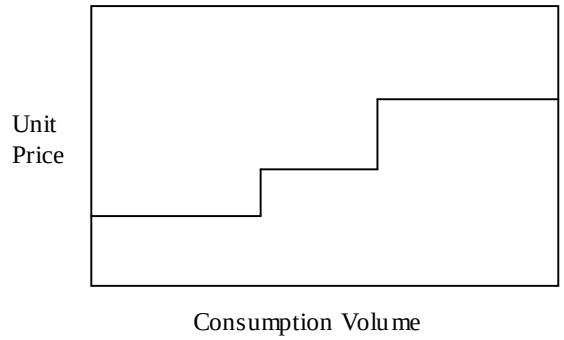

Figure 4-1: Increasing block rate structure

- **Water budget-based, individualized rates –** a variation of increasing block rates where the block size is defined by an empirical determination of efficient use for each customer using customer specific characteristics such as irrigable area as shown in Figure 4-2. Colorado utilities implementing water budget-based rates include: Centennial Water and Sanitation District, City of Castle Rock, and City of Boulder.

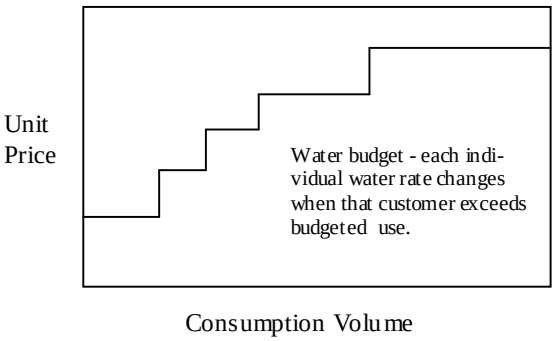

Figure 4-2: Water budget-based rate structure

- **Seasonal rates** – higher prices are charged during periods of scarcity (typically summer and fall to more efficiently allocate water in times or shortage and to encourage reduced demand) as shown in Figure 4-3. Denver Water, City of Castle Rock, Colorado Springs, Fort Collins, and Durango are examples of utilities that have incorporated some element of seasonal rates into their increasing block rate structures.

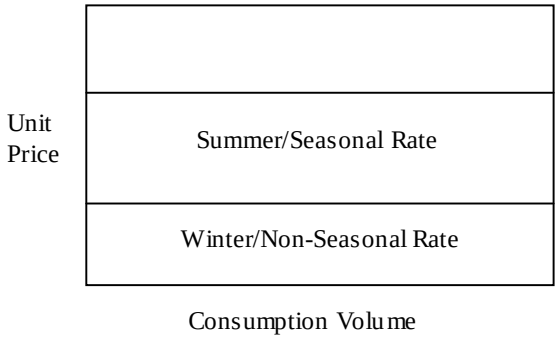

Figure 4-3: Seasonal rate structure

Key Conservation Considerations When Selecting and Designing a Rate Structure – Most of the literature on selecting and designing rates focuses on revenue requirements and cost of service evaluation. The following are important considerations related to water efficiency.

- **Sizing blocks appropriately** – Increasing block rate structures will not achieve desired conservation results if the blocks are not properly sized (i.e. if the blocks are too large). For residential customers, the size of block 1 should be based on an efficient level of monthly (or bimonthly) indoor use. Reasonable block 1 sizes range from 3 to 8 kgal per month. The smaller the block size, the more potent the conservation price signal. The beauty of water-budget-based rates is that the blocks sizes are tailored to each customer in the system. When sizing blocks for an increasing block rate structure (without water budgets) it is more difficult to send a fair and effective conservation price signal for individual customers.
- **Make block price differential meaningful –** Many increasing block rate structures have very small differences in rate between each block. For example, a rate structure that charges $2.20 per kgal in block 1 and $2.40 per kgal in block 2 will not send much of a price signal to customers since the difference in rate is so small as to be trivial. A rate structure such as the one in this example is little improvement (from a conservation standpoint) over a uniform rate. Setting the block rates is a complicated process that must by necessity include a cost of service analysis, but it should be possible to make the block price differentials significant enough to send a meaningful price signal to customers when their usage moves them into a higher rate block. One measure of a meaningful price signal is a positive slope in the average price curve. The steeper the positive slope, the stronger the price signal. The average price curve should be examined for any rate structure under consideration. With a water budget-based system, where blocks are sized based on customer-specific information, it is possible to employ more dramatic block price differentials in a more equitable manner since water use over the budgets is charged at marginal rates, or penalty rates for excess use, as specified in the water waste ordinance. Marginal rates are based on the cost of the most expensive water in the system, and penalty rates are fines for excess use, and are not linked to costs directly. Some utilities use revenue from high tiers to fund conservation programs

efforts directed at the customers who use water in the high tiers. The issue of revenue stability must also be carefully considered when setting differential block prices.

- **High fixed service charges can ensure utility revenue, but may weaken intended conservation effects –** Utilities that set a high fixed service charge each billing period will generally have a more stable revenue stream, however if more money is collected via fixed charges, less can be collected via the variable rate. Fixed service charges can offset the conservation incentives of increasing rates (Michaelson, et. al. 1998).
- **Billing cycles and the ability to track water use can influence customer rate response –** Customers should be provided regular information on how much water they use as well as some context for understanding the relative efficiency of their usage through comparisons with historic use and established benchmarks (what they could or should be using). Bimonthly or quarterly billing cycles are far less successful at influencing customer behavior than monthly billing. Providing customers easy access to their account and consumption information via regular billing, smart meters with remote readers, or even internet access will better encourage conservation behavior (WRA 2004). Monthly billing with understandable billing documents that clearly show the volume consumed and, if possible, comparisons with previous usage and usage by other similar customers is ideal.

Tap or connection fees – Connection fees are set by the water utility and apply to developers seeking new water service and occasionally to customers who intend to significantly change the usage patterns at an existing site. Utilities may have differing objectives when establishing their connection fee structure, but generally the idea is for new customers to pay the full buy-in costs associated with joining an existing water system. The buy-in costs should be thought of as covering both water resources and facilities costs. Water resources costs are normally based on the annual volume of water required to serve the new customers and the value associated with that amount of water. These normally include water rights, raw water contracts, reservoir storage costs and other raw water facilities. The facilities costs are based on the percent of the treatment and distribution capacity of the system that will be required to serve the new customer. These are normally based on peak day use of the customer and peak day capacity of the system.

In order to be both fair and accurate it is important for tap fees to consider both annual volumes and peak demand for their new customers. If peak demands are the only factor used for setting tap fees then they provide no incentive for investing in efficiency. Obviously, customers with lower peak flow demands are less expensive for a utility to serve from a facilities perspective, but if only peak demand is used to set tap fees then inequitable situations will occur when customers with low peak demands but high volumetric usage pay smaller tap fees than customers with high peak demands and low volumetric use. Tap fees will incent developers to underestimate demands. Utilities should carefully review anticipated demands before approving.

> This tap fee concept is essentially the same as requiring new customers to dedicate water rights to the utility based on anticipated future demand.

Utilities have the opportunity to ensure that new buildings and new customers added to a water system are efficient right from the start by developing conservation-oriented tap fees where part of the connection charge is based on the anticipated annual water demand at the site. This

provides a built in incentive for new customers to equip their facilities with water efficient fixtures and appliances and landscaping so they can save money on their connection fee.

Tap fees can be alternative to rebates and other incentives for new construction. If both types of programs are implemented by a utility, the programs must be designed to work in concert.

Implementation of a tap fee structure that considers both anticipated peak flows *and* anticipated annual demands requires a utility to develop a methodology for estimating future demands for new customers. This is much the same as establishing a water budget for a site and utilities that have implemented water budget-based rates can link water budgeting for tap fees with establishing the water budget to be used for billing purposes. Water budgets also provide an important mechanism for insuring that low demands estimated for the tap fees carry over into actual low demands during normal use.

The City of Westminster is a leader in the utilization of volumetric and flow rate based tap fee structures. A copy of the tap fee ordinance from Westminster in included at the end of this best practice description.

Customer categorization and information – Many utilities already have basic customer classification information. At the most basic level utilities distinguish between residential and non-residential customers. An improvement over the basic level is to distinguish between single-family residential, multi-family residential (with the number of units served per tap included), dedicated irrigation, commercial, industrial and municipal water users.

To effectively benchmark and target water conservation to the customers with the greatest potential to conserve, more detailed classification is recommended, particularly in the non-residential sector. The established North American Industry Classification System (NAICS nee SIC) provides a uniform numerical classification system that is ready for utilities to use. NAICS offers several levels of specificity (for example – restaurants can be further subdivided into fast food restaurants, French Restaurants, Chinese Restaurants, etc.). NAICS codes are created and maintained by the U.S. Census Bureau. References and files may be obtained through the Census Bureau website (www.census.gov/eos/www/naics/).

Adding a NAICS code classification, as appropriate for each customer requires the ability to add at least one new field to the utility customer database. Most importantly, this field must be populated. For residential and irrigation-only customers, the code assignment process can often be accomplished quickly because utilities already know who these customers are at the desired level of precision. For the commercial and municipal sectors, classifying each customer may require significant effort including surveys, telephone calls, site visits, and web research. Once established, the classification of new customers can be handled by customer service personnel when each account is set up.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

Metering – Studies on the impacts of metering have found significant water savings for metered customers vs. unmetered customers. Since metering in Colorado is required by statute these savings may have been fully realized already. Typical water savings achieved through metering are in the range of 10 – 40% reduction in residential demand with more recent studies showing a 15% reduction (Mayer 2004, Porges 1957, Hanke and Flack 1968, Hanke 1970, Flechas 1980). However, these savings will not be realized if customer meters are not being read and billed appropriately. Separate metering and billing of irrigation accounts and multi-family apartments has also been shown to be an effective conservation measure resulting in measurable water savings.

Rate structure – The water savings achieved from implementing a new rate structure depend greatly upon the design and rates of both the new and the old rate structures. One key to determining savings is that much of the excess water use in a system is associated with a small number of customers. Consequently, conservation based rate structures are able to reduce average water use while impacting a relatively small number of customers. However, utilities must be careful to ensure revenue stability when implementing rate structures. Utilities that implement water budget-based rate structures can anticipate demand reductions on the order of 10 – 30% based on the experience other utilities (Mayer, et. al. 2008).

Tap or connection fees – Recent studies have found that water efficient new buildings and landscapes can use 30 – 70% less water than comparable standard buildings and landscapes constructed without concern for water efficiency. Conservation-oriented tap fees also have the benefit of equity and fairness to both new and existing customers in that they base charges on the anticipated demands of new customers and the burden of water service they place on a water system that has already been bought and paid for by existing customers. Tap fees based solely on meter size or anticipated peak demand may achieve only a portion of this level of equity. Agencies must be aware that offering customers savings on their tap fees for conservation efforts can create an incentive to under-estimate demands. This is why if these types of incentives are offered for tap fees they should be linked to water budgets or some method to ensure that the promised reductions in demand actually occur.

Customer categorization and information – Customer categorization by itself is not a water conservation measure. However, the ability to identify similar customers and to compare their water demands against each other and established benchmarks provides utilities with a powerful targeting tool for directing limited conservation resources to the customers who have the most potential to conserve. Utilities that have a better understanding of who their customers are and the nature of their water needs are better able to provide a high level of service. As water utilities evolve and adapt to the inevitable changes and challenges of the 21st century, customer level information will play an increasingly important role as utilities strive to meet the water needs of an ever changing customer base.

How to Determine Savings

When examining changes in water use due to broad scale efforts such as metering or rate structure changes it is important to make corrections for changes in climate, population, and customer composition. Other factors such as special events that occur in one year but not another could also impact results.

Metering – Water savings from metering can be measured by comparing treatment plant production records before and after metering is implemented, corrected for changes in climate and population.

Rate structure – Water savings from a change in rate structure can be measured by comparing demands before and after implementation of the rate structure. Ideally at least one full year of data after the rate structure has gone into effect should be obtained, but comparisons of monthly demands can be made. Corrections for differences in climate, population, and possible other factors should be considered.

Tap or connection fees – Conservation-oriented tap fees result in customers joining the water system with smaller water demands than they would have otherwise. Direct measurement of the impact of conservation-oriented tap fees is not feasible, but it is possible to compare demands against what might have happened without the conservation tap fee incentive.

Customer categorization and information – No direct and measurable water savings are achieved through improved customer categorization, but this effort can greatly improve the efficacy of many other conservation efforts.

Savings Assumptions and Caveats

Lifespan of Best Practice

- **Metering** – Meters must be regularly tested, maintained, and replaced. A meter in the field should last 15 years or more although automated meter reading (AMR) meters often have batteries that must be replaced every five years. Older meters tend to lose accuracy. Under-reporting (particularly at low flows) is more common than over-reporting.
- **Rate structure** – Not applicable. A utility rate structure does not have a fixed lifespan. A rate structure stays in place until a utility decides to change or replace it.
- **Tap or connection fees** – Not applicable. A utility tap fee structure does not have a fixed lifespan. A tap fee structure stays in place until a utility decides to change or replace it.
- **Customer categorization and information –** Customer categorization information must be maintained and updated, but does not have a set lifespan.

Utility Savings Perspective

- **Metering** – Metering reduces total water demand and makes customers accountable for their water use. Since all customers in Colorado who are part of a utility with 600 connections or more are supposed to be metered there should be little or no water savings available from metering at this time. However, there may be potential savings from individually metering

apartments and condo units, provided the installation costs do not outweigh the benefits for some utilities.

- **Rate structure/individualized rates** – A well designed conservation-oriented rate structure provides a utility with stable and sufficient revenue while helping to ensure that customers use water efficiently by charging them higher rates for higher use. Flat-rate storm water fees may dampen the effects of rate structures. Utilities that implement water budget-based rate structures can anticipate demand reductions on the order of 10 – 30% based on the experience of other utilities (Mayer, et. al. 2008). A lot depends upon the circumstances of the utility and in particular the differences between the old and new rate structure may impact overall demand changes. Wastewater charges should also be considered, as in some cases they are higher than water rates and may be the real price driver for inefficient customers.
- **Tap or connections fees** – A conservation-oriented tap fee structure provides incentive for customers to join the water system at a better level of water efficiency and can result in 30 – 70% less water use than in comparable buildings and landscapes constructed without concern for water efficiency. From the utility perspective this helps slow the growth of demand in the water system and can result in reduced capital expenditures over time.
- **Customer categorization and information –** The measure does not save water by itself, but enables targeting of water conservation initiatives at the customers who have the greatest potential to save (i.e. to the least efficient users in their class). From the utility perspective, customer categorization can make other conservation efforts more cost effective.

Customer Savings Perspective

- **Metering** – Metering provides customers essential information about the amount of water they use each billing period. This helps customers to make rational water use behavioral decisions and may encourage physical efficiency improvements. However, in a number of cases including many multi-family and commercial properties water bills are paid by an accountant or someone completely separate from the property itself. In these cases the people that actually use water on the site are not provided any information about their consumption patterns or the cost of that consumption. This is an information gap that utilities and customers alike may seek to overcome in the future.
- **Rate structure** – The rate structure directly impacts how much a customer pays each month for water and wastewater service and consequently may influence people to try and use less water in some circumstances. When customers use more water they pay more for the water they use. However, because the water bill only arrives once a month the linkage between higher consumption and rates is not always obvious. Additional information, such as comparisons with previous consumption, neighboring properties, or established benchmarks (what a customer could or should be using) provides useful context. Research has shown that customers frequently respond to comparisons which show their consumption to be different from their neighbors or the "social norm" (Beckwith 2009).
- **Tap or connection fees** – Customers can directly benefit from conservation-oriented tap fees. Conservation-oriented tap fees result in lower connection charges for developers who commit to installing water efficient fixtures and landscaping during the construction process. This also results in lower water bills for eventual customers than they would have received with a less efficient property. The actual cost savings to the customer is determined by the specific tap fee structure and water rate structure in place.

- **Customer categorization and information –** No direct water savings for customers are associated with customer categorization. But if water agencies implement improved customer categorization and then utilize this information to better target water conservation programs, customers should realize benefits.

Society Perspective

- **Metering** – Metering assures that all customers are responsible for the water they use, providing equity and accountability.
- **Rate structure** – A well-designed conservation-oriented rate structure accomplishes several key societal goals: stable and sufficient revenue for the community water system; a fair and effective price signal that encourages conservation and ensures that those who use more water and thus place a higher cost burden on the system pay their fair share; a mechanism for providing useful feedback to customers about their water demand patterns.
- **Tap or connection fees** – Communities can benefit from the water savings achieved through conservation-oriented tap fees. Conservation-oriented tap fees help ensure that new customers who join the water system pay their fair share of the system development charges based upon the real demands they will place upon the system. This encourages new customers to join the system at a greater level of efficiency.
- **Customer categorization and information –** The societal benefits of improved customer categorization and information hinge on the utilization of this system to improve targeting of water conservation efforts.

Goals and Benchmarks

Metering – 100% metering is the law in Colorado. As such, metering of all water use is the goal and the benchmark.

Rate structure – The goal should be for every utility in Colorado to have a well designed conservation-oriented rate structure that provides stable and sufficient revenue.[4]

Tap or connection fees – Conservation-oriented tap fees are more important in growing communities where significant numbers of new customers are joining the water system each year. Colorado utilities should have the goal of developing fair and reasonable tap fees that encourage water efficiency during the construction process and which ensure that new customers pay their fair share of system and water resources development costs.

Customer categorization and information – All water providers should know who their customers are and should understand what volume of water use constitutes "reasonable" or "typical" consumption for that type of customer.

[4] Conservation-oriented rate structure = inclining block, water budget, or seasonal rate structure as described earlier in this best practice.

Costs

Utility Costs

Metering – Meters are part of a water utility's infrastructure and costs for installing, maintaining, repairing, and replacing meters are usually part of annual budgets which are in turn funded through water sales to customers. Water meters themselves range in cost from under $50 to thousands of dollars depending upon the size, type, and quality of the meter. AMR infrastructure is more expensive initially, but can be cost effective over time if meter reading costs can be reduced or eliminated.

Rate structure – The cost of implementing a water conservation-oriented rate structure varies depending upon many factors including:

- Cost of service study that often precedes implementation of a new rate structure.
- Customer information and billing system – is new billing software and/or hardware required to implement the proposed rate structure? Can the current billing system be adapted to incorporate proposed changes?
- Data requirements – is additional data required to establish the new rate structure? Water budget-based rate structures can have significant one-time data development costs, although many utilities have found the data necessary to establish water budgets is cheaply (or freely) available from already existing geographic information systems (GIS) coverage or county tax assessor records.
- Customer information – customers must be informed and educated about upcoming changes to water rates and charges and rate structures. Utilities should budget staff time and money for the important task of informing customers about any changes to the rate structure.
- Customer service – some rate structures such as water budgets, may have ongoing customer service requirements. When implementing water budget-based rates it is common for utilities to establish a review process whereby customers may request to have their assigned budget altered and can apply for a variance (because of errors, circumstances unforeseen by the utility, etc.). Many utilities that implement water budget-based rates experience a higher number of review requests during the first year or two after implementation. Once customers become accustomed to the rate structure requests for reviews stabilize at a minimal level. Water budget reviews are usually managed by customer service personnel and increased staffing levels may be required in the months following implementation.

Most of the water budget-based rates have been implemented "in house" by utility staff with limited outside hired help, but some implementations are more expensive. Documented implementation costs range from free (in-house development using existing hardware and software) to more than several million dollars (consultant developed cost of service analysis and rate structure and new billing hardware and software) (Mayer et. al. 2008).

Tap or connection fees – Implementing a new tap fee structure usually requires significant research and planning to ensure that the fees will cover all necessary costs and are equitable for both new and existing customers. A cost of service study often accompanies implementation of

a new tap fee structure. The cost of implementing a conservation-oriented tap fee structure is difficult to predict and will vary depending upon the current structure and the significance of the changes proposed.

Customer categorization and information – Categorizing customers using the NAICS should be relatively inexpensive for small utilities with few customers and limited categorization diversity. Large water utilities with a diverse customer base will likely find the process more expensive and time consuming particularly if a large survey or data collection effort must be undertaken. Utilizing existing data, such as county tax assessor records or commercially available databases of commercial enterprises, may expedite the process. The cost of adding additional fields to the billing database to accommodate customer categorical information should also be considered.

Customer Costs

Metering – Meter purchase and installation costs are not directly billed to customers except in rare circumstances. From the customer perspective the most significant impact of metering is that they are accountable to pay for the measured amount of water used rather than paying a fixed fee for an unlimited amount.

Rate structure – When a conservation-oriented rate structure is implemented, customers with lower water use will likely see their monthly bill[5] decline, but high demand customers may experience a significant increase in water costs. This is exactly the intent of a conservation-oriented rate structure – to charge higher rates for higher use with the goal of incenting customers to adopt more water efficient behaviors and to install more efficient fixtures and appliances. Customer costs will of course vary depending upon the rate structure implemented and all of the factors that go into determining the monthly bill for each specific customer.

Tap or connection fees – The idea of conservation-oriented tap fees is for utilities to base connection charges on the anticipated future peak and total demand at the site. Developers wishing to pay a lower tap fee can agree to implement water efficiency measures as part of the building construction process. From the customer perspective, this will reduce the initial cost of joining the water system (the tap fee), and the ongoing monthly cost of water service.

Customer categorization and information –There are no customer costs associated with utility customer categorization.

Examples

Metering

Colorado Revised Statutes 37-97-103 "Water Metering Act" requires all utilities in Colorado to be fully metered as of January 1, 2009. Examples of fully metered water utilities can be found all across Colorado.

[5] Monthly billing is a best practice. Bimonthly or quarterly billing does not convey a price signal as effectively.

Rate structure

Several rate structure examples are provided below to demonstrate the different rate forms discussed in this best practice. The actual water rates cited below were accurate as of January 2010, but utility rates change annually in many places.

Increasing block rate structure – Glenwood Springs

Glenwood Springs is a fully metered community and currently bills its customers on a monthly basis using a three tier increasing block rate structure. This rate structure has been in place since January 2000. The City's rate structure provides for 5,500 gallons of water per month in tier 1, an additional 12,000 gallons of water per month in tier 2, and all monthly usage greater than 17,500 gallons is billed at the tier 3 rate as shown in Table 4-1. Separate rate structures apply to bulk water purchases and raw water customers.

Glenwood Springs billing system and water rates

The City utilizes a computerized billing system and is in the process of upgrading the entire metering infrastructure to the Badger Orion AMI system. This system enables frequent remote interrogation of water meters. The City is already taking advantage of this capability to help identify leaks and abnormal usage in the sites where the meters have been installed. The meter replacement project will be implemented over a 4 to 5 year time frame.

The standard (not bulk or raw water) schedule of rates and charges for water customers in Glenwood Springs is shown in Table 4-1. In this rate structure, Tier 2 represents a 33% increase over Tier 1 and Tier 3 represents a 33% increase over Tier 2. The rates themselves are set based on the cost of service requirements of the City.

Table 4-1: Glenwood Springs water rates and rate structure, 2009

Rate Tier	Water Rate Per 1,000 gallons
Tier 1 – up to 5,500 gallons/month	$1.76
Tier 2 – from 5,501 – 17,500 gallons/month	$2.34
Tier 3 – over 17,500 gallons/month	$3.11
Fixed monthly service fee	$10.25/month

Increasing Block Rate and Seasonal Rate Structure – Fort Collins Utilities, Colorado

All Fort Collins Utilities water customers are metered. Historically, residential customers paid a set rate per 1,000 gallons regardless of water use. Since January 2003, single-family and duplex water rates are tiered. For many years, commercial customers have had a two-tier water rate. Beginning in 2003, commercial and multi-family customers are billed seasonal rates–with higher rates from May through September. Commercial rates still have a second tier for higher water use. Table 4-2 presents the 2010 residential water rates and rate structure utilized by Fort Collins. In this rate structure, for single-family accounts, Tier 2 represents a 33% increase over Tier 1 and Tier 3 represents a 15% increase over Tier 2.

Table 4-2: Fort Collins residential water rates, 2010

		Single-Family	Duplex
	Base Charge	$ 13.21	$ 15.51
Tier	**Tier Size**	**$/1,000 gal.**	**$/1,000 gal.**
1	0-7,000 gal	$ 2.04	
	0-9,000 gal		$ 1.97
2	7,001-13,000 gal	$ 2.35	
	9,001-13,000 gal		$ 2.26
3	Over 13,000 gal	$ 2.70	$ 2.60

In Fort Collins, multi-family customers have a seasonal increase in rates. The volume charge is 25% greater during the five lawn-watering months (May - September) than in the other months (October - April) as shown in Table 4-3. These seasonal rates are due to peak demand for irrigation.

Table 4-3: Fort Collins multi-family seasonal water rates, 2010

Multi-Family Water Rates	**Winter (Nov-Apr)**	**Summer (May-Oct)**
Base Charge (per account)	$13.10	$13.10
Additional per dwelling unit	$4.37	$4.37
Volume Charge per 1,000 gallons	$1.90	$2.38

Increasing Block Rate and Modified Water Budget Rate Structure – Aurora Water

Aurora Water meters all customers and in 2010 utilized an increasing block rate structure for single-family residential customers (and multi-family up to 4 units); and an allocation based rate structure (essentially a modified water budget) for large multi-family, commercial, and irrigation only customers. Aurora Water's single-family residential rate structure is presented below in Table 4-4.

Table 4-5 shows Aurora Water's commercial rates which are allocation based. Each commercial customer is given an annual allocation which is the higher of 2005 and 2006 total annual consumption plus an additional 25% allowance. Aurora's water rates start at a high level which means water customers will be confronted with a substantial bill even if their usage is low. However, the relatively small price differential between Tier 1 and Tier 2 may not alert customers who exceed their allocation. Furthermore, water budgets based on historical use (such as Aurora's) are inherently less conservation-oriented since customers who have historically used water inefficiently are rewarded with a high allocation and customers who conserved water in the past are given a lower allocation. Empirically derived water budgets, as presented below for Centennial Valley, Castle Rock, and Boulder, are generally considered superior from a water conservation perspective.

Table 4-4: Aurora Water residential water rates and base charges, 2010

Residential, Single Family, Multi Family (1-4 units)		
Usage Tier	**Cost/1,000 gal. Monthly Use**	
Tier 1	$5.27	Up to 20,000 gallons
Tier 2	$6.00	20,001 to 40,000 gallons
Tier 3	$7.50	More than 40,001 gallons
Base Charges That Apply to All Customer Classes		
Meter Size	**$/month**	
5/8” & 3/4"	$12.06	
1” & 1 1/4”	$17.77	
1 1/2"	$27.31	
2”	$38.74	
3”	$69.23	
4”	$103.53	
6”	$198.81	
8”	$465.60	

Table 4-5: Aurora Water commercial water rates, 2010

Commercial	
Cost/1,000 gal. Monthly Use	
Tier 1	$5.67 up to 100% of allocation
Tier 2	$6.24 greater than 100%
Annual allocation = the higher of 2005 and 2006 total consumption, plus 25 percent allowance. A 10 percent surcharge will be applied for consumption over the annual allowance.	

Water Budget-Based and Seasonal Rate Structure - Centennial Water and Sanitation District

In response to the drought in 2002, and to encourage water conservation, Centennial Water and Sanitation District and the Highlands Ranch Metro District implemented an innovative water budgeting concept for water customers. The rate structure includes progressively higher tiered rates over the allotted budget to encourage conservation. The method of computing residential bimonthly water bills is based on an indoor and outdoor allocation component. The indoor residential component is based upon average wintertime usage and may be adjusted for household population. The outdoor irrigation component allows residents an amount tailored to their individual lot size which is allocated across the irrigation season based on historic climate conditions. The indoor non-residential budget is based on meter size. The outdoor irrigation component allows non-residential customers an amount tailored to their lot size if a separate irrigation-only meter is installed. The 2009 water rates for the Centennial Water and Sanitation District are shown in Table 4-6.

Table 4-6: Centennial Water and Sanitation District water rates, 2009

	Residential		Non-Residential	
	Summertime	**Wintertime**	**Indoor**	**Irrigation**
		(non-irrigation)	**Only**	**Only**
Usage of Budget	per 1,000 gallons			
Up to 100%	$2.55	$2.55	$2.55	$2.55
100 to 120%	$3.50	$3.50	$3.50	$4.00
120 to 140%	$5.25	$3.50	$3.50	$7.00
140% and over	$7.90	$5.80	$5.80	$12.00
Water service availability fee = $25 per bimonthly period.				

Water Budget-Based and Seasonal Rate Structure – Town of Castle Rock

The Town of Castle Rock implemented a water budget-based rate structure with a seasonal component in 2009. Water budgets in Castle Rock are based on an indoor and outdoor component. The indoor component of the water budget for each customer is sized from the average winter monthly consumption (AWMC) use at the site (i.e. the average of monthly consumption between Nov. – Feb.). The outdoor component of each customer's water budget is based on the landscape area at the property. The 2010 residential water rates for Castle Rock are shown in Table 4-7 and Table 4-8 and the non-residential water rates are shown in Table 4-9.

Table 4-7: Town of Castle Rock residential water rates, 2010

Table 4-8: Town

	Irrigation Season, 4/1 - 10/31	**Winter Season, 11/1 - 3/31**
Block	**$ per 1,000 gallons**	
Block 1 (Up to 100% of AMWC)	$2.44	$2.44
Block 2 (>100% of AMWC and up to 100% of outdoor budget)	$4.24	$4.24
Block 3 (Above AMWC + Outdoor budget)	$7.04	N/A

AMWC = average monthly winter consumption

of Castle Rock water service charges, 2010

Meter Size	**Monthly Charge**
3/4"	$13.52
1"	$14.33

Table 4-9: Town of Castle Rock non-residential water rates, 2010

Category and Block	Irrigation Season, 4/1 - 10/31	Winter Season, 11/1 - 3/31
	$ per 1,000 gallons	
Irrigation		
Block 1 (Up to 100% of budget)	$5.98	NA
Block 2 (>100% of budget)	$9.01	NA
Multi-Family		
Block 1 (Up to 100% of AMWC)	$2.51	$2.51
Block 2 (>100% of AMWC and up to 100% of outdoor budget)	$4.61	$3.33
Block 3 (Above AMWC + Oudoor budget)	$6.94	NA
Commercial		
Block 1 (Up to 100% of AMWC)	$2.51	$2.51
Block 2 (>100% of AMWC and up to 100% of outdoor budget)	$4.52	$3.46
Block 3 (Above AMWC + Oudoor budget)	$6.81	NA
Water Service Charge		
Meter Size	**Monthly Charge**	
3/4"	$13.52	
1"	$14.33	
1.5"	$15.93	
2"	$19.15	
3"	$27.19	
4"	$41.67	
6"	$88.35	
8"	$173.63	

AMWC = average monthly winter consumption.

Water Budget-Based Rate Structure – City of Boulder

The City of Boulder established a water budget-based rate structure in 2007. In Boulder, budgets are established by customer type: single-family residential, multi-family residential, irrigation only and commercial/industrial accounts. For most customers, the annual water budget is the sum of the indoor and outdoor water allocations for a particular month.

- ***Single-Family Residential Accounts***
  Monthly water budget = indoor allotment (7,000 gallons for a family of four) + outdoor allotment (based on customer-specific irrigable area and seasonal watering needs).
- ***Multi-Family Residential Accounts***
  Monthly water budget = indoor allotment (4,000 gallons per dwelling unit with 1-2

bedrooms) + outdoor allotment (based on customer-specific irrigable area and seasonal watering needs). Dwelling units that have more than two bedrooms may receive an additional 1,000 gallons per month, but the total indoor allocation per dwelling unit may not exceed 7,000 gallons per month, which is the equivalent of five bedrooms.

- ***Irrigation-Only Accounts***
  Monthly water budget = outdoor allotment (based on customer-specific irrigable area and seasonal water needs).
- ***Commercial/Industrial/Institutional (CII) Accounts***
  CII customers may choose from the following options:
    - **Average Monthly Use (AMU)** - This is the default option. The AMU budget is calculated using the historical average of 12 consecutive months of water use for that account, so that every month's water budget is the same. Customers can apply to change the timeframe used for the 12-month average. (The default timeframe is January through December 2005.)
    - **Historical Monthly Use (HMU)** - The HMU budget is calculated using a rolling three-month average for each individual month. For example, the average of the past three January's use would be next year's January budget.
    - **Indoor/Outdoor** - The Indoor/Outdoor budget is similar to the single-family budget in that it is comprised of both an indoor and an outdoor water allocation. The indoor allocation is based on the most recent Average Winter Consumption (AWC), which is the average water use for that account for December through March. The outdoor allocation is calculated based on irrigable area, including right of way, and seasonal watering needs.
    - **Efficiency-Standard** - This option allows for a specific customized water budget. The customer must hire a professional engineer to evaluate and recommend a personalized indoor budget, which then must be reviewed and approved by the City. The customer will be charged a fee for the City review.

Boulder's water rates are shown in Table 4-10.

Table 4-10: City of Boulder water budget-based rates, 2009/2010

Billing Block	Rate per 1,000 gallons	% of budget
Block 1	$2.06 (3/4 the base rate)	0% - 60%
Block 2	$2.75 (the "base rate")	61% - 100%
Block 3	$5.50 (2 x base rate)	101% - 150%
Block 4	$8.25 (3 x base rate)	151% - 200%
Block 5	$13.75 (5 X base rate)	Greater than 200%

Tap or Connection Fees

The idea of conservation-oriented tap fees is for utilities to base connection charges on the anticipated future peak and total demand at the site. Developers wishing to pay a lower tap fee can agree to implement water efficiency measures as part of the building construction process. From the customer perspective, this will reduce the initial cost of joining the water system (the tap fee), and the ongoing monthly cost of water service.

In the example below from the City of Westminster, tap fees are based on a variety of factors including the type of business, the size of the business, and the proposed irrigated area. Staff from Westminster regularly work with new customers who upon learning about their impending tap fee find significant ways to reduce demands through improved plumbing fixtures and landscape efficiency so that they can obtain a lower tap fee from the City.

City of Westminster Non-Residential Tap Fee Calculation Instructions

- Rather than basing non-residential tap fees on the size of the tap Westminster has determined that a more equitable method would be to base the fee on the type, size and historical usage of similar businesses.
- A non-irrigation tap fee contains three components;
    1. The Water Resources Charge
    2. The Treated Water Investment Charge
    3. The Connection Charge
- The first step is to determine the business type.
- The size of the facility is then calculated based on the type of business. For example if the business is a motel the usage is based on the number of units while a restaurants usage is based on square footage.
- The size is then multiplied by the unit use per year.
- The sum (total usage per year) is then divided by 140.000, which is the amount of a base service commitment (SC).
- The result is the number of service commitments required which is then multiplied by the Water Resources Charge per SC. The product is the Water Resource Charge portion of the Tap Fee for the facility. The Water Resources charge is directly related to the cost of the City to purchase raw water rights to supply the required annual amount of water to the customer's tap.
- The customer requests a specific tap size based on fixture unit calculations. The building Division reviews the tap size based on the plumbing code and develops a final tap size.
- The Treated Water Investment Charge is based on the tap size and listed on the Tap Fee chart. The water tap size, and resulting maximum flow needs, directly impact the sizing of the City facilities and the Treated Water Investment portion of the tap fee recovers the related portion of that investment.
- Finally the connection charge is applied based on the size of the tap. The connection charge covers the actual costs to the City to calibrate and install the commercial water meter.
- The three portions of the fee are added to produce the total Tap Fee.

Irrigation Water

- Any lot with irrigated area over 40,000 square feet (SF) would require a separate irrigation tap.
- The irrigation portion of the Tap Fee is to be calculated for separate irrigation taps, and where irrigation is included in the domestic tap. *The fee is calculated by*

multiplying the irrigated area by the per square foot cost for both low and high water areas.

- The tap fee for irrigation is based on water need. High water use areas (turf) are based on a need of 18 gallon per square foot per year. Low and medium water areas are based on a need of 9 gallons per square foot per year.
- Based on the flow needed for irrigation, the tap is sized and the connection charge is added to the square foot charge for the total irrigation tap fee. Irrigation taps should be sized based on actual pressure needs since there is very little tap fee impact from irrigation tap sizes.
- Irrigation taps on the City's Reclaimed Water system are billed at 80% of the potable tap rate.
- For lots under 40,000 square feet, the square foot charge is added to the potable tap fee and the tap is sized to include irrigation needs.

Sewer Tap Fee

- The sewer tap fee is calculated based on the water tap size. Metro sewer tap fees apply for the portion of Westminster generally south of 92nd Ave. Westminster sewer tap fees apply for areas generally north of 92nd Ave. Metro performs regional studies that determine the amount of wastewater produced based on water tap size installed, which is why the sewer tap fee is based on the water tap size.

City of Westminster Tap Fee Ordinance

8-7-3: WATER TAP FEES AND CREDITS: (1129 1217 1311 1365 1456 1527 1664 1788 2097 2123 2257 2298 2440 2634 2956 3281 3306)

(A) FEE CALCULATION:

1. An applicant for a water tap shall pay the fees set forth hereinafter, the total of which shall be known as the Water Tap Fee, or those portions that are applicable to the type of tap required by this Chapter. The Water Tap Fee or portions thereof are due and payable upon issuance of the water tap utility permit unless earlier paid as provided in Section 8-7-2(C). The Water Tap Fee may consist of the following individual fees.
    a. Water resources fee, being the share of the cost to provide adequate raw water supply to be utilized by the tap;
    b. Treated water investment fee, being the share of the utility system related to treating and distributing water to be utilized by the tap;
    c. Meter connection fee, being the actual City cost for installation of a meter with electronic remote readout device, when applicable; inspection of the tap, service line and meter pit installation; meter testing, when applicable; account and billing activation and other administrative procedures;
    d. and, when applicable, a fire connection fee, being that charge associated with a tap providing fire protection.

2. Water taps, water tap lines, and meters for the same service shall normally be the same size. If otherwise approved and/or required by the City, the tap and meter may be of different sizes in which case the fee for the meter size shall be paid. Water taps cannot be issued prior to building and/or tap entitlement approval. Any exceptions must be approved by the City Manager, i.e., conversion from well to the City water system, pursuant to Section 8-7-15.

3. The base water tap fees are as follows*:

Water Resources Fee	$6,435.00
Treated Water Investment Fee	$7,880.00
Meter Connection Fee	This connection fee is based on installed meter size and assessed on a per meter basis. See connection fee chart below.
Fire Connection Fee	$161.00

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*On April 1st of each year, the Water Tap Fee and its individual components shall be automatically increased in accordance with the Consumer Price Index (CPI) for the previous calendar year as established for the Denver metropolitan area. The meter connection fee may also be adjusted separately at any time, when necessary, to reflect the full cost of said connection to the City

4. The connection fees based on meter size are as follows:

METER SIZE (INCHES)	CONNECTION CHARGE*
5/8"	$283
3/4"	$283
1"	$226
1-1/2"	$226
2"	$283
3"	$340
4"	$396
6"	$453
8"	$511

5. The water resources and treated water investment portions of the tap fee for City owned facilities may be implemented at rates below 100% at the direction of the City Manager or his designee.

(B) RESIDENTIAL WATER TAPS: The following regulations apply to residential water taps:

1. The Water Tap Fee is based on a standard 5/8"meter size (commonly called a 5/8" by 3/4" meter) and is assessed on a per-dwelling-unit basis. One single-family

detached dwelling unit served by a standard 5/8" meter has an assumed average annual water usage of 140,000 gallons per year.

2. The ratio of the average annual water usage of each dwelling unit type to the water usage of a single-family detached unit establishes the service commitment factor (SC factor). The service commitment factors are listed in the following chart:

Residence Type	Single Family Detached	Mobile Home Space	Single Family Attached Unit	Multi-Family Unit	Attached Senior Housing Unit
SC factor	1.0	1.0	0.7	0.5	0.35

3. The residential tap fees shall be calculated by applying the respective SC factor to both the water resources fee and the treated water investment fee on a per unit basis plus the applicable meter connection fee, on a per meter basis, plus any applicable fire connection charge. If a tap and meter larger than the standard 5/8" meter is requested for any residential unit, the tap fees shall be calculated using the non-residential treated water investment calculation and SC factor in subsection (C)2 below.

4. No additional tap fees are required for landscaped areas on residential properties that are irrigated by the water tap for the individual unit or units. Tap fees for landscaped areas on or adjacent to residential properties, such as common areas, private parks and play areas, medians, and right-of-way strips, not irrigated by individual units shall be assessed as provided hereinafter under subsections (C) or (D).

5. Tap fees for clubhouses, swimming pools, and other common buildings or structures shall be assessed as provided hereinafter under subsections (C) or (D).

(C) NON-RESIDENTIAL WATER TAPS: The following regulations apply to non-residential water taps:

1. The City shall review and evaluate each applicant's requested water tap and meter size, and may adjust the requested tap and/or meter size if it determines the projected water usage will be greater than that requested.

2. Every meter size has a corresponding service commitment factor (SC factor) that is based upon multiples of a single-family detached dwelling unit's usage characteristics. The treated water investment fee portion of the tap fee shall be calculated by multiplying the treated water investment fee, in subsection (A)3 above, by the respective SC factor in the following chart:

METER SIZE (INCHES)	Treated Water Investment SC Factor
5/8"	1.0
3/4"	1.5
1"	2.5
1-1/2"	5.0
2"	8.0
3"	17.5
4"	30.0
6"	62.5
8"	90

3. The water resource fee portion of the tap fee shall be calculated based upon the estimated annual consumption, business type, and tap size required using methods and estimates developed by the Public Works and Utilities Department to determine the appropriate water resources service commitment factor, which shall be multiplied by the water resources fee in subsection (A)3 above.

4. All non-residential developments that contain an irrigated area less than 40,000 square feet, which area is served by the water tap and meter for the building, shall pay the irrigation tap fees calculated pursuant to subsection (D)4 below, in addition to the Water Tap Fee for the building.

(D) IRRIGATION WATER TAPS: The following regulations apply to taps for irrigation:

1. Separate irrigation taps and meters shall be required for all residential developments other than a development whose land area consists entirely of single-family detached lots. A separate irrigation tap and meter is not required for non-residential developments having less than 40,000 square feet of irrigated area.

2. Irrigation tap fees are required based on the area and type of landscaping. Landscape types are defined as either standard or low-water as determined by the Community Development Department.

3. An irrigation water tap shall be used only for irrigation purposes. Each irrigation water tap shall be assigned a service address and billing account in the name of the property owner or manager.

4. The irrigation tap fee consists of the meter connection fee plus the following square footage fees based upon landscape type:
   A. $1.43 per square foot for standard landscaping requiring an annual application of more than ten (10) gallons of water per square foot;
   B. $0.72 per square foot for low water landscaping requiring an annual application of up to and including ten (10) gallons of water per square foot.

(E) FIRE PROTECTION:

1. For any water tap which is intended to also provide fire protection, the fire connection fee shall be included in the total water tap fee in the amount provided for in subsection (A) 4 of this Section.

2. For any size tap that is determined by the City Manager, or his designee, to provide solely fire protection, only the fire connection charge shall be collected. The applicant for a fire protection tap shall furnish all materials and labor as specified by the City, including any device required to detect any use of water for purposes other than fire protection.

(F) CONSTRUCTION WATER METERING: If any water is required for construction purposes, construction water meters must be installed, deposits collected as per Section 8-7-10, and water usage billed at commercial rates as per Section 8-7-7(D). It is prohibited to install any by-pass or jumper to provide water service without the installation of a water meter as per Section 8-7-12.

(G) PROVISION OF MATERIALS AND LABOR: For all water taps, the applicant shall furnish all labor and all materials as specified by the City except as provided by this paragraph. The City shall provide the applicant with a list of required materials and approved suppliers at the time of application. The City shall provide all 5/8" by 3/4" meters. All other meter sizes shall be provided by the applicant as specified by the City at applicant's sole cost and must be tested for accuracy by the City before installation. After payment of all required fees and charges, the City shall install all meters.

(H) TAP CREDITS:

1. Upon issuance of a tap permit for the first new service tap, a tap fee credit shall be given in an amount to be calculated by subtracting the cost of the current water resources fee and treated water investment fee of the original tap from the current value of the water resources fee and treated water investment fee of the first new service tap.

2. Treated water service commitment credits shall be calculated based on the tap size of the former tap. Water resource service commitment credits shall be calculated based on the most recent ten (10) year average annual water consumption through the former water tap.

3. The amount of credit shall be fixed at the issuance of the first new service tap and may be used for payment for additional service taps that are used on the same property.

4. When a credit is used for full or partial payment for a new water tap, all other applicable charges shall be assessed using the then current fee schedule in effect.

5. In no instance shall cash refunds be granted.

6. No credit shall be given for the meter connection fee or fire connection fee portions of the Water Tap Fee.

7. If any tap is installed and completed without receiving a utility permit and the proper inspection and approval by the city, no tap fee credit shall be given.

8. If a demolition or vacation of a unit results in an abandonment of an associated water tap as defined in Section 8-7-5, no tap fee credit shall be granted at the time a new tap permit is issued.

9. Any service commitments associated with water taps to serve buildings demolished in established urban renewal areas may be transferred as tap credits to an urban renewal authority or the City for use in approved redevelopment projects within that same urban renewal area.

BEST PRACTICE 2: Integrated Resources Planning, Goal Setting, and Demand Monitoring

- Foundational best practice
- Utility operations - implemented by water utilities
- Customer impacts - varies depending on conservation measures selected

Overview

Integrated resources planning (IRP) is a comprehensive planning effort that incorporates both supply-side and demand-side management options utilizing least-cost planning principles and an open, participatory process. Unlike conventional water resources planning, that focuses solely on increasing supply to meet demand, IRP 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 results in a water supply plan that keeps costs as low as possible while still meeting all essential planning objectives.

Key components of integrated resource planning are:

- equal treatment of supply-side and demand-side options,
- clear objectives,
- consideration of supply-side and demand-side reliability,
- an open process,
- integrating engineering analysis with a range of policy objectives,
- a planning horizon or future design year,
- explicit consideration of uncertainty, and
- demand monitoring.

Goal setting is part of the IRP process, but is important in its own right. Establishing demand management goals or targets provides a clear vision for the community and provides incentive for developing programs to meet the goals.

Demand monitoring provides regular feedback on consumption patterns in a utility. Tracking demands over time is essential for determining if a conservation program is achieving the desired results. Without demand monitoring there is no way to determine if a conservation goal has been achieved.

Why a Best Practice?

Integrated resources planning (IRP), goal setting, and demand monitoring are foundational best practices endorsed by the American Water Works Association[6] (AWWA) that should be implemented by all water providers who expect to meet the future water demands of a growing population with limited financial resources. The IRP process of integrating water conservation into overall system water supply planning is fundamental to creating a vital, successful water conservation program. It is often through the IRP process that decision makers explore the

[6] Maddaus 2008.

potential benefits and limitations of both water conservation and supply-side options in a fair manner. The IRP process also helps water utilities establish realistic performance goals and demand monitoring regimes which benchmark progress and provide essential data inputs for future planning efforts.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. The water conservation planning process described under this statute [CRS 37-60-126] and in various supporting documents follows standard IRP methodology. The statute requires a "full evaluation" of specific planning elements which should include least-cost analyses of demand-side and supply-side options.

Applicability

Integrated resource planning activities, goal setting, and demand monitoring apply exclusively to water providers and those that manage and maintain water delivery infrastructure. This practice only involves utility customers through the participatory public process.

Implementation

Integrated water resource planning uses two levers – demand management and supply resources – to meet forecasted demand. Different combinations of measures can be evaluated for meeting projected water needs. Figure 4-4 (from Maddaus 2008[7]) outlines the process of integrated resource planning and the different inputs needed.

Agencies must have clear objectives (goals) at the outset of the IRP process. Key criteria to evaluating different resource scenarios are:

- Projected demand and ongoing demand monitoring
- Environmental impacts
- Public acceptability
- Costs
- Risks
- Reliability

Once identified and analyzed, scenarios are rated and ranked. Rating scenarios based on their ability to meet key objectives and comparing ratings can help determine which scenarios are more favorable. The Alliance for Water Efficiency offers a demand tracking tool to members that can aid planners in refining demand modeling data and in developing and comparing different scenarios (AWE 2009).

Demand-Side

Managing demand is crucial for addressing long-term water needs. Demand management extends beyond short-term drought responses. Long-term conservation programs consist of multiple measures, each implemented to different degrees. Different measures and different degrees of implementation should be evaluated to create a matrix of multiple scenarios. These different conservation scenarios are used in the IRP process. Life-cycle costs and water savings

[7] www.awwa.org/files/Resources/Waterwiser/references/PDFs/sustainable2008_wed2-1.pdf

for each program and the degree of implementation should be tracked for each scenario. Short-term demand management programs to help address source reliability problems may also be considered. Load management (such as irrigation restrictions designed to reduce peak demands) may also play a role in helping an agency meet demand (Beecher, 1996).

Supply-Side

Full consideration of supply resources development options is half of the IRP equation. Providing high-quality, reliable water supply at the lowest cost to rate payers is paramount. A full consideration of supply options should include all realistic new water development opportunities including groundwater, surface water, storage, and alternative sources such as re-use. Both water and wastewater treatment capacity must be evaluated. New water sources should be evaluated based on several questions:

- Technical reliability – Can the project be implemented with proven technology?
- Environmental impact – Can impacts be mitigated?
- Institutional feasibility – Does the agency have funding and water rights?
- What institutional changes are needed?

Multiple possibilities from both the supply and demand sides should then be evaluated in combination to create several scenarios for meeting forecast demand. Once developed, each scenario should be compared against the agency's stated objectives.

Economic analysis is implemented to clarify which combinations of supply sources and demand controls are financially viable. The time frame for economic analysis should be on the order of 20 to 50 years and the time value of money must be considered. Benefit-cost analysis may be used, but IRP also frequently employs alternative evaluation methods where project costs, features, and environmental impacts are presented side-by-side for assessment (Maddaus 2008).

Other Implementation Factors

Integrated resources planning is an iterative process. Demand management will change demand, and meeting future demand is the fundamental objective of the IRP process. If projected demand changes, subsequent analyses must be updated. Figure 4-4 shows several loops to the IRP process. A three to five-year evaluation cycle is recommended (Maddaus 2008).

Integrating all the supply-side and demand-side factors takes more than technical skill. Working with different and possibly competing interests requires consensus building. Several suggestions for approaching the planning process are presented below (Maddaus 2008):

- Planning goals must be realistic. Focus on key requirements and let go of non-essential issues.
- Optimize participation and get the right players to the table. Be open, but also realize that smaller groups (25 or less) may be more efficient.
- Discourage hidden or disruptive agendas. Planning processes can be used by special interests, to further their causes which can undermine the process.

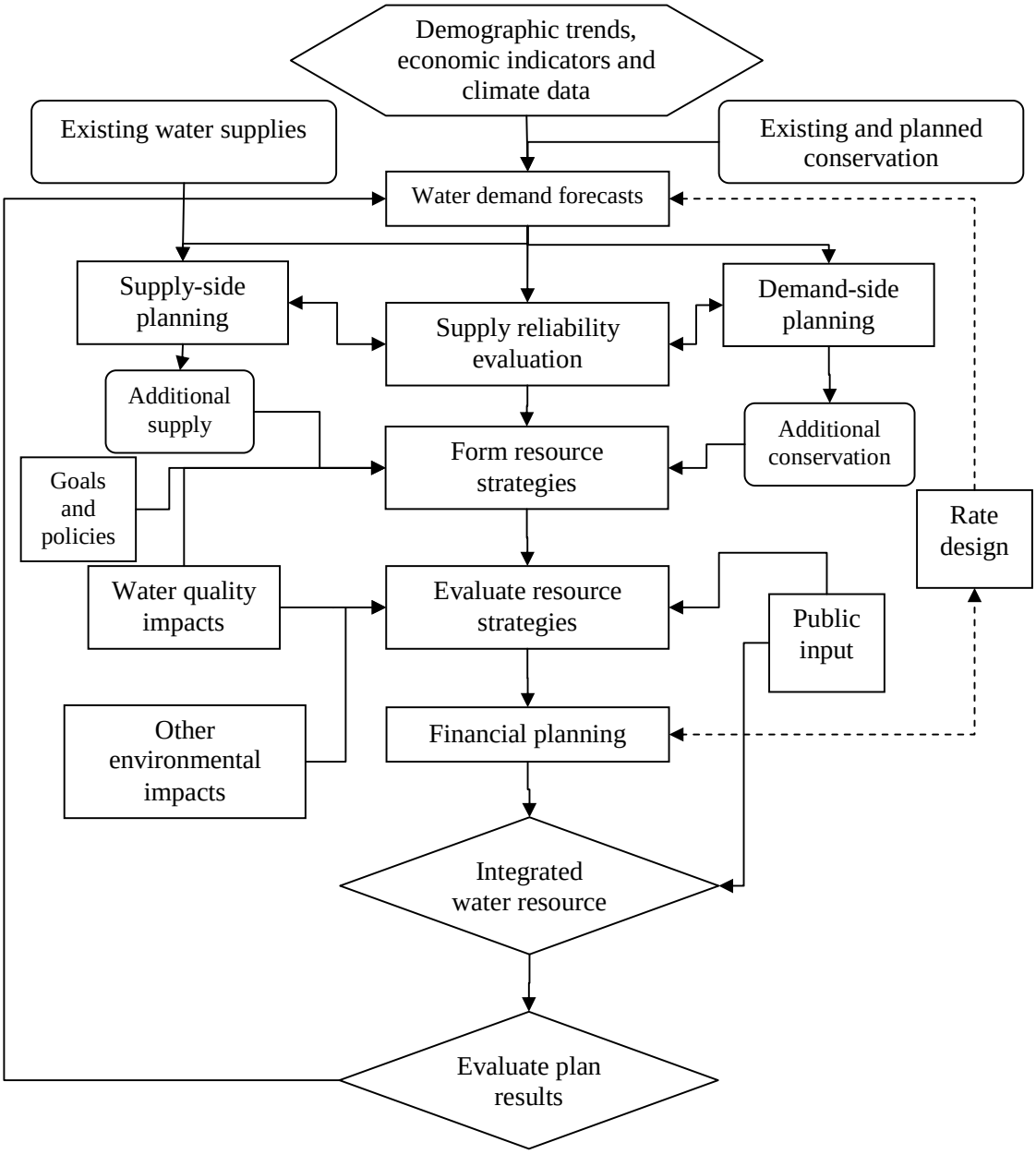


Figure 4-4: Integrated resource planning process (Maddaus 2008)

Goal Setting and Demand Monitoring

Goal setting is typically part of the IRP process, but can also be done outside of an IRP effort. Utilities have found that establishing a demand management goal can provide an important incentive for the implementation of programs as well as a benchmark against which to measure progress.

Demand monitoring is the process of measuring and assessing demands and comparing the results against a known baseline and the goal. This can be done on the utility scale or for a specific category of customers (i.e. SF residential, MF residential, commercial, irrigation only, etc.). Ideally, demand monitoring will be implemented at multiple levels so that it is possible to assess progress towards the goal by customer sector.

Colorado Water Conservation Board Guidance

The Colorado Water Conservation Board provides extensive guidance and model plans for developing water conservation plans.[8] The CWCB planning resources follow the IRP philosophy and outline a nine step process which include goal setting and monitoring:

Step 1 – Profile Existing Water System
Step 2 – Characterize Water Use and Forecast Demand
Step 3 – Profile Proposed Facilities
Step 4 – Identify Conservation Goals
Step 5 – Identify Conservation Measures and Programs
Step 6 – Evaluate and Select Conservation Measures and Programs
Step 7 – Integrate Resources and Modify Forecasts
Step 8 – Develop Implementation Plan
Step 9 – Monitor, Evaluate, and Revise Conservation Activities and the Conservation Plan

AWE Conservation Tracking Tool[9]

The Alliance for Water Efficiency (AWE) has developed a water conservation tracking tool for integrated resources planning. Built in Microsoft Excel, it can be used to track water savings of multiple conservation measures. The software can also be used to compare multiple conservation scenarios for determining the optimum combination of activities. The AWE tracking tool models data for a 30 to 40-year horizon. The Alliance for Water Efficiency tracking tool is free to AWE members. Membership information is available at www.allianceforwaterefficiency.org/awe-membership-page.aspx.

The AWE tracking tool is relatively easy to use and assembling the necessary data inputs will probably be the most time consuming task for water utilities using the software. First, the tool requires basic data such as population, expected growth rates, water billing rates, and information on water customers such as the relevant account classes and the percent of water deliveries made to each class. While these parameters are used by the model, it is worthwhile for a utility to realize other factors may affect demand, and as such to understand that the model is good at estimating use but it is not perfect. Next, demands for at least one baseline year are input. Demands can either be entered manually for every year after the baseline or can be set to grow automatically with population. Another essential data input is the avoided cost of water for the utility which represents the realistic cost savings (per acre-foot or million gallons) realized by

[8] http://cwcb.state.co.us/Conservation/RelatedInformation/Publications/WaterConservationPlanDevelopmentGuidanceDocument/WCPDevelopmentGuidanceDocument.htm .

[9] Other proprietary conservation planning models are available, but few if any have the combination of capability and low cost offered by the AWE Conservation Tracking Tool. However, larger water providers may find the AWE tool insufficient for their needs.

the utility by reducing demand. The fourth worksheet of inputs relates to specific conservation plans. Users may input data defining various conservation measures or import data from a library of conservation activities. Figure 4-5 is a screen capture of the worksheet where users may define conservation activities. Note that users are asked to input the useful life of various measures. This is important because it identifies and quantifies how long the effects from a measure may last and therefore affect long-term demands. The final data entered into the tracking tool is the level or intensity of activity for each conservation measure.

Once all the activities of a conservation program are defined and saved, the AWE tool can be used to create multiple scenarios. These scenarios are used to evaluate the savings achievable through menus of different conservation measures.

After the basic input data are entered, the AWE tool calculates the water savings attributable to each water conservation activity including the anticipated passive savings from natural replacement of fixtures and appliances and the anticipated impact of "free-riders" who accept rebates and incentives for implementing measures they would have done even in the absence of an incentive. The AWE tool graphically displays demand changes over time with bar charts showing the savings achieved by each conservation activity. Per capita demand is tracked numerically and graphically which can help an agency find a combination of conservation activities that are aggressive enough to meet specific goals.

The AWE tracking tool also evaluates how water conservation activities impact utility revenue. The tool models how specific conservation measures save water and what costs and benefits each measure offers the utility, customer, and society.

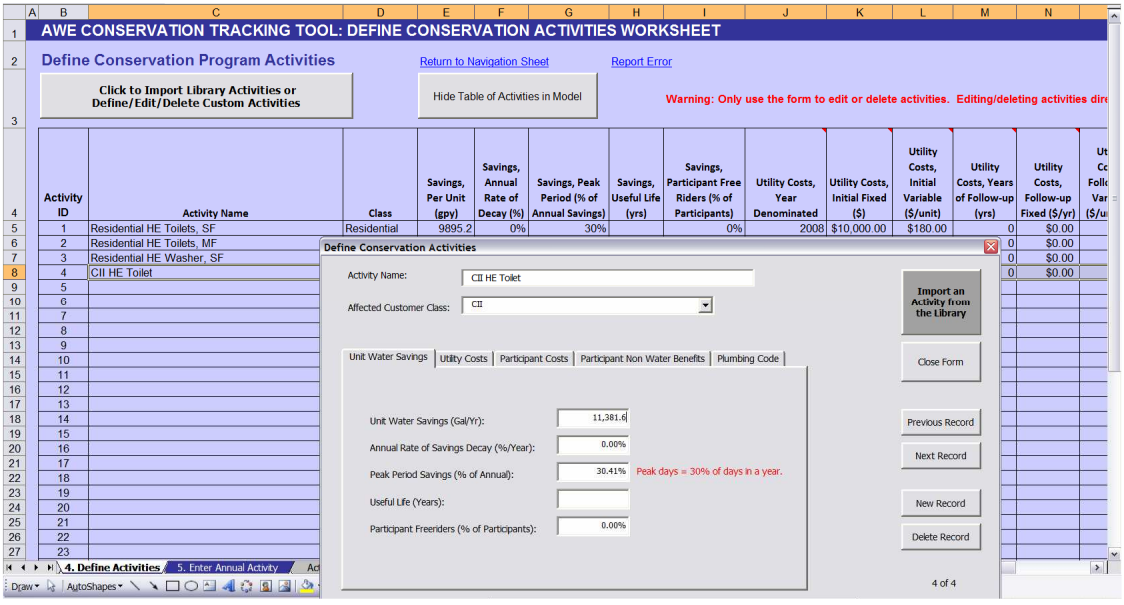


Figure 4-5: Screen capture of AWE conservation tracking tool showing how users can define conservation activities.

Water Savings and Other Benefits

Setting a goal and developing a plan by themselves do not save water. By the same token, utilities that lack goals and plans for conserving water are unlikely to realize water savings beyond what customers implement of their own volition. Planning is an essential step in the process of implementing cost-effective conservation measures and realizing lasting demand reductions.

From the benefit-cost perspective, water savings are attributed to individual conservation measures, actions, or "natural" processes such as the gradual replacement of inefficient fixtures and appliances. Tracking changes in water use from specific programs and natural replacement is essential if these savings are to be relied upon in the future. Measuring impacts can also help utilities properly value conservation program efforts. Tracking conservation savings also assists with demand forecasting and modeling – a key component of integrated resource planning.

Other Benefits of Integrated Resources Planning – Financial Savings

Additional benefits of integrated resource planning include:

- Reduced expense of developing new water supplies
- Reduced operating / maintenance expenses from new or expanded water supply projects
- Reduced environmental impact from new or expanded water supply projects
- Reduced liability from new or expanded water supply projects
- Increased transparency in planning process
- More public involvement in planning process
- Balanced planning approach

Integrated resources planning can help spur water savings, but IRP as a stand alone utility function does not save money. Integrated resources planning aims to help utilities choose the water supply and demand management options that offer cost-effective solutions. Properly implemented IRP efforts should result in significant avoided costs for water providers by directing new supply and demand management efforts towards the least-cost option. Avoided costs can be thought of as the savings obtained from using a cheaper water source – even if a part of that "source" is water saved through conservation. Agencies must pay for both new source development and conservation programs, but the difference in costs function as a financial savings (Beecher 1996).

Costs

Utility costs

Integrated resources planning can be accomplished by water utilities in-house or contracted to a consulting firm. The cost for developing an IRP with a consultant ranges from approximately $30,000 (small water utility and limited public input process) to over $1,000,000 (large utility, consulting team, proprietary model, staff time). The capable (and inexpensive) AWE tracking tool could result in significant cost savings particularly for smaller providers that can take advantage of this resource. Costs associated with specific conservation measures are attributable to those measures, not a conservation plan.

Customer costs

Customers bear no direct costs for the IRP process.

Resources and Examples

Resources

- American Water Works Association (2007) *Water Resource Planning Manual of Water Supply Practices (M50),* American Water Works Association, Denver, CO – available for purchase from www.awwa.org
- Colorado House Bill 04-1365, which initially authorized Colorado's water conservation planning program, can be found at: http://cwcbweblink.state.co.us/weblink/docview.aspx?id=111879&searchhandle=25493&dbid=0
- The Colorado Water Conservation Board water conservation plan guidance document can be found at: http://cwcb.state.co.us/Conservation/RelatedInformation/Publications/WaterConservationPlanDevelopmentGuidanceDocument/WCPDevelopmentGuidanceDocument.htm
- The Colorado Water Conservation Board's Office of Water Conservation and Drought Planning (OWCDP) promotes water conservation planning by providing public information, technical support, and financial assistance. http://cwcb.state.co.us/Conservation/
- The Alliance for Water Efficiency has a conservation tracking tool free to Alliance members. www.allianceforwaterefficiency.org/Tracking-Tool.aspx

Examples

The Colorado Water Conservation Board provides a model conservation plan and water conservation planning worksheets. The model plan outlines the nine conservation plan steps and includes descriptions of recommended subsections. For example, step seven focuses on integrating resource planning and modifying forecasts. The model plan gives descriptions on five subsections in this step. The worksheets help conservation planners gather and organize data and then make system-wide calculations from gathered data.

These materials can be found at http://cwcb.state.co.us/Conservation/RelatedInformation/Publications/WaterConservationPlanDevelopmentGuidanceDocument/WCPDevelopmentGuidanceDocument.htm

BEST PRACTICE 3: System Water Loss Control

- Foundational best practice
- Utility operations - implemented by water utilities on their own system
- Customer participation – not applicable

Overview

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. The American Water Works Association water loss methodology (detailed in the M36 manual and described in this best practice) is considered the industry standard (2009).

Auditing a water distribution system for real and apparent losses and evaluating the costs of those losses is the foundation of water loss control. Real losses are actual physical losses of water due to leaks or other problems with the system. Apparent losses are due to meter inaccuracy, unauthorized consumption, and data handling errors. Cost and benefit considerations drive implementation actions in the recommended methodology, described in detail in the AWWA M36 Manual.

Why a Best Practice?

Water loss control represents the efforts of water utilities to provide stewardship and accountability in their operations and sets a positive example for customers. Water auditing and loss control give water utilities the potential to conserve significant volumes of treated water by reducing real losses and to increase revenue by reducing apparent losses. Water loss control is a foundational, cost-effective water conservation practice that should be implemented by all providers in Colorado.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Distribution system leak identification and repair." [CRS 37-60-126 (4)(a)(V)].

The industry standard approach to water loss control described in this *Best Practices Guidebook* includes distribution system leak identification and repair as a key component. This best practice is an excellent fit with current state planning requirements even though water loss terminology and methodology has developed and changed since CRS 37-60-126 was passed. Future updates to this statute should incorporate language on system water audits and water loss management.

Applicability

Water loss control actions as described in this best practice apply exclusively to water providers and those that manage and maintain water delivery infrastructure.

Implementation

Water loss control programs are undertaken by utility staff and their designated contractors with little or no involvement from customers. Three fundamental resources are recommended as a starting point for those seeking to implement or improve a water loss control program:

- American Water Works Association (2009) *Water Audits and Loss Control Program: Manual of Water Supply Practices (M36),* American Water Works Association, Denver, CO – available for purchase from www.awwa.org
- Aquacraft (2009) *Utility Water Loss: A Review of Current Practices in Colorado, Requirements in Other States and New Procedures and Tools,* Colorado Water Conservation Board, Denver, CO – available for free download from http://cwcb.state.co.us/NR/rdonlyres/AC6E43FD-0EB9-4335-BA95-AA139279CC44/0/16.pdf
- Free Excel-based water audit and loss control evaluation software developed by the AWWA Water Loss Control Committee. Free download available from www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&navItemNumber=48158

There are two fundamental steps when conducting a utility water system audit using the 2009 AWWA M36 methodology: (1) The Water Audit; and (2) The Water Balance.

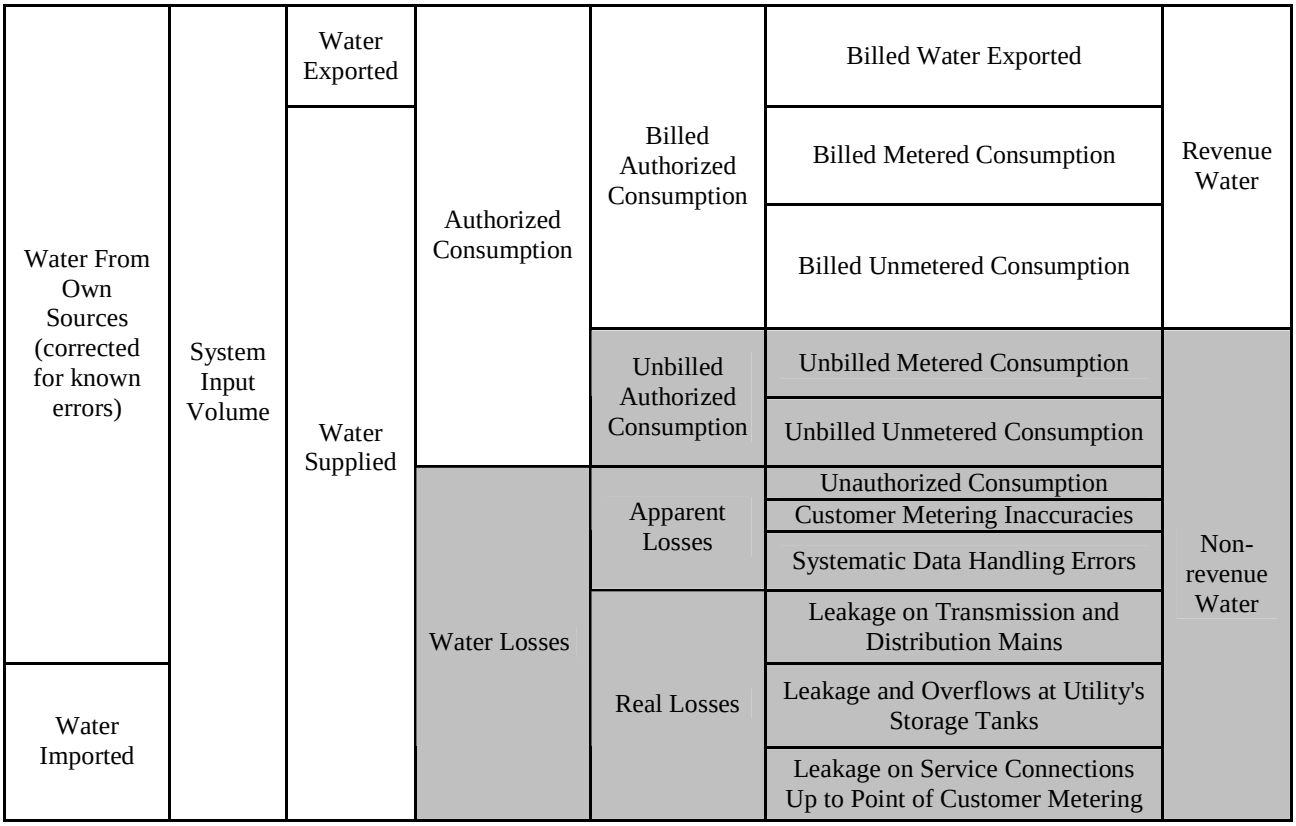
The ***water audit*** typically traces the flow of water from the site of withdrawal or treatment, through the water distribution system, and into customer properties. The ***water balance*** summarizes the components and provides accountability, as all of the water placed into a distribution system should – in theory – equal all of the water taken out of the distribution system.

The combination of the system water audit and the water balance provide a variety of useful measures of utility water loss. Of particular interest to water agencies is the ability to quantify the costs of real and apparent water losses and to use this information to improve the bottom line. Traditional water loss accounting focused on the percentage of unaccounted for water. Under the 2009 M36 methodology, the term "unaccounted for water" is eliminated. Key water loss performance metrics include:

- Apparent losses per service connection per day
- Real losses per service connection per day
- Real losses per length of main per day
- Unavoidable real losses
- Non-revenue water as a percent by volume of water supplied
- Non-revenue water as a percent by cost of operating system
- Annual cost of apparent losses

- Annual cost of real losses

Figure 4-6 shows the key components of the water balance and water loss accounting in the 2009 M36 methodology. The shaded area represents water losses. Developing a utility water audit using the M36 methodology involves developing measurements or estimates of all of the values shown in Figure 4-6. Utilities first implementing this methodology are encouraged to start with a desktop audit where existing data and estimates are used as inputs to the water balance. This process is called the "top-down" audit. The "bottom-up" approach involves replacing estimated values with actual measurements and generally takes planning and effort of a number of years for a utility to fully implement. Both the top-down and bottom-up approaches are made much easier with the free software which automatically performs the required water balance calculations.



Note: All data in volume for the period of reference, typically one year.

Figure 4-6: Water balance for water loss audit accounting (AWWA 2009)

Essential implementation steps are detailed in Table 4-11. AWWA's water audits and loss control stresses information collection and data analyses. A key point in the audit process is valuing apparent losses at the prevailing retail rate. By valuing apparent losses this way, corrective actions become much more cost effective. As with any action, cost considerations are important. The AWWA water loss control audit places significant emphasis on assessing costs and benefits before setting water loss reduction targets. However, there are potential barriers to even beginning a water loss audit. Staff time and availability are probably the first barriers to

confront. Data availability and limitations of data validity are also critical barriers during the initial phase of the audit process.

Apparent losses due to meter inaccuracies are an under collection of potential revenue and are inequitable in that some customers pay for less water than they actually use. The practice of right sizing meters in new accounts and in old accounts where use patterns have changed is as important as maintaining and replacing old meters. For example a site that originally was a restaurant that is replaced by a retail shop and is equipped a 2" meter when it could be adequately served by a 3/4" meter has real potential to under report consumption. Compound meters can be used on some multi-family residential accounts to ensure higher accuracy and full accounting during low consumption periods.

Table 4-11: Key water loss audit implementation steps

Water Audit Step	Brief Description
1. Collect distribution system information	Includes infrastructure, financial, and operational data. Most info should be readily available to a utility.
2. Measure water supplied to the distribution system	This task identifies how much water enters the distribution system and where it originates.
3. Quantify billed authorized consumption	Identifies the amount of water delivered to customers that have accounts in the customer billing system.
4. Calculate non-revenue water	Non-revenue water is amount remaining after billed authorized consumption is deducted.
5. Quantify unbilled authorized consumption	Includes unmetered fire hydrant use, flushing, street cleaning, etc.
6. Quantify water losses	Water losses are made up of apparent and real losses.
7. Quantify apparent losses	Comprised of customer meter inaccuracy, systematic data handling errors, and unauthorized consumption.
8. Quantify real losses	In the “top-down” approach, this is calculated total water loss minus apparent losses. In “bottom-up” approach, physical measurements improve the measurement of real losses.
9. Assign costs of apparent and real losses	Apparent losses should be valued at the prevailing retail rate charged to customers. Real losses are typically valued the same as the variable production costs to treat and deliver water.
10. Calculate performance indicators	This task (along with many others) is done automatically through the free AWWA software.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

Water savings from water loss management programs depend entirely on the ongoing level of loss. It should be the goal of all water providers to limit real and apparent losses to economically efficient levels. Water losses vary significantly from system to system. Typically, systems with older pipes and/or higher pressure have greater real losses while systems with old, over-sized water meters and/or poor accounting practices have greater apparent losses. For many water providers in Colorado, implementing the AWWA M36 water loss audit methodology may reveal

that greater financial benefits can be achieved from improved accuracy in metering than by repairing or replacing water mains.

How to Determine Savings

Economic levels of real and apparent water loss can be determined easily by utilizing the free AWWA water audit software. Understanding the parameters that influence loss can help an agency better understand the potential cost and water savings from various water loss control measures. Water loss from leakage is highly dependant on system pressure, length of mains, number of connections, and location of customer meter on service lines as well as infrastructure material and age. AWWA's 1996 benchmark of 10% unaccounted for water is no longer applicable and only measuring unaccounted for water is no longer considered an industry standard approach (AWWA 1996, 2009). The industry standard is to implement the 2009 AWWA M36 water loss methodology.

The financial metrics incorporated into the AWWA M36 methodology and the free water audit software may prove to be the most valuable component for water agencies. Financial indicators are based on user-entered variable production costs and water retail costs. The software automatically calculates costs of real and apparent losses. Using these results, agencies can make rational cost-benefit decisions on prioritizing water loss control. Many utilities who have implemented this methodology were surprised to learn that the cost of their apparent losses were more significant (financially) than the cost of their real losses. In Philadelphia, PA for example, when a water audit was conducted the apparent losses were valued at $34.5 million and the real losses at $4.2 million (AWWA 2009).

Savings Assumptions and Caveats

The free Excel-based software calculated values are accompanied by a clear explanation showing how each calculation was made (as opposed to having the calculations performed in hidden cells or macros). This show-your-work approach allows the user to quickly understand the methodology for computing given values.

The AWWA software provides a built-in assessment of the data used to calculate water loss. Because collecting valid data is an essential part of the water audit process, low data validation scores prioritize actions for improving data in water loss control.

Depending on the corrective action water loss control, the lifespan of savings will vary. Utilities should understand that water loss control is an ongoing activity. Ideally a system audit should be conducted annually.

Goals and Benchmarks

At this time there are no established state or national standards for water loss using the 2009 M36 methodology. However, many local agencies have in-house goals relating to this best practice. The cost benefit analysis component of the water audit process can help guide agencies in setting reasonable water loss control goals.

It is anticipated that when a significant number of utilities have successfully completed the AWWA water audit methodology and achieved an acceptable level of data validity then realistic

benchmarks can be established. In most cases a cost-benefit ratio greater than 1.0 is desired for implementation of a conservation measure.

Other Benefits of Water Loss Control

Additional benefits of water loss control include:

- Reduced road repair by decreasing frequency of main breaks via pressure management
- Improved utility water and cost accounting
- Improved water meter testing and evaluation
- Establishes the utility as a good actor and leader in the cause of water efficiency

Costs

Utility Costs

Utility costs for water loss control vary. Initial implementation of the AWWA water loss audit methodology using the free software costs little more than a few hours of staff time. Taking this step then enables a utility to make sensible decisions about how best to allocate resources to water loss reduction. In some cases the first steps may involve improving the data used to calibrate the water loss accounting.

The financial accounting elements included as part of the AWWA water loss auditing tool provide powerful decision support tools for water providers. The software examines real and apparent losses and associated costs and water values. This analysis provides clear information on how real and apparent water losses impact a utility's bottom line. For example, apparent losses from under-reporting meters are valued at the retail rate of water. Installing meters on unmetered accounts may represent a major water loss control activity that, in the long run, generates revenue for the utility. On the other hand, efforts to correct some types of loss will be expensive. For example, if a utility finds major infrastructural repairs are need, costs can be quite large. In all cases, cost-effective analysis should guide decision making.

Customer Costs

Utility customers do not have direct costs associated with water loss control. However, if large loss problems exist, customers will ultimate bear costs related to repair and replacement of infrastructure.

Resources and Examples

Resources

Three fundamental resources are recommended as a starting point for those seeking to implement or improve a water loss control program:

- American Water Works Association (2009) *Water Audits and Loss Control Program: Manual of Water Supply Practices (M36),* American Water Works Association, Denver, CO – available for purchase from www.awwa.org

- Aquacraft (2009) *Utility Water Loss: A Review of Current Practices in Colorado, Requirements in Other States and New Procedures and Tools*, Colorado Water Conservation Board, Denver, CO – available for free download from http://cwcb.state.co.us/NR/rdonlyres/AC6E43FD-0EB9-4335-BA95-AA139279CC44/0/16.pdf
- Free Excel-based water audit and loss control evaluation software developed by the AWWA Water Loss Control Committee. Free download available from www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&navItemNumber=48158
- Journal AWWA (1996) AWWA Leak Detection and Water Accountability Committee, "Committee Report: Water Accountability," *Journal AWWA* (July 1996): 108-111.

Examples

The following examples come from the CWCB's *Utility Water Loss: A Review of Current Practices in Colorado, Requirements in Other States and New Procedures and Tools* (Aquacraft, 2009).

City of Longmont

Longmont tracks water loss on a multi-year basis. Longmont is promoting the term "water loss" in line with the IWA/AWWA standards. The calculation used by Longmont is system input measured at treatment less authorized consumption. Authorized consumption includes billed, metered accounts as well as unbilled metered accounts. Longmont reports that they are fully metered. Water losses in 2006 and 2007 were 8.3% and 8.2%, respectively. Losses have reportedly dropped since 2007.

Line losses are assumed to be the major component of loss in the system, but this assumption comes from a process of elimination about other sources of loss. Main breaks are reportedly minimal, no accounts are un-metered, tests on replaced meters indicate that meter inaccuracy is not a problem, and changes to customer bills are handled without adjusting volumes recorded in the accounts database.

Longmont staff also performs customer side leak detection, but generally, it is in response to customer concerns about unusual increases in consumption.

Pueblo Water

Pueblo Water uses the term "unaccounted water." They define this as the amount of water pumped from treatment into the system minus the volume of billed water. The system is 100% metered. Losses are estimated at 6% to 7%. The biggest component of water loss in Pueblo is under metering. Although the system is fully metered, inaccuracies were the largest point of loss, officials said.

Leak detection is performed on the system. This is sometimes done via contractor, but Pueblo Water also has the capability to do leak detection in house. They also do leak detection after mains are replaced. Pueblo Water collects readings monthly, but volumes do not necessarily match due to lags in billing data, etc. The primary metric is the yearly loss, but they also look at a five-year average of losses.

BEST PRACTICE 4: Conservation Coordinator

- Foundational, Operations, Understanding, Informational, Support, and Control best practice
- Utility operations - implemented by water utilities for their own customers' benefit
- Customer participation – not applicable

Overview

A conservation coordinator is vital 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 (or conservation manager) is a full time job and may involve managing a staff and/or contractors. 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 for planning and implementing water conservation efforts.

Ideally, a conservation coordinator needs to have equal footing with other resource planning divisions. A conservation coordinator who cannot sit at the table with other managers will only coordinate what is given and not be part of the supply discussion.

Why a Best Practice?

Successful conservation programs need leadership. The fundamental responsibilities of a water conservation coordinator or program manager are to (AWWA 2006):

- Develop (or supervise development of) the utility's water conservation plan
- Organize and direct implementation of the conservation plan.
- Track, monitor, and evaluate water conservation programs.

Establishing a water conservation coordinator is a foundational best practice for water utilities. A conservation coordinator impacts utility operations, improves customer understanding of conservation, assists in development and dissemination of information, develops and supports conservation planning and program activities, and when necessary assists in implementing mandatory demand restrictions.

Water conservation coordination was one of the BMPs identified by the Metro Mayor's Caucus (Metro Mayors Caucus et. al. 2005). The Metro Mayor's Caucus is a team of 39 municipalities in the greater Denver area that work to foster collaboration and cooperation on multi-jurisdictional issues. Water is one of their main areas of emphasis. By identifying conservation coordinator as a best practice, the Caucus highlighted the importance of this practice.

State Planning Requirements

Colorado's water conservation planning requirement (CRS 37-60-126) does not specifically reference a water conservation coordinator. However, a water conservation coordinator would help facilitate all aspects of CRS 37-60-126 starting with the creation of the conservation plan.

Applicability

The concept of a water conservation coordinator applies to all water utilities. Not all utilities have the budget and resources to hire a full time (or even part time) water conservation coordinator for their staff. In these cases, the utility should select a staff member who has other primary assignments to be the designated conservation coordinator – the "go to" person responsible for planning and implementing water conservation efforts.

Implementation

Hiring Staff

Hiring or designating a water conservation coordinator is implemented by water utilities using standard hiring procedures or work assignment protocols.

What are the qualifications required for a water conservation coordinator? Typical qualifications for a water conservation coordinator include the following (adapted from a recent job posting):

Knowledge of:

- Principle and practices of public administration, particularly municipal government.
- Public administrative research methods, techniques, and methods of report presentation.
- The organization of highly complex resource management programs.
- Water conservation laws, regulations, practices, and techniques.
- Environmental planning.
- Landscape water efficiency practices.

Ability to:

- Conduct original research and to make sound administrative analyses relating to policy and management problems.
- Communicate verbally with customers, clients, and the public in face-to-face, one-to-one settings, in group settings and using a telephone.
- Comprehend and make inferences from written material.
- Produce written documents with clearly organized thoughts with proper sentence construction, punctuation, and grammar.

Additional requirements:

- This position requires the use of personal or City vehicles on City business. Individuals must be physically capable of operating the vehicles safely, possess a valid drivers' license and have an acceptable driving record. Use of a personal vehicle for City business will be prohibited if the employee is not authorized to drive a City vehicle or if the employee does not have personal insurance coverage.
- Performs other essential or marginal functions as assigned.

Acceptable experience and training:

- A bachelor's degree or associates degree in business or public administration, environmental science, or in any field which specializes in the management of natural resources, or a related field; one to three years of experience in water or resource conservation.[10] Other combinations of experience and education that meet the minimum requirements may be substituted.
- Landscape Irrigation Auditor certification; Horticulture, Landscape Architecture or Design, and Turfgrass Management certification or equivalent.

Other job characteristics:

- Frequent driving in city traffic.
- Occasional confrontations from angry customers.
- Occasional work evenings and weekends as necessary.
- Subject to call back to work related to emergencies or public relations issues.

Additional experience and characteristics that are applicable to a water conservation coordinator include:

- Experience with contracting.
- Experience with hiring and management.
- Experience with budget management.
- Knowledge of landscape and irrigation practices.
- Knowledge of residential and non-residential indoor conservation.

Part-time conservation coordination

Conservation coordination is a full-time job, but at smaller utilities, the conservation coordinator's duties may be added to an existing staff position's duties. Several approaches can help:

- Focus resources: There are many resources available. Limiting resources can save time. This guide of best practices is a good starting point. Consider purchasing the *Handbook of Water Use and Conservation* by Amy Vickers. This text is well organized and readable. Newsletters and other periodicals can provide conservation information, but just as importantly, periodic information can be a regular nudge to keep conservation in mind. Many newsletters are free by email, such as Colorado WaterWise's newsletter (signup at http://coloradowaterwise.org//index.php?option=com_acajoom&act=subone&listid=2&Itemid=224).
- Use proven methods: Original ideas are great, but not necessarily efficient. If another utility's conservation plan looks feasible, use it as a template. Large utilities around the state have

[10] Currently only a very few college level training programs specifically offer courses in water conservation and resource management. One of the more developed programs offered is through Lane Community College in Eugene, Oregon.

detailed conservation plans and parts of those plans may be adaptable to smaller utilities. Be sure not to infringe on copyrighted material, such as copying an advertising campaign.

Water Savings and Other Benefits

Hiring or designating a water conservation coordinator does not directly result in water savings. A conservation coordinator facilitates and implements programs, improves customer understanding of conservation, assists in development and dissemination of information, develops and supports conservation planning and program activities, and when necessary assists in implementing mandatory demand restrictions.

Goals and Benchmarks

The goal for each utility should be to have a staff member designated to be in charge of water conservation planning and implementation, even if this person's primary work responsibility is in another area.

Other benefits

A conservation coordinator facilitates and implements programs, improves customer understanding of conservation, assists in development and dissemination of information, develops and supports conservation planning and program activities, and when necessary assists in implementing mandatory demand restrictions.

Costs

Utility costs

Hiring a conservation coordinator is like hiring any other full time utility staff member. The annual salary for a conservation coordinator starts around $40,000 and increases depending upon experience and the level of responsibility associated with the position. Large utilities have a conservation staff with a conservation manager whose salary will be at the utility management level. Additional costs that must be considered include benefits, retirement contributions, office space, equipment, and all other costs associated with hiring an additional staff member.

Customer costs

There are no direct costs to the customer associated with hiring or designating a water conservation coordinator.

Resources and Examples

Resources

Numerous websites offer useful information for prospective and current water conservation coordinators. Some of the better resources are available at the following sites:

- Alliance for Water Efficiency – www.a4we.org
- American Water Works Association – www.awwa.org
- Colorado Water Conservation Board - http://cwcb.state.co.us/Conservation/
- WaterWiser – www.waterwiser.org

- California Urban Water Conservation Council – www.cuwcc.org
- Lane Community College – www.lanecc.edu
- Colorado WaterWise offers opportunities for networking with other conservation professionals and has an excellent newsletter covering conservation issues. Sign up at: http://coloradowaterwise.org//index.php?option=com_acajoom&act=subone&listid=2&Itemid=224
- Amy Vickers' book *Handbook of Water Use and Conservation* (WaterPlow Press 2001) should be required reading for anyone interested in becoming a utility water conservation coordinator.

Examples

City of Fort Collins

Fort Collins has had a staff person dedicated to water conservation programs since 1977. The Fort Collins water conservation coordinator is responsible for managing and implementing a diverse program which includes public education and information, an increasing block rate billing structure and seasonal rates for commercial customers, rebates for efficient residential clothes washers, an innovative zero-interest loan program, irrigation audits, several ordinances, and a utility water loss detection program.

City of Greeley

Since 1997 the City of Greeley has had a full time water conservation coordinator to manage the city's water efficiency efforts. In Greeley the water conservation coordinator manages a $500,000 budget and supervises seasonal staff. The conservation coordinator co-authored the city's water conservation plan and implements Greeley's water conservation program which includes both indoor and outdoor programs geared to the residential and non-residential sectors.

City of Glenwood Springs

The City of Glenwood Springs does not have a full time staff member dedicated to water conservation because of the limited staff resources available at the utility. In Glenwood Springs, the water and wastewater treatment supervisor has assigned additional duties as the water conservation program lead. This designated staff member assisted with development of the water conservation plan and has responsibility for ensuring that all plan elements are implemented.

BEST PRACTICE 5: Water Waste Ordinance

- Foundational and Operations best practice
- Utility operations - implemented by water utilities on their own customers
- Customer participation – avoiding waste is the responsibility of customers

Overview

A water waste ordinance is a local regulation that explicitly prohibits the waste of water from a variety of sources including (but not limited to) excess irrigation runoff or from irrigation that occurs at a prohibited day and/or time, excessive pavement washing, failure to repair leaks, utilizing single-pass water cooling, or even improper maintenance of cooling towers at an unnecessarily low conductivity level.

Conservation through ordinance can have limitations. Enforcement is a key piece of making an ordinance effective and enforcement requires staff resources. Additionally, some entities such as special districts may lack proper jurisdiction to enact a water waste prohibition ordinance.

Why a Best Practice?

A water waste ordinance is an important regulatory tool for water utilities that serves several useful purposes.

- A water waste ordinance establishes the importance of wise water stewardship in a community and establishes a utility's intent to put its water resources to maximum beneficial use.
- A water waste ordinance establishes penalties for the blatant waste of water. Such an ordinance empowers local officials to target hands-on assistance and education as well as issue warnings and fines.
- A water waste ordinance provides an important regulatory "stick" during a drought when agency-wide restrictions are put in place and enforcement is required to ensure water supplies are adequate.
- Without a water waste ordinance, a utility may be powerless to act against egregious and profligate waste of water.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Regulatory measures designed to encourage water conservation." [CRS 37-60-126 (4)(a)(IX)].

Applicability

This best practice applies to all water agencies and all water customers. Water waste usually targets excessive irrigation and drought restriction violations, but other sources of waste could also be the subject of a water waste ordinance. For example, water waste violations could be levied for excessive pavement washing, failure to repair leaks, utilizing single-pass water

cooling, or even improper maintenance of cooling towers at an unnecessarily low conductivity level. Utilities with individualized water budgets could utilize a water waste ordinance to enforce mandatory drought limitations requiring all customers not to exceed their water budget.

Implementation

A water waste ordinance is usually enacted by the municipality or local government, not the water utility itself. Typically water waste ordinances are passed by the city council and entered into municipal code, often at the request of the water utility. Several examples of code language for water waste ordinances are provided in this section.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

A waste-prohibition ordinance cannot just be a rule that exists only on the books – it must be actively enforced. The water savings achieved through a water waste ordinance depend largely upon the level of publicity and enforcement given to the rules. A water waste ordinance is similar to a new traffic law – without some measure of enforcement the public is unlikely to pay much attention. With a water waste ordinance, savings are only likely to be achieved if there is some level of active enforcement to keep people "on their toes".

How to Determine Savings

Initially, water savings from a water waste ordinance can be estimated from the number of warnings and tickets issued. Utilities with advanced data tracking capabilities can identify customers who received a citation for water waste and examine billed consumption records before and after the citation was issued.

Once a water waste ordinance has been in place and actively enforced for a year or more it may be possible to measure the impacts on a community-wide level, but much depends upon the implementation effort.

Savings Assumptions and Caveats

Water savings from a water waste ordinance cannot be assumed since it is possible that no savings will be achieved, because it relies heavily on behavior change.

Goals and Benchmarks

The goal of a water waste ordinance should be to eliminate all obvious water waste in a community. Of course this goal is much like the goal of eliminating all speeding from local roads. The water waste ordinance represents an effort to move a community toward a goal, but it does not ensure success and in fact complete success is a virtual impossibility.

Other Benefits

A water waste ordinance on the books, even if it is not actively enforced in normal water years, can be extremely important during a drought. When demand reductions are required to ensure minimum supply levels during a drought, a water waste ordinance is an essential tool for water providers and gives the necessary enforcement power to cite, and if necessary fine, those who do

not obey drought restrictions. As an additional possible benefit, a waste prohibition ordinance can help create a culture change where wasting water is unacceptable.

Costs

Utility Costs

Implementing a water waste ordinance is inexpensive and usually only requires that an ordinance be prepared by staff and then approved by the City Council or other leadership body.

Enforcing a water waste ordinance requires staff time from the water utility and possibly from other city service workers. To enforce their water waste ordinance, Denver Water hires temporary workers, provides them with vehicles (and bikes) and uniforms, and literature. They also incur expenses related to tracking violations and integrating them into their computerized customer information system. During a drought, some municipalities empower all city workers, including law enforcement, meter readers, and road crews, to watch for watering violations and to issue citations.

Depending upon how the ordinance is constructed, citizens who receive a citation may have the option to appear in court to contest the violation and fine. This can increase implementation costs.

Customer Costs

A water waste ordinance does not place costs on the customer *unless* they are caught in violation of the rules at which point they may be subject to a penalty, much like a traffic ticket.

Resources and Examples

Resources

The published literature on water waste ordinances is virtually non-existent. The best resources for water waste ordinances are rules on the books in communities in Colorado and across the US and the experience of water providers in implementing their water waste ordinance.

Examples

Several examples of water waste ordinances with varying levels of detail and specificity are presented below.

Denver Water

Denver Water prohibits water waste, carefully defines what waste is, and enforces the ordinance with seasonal staff.

From ***Chapter 14 Water Conservation***

14.01 Water Waste Prohibited. Water shall be used only for beneficial purposes and shall not be wasted.

14.01.1 Water Waste Defined. Prohibited water waste includes, but is not limited to:

a. Applying more water than is reasonably necessary to establish and maintain a healthy landscape. Routine watering of turf shall be limited to three days per week, except for watering for up to 21 days to establish new turf from sod or seed; and except for syringing golf course greens when necessitated by weather conditions.

b. Watering with spray irrigation between the hours of 10.00 a.m. and 6.00 p.m. during the period from May 1 to October 1, except for the following uses:

(1) Watering for up to 21 days to establish turf from seed or sod.

(2) Watering new plant material such as flowers, trees and shrubs on the day of planting.

(3) Watering essential to preserve turf subject to heavy public use.

(4) Operating an irrigation system for installation, repair or reasonable maintenance, so long as the system is attended throughout the period of operation.

c. Watering landscaped areas during rain or high wind.

d. Applying water intended for irrigation to an impervious surface, such as a street, parking lot, alley, sidewalk or driveway.

e. Using water instead of a broom or mop to clean outdoor impervious surfaces such as sidewalks, driveways and patios, except when cleaning with water is necessary for public health or safety reasons or when other cleaning methods are impractical.

f. Allowing water to pool or flow across the ground or into any drainage way, such as gutters, streets, alleys or storm drains.

g. Failing to repair, for a period of more than ten business days after notice, leaking or damaged irrigation components, service lines or other plumbing fixtures.

h. Washing vehicles with a hose that lacks an automatic shut-off valve.

14.01.2 "Water Use Restriction" Distinguished. These prohibitions on water waste are not related to drought response, insufficient water supply or system emergency and therefore do not constitute water use restrictions within the meaning of Denver Water's various water supply agreements and environmental permits.

City of Aurora

The City of Aurora Waste of Water ordinance prohibits water from pooling on or running across impervious surfaces and into the street gutter. This ordinance can also be applied during times of drought restrictions to enforce wrong day watering or watering between 10 a.m. and 6 p.m.

Sec. 138-190. Waste of water.

(a) *Waste of water prohibited.* Waste of water shall be defined as noncompliance with the city's water management plan as defined in section 138-223(b). Notwithstanding the enforcement provisions set forth in subsection (b) of this section, the director may order the installation of a flow restrictor or the shut off of water service to a property if the director reasonably finds that an extreme waste of water is occurring on the premises.

(b) *Enforcement.* The director is hereby authorized to enforce this section. The person billed for water service to a property, whether owner or occupant, shall be responsible for compliance with subsection (a) of this section and shall be subject to the following actions and penalties:

(1) Upon a first violation, the person billed will be issued a warning.

(2) Upon any further violations at the same property within a 12-month period, from the date of the warning notice, the person billed will be issued a written violation and the following penalty (see Table 4-12) will be added to the water bill for the property as a civil penalty.

(3) Any penalty imposed pursuant to this section may be appealed to the director of water pursuant to the appeal procedure set forth in section 138-226.

(4) Upon any notice(s) of violation of this section, a copy of such notice(s) shall also be mailed to the owner(s) of the real property served, if the owner(s) address differs from the subject property address.

(Code 1979, § 39-78; Ord. No. 2000-132, § 3, 12-11-2000; Ord. No. 2002-29, § 1, 6-3-2002; Ord. No. 2003-08, § 1, 3-24-2003; Ord. No. 2005-74, § 1, 10-10-2005)

Table 4-12: Aurora water waste violation penalties

Customer Category and Meter Size	2nd Violation	All Additional Violations
Single-Family		
All (5/8" - 1")	$250.00	$500.00
Non Single-Family		
5/8"	250.00	500.00
3/4"	300.00	600.00
1"	400.00	800.00
1 1/2"	600.00	1,200.00
Large Commercial		
2"	800.00	1,600.00
3"	1,200.00	2,400.00
4"	1,600.00	3,200.00
6"	2,400.00	4,800.00
8"	3,200.00	6,400.00
Irrigation Only		
2"	1,000.00	2,000.00
3"	1,500.00	3,000.00
4"	2,000.00	4,000.00
6"	3,000.00	6,000.00
8"	4,000.00	8,000.00

City of Durango

Water waste. The intentional or unintentional use of water for a non-beneficial use. Non-beneficial uses include, but are not restricted to:

(1) Landscape water applied in such a manner, rate and/or quantity that it overflows the landscaped area being watered and runs onto adjacent property, public rights-of-way or into drainage ways, including gutters and storm sewers.

(2) Landscape water which leaves a sprinkler, sprinkler system, or other application device in such a manner or direction as to spray onto adjacent property or public rights-of-way.

(3) Failing to repair any irrigation system that is broken or leaking.

(4) Applying water to hard surfaces such as parking lots, aprons, pads, driveways, or other surfaced areas, such as wood or gravel, when water is supplied in sufficient quantity to flow from that surface onto adjacent property or public rights-of-way.
(Ord. No. O-2007-30, § 1, 9-4-07)

City of Longmont

Waste of water prohibited. Customers shall not cause or permit water furnished by the city to run to waste in any gutter or other impervious surface, or other application. Waste, for purposes of this section, shall constitute the use of water serving no beneficial use, and not constituting an unavoidable consequence of the beneficial usage of water. Waste of water does not include incidental and occasional over spraying. For the purposes of this section, the term customer shall include homeowners associations or other entities obligated to maintain irrigation systems along city streets.

BEST PRACTICE 6: Public Information and Education

- Foundational, Education and Support best practice
- Utility operations - implemented by water utilities for their own customers
- Customer participation – recipients

Overview

Public information and education are broad best practices that encompass 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 in this guidebook. Central components of this best practice include effectively communicating the value of water, and delivering consistent and persistent messages. This best practice also includes measures to provide customers with timely information on their water consumption and alerts if unusual usage or leakage is detected.

Why a Best Practice?

Water conservation programs cannot hope to succeed without a public information and education component. Sometimes public information by itself comprises a utility's entire water conservation program, but for most agencies it is the mortar that holds together all other program elements. Raising awareness about conservation and water use is fundamental to getting people to take the next step and doing something practical that saves water directly (Vickers 2001).

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Dissemination of information regarding water use efficiency measures, including by public education, customer water use audits, and water saving demonstrations." [CRS 37-60-126 (4)(a)(VI)].

Applicability

Public information and education about water conservation and water supply applies to all utilities and ideally impacts all customers. A wide variety of educational, social marketing, and public outreach programs may prove effective. While small utilities may not have sufficient staff or budget to implement elaborate campaigns, the fundamental principles apply to all providers.

Implementation

This best practice incorporates a wide variety of informational and educational efforts and programs that water utilities can offer to their customers. All of these efforts can generally be classified as *social marketing* which is defined as: "The process of communicating with the public in an effort to change people's behaviors for the benefit of an individual, group, or community" (Silva et. al. 2010). Typical water conservation information and education programs may include some or all of the following elements:

- School education programs (K-12)
- Bill stuffers
- Newsletters
- Media relations, direct mail and marketing materials
- Advertising campaigns (newspaper, radio, TV, web, billboards, theater slides, bus signs, etc.)
- Informational and educational websites
- Social media (Facebook, Twitter, etc.)
- Water festivals and public events
- Informational billing (customer feedback on water use patterns and leakage)
- Conservation kit give-aways
- Seminars, trainings, classes, and demonstrations

The Water Research Foundation report, *Water Conservation: Customer Behavior and Effective Communication* (Silva et. al. 2010) provides a helpful checklist for developing any type of water conservation outreach campaign. Applying the principles and recommendations in this checklist to the extent possible will improve the effectiveness of water conservation education and information programs. Budget constraints will often set limits on the scope and breadth of an outreach campaign, but thinking strategically can help a utility make the most with limited funds. The following italicized and indented section is adapted from Silva et. al. 2010.

Use a Strategic Communications Approach

Think strategically. Develop a sound approach based on clear, consistent, timely and strategic communications with social marketing techniques to deliver the right message to the right audience through the right channels at the right time. A strategic communication approach requires a solid understanding of the current situation. What are the barriers that prevent the target audience from acting upon a specific behavior? How are audiences receiving information and which messages might most compel them to action?

Define Campaign Objectives

Set objectives and define the target audience. Will the campaign try and reach the entire population served or a subset of customers? Without a clear understanding of what is to be achieved and who needs to be reached, the campaign will not be focused and the results may be fragmented and weak. The objectives directly determine the best strategy to take and the audience to target.

Identifying distinctive objectives allows the development of activities, which target specific audiences to fulfill individual goals. For instance, some campaign activities may need to be tailored for different audiences. To use the 4 P's - (product, price, place, and promotion) as an example, the "place" where messages and activities are delivered will be different for homeowners than for business owners. Defined objectives will facilitate an easier examination of the general ROI (return on investment) for each audience. Monitoring and evaluating achievements over time will inform which media channel best fulfilled the goals. This results in greater informed planning for future social marketing initiatives.

Know Your Audience

To successfully engage in social marketing, you have to know your audience:

- *What do they know?*
- *What stage of change are they in?*
- *What do they like? What interests them?*
- *What motivates them?*
- *What are their barriers to change?*

The planning process takes the target audience into account by addressing the elements of the "marketing mix" – product, price, place, and promotion. Water conservation messages often work over time and through repeated exposure. Many consumers already have a high level of awareness about water conservation practices, and make a concerted attempt to integrate water conservation practices into everyday life. A good approach to improve understanding of your audience is through survey research or focus groups. This helps develop messages aimed at overcoming informational or attitudinal barriers.

Messaging should move consumers to action. Saving money is becoming a higher priority in households across the nation, so messages should address this issue as appropriate and necessary. Utilities need to exercise caution when using a message related to saving money. For example, buy a low-flow shower head will lower water use only if all other factors (such as length of shower remain the same). Message may require a specific caveat that explains how actual dollar savings can be achieved.

Understand Current Perceptions

Many consumers believe they are already conserving as much water as they can. However, drought can be a powerful motivator to further water conservation activities. Take into account conservation efforts that consumers practice least often in your community.

Carefully Consider Communications Channels

Using multiple communications channels can be effective in disseminating information about water conservation to consumers (e.g., utility bill inserts, print advertising, radio spots, and web presence). Coordinate messaging and maintain consistency. Research has found that water supply managers are considered to be the most credible source for water conservation information. Use this to your advantage.

Evaluate Performance

The true test of the effectiveness of the campaign is not the number of PSAs that were aired, but whether they actually contributed to improving water conservation. The levels of evaluation se can be divided into three basic types: process, outcome and impact evaluation.

(Adapted from Silva, T. et. al. 2010.)

Water Savings and Other Benefits

Utilities should not rely on any water savings from a public outreach campaign alone. While it is possible that a campaign will stimulate customers to more swiftly adopt conservation practices, it is more realistic to take a longer view of program impacts. Conservation outreach programs help establish a culture of wise water stewardship, which over time results in behavior change and effective action such as replacing inefficient fixtures and appliances. Conservation marketing efforts may also increase participation levels in other utility sponsored programs such as landscape audits or rebates.

How to Determine Savings

Don't determine the success of a water public outreach campaign based exclusively on measured changes in water use. Instead, focus on the campaign activities themselves. For example, did the advertising effectively reach the intended audience members?

The impact of conservation education and outreach campaigns can be measured over time through survey research. Changes in water use should also be tracked but it is nearly impossible to credit water savings to an education and outreach program alone, except perhaps during a drought where customer response is mandated.

Savings Assumptions and Caveats

Not applicable.

Goals and Benchmarks

Program goals should be based on the initial objectives. Was the campaign designed to reach the entire customer base or a specific sector? Was the program implemented as planned? Did the target audience see (or hear) the message?

Other Benefits

Conservation education and outreach campaigns provide multiple benefits to water providers including:

- Framing the provider as a wise steward of essential water resources.
- Framing the provider as a knowledgeable source of information about water use and conservation.
- Educating customers about water conservation methods and the importance of conservation.
- Informing customers about different conservation program offerings.
- Increasing participation in all utility resource conservation programs.

Costs

Utility Costs

Outreach programs in Colorado range from $500 to $1,000,000. Cost depends on the type of program and the level of implementation. An annual outreach program budget between $10,000 (small agency with fewer than 5,000 connections) and $50,000 (up to 25,000 connections)

should be sufficient to implement a basic print media and bill stuffer campaign. A larger budget will be required to implement a mixed media program with web, billboards, and radio spots. Television is probably the most expensive media both in terms of production and placement. In Colorado, the only advertising campaign sufficiently funded to even consider commercial television opportunities is Denver Water's "Use Only What You Need" campaign. Public access channels offer the possibility of low cost television spots, but viewership is often limited.

Some television and radio stations will air well produced public service announcements for civic causes such as water conservation at significantly reduced or no cost. If a radio or television campaign is desired this is another angle to explore.

Several organizations offer school curriculum and materials focused on water supply and water efficiency. Since developing curriculum can be expensive, it is almost always cheaper to use an existing program such as My H2O (Boulder and St. Vrain Valley School districts) or Project WET (Project WET Foundation, Bozeman, MT). A number of states and regions offer free water conservation curriculum to local schools. The Texas Water Development Board created their own water education curriculum called "Water IQ", which includes a section on water efficiency, for use in Texas schools.

A Google search on "water conservation curriculum" returns a wide variety of conservation curriculum materials from both public and private entities.

Customer Costs

There are no direct customer costs associated with customer education programs.

Resources and Examples

Examples

Denver Water

Denver Water's "Use Only What You Need" water conservation public outreach campaign (see Figure 4-7 and Figure 4-8) is the largest conservation outreach effort in Colorado and one of most notable conservation marketing programs in the country. Denver Water's program is one of the best examples of the use of social marketing to promote water conservation or any environmental practice. The campaign is clever, memorable, consistent in design, and each piece is targeted to a specific segment of the market.

Figure 4-7: Marketing piece used as part of Denver Water's "Use Only What You Need" campaign

The "Use Only What You Need" campaign came about when, in 2006, the Denver Water Board adopted a conservation plan aimed at accelerating the pace of water conservation in its service area and reducing overall water use by 22 percent by 2016.

As part of the effort to reduce demand by 22 percent, an intensive social marketing campaign was launched which includes billboards, bus stops, print media, television, and numerous clever marketing ploys including the now famous "running toilet" shown in Figure 4-8.

Figure 4-8: "Broken Sprinklers Waste Water" marketing piece from Denver Water's "Use Only What You Need" campaign.

Figure 4-9: Denver Water's famous "running toilet"

The running toilet was a person dressed in a toilet suit who was tackled in front of a crowd at a college football game while the scoreboard flashed, "Stop running toilets". Video of the stunt appeared immediately on You Tube, and television coverage spread the message farther and faster than any paid publicity.

Part of Denver Water's marketing campaign included billboards such as the one shown in Figure 4-10 that informs customers about when to irrigate. The billboard uses bright colors and a clear message in their design to get the point across to their customers.

The effective and eye catching Denver Water outreach program is also remarkably cost-effective. Denver Water, which serves 1.3 million people, spent between $600,000 and $900,000 annually since the campaign began in 2006, which is quite reasonable for a high visibility multi-media campaign in a major metropolitan area.

Figure 4-10: A Denver Water billboard educates customers about permitted irrigation times

Grand Valley / Lower Gunnison Wise Water Use Council

Figure 4-11: A WWUC billboards designed to reduce water used for irrigation

The Grand Valley/Lower Gunnison Wise Water Use Council (WWUC) is a collaborative effort among local, state, and federal agencies and water providers to improve public understanding of the value of water and to promote wise water use in the lower Gunnison and Grand Valleys. The WWUC was formed based on the mutual benefits of combining resources and the desire of individual agencies to combine resources to get more "bang for their buck" in promoting water conservation and education.

One of the key efforts of the WWUC is the coordination of education programs including:

- Irrigation providers' education program
- Drought Response Information Project

Figure 4-12: A WWUC billboard reminding customers not to waste water

The irrigation providers' education program included a clever billboard campaign implemented in 2006 and the Drought Response Information Project (DRIP). Examples from the campaign are shown in Figure 4-11 and Figure 4-12. The campaign was judged a success by both the WWUC and the local citizenry. The billboard campaign generated significant interest including a number of supportive letters to the editor in local newspapers and doubled the number of hits on the WWUC website. Most importantly, the campaign is credited with helping to reduce irrigation demands (see Figure 4-13) in Grand Junction in 2006.

Figure 4-13: Marketing piece from Grand Junction's campaign attributed with reduction in irrigation

The Colorado River District and the Northwest Colorado Council of Governments

The Colorado River District based in Glenwood Springs and the Northwest Colorado Council of Governments based in Silverthorne teamed up in 2010 to create a public education and information campaign called "It's the Same Water". "It's the same water. Conserve it!" is overprinted on images of mountains, a skier, a lawn sprinkler and a woman taking a shower.

In March 2010 the first billboard was placed on Interstate 70 near the top of Floyd Hill in Clear Creek County to catch the attention of eastbound traffic heading back to the Front Range from

the mountain ski areas (Figure 4-14). The message is also featured on 200 bus stop benches in the Denver metro area (Figure 4-15).

While the message is primarily directed at residents living on the Front Range, it applies equally to those living on the West Slope. Billboards in western Colorado help broaden the audience and the water education message. The campaign also features a Smartphone compatible website www.itsthesamewater.com, containing a wealth of information on water use, conservation and less-water-intensive landscaping.

Figure 4-14: Marketing piece placed on east bound I-70 targeting Front Range customers

Figure 4-15: This advertisement on bus benches in the Denver metro area

BEST PRACTICE 7: Landscape Water Budgets, Information, and Customer Feedback

- Foundational, Programmatic, Understanding, Informational, Support, and Control best practice.
- Utility operations - implemented by water utilities.
- Customer participation – potentially impacts all customers depending upon implementation

Overview

In Colorado, urban landscape irrigation typically accounts for 50 percent or more of the total annual water demand for a utility (Mayer 1999). Landscape water budgets are a powerful conservation tool for addressing landscape water use and encouraging efficiency. A landscape water budget compares actual metered consumption against the legitimate outdoor water needs of the customer based on landscape area, plant materials, and climate conditions.[11]

Why a Best Practice?

Information is power. Landscape water budgets provide essential information to help customers manage their water use:

- How much water was used?
- How much water was required?
- What is the efficiency of use at this site?

Because many landscapes, particularly turf, can accept excess irrigation without damage many irrigators are not aware of whether they are using water efficiently or grossly over-irrigating. A landscape water budget provides a reasonable target level of water use that is customized for each customer and landscape. Water budgets help water users better understand their consumption patterns and make sound decisions about how to best manage irrigation properly. Water budgets provide utilities with a powerful tool for identifying which customers are over-irrigating and could most benefit from efficiency improvements. Water budgets can be incorporated into a utility rate structure as has been done in Castle Rock, Centennial Water and Sanitation District, and Boulder, but they are also useful in their own right outside of a rate structure as a tool for assessing water use.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Low water use landscapes… and efficient

[11] Some utilities link the water budget with an increasing block rate structure to provide financial incentive for keeping usage within the calculated budget. More details about water budget-based rate structures can be found in the Metering and Rates best practice.

irrigation," [CRS 37-60-126 (4) (a) (II)]. Another water conservation measure to be considered is, "Water rate structures and billing systems designed to encourage water use efficiency in a fiscally responsible manner," [CRS 37-60-126 (4) (a) (VII)].

Applicability

This best practice is geared towards utilities seeking to reduce outdoor demands and it applies specifically to customer accounts with significant irrigation demand. There are two fundamental methods for reducing irrigation demands: (1) Improving the efficiency of irrigation at the site (i.e. reducing over spray and runoff, improving distribution and uniformity, improving scheduling); and (2) Reducing irrigation demands by changing and improving landscape and plant materials (i.e. waterwise planting, soil improvement, mulch, etc.).

Although the focus of this best practice is on outdoor use, water budgets can be developed for all accounts in a utility's system including all commercial, institutional and industrial (CII) water users and can be established for both indoor and outdoor demands.

Implementation

A landscape water budget is typically a volume of water that is calculated from two fundamental parameters: the landscape size (usually in square feet) and the water requirement of the plants in that landscape which is often represented by the ET rate (Mayer et. al. 2008). Developing landscape water budgets is a process that has been accomplished by water utilities both small and large.

For large irrigators, an informational water budget is only effective when the information is shared by the part of the organization paying the bill as well as the landscape manager. For example, with a condo's HOA, the board, the property manager and the landscape company all need feedback from the bill. Creating financial feedback for overwatering can prompt the parties responsible for finances to share information with on-the-ground landscapers.

Landscape Area Measurement Options

Option 1 – GIS

Landscape water budgets are often calculated using a utility's geographical information system (GIS), aerial imagery, and data from local weather stations. Good GIS coverage with linkage to the utility billing database allows for the irrigated area of each customer to be determined with reasonable accuracy as shown in Figure 4-16. Many utilities have high-resolution aerial imagery available. If not, free lower resolution imagery is usually available through Google Earth and/or other sources. The analysis does not need to be as detailed as shown in Figure 4-16 and could be limited to something as simple as permeable and non-permeable area.

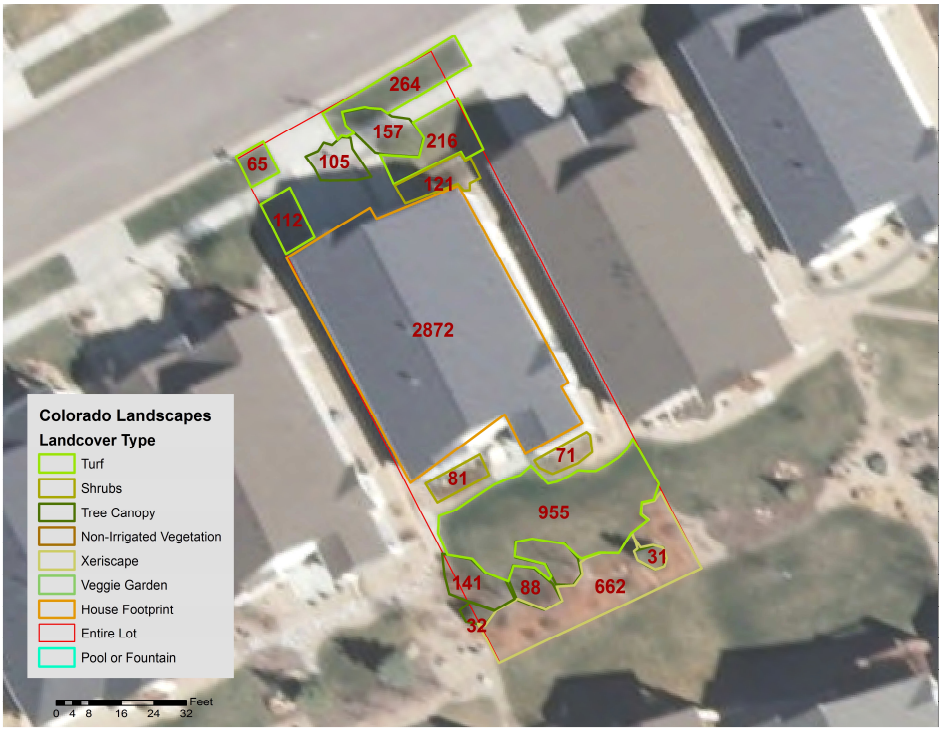


Figure 4-16: Landscape area calculation using GIS and available aerial imagery

Option 2 – Tax Assessor Records

Another option for estimating the irrigable area at a site or set of sites is to use county tax assessor records, which usually include a measurement of lot size and occasionally include measurements of the building footprint. Linkage between tax assessor records and utility billing accounts can be a complicating factor in this method as address matching (especially in large cities) is problematic. Tax assessor records typically only provide the total lot size area, so under this method estimated measurements of impermeable areas (roofs, pavements, etc) must be made. Since tax assessor records often include information about the buildings at each site including number of floors, total square footage, and presence of a garage, these data can also be used to estimate impermeable areas. However, this methodology will be more prone to systematic errors than any of the other proposed methods.

Option 3 – Physical Measurement

A third option is to hire a survey crew to physically measure the landscape area at selected sites. This is a reasonable option for a small utility or limited scale water budget program, but may not be practical when seeking to develop water budgets for an entire service area.

Option 4 – Sampling

Agencies with a reasonably homogeneous customer base can measure (via GIS or physical measurement) the irrigable area at a carefully selected sample of sites in the service area. This allows for a ratio between pervious and impervious areas to be established for each site in the sample. Once the range of areas is better understood, landscape area "bins" can be created and each property in the service area can be placed into the appropriate bin – usually based on tax

assessed lot size. All sites within a bin would have the same water budget each month. Centennial Water and Sanitation District in Douglas County used this method for establishing landscape water budgets for their budget-based rate structure. Based on the sampling effort, Centennial assumes 45 percent of the total lot size is irrigable.

Option 5 – Existing Impervious Area Measurements from Storm Water Programs

Colorado water providers that have calculated pervious and impervious area as part of a storm water management program may already have the data necessary to establish basic landscape water budgets. Since landscape water budgets are based on the irrigable (or pervious) area at a site, the storm water data by itself or in concert with tax assessor records may be sufficient to make the necessary calculations. Utilities seeking a low cost methodology for establishing landscape water budgets should consider this approach first as much of the work may already have been done on a site by site basis.

Appeals Process

If landscape water budgets are used as the basis for billing and are linked to the water rate structure, then inaccuracies can hit end users in their pocket book and an appeals process is required. An appeals process typically allows the customer to submit information in support of a revised landscape water budget, typically enlarging the budget from what was established by the City. Since customers are usually more knowledgeable about their landscape than anyone else, reasonable appeals are usually accepted. If landscape water budgets are used for informational purposes only, then an appeals process is probably unnecessary.

Water Requirement Options

Determining the legitimate water needs for each landscape in a service area is usually accomplished using evapotranspiration (ET) rate data obtained or calculated from local weather stations. ET, which originally comes from agronomy, is a measurement of the water requirement of plants and is typically reported in inches. Historic or real-time ET can be used to develop landscape water budgets.

There are a number of methods for calculating ET. A key difference is that many of the established methods do not include precipitation in the calculation. When seeking to improve irrigation efficiency it is essential to include effective precipitation[12] in the formulation of ET since effective rainfall can reduce the irrigation requirements of a landscape. ET is calculated for a specific reference crop (usually Kentucky bluegrass), but different plants have different water requirements and hence different ET values. Low-water use plants have a lower ET value. Utilities often establish water budgets based on the ET for bluegrass, but then reduce this by a 20 to 30% (or more) to account for different plants with a lower water requirement. Water budgets can be created with different objectives in mind. Some communities with ample water supply may wish to provide budgets that encourage lush, well irrigated landscapes while others may

> ET_o is typically a measure of ET that *does not* include precipitation. Factoring in effective precipitation is extremely important for establishing realistic water requirements.

[12] The Irrigation Association defines effective precipitation as "the portion of total precipitation which becomes available for plant growth".

wish to develop more restrictive budgets to encourage landscapes more appropriate for a drier climate (Mayer et. al. 2008).

There are several sources for ET data for Colorado. Colorado ET provides access to different ET networks around the state - www.coloradoet.org/etnetworks.html. Denver Water maintains nine weather stations in the metro area, where the historical ET for bluegrass is 27 inches. The Northern Colorado Water Conservancy District has 24 weather stations located along the northeastern part of the state. Some are located on turfgrass and others are in agricultural settings. CoAgMet is a network of over 30 weather stations located around the state primarily in rural agricultural settings. It is important to know the site factors of weather stations to determine which ones are most appropriate to use.

Calculating the Water Budget

A simple landscape water budget can be calculated using the following equation:

Water budget (gal) = Area (sf) x ET (inches) x 0.0833 (ft/inch) x 7.48 (gal/cubic foot)

or simplified to

Water budget (gal) = Area (sf) x ET (inches) x 0.623 (gal/inch/cubic foot)

For example, a 10,000 square foot (sf) turf landscape and an annual ET rate of 28 inches/year results in an annual water budget of 174,464 gallons (174.5 kgal) per year.

To determine a reasonable landscape water budget for the diverse landscapes served by a Colorado utility, an ET adjustment factor of between 0.5 and 0.8 can be used. This factor simply reduces the overall allocation to between 50% and 80% of a full bluegrass allotment to account for plants with lower water demands.

Using the example above, a 10,000 SF mixed turf and water wise landscape that only needs 70% of the 28 inch/year ET rate would have an annual water budget of 122,124 gallons (122 kgal) per year.

Water budgets can be set on an annual, quarterly, bimonthly, or monthly basis by setting the ET factor in the equation above to correspond with the desired time period (e.g. ET_{July} could be used to establish a water budget for the month of July). When incorporated into a utility billing rate structure, the budget is allocated based on the utility billing period. This may require adjusting ET rates to correspond with billing periods with differing start and end dates (a meter may be read on the 22nd of the month for example).

When implementing informational water budgets, different time periods can be considered. Monthly budgets provide regular feedback and are usually the best option. In Colorado, the irrigation season is usually only six or seven months long, so water budget updates need only be provided for half the year from April – October. Monthly budgets provide opportunity to make changes to irrigation schedules or system improvements to adapt to water budget allotments and

then to learn if these changes have had the desired effect. Annual budgets are far less immediate and informational and unless tied to the rate structure are unlikely to stimulate efficiency improvements.

Customer Education and Communication

If landscape water budgets are to be effective, customers must understand what they are and how they are calculated. Public input in the early stages can create wider-public support for budgets. Where water budgets are established it is also important that customers be given regular feedback on their consumption. Providing customers with a remote meter reading device or instructions for reading their own water meter is an important consideration. Currently some Colorado utilities do not permit customers to read their own water meter, while others promote self-meter reading and provide instructions on the utility website.

Green Industries of Colorado (GreenCO), a consortium of trade associations representing diverse aspects of the plant and landscape industry, has a landscape water budget calculator which gives customers and utility planners an estimation of efficient water use. It can be downloaded from their website at: www.greenco.org/. This calculator (a screen shot is shown in Figure 4-17) takes water bills, local ET data and information about landscape and develops a site specific water budget.

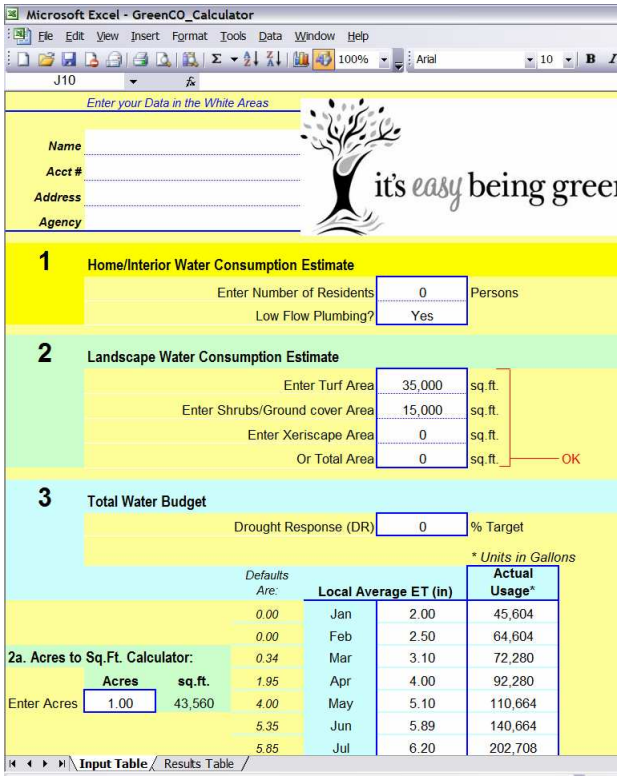


Figure 4-17: GreenCO's landscape budget calculator spreadsheet available for free download from www.greenco.org/

There are a number of web-based water budget calculator tools that may be useful as well including one from the California Urban Water Conservation Council (CUWCC) -

www.waterbudgets.com/ConserVision/CUWCC/DataInput.htm that automatically calculates a landscape water budget based on zip code.

Water Savings and Other Benefits

Range of Likely Water Savings: Significant

The savings achievable from landscape water budgets is largely based on the level of over-watering that occurred prior to implementation of the program. Customers who have historically over-irrigated have significant potential for savings, while those who have been frugal with outdoor water use will have little potential to reduce their use and may even increase their use.

Water budgets, particularly when linked with an increasing block rate structure, have lead to significant reductions in water use in Colorado. After implementing budget-based rates, the Centennial Water and Sanitation District reported a 25% reduction in demand vs. their previous inclining block rate structure. This over-all reduction can be tied to landscape reductions. Irvine Ranch Water District found that irrigation levels dropped substantially when landscape water budgets were used as part of the rate structure (Mayer 2008).

How to Determine Savings

Water savings from landscape water budgets can be calculated on a property by property basis by comparing outdoor or seasonal water use before and after implementation of the water budget program, taking care to adjust for differences in weather conditions during the pre- and post-implementation period.

Savings Assumptions and Caveats

Water savings from water budgets cannot be assumed; they should be measured and verified. Adjusting for differences in weather during the pre- and post-implementation period and accounting for other changes at the site not related to the water budget will yield more accurate results.

Goals and Benchmarks

Landscape water budgets offer utilities and customers the best available method for comparing actual water use against a reasonable efficiency benchmark.

> Utilities should set the goal of establishing landscape water budgets for all customers – even if they do not intend to take the step of linking the budget to the water rate structure.

If irrigable area data are readily available from a GIS or another source, then basic landscape water budgets can be established for all customers. When landscape area data must be measured or obtained manually, the process is more time consuming and expensive.

Utilities seeking a phased approach can choose to first establish landscape water budgets for their dedicated irrigation accounts including parks, medians, open space, and large landscapes. A dedicated irrigation account with a dedicated irrigation water meter makes it much easier to compare the proposed water budget against actual outdoor use and to determine program impacts. Once this is completed, the residential sector is the next logical customer group to target

under a phased approach followed by the commercial and industrial sector. Landscape irrigation is an often under appreciated component of CII use.

Other Benefits

Landscape water budgets are not just a good conservation tool; they can also help manage demand during a drought emergency. Landscape water budgets and water budget rate structures offer water utilities powerful tools for reducing demand during drought and for monitoring customer compliance with drought restrictions.

The following comes from Mayer, et. al. May 2008 AWWA Journal and sums up the uses of water budgets and water budget-based rate structures for drought response.

"*Landscape water budgets establish an empirical and quantifiable limit to the amount of water that a customer is entitled to use at a given price from a given tap. Water budgets theoretically reserve a volume of water that is set aside for the customer to use as he sees fit. Water budgets have the potential to protect the utility from overuse and to protect the customer from having her water allocated to other uses or micromanaged by the utility. In time of shortages, water budgets allow a water provider to quickly and easily identify excess use and even penalize it if necessary. By summing all water budgets, utilities can quickly understand the amount of water likely to be required to meet customer demands in any given month. During a drought, water budgets have the potential to assist water utilities in more fairly apportioning demand reductions among customers with different needs and among different customer classes since the reference point for reductions is based on the water required by each customer in normal times. Historically, when customers are asked to reduce their use from the previous year, justified complaints arise from customers who are already conserving, and don't have as much room for additional curtailments.*

"Water budget rate structures can help with drought plan enforcement in the area of communications. The water budget rate structure, with its billing system, informs all customers on a regular basis of the required use reductions. The water bill can show each customer how much water they are allocated during the drought. This information can be developed well before the drought occurs as part of the budgeting process. This is a far more reliable and effective way to implement drought related conservation since it is pre-planned rather than improvised. The billing system is already in place and the bills can provide the public with the information needed to respond to the drought.

"Another way that water budges aid with drought plan implementation is in the enforcement of mandatory demand curtailment. A simple query can inform the utility each billing period which customers have complied with drought restrictions and remained within budget and which have not. If the higher water rates being charged are not sufficient to elicit cooperation then additional fines and penalties can be considered. This is a highly reliable system. Unlike the "water cop" approach where customers are ticketed if they happen to be observed violating the drought restrictions, a water budget drought enforcement program automatically identifies every customer who is not complying, thus enabling fair and uniform enforcement. Water enforcement patrols are costly and can only catch violators "in the act" of violating a watering restriction. A

water budget, however, provides a regular and automatic check on which customers are in or out of compliance with drought response."

Costs

Utility Costs

Utilities will face financial costs in the form of staff or contractor time needed to develop and implement budgets. Utility billing systems may need to be upgraded to accommodate water budgets. Geographical information systems (GIS) can greatly enable establishment of water budgets on a system-wide scale, but GIS is not a requirement for creating landscape water budgets. Other less expensive methods have been used and utilities that have already calculated pervious and impervious areas as part of a stormwater management program can re-use that same information to establish landscape water budgets. Data savvy utilities may find that they can create basic landscape water budgets using existing data which can reduce costs substantially. However, agencies that do not have existing data resources may need to make a more significant investment in order to establish accurate water budgets.

Customer Costs

There are no direct customer costs associated with implementing water budgets, but customers do finance the programs through water bill payments as will all utility functions and programs.

Resources and Examples

Resources

GreenCO, a consortium of trade associations representing diverse aspects of the plant and landscape industry, has a landscape water budget calculator which gives customers and utility planners an estimation of efficient water use. It can be downloaded from their website at: www.greenco.org/

There are several sources for ET data for Colorado. Colorado ET provides access to different ET networks around the state. www.coloradoet.org/etnetworks.html.

The California Water Conservation Council offers one of the best available online water budget calculators which is capable of associating zip code with local ET data. This calculator can be found at: www.waterbudgets.com/ConserVision/CUWCC/DataInput.htm.

Examples

Centennial Water and Sanitation District

In response to the drought in 2002, and to encourage water conservation, Centennial Water and Sanitation District and the Highlands Ranch Metro District implemented an innovative water budgeting concept for residential and commercial water customers. The rate structure is detailed in the best practice on metering, conservation-oriented rates and tap fees, customer categorization within billing system. This landscape budget best practice takes a closer look at how the outdoor allocation is determined.

Lot size is the prime factor in determining the outdoor allocation. Tax assessor records were used to provide data on lot size. The basic calculation assumes 45% of the lot is irrigable. Centennial allots 27 inches of irrigation use for landscapes for a year. This is based on historic ET for the Highland's Ranch area. This means that the area of a given lot is multiplied by 27 inches to determine a volume for budgeting. Converting between various units (square footage of lot, inches of allocation and units of volume used for billing) can be tedious, but is a simple arithmetic operation. For example, a 10,000 square foot lot would be expected to have 4,500 square feet of irrigable area. Irrigating 27 inches (per season) on this 4,500 square feet would yield 75.7 kgal added to the home's budget for the irrigation season.

Determining what portion of the landscape is irrigable (the 45% factor) involved research. Detailed irrigable area was determined for a sample of 1,000 residential accounts. This analysis was done using aerial photography and geographical imaging system technology. This research found that lots had an average of 45% irrigable area and 55% impervious surfaces.

Commercial budgets are similar. However, for commercial, actual measured irrigable area is used to calculate water allotments for each site. Commercial customers are responsible for submitting this data.

Once in place these budgets were adjusted to include winter watering and extra allotments for establishing sod. Both block rates and break points were also adjusted.

Implementation took less than six months. Creating the new rate structure (including landscape budgets) was all done by utility staff. A major asset in developing the program was electronic versions of lot size data from county records. Centennial's billing system did not need to be replaced, and this too saved time and money.

Customer communication was also a prominent piece of the implementation process. Centennial conducted public meetings and workshops. Mailings were and still are used to communicate with customers about the rate structure.

City of Boulder

The City of Boulder established a water budget-based rate structure in 2007. This was also in response to the 2002 drought. This drought necessitated severe watering restrictions. These restrictions caused landscape to suffer and raised questions about drought enforcement policies.

In Boulder, budgets are established by customer type: single-family residential, multi-family residential, irrigation only and commercial/industrial accounts. For most customers, the annual water budget is the sum of the indoor and outdoor water allocations for a particular month.

Irrigable areas were measured using GIS. The outdoor budget for single family is determined by a tiered structure. The first 5,000 square feet of irrigable area is allotted 15 gallons of water per square foot. The next 9,000 square feet of irrigable area is allotted 12 gallons per square foot. Irrigable areas over 14,000 square feet are allotted 10 gallons per square foot. For reference, low-water use plants should need 10 gallons of water per square foot in Boulder's climate. For multi-

family and dedicated irrigation meters the allotment is 15 gallons per square foot over the whole irrigable area. To handle the variable water demands of CII accounts, and to keep the implementation process moving swiftly, Boulder decided to use historical consumption for each account as the basis for budgets.

Boulder's billing system had already been slated for replacement prior to the contemplation of budget-based billing. Before the new billing system was online, Boulder staff made an intensive effort to determine lot sizes and irrigable areas for each single family, multi-family and irrigation meter. Customer education was also a high priority during the interim before the new billing system was in place. Fliers explaining budget-based billing were sent to customers. A telephone hotline was set up for customer's queries. Forms were created for customers requesting an adjustment to their bill.

City of Castle Rock

The City of Castle Rock established a water budget-based rate structure in 2009 in an effort to reduce water demands in their groundwater-fed system as they transition to different water sources. In Castle Rock, the indoor portion of the water budget is based on the average winter consumption of the customer and the outdoor portion of the budget is based on the irrigated area.

Castle Rock contracted with a consulting firm to help develop the water rate structure and billing system used for implementation.

BEST PRACTICE 8: Rules and Regulations for Landscape Design and Installation and Certification of Landscape Professionals

- Programmatic and control practice
- Customer side best practice - implemented by water customers with support from water utilities
- Customer participation – action by customers required for successful implementation

Overview

The key concept of this best practice is creating landscapes that are "water smart from the start." 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 and install water efficient landscapes and irrigation systems that meet mandated standards.

Why a Best Practice?

In Colorado, urban landscape irrigation accounts for 50 percent or more of the total annual water demand for a utility.[13] Improving the efficiency of water use on urban landscapes is perhaps the single most important urban water conservation effort than can be made in Colorado.

Colorado's population is expected to double over the next 40 years. If all new landscapes in Colorado are designed, installed and maintained with water efficiency as a priority there is tremendous potential to reduce future demands below what they might be otherwise.

Ensuring that landscapes are designed and installed with water efficiency in mind and that landscape professionals have the best available training represents a best practice for water providers.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Low water use landscapes, drought-resistant vegetation, removal of phreatophytes, and efficient irrigation." [CRS 37-60-126 (4) (a) (II)].

[13] AWWA (1999), Aquacraft (2007), Davis et. al. (2009), Grabow et. al. (2009), Mayer et. al. (2009), McReady (2009), County (2008), Dukes et. al. (2008), GreenCO (2008), Guz (2008), Jakubowski et. al. (2008), Haley et. al. (2007), US BOR (2007), NCWCD (2008), Baum (2005), CSU, (2005), PMSI (2005), Bamezai (2004), Barta (2004), CWRRI (2004), MWDOC (2008, and 2004), DeOreo et. al. (1998), CSU (1994).

Applicability

This best practice is applicable to all utilities, cities, counties, and states seeking to improve the efficiency of outdoor use and increase the technical capabilities of local landscaping professionals.

Implementation

This best practice can be implemented through local ordinances and codes such as a model landscape code, green building programs, local building and plumbing codes, and the specification of training requirements. Proper jurisdiction must be determined for successful implementation and enactment may require approval of city or county government for some code provisions. This is an area where the State of Colorado could enact stricter plumbing codes and set landscape standards.

Mandating certification of landscape professionals is greatly simplified by the WaterSense Certification offered by the US EPA which accredits programs such as the Irrigation Association's training courses. An entity such as a city, county, or state can specify that all landscapes must be designed and installed by a WaterSense certified professional.

Additional landscape certification programs that may be considered are listed in Table 4-13 along with the sponsoring organization and link to access addition information.

Table 4-13: Landscape certification programs

Certification Program	Sponsoring Organization	Web Link
Licensed Landscape Architect	State of Colorado	www.dora.state.co.us/la/LAInstructions.pdf
Professional Land Care Network (PLANET)	Various programs	www.landcarenetwork.org/cms/certification/categories.html
- Landscape Industry Certified Technician (formerly CLT)	Professional Land Care Network (PLANET) and Associated Landscape Contractors of Colorado (ALCC)	www.landcarenetwork.org/cms/certification/clte.html www.alcc.com/index.php?option=com_content&view=article&id=154&Itemid=84
- Certified Landscape Professional (CLP)	Professional Land Care Network (PLANET)	www.landcarenetwork.org/cms/certification/clte.html
- Certified Turfgrass Professional	Professional Land Care Network (PLANET)	www.landcarenetwork.org/cms/certification/clte.html
Colorado Certified Nursery Professional (CCNP)	Colorado Nursery and Greenhouse Association (CNGA)	www.coloradonga.org
Certified Greenhouse Growers Program (CGG)	Colorado Nursery and Greenhouse Association (CNGA)	www.coloradonga.org
Certified Arborist	International Society of Arboriculture (ISARMC)	www.isarmc.org/pro/index.htm
Board Certified Master Arborist	International Society of Arboriculture (ISARMC)	www.isarmc.org/pro/index.htm

Certification Program	Sponsoring Organization	Web Link
Irrigation Association	Various Programs	
- Certified Irrigation Contractor (CIC)	Irrigation Association	www.irrigation.org
- Certified Water Conservation Manager – Landscape (CWCM-L)	Irrigation Association	www.irrigation.org
- Certified Irrigation Designer (CID)	Irrigation Association	www.irrigation.org
- Certified Landscape Irrigation Auditor (CLIA)	Irrigation Association	www.irrigation.org
- Certified Golf Irrigation Auditor	Irrigation Association	www.irrigation.org
- Certified Agricultural Irrigation Specialist (CAIS)	Irrigation Association	www.irrigation.org

Customer outreach is also an important component to implementing this best practice. A utility should communicate with customers about the value of quality landscape service. Customers should know who they are hiring and what their certifications and accreditations mean.

Water Savings and Other Benefits

Range of Likely Water Savings: Moderate to Significant

A 2002 study of three landscape tracts located in northeastern Colorado Springs compared water use between a traditional landscape and two landscapes developed using the principles of xeriscape. The study found water savings ranging from 22% to 63% over that of a traditional turfgrass landscape after implementing the rules and regulations set forth in the 1998 Colorado Springs Landscape Code and Design Manual. The tract developed prior to implementation of the 1998 manual applied 170% of ET to the landscape. The landscape manual was developed by following the main principles of good xeriscape design, installation, maintenance and "regulations set forth by the city, requiring additional [soil] amendments, inspections, and the submittal of landscape professional's credentials" (Schneider 2008).

There are many factors that contribute to water use and savings when considering urban landscapes. Many of the factors are behavioral (irrigation scheduling, maintenance, etc.) and education should be a component of a landscape efficiency program.

How to Determine Savings

Determining savings from new development is difficult since new demand patterns are being established and pre- versus post-analysis is not possible. Savings can be determined by comparing annual water demands on a new property against an older property or properties with comparable area, plantings, and irrigation methods.

There are no established methods for measuring the effectiveness of training and certification for landscape professionals.

Savings Assumptions and Caveats

Mandatory landscape water efficiency standards are more likely to achieve measurable savings for a community compared with voluntary programs. If programs consist of voluntary certifications (such as LEED), the number of new accounts with conservation measures in place will be significantly lower than if standards are mandated and enforced. Many voluntary green

building programs encompass much more than water conservation, and as such, buildings may qualify as green without having significantly reduced water use.

Goals and Benchmarks

Water providers seeking to ensure long range irrigation efficiency should establish a goal of having all new landscape and/or irrigation system installations and retrofits meet strict efficiency standards. Water providers should also seek mandate that local landscape professionals be trained and certified. Because of jurisdictional issues, water providers may need to work with local and/or state to enact certain code and training requirement provisions.

Other Benefits

In addition to water efficiency, well-designed and maintained landscapes also improve storm water management, provide recreation opportunities, offer habitat to local wildlife, and provide aesthetic benefits (GreenCO 2008). Additionally, proper landscape installation can reduce life-time maintenance costs.

Costs

Utility Costs

Costs for new rules fall less on utilities than on customers. However, passing ordinances costs legal fees, staff time for research and political capital. There are no exact numbers for costs of adopting ordinances, codes and rules.

Enforcement of any new rules can add to costs. However, in the case of rules involving new construction, water utilities are not solely responsible for enforcement. If water conservation standards are incorporated into the local government's building code, enforcement can be part of the building department's permitting process.

Costs associated with requiring certification of landscape professionals are similar to rules for landscape installation. Creating requirements will take staff time, some financial outlay and political will. These costs are small compared to enforcing such rules. Enforcement costs can be significant, however. One way to manage enforcement costs is to have requirements built into the building permit process. For example, the permitting process could require that only certified professionals are allowed to design landscapes. While this approach will capture new building projects, new installation of landscape on existing buildings may not be controllable through the building permitting process. This approach will not be able to control who performs maintenance of landscapes and irrigations systems.

Customer Costs

Utilities contemplating landscape installation regulations must realize that there are many stakeholders who will see both costs and benefits. There are two distinct types of customers affected by rules for new construction. Builders and residents each face different costs and savings potentials from rules for new construction. The commercial sector sees an additional disconnect in costs for green building in that building owners may bear the costs associated with green building but tenants may reap the rewards in the form of lowered utility bills.

Builders face increased costs from constructing green buildings. A study on the costs associated with LEED certification found that green building practices added 1.5% to 3% to the so-called soft costs (such as design and certification) of building a commercial building. Complete costs, from design through implementation were estimated to be 4% to 11% (Northbridge Environmental Management Consultants, 2003). The EPA calculates additional costs associated with WaterSense New Home Specifications to range from $700 to $3,000, with $300 of that allocated for turf and mulching.

Occupants of green buildings, on the other hand, will likely see savings in the form of reduced utility bills. The EPA estimates that WaterSense homes save $100 per year in utility costs over standard new homes and $200 in utility costs over a typical home.

Most of the costs for professional certification requirements will be borne by customers and contractors and not by the utility. Professionals and companies employing irrigation professionals will be faced with costs of certification. Irrigation Association certification costs range from $250 to $500 for examination fees; annual renewal fees cost between $50 and $150. Certified professionals will likely charge a higher rate for their services, meaning these costs may be passed on to customers. Requiring certification will tend to level the playing field for irrigation professionals who currently have to compete with businesses with fewer qualifications and less training.

Resources and Examples

Resources

Additional information on WaterSense – including information for utilities – can be found online at the EPA website: www.epa.gov/watersense/partners/promotional.html

Information on LEED can be found at the US Green Building Council's website: www.usgbc.org/

Utilities must identify and make available a local source of ET data. There are several sources for ET data for Colorado. Colorado ET provides links to different three ET networks around the state. www.coloradoet.org/etnetworks.html. Denver Water maintains nine weather stations in the metro area.

Northern Colorado Water Conservancy District (NCWCD) has 24 weather stations located in the northeastern part of the state, six of which are located east of Greeley. Some stations are located on turfgrass and others are in agricultural settings. The website provides daily weather summaries at each station dating as far back as 1996 for some stations. More information can be found at www.ncwcd.org/weather/weather.asp.

Colorado Agricultural Meteorological Network (CoAgMet) is a network of over seventy-two weather stations located around the state primarily in rural agricultural settings. Originally developed by plant pathology specialists at Colorado State University and the USDA's Agricultural Research Service Water Management Unit, as a means of collecting local weather data in irrigated agricultural areas, the site now provides ET data for many areas of Colorado.

Climate data is now being collected by the Colorado Climate Center at CSU and can be found at www.coagmet.com/

Examples

Model Codes – DOLA Steamboat Springs and Routt County

Colorado's Department of Local Affairs has various model building codes, including a green building program that includes rules for new landscapes. The City of Steamboat Springs, Routt County and DOLA collaborated to develop a green building program. DOLA offers the program as a working model for other communities. The program was developed to provide guidance for green building and to raise the bar on green standards. The program applies to single family, duplex and row town home construction. A green building checklist is required when applying for a building permit. The building plans will then be reviewed against the checklist. If the minimum point threshold is met, the building permit will proceed through the usual sign off process.

The checklist is organized to follow the construction process. It comprises 17 categories and a total of 321 possible points. The categories include energy, recycling and reuse, electrical, landscaping and plumbing. The landscape requirements section has a score of 27 possible points. The mandatory measures affecting water use include:

- Turfgrass must have water use requirement less than Buffalo Grass, Tall Fescue or Blue Grama.
- Installed irrigation systems must use low-flow drip or bubblers and low-flow sprinklers.

Table 4-14 shows a list of water conservation rules for landscape in the DOLA plan.

Table 4-14: Water conservation rules for landscape found in DOLA Model Green Building Program

Measure	Means of Conservation
Construct water efficient landscapes	Native species account for 75% of plants, and these must be drought-tolerant species.
Group plants by water needs (hydrozoning)	Hydrozoning matches water needs of plants located together.
Turf type	Water requirement will be less than or equal to Tall Fescue, Buffalo Grass, or Blue Grama.
No turf on hard to irrigate areas	Turf shall not be installed on areas with slope greater than 10% or on turf strips less than eight feet wide because these types of areas are hard to irrigate efficiently.
Limited turf area	Turf must be less than 33% of landscape area (for 2 points) or less than 10% of landscape area (for 3 points).
Irrigation system uses low-flow technology	System uses only low-flow drip, bubblers, or low-flow sprinklers.
Irrigation system includes rain sensor	The system includes a rain shut-off device.
Irrigation system includes a weather-based irrigation controller	The irrigation system is controlled by a weather-based irrigation controller with the idea that such controllers reduce over-watering.

The Colorado Department of Local Affairs (DOLA) has links to other green building programs in the state. Links and details on the Steamboat Springs and Routt County program can be found at: www.dola.colorado.gov/osg/modelcodes.htm#GreenBuildingProgram

Castle Rock – required training for landscape professionals

The Town of Castle Rock requires anyone designing, installing or maintaining properties within the Town to attend the Town's Landscape Registration Program and GreenCO's Best Management Practices Training and Exam. The Landscape Rules and Regulations training covers their ordinance information and also affidavits to confirm understanding of the regulations. If professionals do not attend, they cannot perform work in the Town of Castle Rock.

Sterling Ranch – conservation from the developer's point of view

Conservation is not the sole purview of water utilities – nor should it be. Developers have a major role to play in water conservation. One example of a proposed development design with strong water planning goals is Sterling Ranch. Sterling Ranch intends to be a 3,100 acre, multi-use development located in Douglas County. Building in the development is slated for 2011, but already the conservation plan is in place. The developer, Sterling Ranch LLC, states that they are, " a firm believer that new development must be planned to meet human needs while protecting natural resources so that these needs can be met into the indefinite future," (Headwaters Corp. 2009). Water planning includes several aspects, such as a water supply plan (recycled water is a major part of the water supply plan), water treatment, water demand planning and conservation.

A major conservation component enacted by Sterling Ranch is a proposal to limit landscapes to an average of 1,500 square-feet per single family detached home. This will be done through landscape water budgets. Sterling Ranch plans to have builders submit front and back yard landscape designs for approval. Sterling Ranch plans to follow up with 100% inspection of all sites. Efficient sprinklers or sub-surface drip will be standard. Narrow swaths of landscaping will be watered with subsurface or drip, in an effort to limit overspray (Headwaters Corp. 2009).

City of Westminster Landscape Regulations

Westminster City Council adopted landscape regulations with provisions for design, installation and maintenance criteria which took effect in September 2004. The landscape regulations are intended to enhance property values and the living environment while improving air and water quality and reducing heat, dust, and noise. The efficient use of water resources is an important component of the landscape regulations as well and addresses water conservation through water wise landscaping, xeriscape and irrigation design. The regulations pertain to all landscaped areas and include:

- New development
- Redevelopment (with exceptions)
- Existing development requesting modification from previously approved plans
- Non-single family detached dwellings with no Official Development Plan or waiver
- Existing single family detached dwellings with no Official Development Plan of waiver

New landscape designs or modification of existing landscapes are subject to approval and must incorporate certain irrigation and landscape design elements. They include:

- The seven principles of xeriscape
- Identification of low, moderate, and high hydrozones on landscape and irrigation plans[14]
- Water budget not to exceed 24 inches (15 gallons) per square foot/year
- Transitioning of hydrozones
- Installation of automatic irrigation systems
- Soil preparation to include rototilling and incorporation of soil amendment. Soil analysis recommended
- Mulching in all non-turf areas; organic mulch required in moderate and high hydrozones
- Plant selection and location must be appropriate for the hydrozone

Section XII of the Westminster Landscape Regulations 2004 provides considerable detail of the design and construction of the irrigation plan and installation requirements. Although not part of the Official Development Plan, the irrigation plan must be submitted for review and approval at the same time. This section reiterates many of the basic irrigation design, installation, and operating recommendations and requirements necessary for efficient operation of an irrigation system as set forth by the Irrigation Association (IA 2002).

An Evaluation of Landscape Regulations in a Planned Community in Colorado Springs

The impact of rules and regulations, designed to conserve water in the landscape, was examined in a planned community in Colorado Springs in 2002. Evaluation of water use was performed on three separate tracts of land located within a master planned community consisting of large areas of open space, including two housing communities and a business campus. Development of the community took place over a period of twenty-five years and as a result the community has created a mix of landscapes "that are representative of different regulation and design eras" (Schneider, 2008) in the three tracts of land.

Because of the similarity of characteristics of the three sites (proximity, climate, part of the same master plan), the study sites provided a much better than normal opportunity to examine the impact of various codes, regulations, and the enforcement of each on water consumption. Each tract was developed using one of three sets of codes:

1. City landscape codes, policies, and guidelines developed and enforced prior to 1998
2. City landscape codes, policies, and guidelines developed and enforced after 1998
3. Regulations required by the master plan combined with city landscape and policy guidelines developed after 1998 but without enforcement

A scoring system of water savings measures[15] was developed for the study as a way to determine the effectiveness of various conservation measures. The site that was developed prior to 1998

[14] Low hydrozones require no more than 3 gallons/SF/yr; moderate hydrozones require 10 gallons/SF/yr; high hydrozones require 18 gallons/SF/yr.

had implemented only six water savings measures at the time of the study whereas the second and third sites implemented thirty and thirty-six measures respectively during the same period. Water use varied considerably at each of the three sites; the site that was developed prior to the 1998 rules and regulations had water use that was 70% greater than that of ET for the same time period. The second site and third sites were developed using the same principles of a water efficient landscape design but showed significant variability in savings. The second site showed a savings of 63% over that of a traditional turfgrass landscape. Irrigation management decisions resulted in water use that exceeded ET by 11%; the result of manually irrigating areas that were not designed to be irrigated. Manual irrigation was applied to plants that were perceived not to be thriving as a result of improper soil preparation. When the data were normalized to control for the manual irrigation, the site showed water savings of 22% over that of a traditional landscape (Schneider, 2008).

WaterSense Certification for Landscape Professionals

In addition to the new home specifications, WaterSense also includes certification for landscape professionals. This program is analogous to the WaterSense label for products in that it provides a standard for evaluating certification programs. As part of the New Home specification, landscapes must be evaluated by a WaterSense irrigation partner. While this requirement can be waived if there are too few WaterSense irrigation partners, it presents a model of possible certification requirement. The labeling program targets three categories of landscape professionals:

- Irrigation system designers,
- Irrigation system contractor[16]
- Irrigation auditors.

Each of these professional types has similar requirements for labeling.

- Programs must have an independent oversight committee.
- Certification must require experience. In the case of auditors, the certification program must require at least one irrigation audit be performed before being certified. For irrigation system designers, certification must require at least three years of experience in the field of landscape design.
- Installation and maintenance professionals must have at least one year of experience before they can be certified.
- In order to be awarded a WaterSense label, a certification program also must have an examination component.
- Exams must be independently administered and graded.
- In order to be awarded the WaterSense label, the certification must require certification renewal including continuing education. (EPA WaterSense Program 2006, Specification for WaterSense Labeling of Certification Programs for Irrigation System Installation and Maintenance Professionals, Specification for WaterSense Labeling of Certification

[15] The scoring system gives points for implementing the principles of xeriscape, good design, efficient irrigation, and regular maintenance of the landscape and irrigation.
[16] Irrigation contractors are responsible for the installation, maintenance, and repair of the irrigation system.

Programs for Irrigation System Designers and Specification for WaterSense Labeling of Certification Programs for Irrigation System Auditors).

Specific exam topics are shown in Table 4-15.

Irrigation Association

The Irrigation Association (IA) provides several training and certification programs for landscape professionals. Association members include landscape equipment manufacturers, landscape installation and maintenance professionals, retailers and distributors. The organization's mission is to promote efficient irrigation. The certification process, including training and the composition of exams, is overseen by IA's Certification Board. Several of the IA certifications have been approved to the EPA WaterSense label. Six areas of certification are offered by the IA. These are shown in Table 4-15. Details can be found at http://irrigation.org/certification/default.aspx?pg=programs.htm&id=93.

Table 4-15: WaterSense experience and exam requirements for certification programs (EPA WaterSense 2006)

	Irrigation Installation and Maintenance Professionals	**Irrigation System Designers**	**Irrigation Auditor**
Experience required	A minimum of one year of experience installing and maintaining irrigation systems	At least three years of design experience	At least one audit performed prior to certification
Exam Topics Required	• Knowledge of system components, system design layout and equipment specifications particularly as they pertain to distribution uniformity and system efficiency • System maintenance • Soil/water/plant relationships • Precipitation rates and irrigation scheduling • Impact of site conditions on equipment choice • System hydraulics • System pumps • System pressure • Equipment commissioning • Blueprint reading and interpretation • Awareness of other aspects of good practice, such as OSHA • Electrical and plumbing codes • Knowledge of when local and state regulations supersede federal regulations. • Recent innovations and technology developments	• Design, operation, and scheduling for water efficiency • Preparation of site design reflecting site requirements • Soil/water/plant relationships • Slope and runoff • Equipment selection and specification • System hydraulics • System pumps • System pressure • Maintenance • Evaluation of available water sources • Water management (budgeting and consumption) • Awareness of other aspects of good practice, such as OSHA • Electrical and plumbing codes • Knowledge of when local and state regulations supersede federal regulations. • Recent innovations and technology developments	• Distribution uniformity • Precipitation rates and irrigation scheduling • Water pressure and impact on sprinkler performance • Auditing process • Soil/water/plant relationships • Recognition of system problems and maintenance requirements • Awareness of other aspects of good practice, such as OSHA and • Electrical and plumbing codes • Knowledge of when local and state regulations supersede federal regulations • Recent innovations and technology developments

Table 4-16: Certification types offered by the Irrigation Association (Irrigation Association 2010)

Certification Type	Overview	Requirements
CIC, Certified Irrigation Contractor	• Execute irrigation projects to meet all specifications and requirements. • Prepare installation sites, including layout, staking, excavation, boring, trenching, grading and back-filling. • Cut and join pipe, know the limitations of different piping systems and understand basic hydraulics. • Layout and install piping and water delivery components; backflow prevention components; mechanical, hydraulic and electrical irrigation controls; and other irrigation system components. • Troubleshoot and repair irrigation components and systems. • Understand good business practices; construction contracts and their legal rights and obligations; and licensing laws and codes in their state.	• Demonstrate a minimum of three years of irrigation-related experience and education. • Pass a written exam on general irrigation and specialty topics. • Agree to follow the Code of Ethics established by the IA Certification Board. • Remain in good standing by submitting 10 continuing education units and a nominal renewal fee each year.
CID, Certified Irrigation Designer	• Evaluate site conditions and determine water availability and use requirements. • Select the most effective irrigation equipment, methods and materials for the application. • Develop efficient and cost-effective irrigation designs that meet the plant or crop's watering requirements. • Prepare comprehensive plans and specifications that include construction details, equipment or materials, as well as appropriate irrigation schedules. • Ensure the installation matches the design intent. • Provide direction to the end user on system use, scheduling and maintenance.	• Evaluate site conditions and determine water availability and use requirements. • Select the most effective irrigation equipment, methods and materials for the application. • Develop efficient and cost-effective irrigation designs that meet the plant or crop's watering requirements. • Prepare comprehensive plans and specifications that include construction details, equipment or materials, as well as appropriate irrigation schedules. • Ensure the installation matches the design intent. • Provide direction to the end user on system use, scheduling and maintenance.

Certification Type	Overview	Requirements
CLWM, Certified Landscape Water Manager	• Evaluate site conditions and determine water availability and use requirements. • Have working knowledge of general irrigation theory, including hydraulics, soil-plant-water relationships, water requirements and electricity principles. • Understand irrigation equipment selection, use, restrictions and installation methods. • Identify and implement system upgrades and modifications, and manage the control system to provide the most efficient irrigation possible. • Provide direction to the end user on system use, scheduling, maintenance and water conservation.	• Demonstrate a minimum of three years of irrigation-related experience. • Be an IA certified landscape or golf irrigation auditor in good standing. • Pass a written exam on irrigation water management topics, including scheduling, efficiency, and uniformity and soil-plant-water relationships. • Agree to follow the Code of Ethics established by the IA Certification Board. • Remain in good standing by submitting 10 continuing education units and a nominal renewal fee each year.
CGIA, Certified Golf Irrigation Auditor	• Develop system testing strategies. • Identify plant materials by general groups and determine irrigation water requirements. • Take soil samples and determine soil types and root zone depths. • Observe system operations, locate irrigation zones, prepare site audit maps and visually identify broken or misaligned equipment. • Check pressure and flow rates, conduct water application distribution tests and collect data to determine irrigation uniformity and efficiency. • Estimate potential dollar and water savings.	• Demonstrate a minimum of one year of irrigation-related work experience. • Pass a written exam on the principles and practices of auditing. • Submit an independently completed audit on a green and fairway for evaluation. • Agree to follow the Code of Ethics established by the IA Certification Board. • Remain in good standing by submitting 10 continuing education units and a nominal renewal fee each year.

Certification Type	Overview	Requirements
CLIA, Certified Landscape Irrigation Auditor	• Develop system testing strategies. • Identify plant materials by general groups and determine irrigation water requirements. • Take soil samples and determine soil types and root zone depths. • Observe system operations, locate irrigation zones, prepare site audit maps and visually identify broken or misaligned equipment. • Check pressure and flow rates, conduct water application distribution tests and collect data to determine irrigation uniformity and efficiency. • Estimate potential dollar and water savings.	• Demonstrate a minimum of one year of irrigation-related work experience. • Pass a written exam on the principles and practices of auditing. • Submit an independently completed audit on one rotor and one spray area for evaluation. • Agree to follow the Code of Ethics established by the IA Certification Board. • Remain in good standing by submitting 10 continuing education units and a nominal renewal fee each year.
CAIS, Certified Agricultural Irrigation Specialist	• Understand surface irrigation methods and pressurized systems, including micro-irrigation and sprinklers. • Evaluate crops and determine water availability and use requirements. • Understand soil-plant-water relationships and how salinity affects irrigation. • Select the most effective irrigation methods and equipment for the application. • Develop efficient and cost-effective irrigation schedules that meet the crop's water requirement.	• Pass a written exam on the principles and practices of on-farm irrigation management. • Agree to follow the Code of Ethics established by the IA Certification Board. • Remain in good standing by submitting 10 continuing education units and a nominal renewal fee each year.

Colorado House Bill 10-1358

Colorado House Bill 10-1358, passed in May 2010 and taking effect in 2011, presents buyers of new homes with the chance to select water efficient appliances and fixtures up front. By integrating high-efficiency toilets, water efficient clothes washers, low flow faucets and showerheads, and water-smart landscapes into new homes at the outset, we can avoid sending precious water and money down the drain. This bill allows new home buyers to chose from several options, including:

- Low use water fixtures like toilets, faucets, and showerheads
- High efficiency washing machines that save both energy and water.
- Financed water wise landscape upgrades implemented by the builder and designed utilizing GreenCO's best management practices (GreenCO 2008) including proper landscape design, installation, irrigation technology, water budgeting and all 7-principles of Xeriscape.

More information about this new Colorado program can be found here: www.leg.state.co.us/clics/clics2010a/csl.nsf/fsbillcont/7F972C539E9610D6872576BE0079EE23?Open&file=1358_rer.pdf

California Model Water Efficient Landscape Ordinance

California's Model Water Efficient Landscape Ordinance presents a sophisticated approach to defining new landscape requirements. California law requires municipalities to adopt ordinances governing landscape conservation and this model ordinance is the approved template. There are supporting documents online, including a table of text that will need to be changed for adoption of the ordinance by other agencies. This table can be found at the California Department of Water Resources website: www.water.ca.gov/wateruseefficiency/landscapeordinance/.

Two methods of calculating a water budget for the landscape were compared for the California Model. One landscape budget was calculated using the maximum applied water allowance and was based on the amount of area landscaped, local climate (using ET) and an ET adjustment.[17] This budget functions as the design standard. The second method of calculating the landscape water budget – the estimated total water use – is calculated based on the water needs of the plants chosen as part of the landscape design and the total area irrigated. The estimated water use may not exceed the maximum water allowance. Because the California ordinance bases water need on local ET, it can be readily translated to Colorado's various local climates.

EPA WaterSense

WaterSense is a label and certification program developed by the United States Environmental Protection Agency. This label has been applied to a number of products, but WaterSense has also released a standard of efficiency for new homes. The development process included stakeholders with different perspectives. Water utilities, product manufactures, retailers and consumers were all involved in creating the WaterSense standards. Products are independently tested to earn the WaterSense label.

[17]The ET adjustment in California is 0.7 in the case of new landscape.

The EPA WaterSense specification for new homes extends beyond labeling fixtures and extends to household-wide uses of water. This standard requires WaterSense fixtures and Energy Star appliances, which are covered in Best Practice 8 but also includes landscape design and installation specifications. These specifications recommend conservation-oriented landscape design, slope management, mulching, and pool covers. Irrigation systems are not required. However, if they are installed, the systems are subject to efficiency standards.

There are two approaches for landscape design in the WaterSense requirements. The simplest approach is to limit turfgrass to 40% of the landscaped area. Alternatively, landscapes may be designed using a water budget (see Best Practice 10). The budget tool is a Microsoft Excel-based calculator that can be found at: www.epa.gov/watersense/nhspecs/water_budget_tool.html. For each hydrozone, the landscape designer enters square footage and then selects plant type and irrigation type. Zip code-based ET and rainfall data are needed and are available from the EPA website (with a hyperlink in the relevant place on the tool spreadsheet). These data comes from the International Water Management Institute and based on historic data gathered from 1961 to 1990. The calculator then determines how much water the given design will use. If it is more than the allowance calculated from the ET and rainfall, the calculator indicates that the design should change. However there is no guarantee that limiting turf will absolutely result in a certain percentage of water reduction, since people can and do over water turf, no matter how much they have in their yards.

WaterSense goes beyond landscape design and has additional standards for outdoor water use:

- Pools must be covered when not in use; water features must use re-circulated water.
- Once installed, the landscape must be evaluated by a WaterSense irrigation partner (unless there are an insufficient availability of irrigation partners).
- The system shall not have leaks, runoff or overspray.
- The lower quarter distribution uniformity shall be 65% or higher. The lower quarter distribution uniformity is, “the average water applied in the 25% of the area receiving the least amount of water divided by the average water applied,” to the total area (The Irrigation Association 2007). It measures the potential for dry patches and over-watered areas. See Best Practice 10 - landscape evaluations.
- The system shall be equipped with a rain sensor.
- Sprinklers shall not be used to water landscape other that turfgrass.
- Micro-irrigation systems shall be equipped with pressure regulators, filters and flush end assemblies.
- Schedules developed in the audit phase shall be posted at the controller.

In addition, there are several measures targeting storm water management: slopes must be vegetated and exposed soil must be covered with mulch.

In order to meet the standard, homes must be inspected by an independent contractor. It is estimated that WaterSense homes will be 20% more efficient than typical new homes. Over the course of a year, these homes are expected to save 10,000 gallons of water. (EPA WaterSense Program 2009 WaterSense Single-Family New Home Specification Supporting Statement).

Utilities looking for water savings in the residential sector can use EPA WaterSense to specify community standards for landscapes. Sixteen utilities in Colorado are WaterSense Promoting Partners. Partners are given a tool kit specific to their needs. For utilities, the kit includes materials promoting conservation.

Additional information on WaterSense – including information for utilities – can be found online at the EPA website: www.epa.gov/watersense/partners/promotional.html

LEED

LEED (Leadership in Energy and Environmental Design) is a scoring program for green building. LEED was created by the US Green Building Council, made up of public and private entities focused on promoting environmental building practices. LEED standards cover a broad range of building types and a few specific CII types such as schools and hospitals. LEED is applicable to both new and existing buildings. LEED certification is voluntary.

The LEED program is based on scoring different conservation measures across a broad range of environmental issues, of which water is only one part. Water efficiency accounts for 11 out of 110 possible points in the scoring system. Certification for LEED is based on four possible scoring levels: certified (40 to 49 points), silver (50 to 59 points), gold (60 to 79 points), and platinum (80 points or higher).

The areas of focus for LEED are:

- Energy and atmosphere
- Sustainable sites
- Materials and resources
- Indoor environmental quality
- Location and linkages (e.g. located near transit options)
- Education and awareness
- Water efficiency
- Innovation and design
- Regional priority

LEED's philosophy on water conservation is, "While saving water may be one boon of the survey, secondary benefits may not be as apparent…. Finding and stopping leaks may also prevent structural or landscape damage."

Water conservation measures for LEED 2009 (version 3) are:

- 20% reduction in water use[18]
- Innovative waste water technologies
- Water efficient landscaping

[18] This is the only required water conservation measure. Additional conservation break points are at 30%, 35%, and 40%.

- Water use reduction beyond 20%.

The Alliance for Water Efficiency has recommendations for water utility personnel who are trying to ensure that their green programs include water conservation:

- Be familiar with green building programs in your service area. This includes voluntary and mandated programs.
- Seek out other programs and governments working on sustainability issues. Guide and advise them about water conservation.
- Know about national standards that may be adopted or in place in your area. Make friends in the local government offices charged with building codes and land use.
- Be alert to "green washing," the tendency to adopt and promote practices that appear to be sustainable but have little or negative impacts on conservation. Be aware that many green building programs focus on energy conservation far more than water conservation.

(Alliance for Water Efficiency 2010)

Built Green Colorado

Built Green Colorado is one of oldest and largest green home building programs in the nation. It was started by the Home Builders Association of Metro Denver for the purpose of encouraging home builders to use technologies, products, and practices that result in homes that are better built and better for the environment.

Similar to LEED certified homes, Built Green homes must achieve a minimum amount of points awarded for incorporating certain technologies across topic areas. A detailed checklist provides the home builder with the required specifications and associated point values. The Built Green standards have also been adopted to certify homes by Build Green Utah. A selection of the Built Green Water Conservation requirements is provided below.

- Efficient hot water delivery system is designed so that water heater is within 20 pipe feet of all hot water fixtures.
- Clothes washer has ENERGY STAR label.
- Toilets are dual-flush gravity, or pressure/vacuum assist averaging 1.1 gallon per flush
- Landscape is designed based on a water budget with a maximum of 15 gallons per square foot per year.
- Efficient irrigation system incorporates hydrozones where shrubs and trees are irrigated with drip or subsurface irrigation.
- A list of drought-tolerant plants is provided to home buyers.

(Source: WRA 2009)

BEST PRACTICE 9: Water Efficient Design, Installation, and Maintenance Practices for New and Existing Landscapes

- Programmatic and customer support best practice (utility perspective)
- Customer side best practice - Implemented by water customers with support from water utilities.
- Customer participation – Action by customers required for successful implementation.

Overview

How we design, install, and maintain our landscapes and irrigation systems can greatly impact the amount of water needed to keep the plants alive and healthy. This best practice describes key considerations for maximizing water efficiency through the proper design, installation, and maintenance of new and existing landscapes and irrigation systems. The information presented here is largely based on the work of the Green Industries of Colorado (GreenCO) published in their 2008 BMP guide (GreenCO 2008).

Recent studies suggest that technology alone will not render the level of efficiency desired in urban landscapes (Mayer, et. al. 2009). Irrigation must be addressed with a systems approach that includes design, installation, and maintenance as well as the selection of plant materials and individual irrigation technologies. Education of those operating and maintaining systems should not be overlooked.

Landscape design, installation, and maintenance practices offer a non-regulatory approach to improving outdoor water use efficiency. Proper design and installation can ensure landscapes are capable of thriving on less water. Maintenance practices can help preserve and ensure conservation savings. This best practice is wide ranging and includes many commonly used everyday practices.

The *Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado: Moving Toward Sustainability* (GreenCO 2008) is the fundamental companion document to this best practice. The GreenCO BMPs are richly detailed and provide tremendous detail on the methods and practices for ensuring water efficiency in Colorado landscapes. These BMPs were developed with broad stakeholder support and form the foundation for the best practices described below.

The seven basic principles of xeriscape, developed years ago by Denver Water (and others), remain the fundamental underpinning for conservation-oriented landscapes. These principles are: planning and design, soil improvement, grouping plants with similar water demands, practical turf areas, efficient irrigation, mulching, and appropriate maintenance. In the *Handbook of Water Use and Conservation*, (Vickers 2001) Amy Vickers adds one additional principal to this foundational list: selection of native and low-water-use plants.

Why a Best Practice?

In Colorado, urban landscape irrigation accounts for 50 percent or more of the total annual water demand for a utility.[19] Improving the efficiency of water use on urban landscapes is perhaps the single most important municipal water conservation effort than can be made in Colorado.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Low water use landscapes, drought-resistant vegetation, removal of phreatophytes, and efficient irrigation." [CRS 37-60-126 (4)(a)(II)].

Applicability

The water efficient landscape design, installation, and maintenance practices described in this best practice apply to both utility customers and landscape professionals who are designers, installers, irrigators, and maintainers of urban landscapes. An irrigator is defined here as anyone that regularly applies utility treated potable water to a landscape through a manual or automatic irrigation delivery system.

Many of the practices and principles described in this best practice will also apply to water utilities for their own irrigation practices and to their efforts to educate and inform their customers.

Implementation

Landscape Design

Whether developing an entirely new landscape or renovating an existing yard, properly planned and designed landscapes can conserve water and protect water quality. For both the do-it-yourself project and the professionally designed landscape, key considerations for water efficient landscape design include:

- Consider site conditions including existing slope, soil, drainage, and plants
- Provide soil most appropriate to the plants
- Use of native and low-water-use plants
- Limit turf areas to those needed for practical purposes
- Group plants according to their water needs (hydrozoning)
- Use efficient irrigation systems
- Mulch over soil and around plants to reduce evaporation

[19] AWWA (1999), Aquacraft (2007), Davis et. al. (2009), Grabow et. al. (2009), Mayer et. al. (2009), McReady (2009), County (2008), Dukes et. al. (2008), GreenCO (2008), Guz (2008), Jakubowski et. al. (2008), Haley et. al. (2007), US BOR (2007), NCWCD (2008), Baum (2005), CSU, (2005), PMSI (2005), Bamezai (2004), Barta (2004), CWRRI (2004), MWDOC (2008, and 2004), DeOreo et. al. (1998), CSU (1994).

The *Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado: Moving Toward Sustainability* (GreenCO 2008) includes 39 guidelines for landscape design in a detailed BMP. Key elements of this and other GreenCO BMPs are summarized into this best practice.

Site Considerations – "Consider existing grade (slope), existing plants to preserve/protect, exposure to natural (e.g., wind, sun) and human elements (e.g., pedestrian traffic), soils, availability of natural precipitation and supplemental irrigation, and drainage when designing the overall landscape." (GreenCO 2008) Groundcovers with lower water requirements are a good choice for slopes and hard-to-mow locations. Place lower-water demand plants at the tops of slopes and higher-demand plants at the bottom, in lower-lying drainage areas, near downspouts or in the shade of other plants.

Soil Condition – Evaluate the soil through tests and improve it, if necessary, to promote efficient water use and healthy plants (GreenCO 2008). In order to determine the proper soil amendments to use at a site, inexpensive soil tests like those conducted by the CSU Soil Testing Lab are recommended. The GreenCO BMPs offers useful guidance on soil amendments and testing. In general, the best soil amendments increase water and nutrient holding capacity while improving aeration and water infiltration which is critical to reducing water demands (Davis and Wilson 2005). In Colorado, there are many areas that have very rocky or porous, sandy soils and amendments can be useful in these soils. Another option is to select plants that thrive in sandy soils. Colorado is also known for its heavy clay soils with poor aeration which are found in many urban areas. Adding water to clay soils can cause oxygen starvation in the root zone. Clay soils can limit the growth of some plants, but many native and xeric plans have adapted well to clay soil and in fact prefer it over amended soil as long as it is not over-watered.

Plant Selection – Many plants are capable of thriving without supplemental irrigation. Reducing supplemental water requirements is fundamental to designing landscapes that are water efficient. Consider creating at least one part of the landscape that can thrive on available precipitation without additional irrigation (except during establishment and during unusually dry periods). Key resources to assist in plant selection include the *Annual and Perennial Plant Guide and Rocky Mountain Plant Guide* published by the Colorado Nursery and Greenhouse Association (www.coloradonga.org) and the X-rated gardening website maintained by the Garden Centers of Colorado (www.gardencentersofcolorado.org/xratedgardening2/) (GreenCO 2008).

Practical Turf Areas – "Limiting lawns to functional spaces devoted only to practical uses – for example, recreation and sitting areas – can significantly reduce landscape irrigation needs" (Vickers 2001). Turfgrass is often the plant with the highest water demand in a landscape, but many varieties of grass are now available including some which require less supplemental water. The CSU Turfgrass Program website (http://csuturf.colostate.edu/) offers the latest studies on the advantages and disadvantages of various grass species (GreenCO 2008).

Hydrozoning – Group plants with similar water requirements together. This practice is known as hydrozoning. The reason hydrozoning is so important is because irrigation systems should be designed to apply water evenly across each zone or area. If plants in one zone have different

water requirements, the irrigation system must be adjusted to meet the needs of the highest water use plant in the zone, thus delivering more water than is necessary to meet the needs of the rest of zone.

Efficient Irrigation – Efficient irrigation means applying the minimum amount of water required for a healthy landscape with an acceptable level of appearance. Efficient irrigation practices are important for both manual and automatic irrigators although most of the literature on this subject is devoted to automatic irrigation systems. Automatic irrigation is not required for effective and efficient irrigation and numerous studies have shown that manual irrigators use significantly less water on average than automatic irrigators (Mayer et. al. 1999). However, many people prefer the convenience of an automatic system.

In order to provide efficient irrigation, **"**Properly design, install and maintain irrigation systems to ensure uniform distribution[20] and efficient delivery of water, thereby conserving water and protecting water resources" (GreenCO 2008).

The Irrigation Association (IA) has established the five fundamental best practices for irrigation systems. They are as follows:

1. Assure the overall quality of the irrigation system.
2. Design the irrigation system for uniform distribution and efficient management of water.
3. Install the irrigation system according to the design criteria.
4. Maintain the irrigation system to adhere to the design criteria, for optimum performance.
5. Manage the irrigation system according to changing plant water requirements.

The GreenCO Colorado BMPs provide detailed information and additional resources on this large topic.

Mulch – Mulches are placed on the soil surface to reduce evaporation. GreenCO recommends using organic mulches to "reduce water loss through evaporation" and "to reduce soil loss due to exposure to wind and runoff and to suppress weeds and to provide a more uniform soil temperature" (GreenCO 2008). Use of mulch should be specified as part of a comprehensive water efficient landscape design.

Other benefits of mulch include:

- The reduction of weeds that compete with plants for moisture and soil nutrients
- Erosion control by allowing rainfall to be absorbed before running off
- Reducing soil compaction from rainfall and overhead irrigation
- Regulation of soil temperatures and reduction of damage to plants from freezing and thawing of the root zone
- Delineation of hydrozones

[20] Distribution uniformity is defined as the measure uniformity of irrigation water over an area (IA 2010).

It is important to select mulches that are appropriate for the hydrozone and plant type. Organic mulches break down with time and in so doing enrich the soil and improve the texture of the soil near the surface. Many plants selected for use in the landscape benefit from these characteristics of organic mulch.

Plants that have adapted to living under xeric conditions often perform better with the use of inorganic mulches. Many of these plants prefer soil without the addition of organic matter and have characteristics that enable them to thrive in poor soil with little or no irrigation. In fact the moisture retained by organic mulches can result in their early demise. The heat absorbed by inorganic mulch encourages plant growth and helps to reduce competition from weeds.

Other Design Considerations – Additional design considerations for maximizing landscape water efficiency include:

- In mountain areas in particular, wildfire hazards must be considered in any landscape design.
- Hardscapes are an often neglected element of landscape design. Hardscapes have no water requirement and as such form an important part in landscapes created to be water efficient.
- Wind can dramatically impact irrigation particularly if the sprinkler head creates a fine mist. In windy areas, sprinkler heads that produce larger drops of water should be considered.
- Water features including ponds, fountains, waterfalls, etc. are notoriously water wasteful even if designed to be re-circulating. Evaporative losses and unavoidable leaks place water features outside the boundary of good water efficient landscape design.

Landscape Installation

When installing a new landscape or replacing an existing landscape, minimize erosion and control sediment leaving the site during landscape installation, follow the landscape design plan carefully, and provide proper care of the landscape during installation (GreenCO 2008).

Sediment and erosion control practices summarized below, are detailed extensively in the *Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado: Moving Toward Sustainability* (GreenCO 2008).

- Protect existing plants and trees that are not to be impacted by the installation.
- Protect drainage areas from runoff.
- Comply with applicable stormwater permit requirements.
- Phase construction to limit exposed land.
- Properly store and if necessary cover topsoil and soil amendments (i.e. not in the street).
- Take special care with planted slopes to slow water runoff.
- Properly handle, store, and dispose of all chemicals, fertilizers and pesticides.

A significant portion of the installation best practices revolve around soil preparation because proper soil preparation can substantially reduce irrigation requirements by increasing water holding capacity.

Assuming that a water efficient landscape design has been completed, the installation process involves carefully following the design plan while minimizing impacts to neighboring properties and ecosystems and maintaining the health of existing plants and trees that are not to be impacted by the installation. GreenCO has identified the following areas for consideration during landscape installation (GreenCO 2008):

- Perform soil analysis to determine what amendments and fertilizer may be necessary.
- Properly amend soil as needed and till to a depth of 4 to 6 inches.
- Sow seeds at proper time of year and mulch seeded areas adequately to retain moisture.
- Maintain health of plants in containers prior to planting in the ground.
- Irrigate adequately and appropriately during the establishment period. Length of establishment varies with different plants.
- Conduct regular, routine inspections of new plantings and attend to any detected problems as soon as possible.

Irrigation System Installation[21]

Each irrigation system should be installed in accordance with design specifications as well as any applicable manufacturer specifications, local code requirements, and the fundamental principles of efficient and uniform water distribution (GreenCO 2008).

The irrigation system installation best practices, summarized below, are detailed extensively in the *Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado: Moving Toward Sustainability* (GreenCO 2008).

- Installation should not commence until all underground utilities are located and marked.
- Install the irrigation system in accordance with design specifications. Any alteration or deviation from the design should be approved in advance by the designer.
- The design and installation should both be completed by reputable professionals. (Please see best practice on certification of landscape professionals for additional information.)
- Ensure the water supply and pressure at the point of connection meet design criteria.
- On-the-ground reality often differs from plan drawings. Carefully review all site plans against what can be observed at the site to minimize conflicts between buildings, hardscape, plants of differing sizes, and sprinkler head placement.
- Alert the property owner and designers about unusual or unexpected site or soil conditions.
- Existing plants that do not receive supplemental irrigation may rely heavily on drainage for water to grow. Ensure that site drainage has not been altered.
- The irrigation designer (or other qualified inspector) and local authorities should perform at least one field observation during installation to ensure adherence to design specifications and local codes and to check for proper installation and function of the backflow prevention assembly, main line, pipes, valves, sprinklers, control wire, irrigation controller, and soil sensor(s) or rain shutoff device.

[21] This section of the best practice applies largely to in-ground automatic irrigation systems, although many of the same principles apply to manual irrigation systems as well.

- Furnish “as-built” record drawings to the owner of the system.
- Test the irrigation system to verify that the system meets the design criteria and delivers water uniformly in each zone.
- Create an irrigation schedule to meet the water requirements of the plants with minimal runoff. Understand that the establishment schedule will differ from normal operational schedule. Re-evaluate the irrigation schedule regularly to ensure efficiency and adequacy.
- Perform a thorough inspection of the system after installation and perform an irrigation efficiency evaluation of the site using established IA procedures after one year of operation of the new system (see Best Practice 10). Make any necessary repairs and adjustments.

Landscape Maintenance

To ensure optimum water efficiency, practice regular and appropriate maintenance for the landscape including (but not limited to): spring clean-up, mowing, aeration, pruning, weeding, mulching, fertilization and attention to the irrigation system (GreenCO 2008).

The landscape maintenance best practices, summarized below, are detailed extensively in the *Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado: Moving Toward Sustainability* (GreenCO 2008).

- Remove dead or dying plants and all weeds that compete with healthy plants for available water. Clean up plant litter and remove weeds before they go to seed.
- Replace or replenish mulch in areas where it has deteriorated.
- Aerate turf in the spring and in the fall, if needed, to eliminate compaction and improve the turf’s ability to take up moisture, nutrients and air.

Irrigation System Maintenance and Operation

Automatic irrigation systems must be maintained regularly to ensure efficient performance and uniform distribution of water. In Colorado, this minimally includes a check-up in the spring when the system is turned on and a winterization before the first hard freeze. During the irrigation season, the irrigation schedule should be modified to accommodate changing plant water needs and repairs should be made as required.

The irrigation system maintenance best practices, summarized below, are detailed extensively in the *Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado: Moving Toward Sustainability* (GreenCO 2008).

- Establish a systematic maintenance schedule for inspecting, testing and reporting on performance conditions of the irrigation system.
- Check, adjust and repair irrigation equipment on a regular basis, ideally on a weekly schedule and within 24 hours of mowing, whenever possible.
- The person mowing the property is often in the best position to identify broken or misaligned heads, overly wet areas, and other potential problems. As part of day-to-day maintenance, staff should understand the irrigation system basics and be able to recognize system problems.

- Set mower height appropriately.
- Identify irrigation system leaks and repair them promptly.
- Where applicable, post irrigation schedules, zone location map and other relevant programming information in or near each controller (or clearly identify where information is kept).
- Employ a certified landscape irrigation auditor at least once every five years to conduct a thorough and comprehensive check for efficiency of water application.
- Make adjustments whenever irrigation water falls or runs onto hard surfaces such as sidewalks, streets or driveways.
- Check for leaks. Signs of leakage include overgrown or particularly green turf areas, soggy areas around spray heads and above-ground hoses, jammed spray heads and torn hoses. In drip systems, leakage problems may be due to damaged tubing from foot traffic or gnawing by animals.
- Periodically perform a thorough inspection of the system components to verify that the components meet the original design criteria for efficient operation and uniform distribution of water.
- Verify that the water supply and pressure are as stated in the design. Differences in the sprinkler system's required design operating pressure and actual water pressure can affect distribution uniformities and operation efficiency. Time of day can affect pressure. Pressure measurements should be made at the same time of day the irrigation is likely to occur. Install pressure reducing valves (PRVs) where needed, and flow control devices on individual sprinklers to stop misting due to excessive pressure. Verify that pressure regulators are adjusted for desired operating pressure.
- Verify that the backflow prevention device is working correctly; annual testing is ideal, but not required in all areas.
- Adjust valves and flow regulators for proper pressure and flow operation. Valves must shut off tightly to prevent leakage and soggy spots, and operate without slamming open or closed to prevent pipeline and sprinkler damage from water surges.
- Install a master valve. This prevents leakage from the irrigation system when the system is not in use.
- Verify that sprinklers are properly adjusted—check the nozzle, arc, radius, level and altitude with respect to slope.
- Verify that sensors are working properly and are within their calibration specifications.
- Look for debris (e.g., rocks, sand, and dirt) lodged in sprinklers and drip emitters and watch for salt build-up around drip emitters.
- Examine filters and clean filtration elements as required.
- Test all repairs.
- Ensure that the replacement hardware used for system repairs matches the existing hardware, and is in accordance with the design.
- As plants mature, trim or remove vegetation as required to preserve system performance.
- Re-program automatic controllers (if necessary) to meet the seasonal plant needs.

Water Savings and Other Benefits

A well designed, installed, and maintained landscape and irrigation system should use substantially less water than a poorly maintained landscape and irrigation system on a similar property.

Range of Likely Water Savings: Varies

The water savings achievable from well designed, installed, and maintained landscapes and irrigation systems are not well quantified. For some landscapes the savings will be substantial, on the order of 30 – 50%, but for others there may no measurable savings achieved and in some cases water use may even increase as a result of changes made to the landscape or irrigation system.

The 2004 YARDX study of Xeriscape sponsored by Metro Water Conservation, Inc. of Denver and the U.S. Bureau of Reclamation, in partnership with nine water utilities examined water use from 1997 through 2002 and compared outdoor water use for traditional (pre-existing) and waterwise landscaping along Colorado's Front Range. The YARDX study found that water efficient landscapes could consistently obtain water savings of 30%, and up to 50%, over traditional landscaping (Medina and Gumper 2004).

The water saving benefits of implementing the recommendations of this best practice will be experienced over many years and likely cannot be accurately measured without great effort. From a water savings perspective the key is that only the necessary amount of water is applied to the landscape and over irrigation is eliminated. A recent study in California found that eliminating over irrigation in sites that had historically over irrigated would reduce outdoor use in single-family homes by about 30%, or about a 15% reduction in total use (DeOreo et. al. 2010). It is estimated that full implementation of the recommendations in this best practice resulting in the elimination of over-irrigation will result in outdoor water savings in the range of 10 – 40% (and total savings in the range of 5 – 20%) over the period of time the landscape remains in place compared with a similar poorly designed, installed, and maintained landscape.

How to Determine Savings

For existing landscapes that are upgraded and improved using the recommendations of this best practice, water savings can be measured by comparing weather-adjusted billed consumption data from pre- and post-completion time periods. For new landscapes that are designed and installed implementing the recommendations from this best practice, it may be possible to determine water savings by comparing water use against similar, neighboring sites that did not implement the recommendations of this best practice. However, this type of analysis must be carefully designed to yield reliable results.

Savings Assumptions and Caveats

Although irrigation accounts for approximately 50% of urban water use in Colorado, the extent of over irrigation and inefficient irrigation is not well understood. The 1999 *Residential End Uses of Water* study found that homes in Denver applied about 85% of the net ET requirement for turfgrass on average while homes in Boulder applied about 68% (Mayer et. al. 1999).

Water savings are achieved by eliminating over-irrigation and by reducing irrigation demands by changing plant materials and improving landscaping practices. If over-irrigation is not occurring, there is little potential to save through irrigation efficiency improvements. Although some people believe over-irrigation is rampant in Colorado, the available data and studies do not support this notion. Over-irrigation is only a problem in a relatively small percentage of properties in any utility service area. Fortunately, it is possible to identify over-irrigators using historic consumption data and a measurement (or even an estimate) of the landscape area. Using landscape area and billed consumption, the amount of water applied over the course of a year can be calculated and compared against the net ET rate (net ET) for the same time period. Sites with an irrigation application greater the net ET are the best candidates for irrigation demand reductions.

Goals and Benchmarks

A reasonable goal or benchmark for landscape irrigation can be calculated for any site in Colorado assuming climate data and the landscape area are available. The Theoretical Irrigation Requirement (TIR) for a site can be calculated using the following equation:

Theoretical Irrigation Requirement (TIR) (inches) = (ET_o x kc) – Effective Precipitation

Where:

ET_o = Gross annual ET (inches)[22]

Effective Precipitation = effective precipitation (inches) which is the useful amount of precipitation stored in the soil in a 24-hour period.

k_c = ET adjustment factor or crop/landscape coefficient (a default value of 0.8 is a recommended starting point and upper limit for a water efficient landscape. Many landscapes, particularly those featuring the principles of xeriscape and/or water wise plantings, should have a lower k_c ranging from 0.5 to 0.7.[23]

In Colorado, expect TIR values to range from 10 to 30 inches depending upon the ET_o rate, amount of precipitation and the water requirements of the plants in the landscape.

Other Benefits

In addition to water efficiency, well-designed and maintained landscapes also improve stormwater management, provide recreation opportunities, offer habitat to local wildlife, provide aesthetic benefits, and help reduce non-point source pollution through reduced runoff (GreenCO 2008). Well designed and maintained landscapes are also healthier and look better.

[22] ETo is more formally defined as "the rate of ET from a hypothetical reference crop with an assumed crop height of 0.12 m (4.72 in), a fixed surface resistance of 70 sec m^{-1} (70 sec $3.2ft^{-1}$) and an albedo of 0.23, closely resembling the ET from an extensive surface of green grass of uniform height, actively growing, well-watered, and completely shading the ground". http://edis.ifas.ufl.edu/ae256

[23] The GreenCO landscape BMPs offer an detailed information about crop coefficients in Appendix E - http://greenco.org/bmp_downloads/BMP_Manual_Appendices.pdf.

Xeriscape plants also provide drought flexibility. In times of drought and mandatory water restrictions, low-water using plants may survive better and therefore reduce replacement costs.

Costs

Utility Costs

There are no utility costs associated with customers implementing the recommendations of this best practice. Some utilities have developed programs to encourage water wise landscapes and efficient irrigation by offering classes, rebates (for turf removal or purchase of low-water requirement plants), or by providing low interest loans for water wise landscape projects. These utility programs are likely to only be cost effective in communities with expensive new water supply projects that might be avoided or delayed through conservation.

Customer Costs

Landscaping costs vary enormously depending upon what work is being done, who is doing it, and the condition of the existing landscape. A local Colorado landscape professional reviewed 18 professional xeric landscape installations that her company performed over the past three years and found tremendous variability in the per square foot costs. The cost data below is provided for informational purposes and to illustrate the possible range of customer costs associated with a professionally installed xeriscape. Please understand that prices will vary and may be more or less than those presented here.

Site Preparation

Most landscape projects require that the existing landscape be removed to make way for the new landscape to be installed. The costs for site preparation varied from $0.43/SF to $3.75/SF with most site prep work falling between $0.60/SF and $1.40/SF (Peck 2010).

Installation Costs

Installation costs depend largely upon the level of planting vs. hardscape and irrigation (i.e. no system, new system, or rehab of existing system).

Least Expensive

The least expensive installations are only plantings (no hardscape), using mostly shrubs and some sod or seeded turfgrass areas. Low cost installations do not have in-ground sprinklers and drip irrigation (if installed) is accomplished by attaching drip lines to a hose bib. An estimated cost for a basic installation such as this is approximately $4.00/SF (Peck 2010). Lower cost installations are also possible. The “Garden in a Box” program offered by Boulder’s Center for Resource Conservation in 2010 provided plant materials for under $3/SF (Woodward 2010).

Lower Mid-Range

The next tier of water efficient landscapes have more extensive shrub plantings with drip irrigation, limited turf area (less than 25% of total area) with in-ground irrigation, and some perennial flowers and ground covers (less than 20% of total area). These landscape installations often include some boulders and/or flagstone walkways or stepping stones (less than 10% of total area). Most of these landscapes were renovations of entire suburban lots,

and the costs were fairly consistent at $8 - $9.50/SF. The size of the plants installed can impact the cost and Peck explained that these installations all used 1 gallon shrubs instead of 5 gallon shrubs along with flats of perennial flowers and ground covers instead of 1 gallon plants whenever possible.

Upper Mid-Range
Landscapes that are similar to the lower mid-range but which include more hardscape and larger sized plants cost $14 - $18/SF to install.

Most Expensive
There is really no upper limit to the amount of money that can be spent on a landscape, but landscapes with extensive hardscape, large boulder placements, flagstone patios and walkways, and elaborate irrigation systems cost in range of $22 - $24/SF to install. Peck reported that installing flagstone mortared over concrete was significantly more expensive than installing dry laid flagstone.

Resources and Examples

Resources

Handbook of Water Use and Conservation, Amy Vickers, 2001, Water Plow Press, Amherst, MA

Xeriscape Plant Guide, 1999, Fulcrum and Denver Water and AWWA, Denver, CO.

Xeriscape Handbook: A How-To Guide to Natural, Resource-Wise Gardening, Gayle Weinstein, 1999, Fulcrum Publishing.

Waterwise Landscaping with Trees, Shrubs, and Vines: A Xeriscape Guide for the Rocky Mountain Region, California, and the Desert Southwest, James M Knopf (Editor), Maureen McIntyre (Illustrator), 1999, Charisma Books.

The Xeriscape Flower Gardener: A Waterwise Guide for the Rocky Mountain Region, Jim Knopf, 1991, Johnson Books.

Dry-Land Gardening: A Xeriscaping Guide for Dry-Summer, Cold-Winter Climates, Jennifer Bennett, 1998, Firefly Books.

Residential Landscape Architecture: Design Process for the Private Residence, Norman K. Booth and James E. Hiss, 1998, Prentice Hall.

Landscaping : Principles and Practices : The Residential Design Workbook, Ferrell Bridwell, 1997, Delmar Publishing.

Landscape Plants for Western Regions: An Illustrated Guide to Plants for Water Conservation, by Bob Perry, Land Design Publishing, 1992 (Out of Print – Only Available Used or Library Loan)

Examples

There are numerous water efficient demonstration gardens across Colorado, but a few locations stand out as offering exceptional examples of water wise plantings and irrigation methods.

Northern Colorado Water Conservancy District – Berthoud
Northern Water's Conservation Gardens contain more than 700 plants and 60 turfgrasses that thrive in Colorado's arid climate. The gardens are located behind the Northern Water headquarters building at 220 Water Ave, Berthoud, CO 80513. The gardens and the adjoining Colorado-Big Thompson Project Interpretive Area are free and open to the public seven days a week April through September during daylight hours. For more information visit: www.ncwcd.org/ncwcd_about/gardens.asp

Aurora Municipal Xeriscape Garden
The Aurora Municipal Center (AMC) Xeriscape Garden is a high plains garden made up of six acres of rolling hills and beautiful plants. The garden is located at the northwest corner of Alameda Parkway and Chambers Road and is open from dawn to dusk daily. Built in 2002 to serve as an example of low-water use landscaping, the garden includes a variety of plants clearly labeled so visitors can take ideas home and use them in their own yard. Signs also explain the seven steps of xeriscape. The garden requires very little water and when irrigated, is watered with reclaimed water (nonpotable water) from Aurora's Sand Creek Wastewater Reclamation Plant. For more information visit: www.auroragov.org/AuroraGov/Departments/AuroraWater/WaterConservation/OutdoorWater/042655?ssSourceNodeId=658&ssSourceSiteId=621

Colorado Springs Utilities Conservation and Environmental Center
Located at 2855 Mesa Road in Colorado Springs and open Monday through Friday, 8 a.m. through 5 p.m., the Colorado Springs Conservation and Environmental Center includes an extensive water wise demonstration garden. For more information visit: www.csu.org/residential/environment/cec/item1034.html

Denver Botanic Gardens
The Denver Botanic Gardens maintains a large collection of native and low water use plants. They also offer trainings in topics such as "Rocky Mountain Gardening" which includes instruction in water wise landscaping. www.botanicgardens.org/

Denver Water Xeriscape Demonstration Garden
Denver Water's xeriscape demonstration garden showcases over 200 plant types on two-thirds of an acre. The garden features interpretive signs and literature. It is also the oldest xeriscape garden in the country. The garden is located at 1600 West 12th Avenue, Denver, CO 80204. www.denverwater.org/Conservation/Xeriscape/

Colorado WaterWise
Colorado WaterWise's website features 11 Xeriscape gardens in Colorado, including photos, features, websites and location. For more information visit: http://coloradowaterwise.org//index.php?option=com_content&task=category&sectionid=10&id=64&Itemid=239.

BEST PRACTICE 10: Irrigation Efficiency Evaluations

- Foundational, Programmatic, Understanding, Informational, and Support
- Utility operations - implemented by water utilities
- Customer participation – potentially impacts all customers depending upon implementation

Overview

The efficiency of an irrigation system can greatly impact the amount of water that is 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 best practice describes key considerations for maximizing water efficiency through the use of regular irrigation efficiency evaluations.

According to the Irrigation Association, "The best irrigation efficiency is achieved when most of the water that is applied to the landscapes by irrigation systems is used by the plants being irrigated. It is the result of appropriate design, installation, operation, and maintenance of the system" (IA 2002).

"The key to conserving water in the landscape is to irrigate properly. You can design and install the most elaborate and efficient irrigation system available, yet through poor management waste huge amounts of water." (Ellefson 1992).

An efficient irrigation system will distribute water more evenly and ensure that "most of the water applied to landscapes by irrigation systems is used by the plants being irrigated" (IA 2002). The information presented here is largely based on the work of the Irrigation Association (IA) published in their Certified Landscape Irrigation Auditor Training Manual (IA 2007).

Irrigation efficiency evaluations offer a non-regulatory approach to improving outdoor water use efficiency. Proper operation of the irrigation system reduces water use by ensuring that the landscape receives the appropriate amount of water when it is needed. Regular maintenance practices help to ensure the health and appearance of the landscape and to preserve and ensure conservation savings.

The *Irrigation Association Certified Landscape Irrigation Auditor Training Manual* (IA 2002, 2007) is the fundamental companion document to this best practice. Practices recommended by the Irrigation Association have been adapted for GreenCO BMPs and provide recommendations on the methods and practices for performing water efficiency evaluations in Colorado landscapes. These BMPs were developed with broad stakeholder support and form the foundation for the best practices described in this section.

Why a Best Practice?

Landscape irrigation accounts for more than half of all potable water used in Colorado.[24] Improving the efficiency of water use on urban landscapes is perhaps the single most important

[24] AWWA (1999), Aquacraft (2007), Davis et. al. (2009), Grabow et. al. (2009), Mayer et. al. (2009), McReady (2009), County (2008), Dukes et. al. (2008), GreenCO (2008), Guz (2008), Jakubowski et. al. (2008), Haley et. al.

urban water conservation effort that can be made in Colorado. This best practice describes key considerations for evaluating and maximizing the level of water use efficiency in existing irrigation systems through the implementation of irrigation efficiency evaluations.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Low water use landscapes… and efficient irrigation" [CRS 37-60-126 (4) (a) (II)].

Applicability

The irrigation efficiency evaluation practices described in this best practice apply to anyone that regularly applies water to an urban landscape through a manual or automatic irrigation delivery system. It includes but is not limited to utility customers and landscape professionals who irrigate and maintain urban landscapes. Many of the practices and principles described in this best practice will also apply to water utilities for their own irrigation practices and to their efforts to educate and inform their customers.

Implementation

Irrigation efficiency evaluations should be performed by a trained auditor. The Irrigation Association offer a training and certification program titled "Certified Landscape Irrigation Auditor" (CLIA) that is well suited for this purpose.

Customer selection should be the first priority when performing landscape efficiency evaluations. Targeting customers with high seasonal demand, older irrigation systems, and dedicated irrigation meters is an effective way to create a successful and cost-effective program.[25] Targeting customers with historically high irrigation use for a landscape evaluation is fundamental to good program design. A landscape water budget (see Best Practice 7) provides a reasonable target level of water use that is customized for each customer and landscape. Water budgets provide utilities with a powerful tool for identifying which customers are over-irrigating and could most benefit from an irrigation efficiency evaluation.

While water budgets set the target, water efficiency evaluations help customers hit the target by providing the tools and recommendations for maintaining a healthy landscape using the proper amount of water. Once customers have been targeted, efforts should be made to reach out and schedule an irrigation efficiency evaluation. Although participation in an irrigation efficiency evaluation is usually voluntary, the offer of substantial potential water savings over time is often sufficient to encourage participation.

(2007), US BOR (2007), NCWCD (2008), Baum (2005), CSU, (2005), PMSI (2005), Bamezai (2004), Barta (2004), CWRRI (2004), MWDOC (2008, and 2004), DeOreo et. al. (1998), CSU (1994).

[25] These are not guarantees that the customer is irrigating inefficiently. Customers with dedicated irrigation meters may be irrigating using a water budget. Accounts irrigating large amounts of turf such as a golf courses or playing fields may have a high seasonal demand and yet be irrigating efficiently.

Once customers have been selected for a landscape efficiency evaluation a site visit should be scheduled with the customer. Prior to implementing a landscape efficiency evaluation every effort should be made by the customer to repair any known problems and have the irrigation system in good working order. The most common irrigation equipment problems are as follows:

- Broken sprinkler heads or broken sprinkler pipe
- Sprinkler heads located above or below grade
- Tilted sprinkler heads
- Over-spray
- Improper operating pressure
- Sprinkler heads with varied precipitation rates (can be as a result of clogging, mismatched nozzles or sprinkler types)
- Equipment with different specifications
- Improper irrigation scheduling

If available, obtain three years of recent water use history[26] for each irrigation meter at the site. Look for trends in irrigation from the billing history and note any unusual changes in water use during the irrigation season. Inefficiency is not the sole reason for changes in irrigation patterns. Drought, watering restrictions, and the installation of more efficient equipment may result in a decrease in water use; the installation of new landscape or undetected damage to the irrigation system may cause an increase in water use.

If possible the site should be mowed the day before the site evaluation to reduce obstruction of sprinkler heads from tall grass and provide the opportunity to repair any damage that may occur as a result of mowing.

Steps to Performing a Landscape Efficiency Evaluation

1. **Obtain a site plan or scaled aerial photographs prior to the landscape efficiency evaluation.** These can be useful for determining irrigated area, identifying meter and controller locations, and recording the location of any problems with the irrigation system found during the evaluation. Newer irrigation systems may have design plans; if available, these should be used to verify the accuracy of the installation at the time of the irrigation evaluation. Note whether the meter provides water solely for irrigation or provides indoor usage as well.
2. **Schedule the site evaluation for a time when the site manager or someone familiar with the irrigation system and has access to the irrigation controller(s) is available.** Water pressure can vary throughout the day and can have a significant impact on the operation of the system. Ideally the site evaluation should be scheduled as close to the time of day that the irrigation system is typically operated and under similar conditions. Check wind speed – if wind speed is greater than 5 mph reschedule the evaluation for another time. At sites where wind is common, early morning evaluations are likely to yield better results when wind is likely to be less of a factor.

[26] A minimum period of three years of billing data during typical irrigation conditions is ideal. Billing data during a period of drought, watering restrictions, or the landscape establishment period will not provide an accurate picture of the customer's usual irrigation application.

3. **Assess and record the overall appearance of the site and the quality of the landscape.** Dry spots, wet areas, eroded areas, and poor quality landscape can all be indications of a poorly functioning irrigation system. Problem areas in the landscape often provide clues to problems with the irrigation system.
4. **Record the zone-by-zone schedule of each irrigation controller.** Make note of multiple runtimes (cycle and soak), multiple programs, percent adjustment, and non-irrigation days, and the use of any irrigation interrupt devices. Make note of changes to the schedule, how they are tracked, how frequently they are made, and how the schedule is determined. Record the make and model of the controller, controller features, and potential for future upgrades.

   Examples of upgrades include:

   - Percent adjust feature
   - Multiple programs
   - Additional zones
   - Non-watering days
   - Sensors and irrigation interrupt devices (e.g. rain, wind, freeze)
5. **Operate and inspect each zone in the system and record any problems noted.** Note the type of sprinkler heads operating in each zone and the plant material being irrigated. In addition to the irrigation equipment problems listed above make note of: (IA 2002)

   - Old or worn out equipment
   - Improperly spaced sprinklers heads
   - Mixed sprinkler head types
   - Mismatched precipitation rates
   - Improper zoning
   - Incorrect pressure (high or low)
   - Improperly sized components
   - Lack of adequate flows
   - Valve malfunctions
   - Spray deflections
   - Arc misalignments
   - Leaky seals
   - Poor drainage
   - Runoff
6. **Measure the distribution uniformity of several representative zones at the site.** "An irrigation system has good [distribution] uniformity when a nearly equal amount of water is deposited on each square foot of irrigated surface area" (IA 2002). Unfortunately the amount of irrigation applied to the landscape is frequently based on the irrigation needs of the driest areas resulting in over-irrigation of the rest of the landscape.

   Distribution uniformity is affected by both the system design (e.g. correct sprinkler head spacing, matched precipitation rates) and how well the system is maintained (e.g. replacing worn or damaged equipment, aligning spray heads). Distribution uniformity is

frequently calculated using catch can devices which measure the amount of irrigation water applied on the area being irrigated. Unfortunately there has been no consensus among professionals as to the minimum or maximum standard for distribution uniformity or whether or not the standard should be the same for rotors or fixed spray heads (Mecham 2004).[27]

Ideally, each catch can device should receive equal amounts of irrigation; most systems fall far short of ideal. Irrigation audits of 6,800 residential and commercial sites using catch can devices, revealed distribution uniformities of the lowest quarter to be approximately 50% and ranged from a low of 11% to a high of 92% (Mecham 2004). "The lower quarter distribution uniformity (DU_{LQ}) is the average water applied in the 25% of the area receiving the least amount of water, divided by the average water applied to the total area. DU_{LQ} is a measure of how evenly water is applied (IA 2002).

7. **Develop an irrigation schedule based on the requirements of the landscape and local weather data.** The goal of efficient irrigation is to replace the water lost through ET – water which evaporates from the soil surface and water that is utilized by the plants. ET is affected by local weather conditions such as temperature, wind and solar radiation as well as plant type, maturity of the landscape, soil type, and efficiency of the irrigation system. Although there are residential and commercial irrigation controllers available that utilize local ET data to adjust the irrigation schedule, most well-maintained sites can be irrigated efficiently simply by adjusting the controller on a regular basis. Adopting an efficient irrigation schedule is essential for achieving water savings from an audit.

8. **Additional recommendations include providing customers with access to real-time local ET and weather data if feasible and historic weather data if not.** Precipitation is not included in ET calculations but should be included when calculating irrigation application. If possible provide a web tool to assist customers with calculating their irrigation application and irrigation schedule.

   Customers and landscape professionals can benefit from knowing how to read the water meter. Allowing access to the water meter can provide an excellent tool for tracking their water use. While monthly billing provides customers with their water use for the previous month it comes too late to provide them with information that allows them to make timely changes to the irrigation schedule and consumption information is seldom if ever communicated to the landscape professional. Irrigation efficiency evaluations provide an excellent opportunity to teach customers and landscapers how read their water meter and make use of the data provided.

   Consider providing the customer with a month-by-month graph of water use on their water bill. For established customers providing their water use for the same month during the previous year can help them see trends in their water consumption and may be their first indication that there is a problem with their irrigation system.

[27] Each utility will need to determine a minimum standard for $DU_{LQ.}$ The Irrigation Association has standards for performance of both spray and rotary sprinklers.

Water Savings and Other Benefits

Range of Likely Water Savings

The water savings will vary and are dependent on the extent of over-irrigation and the extent to which the customer can reasonably be expected to implement the recommendations. The likely range of water savings are between 5 and 40%. However, targeting is key; evaluating under irrigators will not lead to savings. Billing data can help identify customers who will benefit the most. Savings are also dependent on customer incentives including the cost of water, available rebates, and customer perception of the importance of reducing their water consumption.

How to Determine Savings

Utility billing data is an excellent tool for comparing water used for irrigation before and after performing a landscape efficiency evaluation. Billing data can reveal trends in water use not only throughout the irrigation season but also over a period of several years.

Fortunately, it is possible to identify over-irrigators using historic consumption data ET data and a measurement (or even an estimate) of the landscape area. Using landscaped area and billed consumption, the amount of water applied over the course of a year can be calculated and compared against the net ET rate (net ET) for the same time period. Sites with an irrigation application greater than net ET are the best candidates for irrigation demand reductions.

Savings Assumptions and Caveats

An irrigation efficiency evaluation does not guarantee water savings at a site. Ultimately an irrigation efficiency evaluation will provide a reduction in water use only if the recommendations and necessary repairs are implemented by the customer. Including a return on investment (ROI) analysis with the efficiency evaluation can help customers better understand the long term benefits and savings associated with implementing audit recommendations.

Unlike the installation of a new fixture or appliance, the savings achieved may not be permanent and will require ongoing maintenance of the system. The extent to which the savings continue is dependent on the motivation of the customer to continue maintaining the irrigation system and staying within a water budget[28]. Unless the customer has incentives to maintain savings, savings may diminish over time as the irrigation system ages and the cost of repairing the system increases. Many of the same barriers that exist for reducing consumption initially also impact reduction in water use over the long term. On the other hand customers who are incentivized through water budgets or rebates may show savings in their water use with time as the customer begins to implement some of the recommendations and improves their efficiency.

Improving irrigation efficiency may also require public education to change the perception of what constitutes an acceptable appearance of the landscape. Landscapes that were developed at times or in places when water was plentiful and inexpensive are not appropriate for the local

[28] Although a utility may not use water budgets for billing their customers one of the goals of an irrigation efficiency evaluation is to develop a water budget for the site and provide the customer the tools with which to meet their budget.

climate but may have become the norm in some service areas. Savings will increase as customers begin to adopt an aesthetic more in keeping with the Colorado landscape.

Goals and Benchmarks

Utilities implementing this best practice should set a goal of performing targeted efficiency evaluations for the top irrigators each year based on the size and situation of the utility. Each utility will have unique savings goals depending on their current and future water supply and anticipated demands.

Implementation of evaluation recommendations is essential to achieve water savings. Initially utilities can benchmark the program based on the number of efficiency evaluations performed in a year. Once the program has been run for at least a year and sufficient post-evaluation consumption data are available, changes in water use can be measured and alternative benchmarks established based on achieved savings.

Other Benefits

There are numerous benefits to improving irrigation efficiency aside from the obvious reduction in water use and include:

- Improved landscape appearance, fewer wet or dry spots
- Improved public perception[29]
- Reduction of deep percolation
- Reduction of runoff[30]
- Reduced fertilizer and chemical requirements[31]
- Reduction in labor costs[32]
- Reduced environmental impact

Irrigation efficiency surveys can be a powerful education tool for customers. Most customers understand that a properly operated irrigation system will reduce water waste and cost them less in utility fees. They may not realize how much water can be wasted by things as simple as a misaligned head. Particularly with older systems customers may have paid an "expert" to install and/or maintain their system and not realize that these systems may now be woefully inefficient.

Avoided Costs

Aside from the obvious benefit of paying less for water, improving the efficiency of the irrigation system has other, less tangible benefits. Overwatering can lead to landscape damage, both to the plants and to the hardscape, and it increases the likelihood of disease. Under watering may result in the demise of plant material some of which may take years to replace. A landscape that is watered efficiently requires a lower expenditure for labor costs needed for mowing, and the application of fertilizer or chemicals needed to treat disease. Sprinkler heads that are not

[29] Particularly in municipalities that have implemented watering restrictions, water budgets, or other conservation measures, the public can be very sensitive to visible irrigation inefficiencies such as runoff, watering during rain events, and broken spray heads.
[30] www.irrigation.org/swat/images/irvine_runoff_reduction.pdf
[31] From the Irrigation Association Certified Landscape Irrigation Auditor training manual
[32] Labor cost is reduced by reducing the frequency of mowing and fertilizer application.

flush with the soil, eroded sprinkler heads, and exposed drip line can all create a tripping liability particularly in public areas.

Costs

Utility Costs

Staff time will be required for customer selection and targeting high-use customers. Utilities that provide landscape evaluations will face financial costs in the form of staff time needed to develop a landscape efficiency evaluation program, training, and perform irrigation system evaluations and some cost for parts and equipment. Unless water budgets are already in place a tool will be needed that provides customers with ongoing information about their irrigation requirements. Utilities may choose to provide this as part of the monthly billing information or develop an online tool that their customers can access. The EPA WaterSense Landscape Budget Tool[33] provides irrigators with an irrigation allotment based on site specific information. Staff will be needed to monitor sites that have received irrigation efficiency evaluations. Irrigation systems require ongoing maintenance and monitoring in order to maintain savings. Customer education is essential. Ongoing customer service, to answer questions and if necessary adjust individual budgets, will also be required.

Customer Costs

Repairs and upgrades to the irrigation system can require considerable capital outlay by the customer depending on the age of the irrigation system, the quality of the original system design, and the extent of upgrades needed. Minor repairs, such as replacing a broken sprinkler head, can often be performed by the customer and are therefore relatively inexpensive. The cost of an irrigation controller upgrade can range from less than fifty dollars for a rain sensor to several thousand dollars for installing a commercial central controller. The cost of rejuvenating an aging system may require the services of a professional irrigation contractor and the cost will depend on the age and size of the system. The cost benefit to the customer will of course vary depending upon the billing rate structure and all of the factors that go into determining the monthly bill for each specific customer. The cost of improving the efficiency of an irrigation system may be offset by savings in water cost and in some cases reduction in sewer fees. A conservation-oriented rate structure – charging higher rates for higher use – is more likely to see savings from customers with high water use than is a uniform or declining block rate structure.

[33] www.epa.gov/watersense/nhspecs/water_budget_tool.html

Resources and Examples

Examples of Irrigation Efficiency Survey Programs

Slow the Flow Colorado

Slow the Flow Colorado provides landscape irrigation evaluation to eligible customers in more than fifteen participating agencies.[34] Although the program is intended primarily for residential customers, HOA's and commercial properties may be eligible in some areas.

Evaluations are provided by trained water auditors through the Center for Resource Conservation during the summer months. Customers are provided with an appropriate irrigation schedule individualized for their landscape and their irrigation system. They also receive instruction on simple do-it-yourself sprinkler repair, and recommendations intended to improve the efficiency of the system and increase longevity of the system. Additional information about Slow the Flow Colorado is available at www.conservationcenter.org/w_SlowtheFlowColorado.htm.

City of Fort Collins

The City of Fort Collins provides irrigation system evaluations free of charge to single-family customers and homeowner's associations in their service area. Customers are provided with recommendations for repairs, system upgrades, and a watering schedule. All new commercial landscapes must undergo a sprinkler performance audit prior to receiving a certificate of occupancy by the City and must be performed by an Irrigation Association Certified Landscape Irrigation Auditor. All sites must meet a minimum level of performance. www.fcgov.com/standards.

Town of Erie Department of Public Works

The Town of Erie began partnering with the Center for ReSource Conservation's Slow the Flow Colorado Program in 2004 to provide free irrigation system surveys for its residential, HOA, and CII customers. By 2006 they had provided surveys to 246 residential customers, 6 HOA's and 4 CII customers. Estimated annual water savings for these customers, as a result of the surveys, was 5.5 acre-feet/year. The 2009 budget provided enough funding for the Town to make surveys available to an additional 144 residential customers and 3 HOA customers on a first come first served basis. Upon request the Town will loan their customers a remote meter reading device to help them determine how much water they are using. The Erie Water Conservation Plan is available at http://cwcb.state.co.us/NR/rdonlyres/D95AE320-2529-4196-815D-49A81CEDB745/0/ErieWCP.pdf.

Highlands Ranch Metro District

Highlands Ranch Metro District has instructions for performing an irrigation system survey[35] and instructions on how to read their water meters. Highlands Ranch Metro District also offers irrigation audits through the Center for Resource Conservation's Slow the Flow program. The

[34] Participating agencies are: Aurora Water, Castle Pines Metropolitan District, Town of Castle Rock, Centennial Water & Sanitation, City of Boulder, Town of Erie, City of Golden, City of Lafayette, Left Hand Water District, City of Longmont, City of Louisville, City of Northglenn, Town of Superior, City of Thornton, City of Westminster

[35] www.highlandsranch.org/06_wsan/06_wsan_pdf/OutdoorWatering09.pdf

District has four staff members trained to respond to customers' questions and concerns about irrigation system maintenance and scheduling. Customers are provided with a water budget and rate billing structure that encourages conservation while taking into account the variability in customers' water needs. The water budget includes a fixed monthly indoor allotment and an outdoor allotment based on several factors including the square footage of the irrigable area and the number of household members. The water budgets serve to encourage customers to keep their irrigation system in good working order since they are most likely to exceed their water budgets when they have an inefficient irrigation system. Additional information about Highlands Ranch irrigation and water budget programs can be found at: www.highlandsranch.org/06_wsan/06_3watercons.html

BEST PRACTICE 11: Rules for New Construction

- Programmatic and control best practice
- Utility operations - implemented by water utilities
- Customer participation – Significant; builders (who may or may not be water customers) are required to install water-efficient fixtures and appliances in new construction

Overview

Many Colorado communities with high growth rates anticipate increasing water demand that will exceed current supplies. Water conservation measures that are "built in" to new buildings can help slow the growth of new water demands. This best practice describes water efficiency specifications that water utilities can make voluntary or mandatory for new residential and non-residential development within their service areas.

This best practice presents a framework for incorporating "built-in" indoor water efficiency in all new construction. Increased interest in "green" building and green building programs like LEED[36] presents opportunities for water utilities to promote water efficiency in new construction. However, green building programs including LEED are voluntary and have largely focused on energy conservation and in some cases water efficiency was only added as an afterthought. Fortunately this situation is improving as new specifications are rolled out.

Why a Best Practice?

The concept of "smart from the start" when applied to water conservation means that new properties that join a water system are efficient at the outset. This is a best practice because it costs very little to implement and it means new customers will use significantly less water and will not require water conservation interventions for the foreseeable future. New customers benefit from reduced water bills, the water system benefits from reduced growth in demand, and scarce conservation program funds can be directed toward existing customers.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Regulatory measures designed to encourage water conservation." [CRS 37-60-126 (4) (a) (IX)].

Applicability

This best practice can be implemented by any municipality. Because this best practice targets new construction and may require changes to local building codes, enactment of this best practice may require a vote by city council or other local governing body outside of utility purview. The level of anticipated new growth is a factor to consider. Utilities anticipating

[36] Leadership in Energy and Environmental Design

significant growth and new construction in their service area will benefit most. Utilities nearing build out or with minimal growth projections have less to gain from this best practice.

Implementation

Mandatory implementation of this best practice is recommended. Participation in green building programs such as WaterSense and LEED is voluntary and encouragement from a water utility to participate in a voluntary program is unlikely to measurably increase participation levels. If water utilities wish to ensure a high degree of water efficiency is built into new construction, the requirement must be mandatory.

Residential

The EPA WaterSense program has created a detailed specification for new homes which includes an inspection certification process to ensure all required conservation measures are actually put in place. *Utilities implementing this best practice can simply require that all new homes joining their water system meet or exceed the EPA WaterSense specification.*

The EPA WaterSense new home specification is too detailed to present it its entirety here, but it can be downloaded from: www.epa.gov/watersense/docs/home_finalspec508.pdf.

The EPA WaterSense new home specification includes the following mandatory criteria all of which are verified through an inspection process.

Indoor Efficiency Criteria

- **Leaks** – No detectable leaks from any fixtures, appliances, equipment.
- **Service Pressure** – Maximum of 60 psi. Pressure reducing valve may be necessary.
- **Hot Water Delivery System** – No more than 0.6 gallons of water shall be collected from a hot water fixture before hot water is delivered.
- **Toilets** – WaterSense labeled 1.28 gpf HETs.
- **Bathroom faucets** – WaterSense labeled 1.0 gpm aerators.
- **Kitchen sink faucets** – 2.2 gpm max flow (1992 EPAct standard)
- **Showerheads** – WaterSense labeled 2.0 gpm showerheads.

If installed by the builder, the following components are also mandatory and verified through inspection:

- **Dishwashers** – ENERGY STAR qualified
- **Clothes washers** – ENERGY STAR qualified with water factor less than or equal to 6.0 gallons per cycle per cubic foot of capacity
- **Evaporative cooling systems** – Maximum of 3.5 gallons per ton-hour of cooling. Blowdown based on time of operation. No once through/single pass systems.
- **Water softeners** – Self-regenerating water softeners shall meet NSF/ANSI 44 standard.
- **Drinking water treatment systems** – Must meet applicable NSF/ANSI standards.

Outdoor Efficiency Criteria

The WaterSense New Home specification has outdoor criteria that apply to the front yard and any other outdoor areas improved upon by the builder. Because this best practice is focused on indoor use the details of the outdoor component are not covered here, but instead can be found in Best Practice 8. The full WaterSense New Home specification can be downloaded from: www.epa.gov/watersense/docs/home_finalspec508.pdf.

Non-Residential

Specifying built-in water efficiency in the commercial, institutional, and industrial (e.g. non-residential) sector is more challenging than for the residential sector as there is nothing analogous to the WaterSense New Home specification. Since each type of non-residential customer (i.e. hotel, school, factory, office building, supermarket, etc.) has a different set of water using fixtures and appliances an over-arching specification program that covers the entire sector is unlikely to emerge.

There are specific actions that water providers can take to ensure that new non-residential buildings include indoor water efficient technologies at the outset. The following actions are best practices for the non-residential sector.

1) Require that WaterSense labeled toilets, urinals, faucets, and showerheads be installed in all new non-residential buildings.
2) WaterSense plans to start labeling commercial equipment such as pre-rinse spray valves in the near future and these new specifications should be promptly incorporated into efficiency mandates.
3) Prohibit equipment that uses single-pass cooling unless there is no other alternative.
4) Specify high-efficiency commercial equipment wherever possible. The 2008 Watersmart Guidebook - A Water-Use Efficiency Plan Review Guide for New Businesses (available for free download from the Alliance for Water Efficiency – www.a4we.org) offers excellent guidance on water efficient equipment for 19 different types of businesses.

Additional Efficiency Specifications

The following programs and specifications may be useful when developing water efficiency regulations for new construction.

IAPMO Green Building Mechanical and Plumbing Code Supplement

IAPMO (The International Association of Plumbing and Mechanical Officials) has created a code supplement specifically supporting sustainable water using fixtures.[37] The supplement details proper use of high efficiency products, grey water and conservation of hot water.

The Green Building Mechanical and Plumbing Code Supplement is not a greener form of the Uniform Plumbing Code (UPC); it acts as a supplement to work with the UPC. The UPC is a recognized plumbing standard. It is a model code adopted by many communities. The green supplement basically works to reduce hindrances to conservation from conventional codes.

[37] The supplement was developed by a committee consisting of 25 conservation specialists, plumbers and contractors as well as code inspectors.

IAPMO states that the Green Supplement "serves as a repository for provisions that ultimately will be integrated into the Uniform [Building] Codes (UBC)."

Still in Progress - ASHRAE SPC 191 - Standard for the Efficient Use of Water in Building, Site and Mechanical Systems

ASHRAE, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, is developing a water efficiency standard for buildings that will, "provide baseline requirements for the design of buildings, landscapes, and mechanical systems that minimizes the volume of water required to operate HVAC systems, plumbing systems, common building special process systems, cleaning systems and irrigation systems."

Once completed, the ASHRAE standard may be an effective specification tool for Colorado water providers.

Water Savings and Other Benefits

How to determine savings

Residential

The EPA estimates that the indoor use in a WaterSense new home will be 101.6 gallons per household per day per home versus 128.1 gallons per day for a standard new home. This represents a 20.7% savings in indoor use. Annually it is estimated that each WaterSense new home will save 9,672 gallons (indoors). Table 4-17 shows a side-by-side comparison of WaterSense water use and conventional new home waster use.

Non-Residential

Non-residential savings depend upon the type of building and the equipment installed. Specific water savings must be estimated on a site by site basis, but it is not unreasonable to expect reductions of 20% or better can be achieved in non-residential buildings through efficiency regulations.

Table 4-17: Estimated water savings from EPA WaterSense New Home Specification ((EPA WaterSense Program 2009 WaterSense Single-Family New Home Specification Supporting Statement)

Indoor Feature	Standard Home Water Use	Standard Use (gal/house/day)	WaterSense Criteria	Expected Water Sense Use (gal/house/day)	Expected Water Savings (gal/house/day)
Toilet	1.6 gpf	21.0	1.28 gpf	16.8	4.2 (20%)
Bathroom faucet	2.2 gpm	29.1	1.5 gpm	27.6	1.5 (4.8%)
Shower	2.5 gpm	25.4	2.5 gpm	25.4	0 (0%)
Hot water delivery	~10 gpd waste		Assumes 20% water savings for improved design	8.0	2.0 (20%)
Dishwasher	8.6 gallons per load	2.7	5.8 gallons per load	1.8	0.9 (33%)
Clothes washer	39.6 gallons per load	39.9	22.0 gallons per load	22.0	17.9 (45%)
Total Indoor		128.1		101.6	26.5 (20.7% savings)

Savings Assumptions and Caveats

The effectiveness of programs for new construction will depend on several factors. If programs consist of voluntary certifications (such as LEED), the number of new accounts with conservation measures in place will be significantly smaller than programs with mandatory standards. Green building programs encompass far more than water conservation, and in a points-based system, buildings may qualify as "green" without implementing water efficiency.

The WaterSense new home savings projections presented in this best practice do not include outdoor use. Since the WaterSense new home specification includes an outdoor component, additional water savings (beyond those shown here) may be achieved.

Other Benefits

In many cases, saving water has the added bonus of saving energy. This is due to the fact that a significant amount of energy use goes to heat water in the building and in some cases to pump water from the source. A 2003 study found that hot water use could be cut by 20% using high efficiency fixtures (DeOreo 2003). Western Resource Advocates released a Colorado-specific white paper about the energy intensity of four Colorado citys' water supplies and found that in many cases water conservation results in energy conservation as well (WRA 2009), making the case that water conservation = energy conservation.

Costs

Utility Costs

Utility costs are limited and minimal. Utilities must only bear the costs of implementing the regulations themselves. Differential costs associated with installing efficiency fixtures and equipment fall on builders and customers. The cost of adopting ordinances, codes, and rules varies by agency.

Enforcement costs for any new rules can add to costs. WaterSense includes verification as part of the program and this is included in the cost of WaterSense certification. If water conservation standards are incorporated into the local building code, enforcement will be part of the building department's permit process.

Customer Costs

Customers and other stakeholders bear the cost of rules governing new construction. Builders and buyers/occupants each face different costs and savings potentials from rules for new construction. The commercial sector sees an additional disconnect in costs for green building in that building owners may bear the costs associated with green building but tenants may reap the rewards in the form of lowered utility bills.

Builders may face increased costs from constructing green buildings, although these costs are likely to decrease in the future. A study on the costs associated with LEED certification found that green building practices added 1.5% to 3% to the so-called soft costs (such as design and certification) of building a commercial building. Complete costs, from design through implementation were estimated to be 4% to 11% (Northbridge Environmental Management

Consultants, 2003). The EPA calculates additional costs associated with WaterSense New Home Specifications to range from $700 to $3,000. Table 4-18 shows the breakdown of WaterSense costs.

Table 4-18: Costs associated with EPA WaterSense New Home Specification ((EPA WaterSense Program 2009 WaterSense Single-Family New Home Specification Supporting Statement)

WaterSense Criteria	Incremental Cost Estimate
Service pressure regulating valve	$0 to $150
WaterSense labeled HETs	$0 to $100
WaterSense labeled faucets and aerators	$10
Efficient hot water delivery system	$0 (core plumbing)
Hot water recirculating system	$2000
Hot water manifold	$200
Energy Star qualified dishwashers	$30
Energy Star qualified clothes washers	$270
Turf and mulching	$300
Third-party certification of home	$50 to $400

Green building occupants will likely see savings in the form of reduced utility bills. The EPA estimates that WaterSense homes save $100 per year in utility costs over typical new homes and $200 in utility costs over a typical older home. The payback period ranges from 5.6 to 30.6 years depending upon factors such as water rates and water heating methods (gas vs. electricity).

Resources and Examples

Resources

The State of Colorado Department of Local Affairs (DOLA) is a good source of codes and plans for Colorado communities. The DOLA website offers links to green building programs in the state. Links and details on the Steamboat Springs and Routt County green building program can be found at: www.dola.colorado.gov/osg/modelcodes.htm#GreenBuildingProgram

Additional information on WaterSense – including information for utilities – can be found online at the EPA website: www.epa.gov/watersense/partners/promotional.html

Information on all things LEED can be found at the US Green Building Council's website: www.usgbc.org/

Examples

Model Codes – DOLA, Steamboat Springs and Routt County

Colorado's Department of Local Affairs has various model building codes, including a green building program. The City of Steamboat Springs, Routt County and DOLA recently

collaborated to develop a green building program which DOLA offers as a working model for other communities. The program was developed to provide guidance for green building and to raise the bar on green standards. After adopting ICEE energy code, Energy Star was identified as the minimum for the DOLA/Steamboat Green Building Program because it represents a 15% efficiency improvement.

The program applies to single family, duplex and row townhome construction. A green building checklist is required when applying for a building permit. The building plans are reviewed against the checklist. If the minimum point threshold is met, the building permit will proceed through the usual sign-off process. The checklist is organized to follow the construction process. It comprises 17 categories and a total of 321 possible points. The categories include energy, recycling and reuse, electrical, landscaping and plumbing. Indoor water use is addressed exclusively in the plumbing section, which has a score of 28 possible points (less than 10% of the total possible). The only mandatory plumbing measure is insulating the hot water heater. Measures for conserving water included in the program are shown in Table 4-19.

Table 4-19: Water conservation measures found in DOLA Model Green Building Program

Measure	Means of Conservation
Efficient distribution of hot water	Speeds the rate of hot water delivery, which reduces time water runs. Also saves energy.
Install HET	High Efficiency Toilets (<1.3 gpf) perform well and reduce water consumption. Water and sewer costs will be lower with HET
Install composting toilet	These use little or no water.
Install showerheads with flow less than 2 gpm.	Low-flow showerheads reduce water use without changing water pressure. Hot-water savings translate to energy savings by reducing energy needed to heat larger volume of water.
Install graywater for toilet flushing	Reduces water used for flushing toilets. Local health codes must be considered.
Install real time water use read out	Leaks become readily apparent and can be quickly fixed.

DOLA has links to other green building programs in the state. Links and details on the Steamboat Springs and Routt County program can be found at: www.dola.colorado.gov/osg/modelcodes.htm#GreenBuildingProgram

Telluride – Required green building for new construction, remodeling and additions

While most green building programs are voluntary, Telluride has established a green building standard for all residential construction including new construction, remodels and additions. Requirements exist for both multi-family and single family homes.

The Telluride green building program includes energy efficiency, material use, indoor air quality, and resource conservation (of which water is only a part). Scoring is based on square footage and is different for new construction than for remodeling. For example, a newly constructed 500 square foot residence must have 15 points worth of conservation measures. A 3,501 square foot home must have 115 points worth of conservation measures. A 2,000 square foot remodel would need 30 points worth of conservation measures. Table 4-20 lists the indoor

water conservation measures included in the Telluride program. There are additional conservation measures required for outdoor water conservation.

Compliance is assured either by an inspection conducted by the city, careful and appropriate documentation, or by self certifying green building measures. A minimum of 10 of points must come from the conservation category. However, this category includes waste reduction and land use (site soil) in addition to water conservation.

Table 4-20: Indoor water conservation measures in Telluride's green building program

Conservation Measure	Possible points
Clothes washer is an ENERGY STAR® labeled product	2
Dual-flush toilets	3
Composting toilets	6
Bathroom faucets fitted with aerator restricting flow to 1.8 gpm	1
Kitchen faucet fitted with aerator restricting flow to 2.0 gpm	3
Installed irrigation system includes a soil moisture or rain sensor, or other irrigation efficiency device	4

Sterling Ranch – Conservation from the Developer's Perspective

Developers have a major role to play in water conservation and one example of a development design with strong water planning is Sterling Ranch. Sterling Ranch is a 3,100 acre, multi-use development located in Douglas County. Construction is slated for 2010 or 2011, but already the water conservation plan is in place. The developer, Sterling Ranch LLC, states that they are, "a firm believer that new development must be planned to meet human needs while protecting natural resources so that these needs can be met into the indefinite future," (Headwaters Corp. 2009). Water planning includes several aspects, such as a water supply plan (recycled water is a major part of the water supply plan), water treatment, water demand planning, and conservation.

The indoor water use target is 0.14 acre-foot per year per unit which is 42 gpcd. Sterling Ranch's conservation plan includes both indoor and outdoor conservation. For indoor conservation, Sterling Ranch will require high efficiency model toilets, washing machines, dishwashers, kitchen and bath faucets and showerheads. The requirements will be enforced through covenants and water budgets (Headwaters Corp. 2009). The water budget component is particularly important since each budget represents a water efficiency performance standard that must be met by each individual end user. The developer will assist the water agency with developing water budgets using yard footprints. Sterling Ranch District, a special district formed for the development, in cooperation with the water supplier will undertake a study of water rate structures.

BEST PRACTICE 12: High-Efficiency Fixture and Appliance Replacement for Residential and Non-Residential Sectors

- Programmatic, regulatory, and customer support best practice (utility perspective)
- Customer side best practice - implemented by water customers with support from water utilities
- Customer participation – action by customers required for successful implementation

Overview

The goal of this best practice 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 adopt this tactic. Rebates and vouchers are also important tools for coaxing customers to replace devices with more water efficient models. For the commercial sector more generalized incentives may be appropriate as fixtures and equipment vary from site to site.

A "retrofit on reconnect" ordinance may be the most effective and least-cost implementation method for accelerating installation of efficient fixtures and appliances. There are a variety of ways this type of ordinance can be written and implemented, but the general concept is that when a property is sold or changes hands, the new owners or occupants must sign up for water service – i.e. reconnect to the system. As a condition of providing water service to the property, the water provider can require that designated fixtures and appliances be upgraded to meet current plumbing code and efficiency standards.

Programs relying on rebates or vouchers must carefully assess the economic trade offs in order to maximize benefits. Incentives are best targeted to customers with high demand who would be unlikely to take action in absence of an incentive. Incentive programs must also guard against customers who would purchase new fixtures or appliances regardless of the financial incentives (i.e. free riders).

Water utilities should maintain lists of equipment eligible for incentive programs. These lists might include hundreds of makes and models. One way to streamline this process is to rely on the EPA's WaterSense labeled products. These products are intended to use at least 20% less water than conventional devices.

Why a Best Practice?

Indoor water use in Colorado presents a significant ongoing opportunity for water savings. High efficiency fixtures and appliances result in long-term demand reductions. Replacement and incentive programs speed the adoption of high efficiency devices.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board

(CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, utilities must consider incentives to implement water conservation techniques, including rebates to customers [CRS 37-60-126 (4)(a)(1 and X)].

Applicability

This best practice is a reasonable option for water utilities with available storage and/or groundwater resources. Utilities that rely on direct flow water rights and have limited storage would be better advised to focus on consumptive use reductions.

The age of homes and commercial facilities in a service area should be taken into consideration. Older buildings tend to have older fixtures and older fixtures tend to be less water efficient. Utilities with significant numbers of older homes (before 1994) might find properly targeted incentive programs particularly useful in curbing demand.

Implementation

Fixture or appliance replacement and incentive programs should have the following components (Vickers 2001):

- Targeting customers with high-water using fixtures.
- Program economic and financial planning including setting reasonable rebate rates.
- Marketing and outreach campaigns reaching target audience.
- Installation guidance or assistance.
- Purchasing information such as toilets that qualify for replacement rebates.
- Rebate application forms.
- A convenient, efficient inspection procedure.
- Payment processing.
- Program monitoring and reporting.
- Relationships with retailers and plumbers.

While many of these components are self explanatory, several deserve further expansion.

Targeting

As with most best practices, targeting incentives to the right customers is essential for success. Retrofits have the greatest impact when exchanging inefficient fixtures and appliances with modern water efficient devices.

As plumbing codes evolve, new fixtures are mandated to be more efficient than older devices. For targeting, it is often assumed that older buildings will have older inefficient fixtures and appliances. The age of a building can be determined from tax assessor records or possibly from the account start date in a utility billing system. This provides water utilities a parameter for targeting program participants. Homes or facilities built after 1994 will likely have toilets, faucets, and showerheads that comply with the 1992 EPAct, which stipulates 1.6 gallons-per-flush toilets, and sets flow limits on faucets and showerheads.

Incentive program costs also highlight the need for targeting. Targeting helps a utility maximize water savings and benefits.

The City of Greeley used their customer billing database and their geographical information system (GIS) to target regions of the city that might benefit from participation in a toilet retrofit program. Using the historic billing data, the average annual indoor use was calculated for each property and daily per capita use was estimated using average household size data from the US Census. Then the GIS was used to map regions of average, above average, and below average water use as shown in Figure 4-18. Areas with above average indoor use are shown in red. These areas represent the best opportunities for indoor conservation including toilet retrofits. This is the type of targeting effort that can significantly improve results from a water conservation program focused on indoor use reductions.

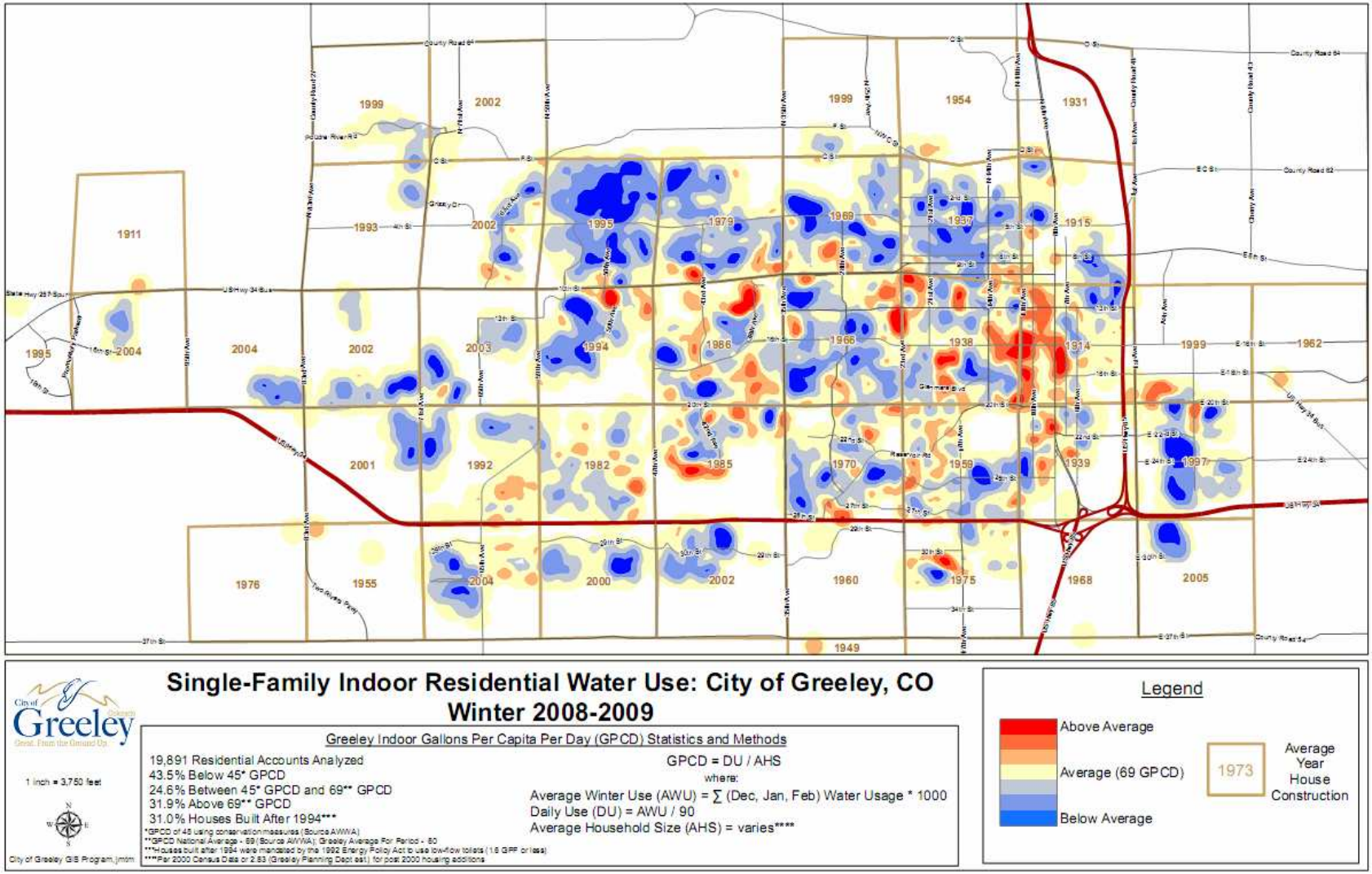


Figure 4-18: Greeley "toilet map" which identifies varying levels of indoor water use across the service area.

Economic and Financial Planning

Evaluating costs and benefits is a key component to creating cost-effective incentive programs. The value of an incentive must be high enough to motivate the customer to replace a fixture or appliance, but given a finite program budget, the incentive value should be minimized to allow greater participation and to ensure cost-effective savings.

Some customers are willing to replace devices without an incentive but they apply for a utility incentive anyway. These customers tap funds that would otherwise go to customers who require a financial incentive to improve water efficiency.

Determining the proper incentive level is an important consideration in program design. As a basic rule of thumb, incentive values should be based on the value of the anticipated water savings to be achieved by the retrofit. Utilities can use the avoided cost of new water supply to help set incentive values. Because of the natural replacement of fixture and appliances, incentive programs only offer accelerated water savings that will likely be achieved without incentive at some future date. This reduces the cost-effectiveness of incentive programs.

Desired replacement rate may also be a factor in setting values for incentives. For a more aggressive replacement program, rebates may be set rather high to drive customers to replace devices before the end of their useful life.

The California Urban Water Conservation Council has extensive resources on a wide array of water conservation measures, including incentive programs. In addition, their *BMP Costs & Savings Study*, which is out of print but can be found online in electronic form, has several extended discussions of cost-benefit analysis for incentive programs. One place to start is www.cuwcc.org/resource-center/technical-resources/bmp-tools.aspx.

Retrofit on Reconnect Ordinance

For utilities, a "retrofit on reconnect" ordinance may be the most effective and least-cost implementation method for accelerating installation of efficient fixtures and appliances. However, customers will bear the brunt of costs. There are a variety of ways this type of ordinance can be written and implemented, but the general concept is that when a property is sold or changes hands, the new owners or occupants must sign up for water service – i.e. reconnect to the system. As a condition of providing water service to the property, the water provider can require that designated fixtures and appliances be upgraded to meet current plumbing code and efficiency standards.

The new account holder would then be given a fixed amount of time (several weeks to a month) to complete the necessary fixture and appliance upgrades. Once completed an inspection should occur to verify that all requirements have been met. Those who fail to comply with the ordinance in a timely manner could be fined and/or penalized. The water provider may also choose to offer financial incentives to assist customers in making the required upgrades, thus "softening" the financial impact of the regulations.

The State of California recently passed a retrofit on reconnect ordinance that was described by the Alliance for Water Efficiency as follows:

> *If you buy a home, condo, or commercial property in California in the coming years water efficient toilets and urinals will be part of the deal – like it or not. Under new legislation passed in October 2009 and signed into law by Governor Arnold Schwarzenegger toilets and urinals across the state must be meet efficiency standards as a condition of receiving a certificate of occupancy.*
>
> *According to California's legislative bill-tracking website, "The bill would require, on and after January 1, 2017, that a seller or transferor of single-family residential real property, multi-family residential real property, or commercial real property disclose to a purchaser or transferee, in writing, specified requirements for replacing plumbing fixtures, and whether the real property includes noncompliant plumbing."*
>
> *"The bill would permit an owner or the owner's agent to enter rental property for the purpose of installing, repairing, testing, and maintaining water-conserving plumbing fixtures, as specified," according to posted information, "and would require, on and after January 1, 2019, that the water-conserving plumbing fixtures prescribed by the bill operate at the manufacturer's rated water consumption at the time that a tenant takes possession, as specified."*
>
> *This bill represents a tremendous leap forward in plumbing retrofit policy in the United States. If other states adopt similar legislation, adoption of efficient plumbing fixtures could occur even more rapidly than anticipated.*
>
> *(Alliance for Water Efficiency from: www.allianceforwaterefficiency.org/water-efficiency-watch-oct-nov-2009.aspx)*

A copy of the California retrofit on resale ordinance is provided in Appendix B.

Recommended Domestic Fixture Replacement Specifications

The following fixture and appliance minimum specifications are recommended for utility incentive programs. Requiring WaterSense labeled equipment wherever possible eases specification requirements and helps ensure water savings and performance.

- **Toilets -- Residential** - Replacing a 3.5 gpf toilet with a WaterSense labeled toilet can save 40,000 gal/household annually (EPA 2010).
  - ***Recommended replacement***: WaterSense labeled high efficiency toilets rated at 1.28 gpf.

- **Toilets -- Commercial** - WaterSense labeled tank-type toilets and flushometer toilets are available for specification.
  - ***Recommended replacement for Flushometer-style toilets:*** WaterSense labeled fixtures rated at 1.28 gpf or less. Bowls must be matched to valves.

- ***Recommended replacement for tank toilets:*** WaterSense labeled high efficiency toilets rated at 1.28 gpf.
- ***Recommended replacement for pressure assist toilets:*** WaterSense labeled 1.0 gpf pressure assist toilets.

- **Urinals – Commercial** – WaterSense labeled urinals are available for specification. Replacing a 1.5 gpf urinal with a WaterSense urinal can save an estimate 4,600 gallons annually (EPA 2010).
  - ***Recommended replacement:*** WaterSense labeled urinals that use 0.5 gpf or less.

- ***Clothes washers – Residential and Light Commercial*** - High efficiency clothes washers can cut water use in half (or better) and reduce energy use by 30%.
  - ***Recommended replacement:*** EnergySTAR rated, Consortium for Energy Efficiency Tier 3 washers with Water Factor < 4.0.

- **Faucet aerators – Residential or Commercial** - WaterSense labeled aerators can reduce flow by 30% or more. Aerators are inexpensive and often achieve economical savings.
  - ***Recommended replacement – kitchen:*** 2.2 gpm aerators.
  - ***Recommended replacement – bathroom:*** 0.5 gpm aerators are mandated by federal code in commercial settings and are also appropriate for residential applications. WaterSense labeled fixtures recommended.

- **Showerheads – Residential or Commercial** - WaterSense labeled showerheads rated at 2.0 gpm. There are also showerheads with even lower flow rates.
  - ***Recommended Replacement:*** 2.0 gpm WaterSense labeled showerheads or better.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

The water savings achieved through domestic fixture replacement are achieved by accelerating the installation date over what would have "naturally" occurred at some later date. When incorporating domestic fixture replacement into demand forecasts it is important not to double count natural conservation savings.

Full retrofit of toilets, clothes washers, showerheads, and faucets in single-family residences has been shown to reduce indoor demand by approximately 30% to between 35 and 40 gpcd (Aquacraft 2001, 2003, 2004). Additional indoor savings may be possible in the future, but at this time this level of demand appears to be a reasonable and achievable minimum.

The savings that can be achieved in the non-residential sector through the replacement of domestic fixtures (as described above) and through specialized equipment (described in more detail in Best Practice 14) are substantial, but less definitively quantified because of the variability inherent in non-residential demand. The *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* guide offers reasonable estimates of water savings that can be achieved in a wide variety of non-residential settings. This guidebook is

available for free and can be downloaded as a PDF from the Alliance for Water Efficiency: www.allianceforwaterefficiency.org/WaterSmart_Guidebook_for_Businesses.aspx

The Alliance for Water Conservation Tracking Tool, available for free to members of AWE, can also be used to estimate water savings from domestic fixture replacement (AWE 2009).

How to Determine Savings

Savings can be estimated by tracking incentive-based fixture replacements and using published estimates of per fixture water savings. Savings should be assumed for the useful life of the fixture, but if forecasts include savings from natural replacement, care must be taken to avoid double counting. Savings can also be measured through a pre- and post- comparison of water use using utility billing data.

Penetration rate is an important parameter in assessing replacement programs. It is best thought of as the fraction of customers in a population that have a given device. Tracking penetration rate helps utilities determine how many low-efficiency devices remain in their service population.

Savings Assumptions and Caveats

The water savings achieved through domestic fixture replacement are achieved (in many cases) by accelerating the installation date over what would have "naturally" occurred at some later date. When incorporating domestic fixture replacement into demand forecasts it is important not to double count natural conservation savings.

The level of water savings that can be achieved through fixture and appliance replacement depends on the efficiency and utilization of the old fixtures as well as the new fixtures. Replacing a 5 gpf toilet with a 1.28 HET offers more savings than replacing a 1.6 gpf toilet with an HET.

Another caveat on water savings from fixture replacement is making sure the replacement actually happens. Simply providing a customer with an aerator or a food service pre-rinse spray valve does not guarantee installation or water savings. If these savings are to be relied upon, it is important to verify installation through an inspection or through a direct installation process. Large installation programs may choose to verify installation on only a sample of customers.

Other Benefits

In the case of devices that use hot water, energy savings are an additional benefit of water conservation. Showerheads, clothes washers, pre-rinse spray valves, faucets, and dishwashers all use hot water. Energy savings often make the return on investment for the conservation measure more attractive. Customers billed for wastewater based on consumption of water will also see a reduction in their wastewater bill.

Costs

Utility Costs

The face value of the incentive offered is only one part of costs related to a device replacement program. Programs can have overhead costs that range up to $100,000 for a large utility

program. Processing costs add $7 to $35 per rebate or voucher. Requiring an inspection (a sound idea) also increases costs. The high overhead costs necessitate large volumes of device replacement over several years. Overhead and startup costs come from marketing materials, setting up tracking systems and banking procedures (Alliance for Water Efficiency 2010).

Customer Costs

While incentives offset some customer costs, replacing fixtures and appliances can be expensive and often limits participation from lower income customers. For residential toilets installed costs range from $200 - $500. Commercial toilets and urinals typically cost an additional $100 - $200 per fixture. Clothes washers typically range from $450 - $1000 installed. Showerheads range from $15 - $100 per fixture installed. Faucet aerators can be purchased in bulk for $1 - $3 each and installation can often be accomplished in conjunction with other measures. Costs for non-residential fixtures and equipment such as pre-rinse spray valves, cooling tower upgrades, air-cooled ice machines, and commercial clothes washers and dishwashers are variable and must be evaluated individually.

When considering the merits of a rebate or voucher program, utilities may wish to consider the potential cost for the customer of "floating" the entire purchase price up front. This happens with rebate programs but not voucher programs. With rebates, customers have to pay full price for the device replacement, but the see a financial return from the rebate (often in the form of a credit applicable to future water bills). Paying full price may be particularly burdensome for low-income customers. On the other hand, with voucher programs utilities pay the retailer an amount for every voucher collected from customers as part of sales. This forces retailers to float some of the costs of the replacement devices (Alliance for Water Efficiency 2010).

Resources and Examples

Resources

The American Water Works Association has conservation case studies, including rebate programs. These can be found at:
www.awwa.org/waterwiser/education/casestudies.cfm?showLogin=N.

AWWA also has links to rebate programs from different water utilities around the country. These may provide useful examples. And they can be found at:
www.awwa.org/WaterWiser/links/index.cfm?LinkCategoryID=34&navItemNumber=3369&showLogin=N.

Energy savings can come from water savings if the water used is heated. As a result, some energy efficiency programs overlap with water conservation programs. The Data base of State Incentives for Renewables and Energy Efficiency provides comprehensive lists of energy rebates, some of which may also apply to water conserving devices. DSIRE's Colorado-specific page can be found at:
www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=CO.

Keeping lists of water efficiency fixtures and appliances up to date can be daunting. However, the EPA's WaterSense program lists different fixtures that qualify for the WaterSense label.

Products bearing the WaterSense label have passed third-party testing that shows water use that is 20% less than conventional fixtures. Info at: www.epa.gov/WaterSense/products/index.html.

The *Handbook of Water Use and Conservation* (2001 Amy Vickers) provides a great deal of information on water conservation measures including fixture replacement and retrofit.

The California Urban Water Conservation Council has extensive resources on a wide array of water conservation measures, including rebate programs. In addition, their *BMP Costs & Savings Study*, which is out of print but can be found online in electronic form, has several extended discussions of cost benefit analyses of rebate programs. One place to start is www.cuwcc.org/resource-center/technical-resources/bmp-tools.aspx.

Examples

Denver Water

Denver Water offers rebates on a number of water-saving fixtures and appliances. These rebates are available to Denver Water customers as well as customers of Denver Water's distributors. Rebate programs are tailored to customer type. The residential rebate program offers rebates for various household fixtures, provided that the fixtures are on Denver Water's lists of qualifying models and that the receipt and application are submitted within 90 days of the purchase. Likewise the commercial rebate program rebates only eligible fixtures purchased within the calendar year.

Residential rebates, as of 2010, include:

- Clothes washers ($150 rebate)
- High-efficiency toilets ($125 rebate)
  Only listed toilets that use 1.28 gallons per flush or less are eligible; low-flow toilets (1.6 gallons per flush) do not qualify for rebate.
- Wireless rain sensors ($50 rebate) and rain sensors ($25 rebate)
- Rotary nozzles ($5 rebate, minimum purchase is four)
- Weather-based smart controllers (25% of purchase price)

Commercial rebates for domestic fixtures, 2010, include:

- Commercial High-Efficiency Toilet Rebate ($125)
- Flushometer Bowl and Valve Combination Rebate
  - $125 for 1.28 gallon per flush HET
  - $60 - $75 rebates for 1.6 gallon per flush valve and bowl combinations.
- High-Efficiency Urinal Rebate ($50). Must flush using 0.5 gallons or less.
- Urinal Half-Gallon per Flush Retrofit Rebate ($25)

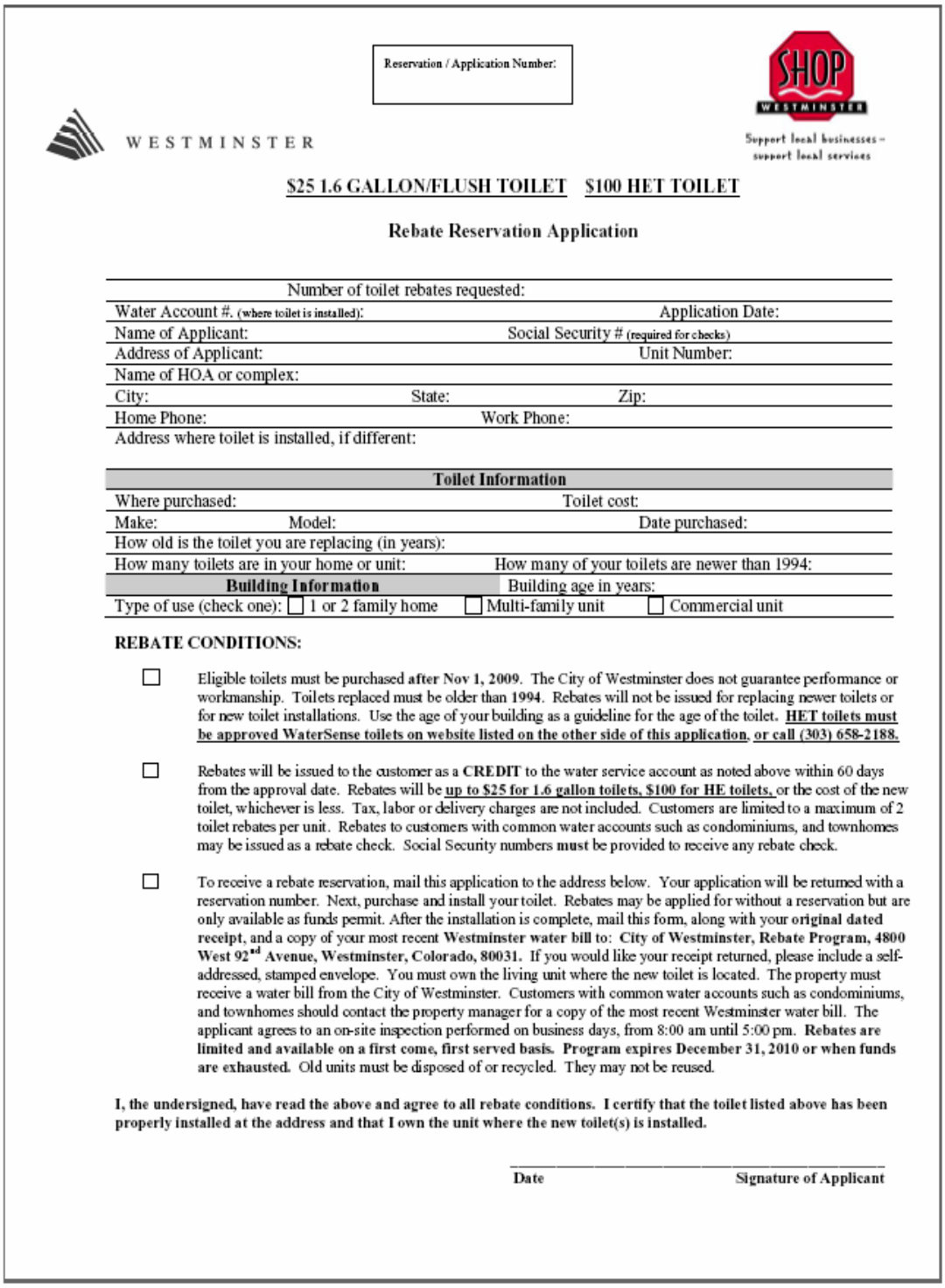
More information can be found from Denver Water's website at: www.denverwater.org/Conservation/Rebates/.

City of Westminster

The City of Westminster Water Department has a rebate program for toilets. Rebates are $25 for 1.6 gallon per flush toilets and $100 for 1.3 gallon per flush toilets. To identify qualifying toilets, Westminster directs potential applicants to the EPA's WaterSense website for lists of qualifying toilets. Residential as well as non-residential water customers can apply for the rebate, but they must be the property owner, not renters. The rebate is issued as a credit on the water bill, but customers who have common water account, such as those living in condos, will be issued a check. Customers can qualify for up to two rebates per dwelling unit. The old toilets are to be disposed of in the customer's trash. A screen capture of the rebate application form is shown in Figure 4-19. Information on the program may be found in the environment section of Westminster's website at: www.ci.westminster.co.us/345.htm

State of California Retrofit on Resale Ordinance

Full text of the ordinance is provided in Appendix B.



Reservation / Application Number:

WESTMINSTER

SHOP WESTMINSTER

Support local businesses – support local services

$25 1.6 GALLON/FLUSH TOILET $100 HET TOILET

Rebate Reservation Application

Number of toilet rebates requested:		
Water Account #. (where toilet is installed):		Application Date:
Name of Applicant:	Social Security # (required for checks)	
Address of Applicant:		Unit Number:
Name of HOA or complex:		
City:	State:	Zip:
Home Phone:	Work Phone:	
Address where toilet is installed, if different:		

Toilet Information		
Where purchased:		Toilet cost:
Make:	Model:	Date purchased:
How old is the toilet you are replacing (in years):		
How many toilets are in your home or unit:		How many of your toilets are newer than 1994:
Building Information		Building age in years:
Type of use (check one): ☐ 1 or 2 family home	☐ Multi-family unit	☐ Commercial unit

REBATE CONDITIONS:

☐ Eligible toilets must be purchased **after Nov 1, 2009**. The City of Westminster does not guarantee performance or workmanship. Toilets replaced must be older than **1994**. Rebates will not be issued for replacing newer toilets or for new toilet installations. Use the age of your building as a guideline for the age of the toilet. **HET toilets must be approved WaterSense toilets on website listed on the other side of this application, or call (303) 658-2188.**

☐ Rebates will be issued to the customer as a **CREDIT** to the water service account as noted above within 60 days from the approval date. Rebates will be **up to $25 for 1.6 gallon toilets, $100 for HE toilets,** or the cost of the new toilet, whichever is less. Tax, labor or delivery charges are not included. Customers are limited to a maximum of 2 toilet rebates per unit. Rebates to customers with common water accounts such as condominiums, and townhomes may be issued as a rebate check. Social Security numbers **must** be provided to receive any rebate check.

☐ To receive a rebate reservation, mail this application to the address below. Your application will be returned with a reservation number. Next, purchase and install your toilet. Rebates may be applied for without a reservation but are only available as funds permit. After the installation is complete, mail this form, along with your **original dated receipt**, and a copy of your most recent **Westminster water bill** to: **City of Westminster, Rebate Program, 4800 West 92nd Avenue, Westminster, Colorado, 80031.** If you would like your receipt returned, please include a self-addressed, stamped envelope. You must own the living unit where the new toilet is located. The property must receive a water bill from the City of Westminster. Customers with common water accounts such as condominiums, and townhomes should contact the property manager for a copy of the most recent Westminster water bill. The applicant agrees to an on-site inspection performed on business days, from 8:00 am until 5:00 pm. **Rebates are limited and available on a first come, first served basis. Program expires December 31, 2010 or when funds are exhausted.** Old units must be disposed of or recycled. They may not be reused.

I, the undersigned, have read the above and agree to all rebate conditions. I certify that the toilet listed above has been properly installed at the address and that I own the unit where the new toilet(s) is installed.

_____

Date **Signature of Applicant**

Figure 4-19: Image of Westminster's rebate application form.

BEST PRACTICE 13: Residential Water Surveys and Evaluations Targeted at High Demand Customers

- Programmatic and customer support best practice (utility perspective)
- Customer side best practice - Implemented for water customers by water providers.
- Customer participation – Significant: customers must communicate and meet with utility representatives.

Overview

Water surveys and evaluations (frequently referred to as "audits") that identify water savings opportunities and educate customers are a fundamental component of residential (and non-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 (Vickers 2001).

Why a Best Practice?

Residential water use evaluations cover both indoor and outdoor use and identify concrete methods for reducing water use in a home. Water surveys often reveal leaks and unintended water usage that some customers are simply not aware of. Water surveys are also an excellent way for water utilities to extend customer service beyond metering and billing and to help customers save water and money.

Targeting is essential because program budgets are limited and not all households can achieve measurable water savings. Once targeted, water surveys present utilities with the opportunity to work with their highest use customers to achieve meaningful demand reductions.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is: "(VI) Dissemination of information regarding water use efficiency measures, including by public education, customer water use audits, and water-saving demonstrations" [CRS 37-60-126 (4) (a)].

Applicability

This best practice applies to high demand residential customers or customers that experience and unexpected spike in usage. High demand customers can be identified as the top quartile of water users on an annual or seasonal basis. Spikes in demand can be identified by comparing consumption against the previous billing period and the same billing period from the previous year. As a rule of thumb, identifying the top 10 – 25% of customers based on average winter consumption (AWC) targets high indoor water users; and selecting 10-25% of customers based on annual or summer demands targets high outdoor water users. Using three years of billing data, rather than one year, and discounting drought years can improve data used for targeting.

Water survey programs, with proper targeting, give utility staff a chance to educate high water using customers and address leaks, excess irrigation, and overall efficiency improvements at

selected residences. Water survey programs are also a good response to customer complaints about high water bills.

Implementation

The following steps are recommended when implementing a residential water survey program.

Pick Low Hanging Fruit - Target Customers with High Water Use Patterns

Targeting water surveys to high demand customers makes the most of limited program resources and improves water savings. Targeting is usually accomplished by querying the utility billing database, sorting all residential customers by annual demand and selecting the top 10 to 25% of water users. Spikes in demand can be identified by querying the utility database and comparing consumption against the previous billing period and the same billing period from the previous year for a given customer. Using three years of billing data, rather than one year, and discounting drought years can improve data used for targeting. This will likely identify the heavy irrigators since outdoor use is usually the dominant component of demand among large residential end users. Sorting the utility billing database by average winter consumption (i.e. average monthly water use over the months of December, January, and February when there is littler or no outdoor use in Colorado) and selecting the top quartile will likely identify customers with high indoor water demands. Customers who are in the top quartile for both indoor *and* total use are probably the best candidates for a water survey since they may achieve significant savings both indoors and outdoors. It should be noted that there are often legitimate reasons for higher than average water use at any given property including: large family size (resulting in high indoor use), and large lot size (resulting in high outdoor use).

Invite Participants

Water surveys require willing participants. Utilities typically send an invitation offer to participate to the targeted customers, or the customers may be contacted through another means such as e-mail or telephone. The invitation should mention the fact that the customer was chosen for the program based on an analysis of historic water consumption that placed them among the highest users in the service area. Peer pressure has been found to be a tremendously powerful motivator for conservation-minded behavior change. Customers who learn that they are one of the largest water users in the area may be substantially more motivated to participate in the survey program and most importantly, to implement the recommendations from the survey. Even if these methods are implemented some customers will remain unwilling to participate.

Perform the Survey

A residential water survey typically takes between 30 and 90 minutes to complete depending upon the complexity of outdoor use at the site. The following steps from the *Handbook of Water Use and Conservation* can assist utilities in implementing cost-effective, residential conservation programs (Vickers 2001):

1. Explain purpose of evaluation.
2. Determine water use.
3. Test for and possibly repair leaks (Provided the leak is simple. Otherwise, customers are responsible for repairs).
4. Provide retrofit devices.
5. Evaluate lawn and irrigation characteristics and recommend design modifications.
6. Customize home irrigation schedule, if needed.

7. Evaluate other outdoor water uses. *(Detailed information on landscape efficiency is provided in Best Practices 7, 8, 9, and 10 in this guide book.).*
8. Identify all water conservation opportunities.
9. Evaluate water efficiency measures.
10. Educate customers.

1. Explain purpose of evaluation
Start with the basics: talk to the customer about the survey process. The purpose of the survey is to find potential water savings. Some water savings may come from hardware changes and some savings may come from changing behaviors such as more careful lawn watering and repairing leaks.

Education can also help customers become proactive about their water use. The California Urban Water Conservation Council and the EPA have created a website that shows water use in a typical home. This website shows homeowners different water-using appliances and makes recommendations for water conservation. The H2ouse website can be found at www.h2ouse.org/tour/index.cfm.

Provide information on other conservation programs for which the customer may be eligible. These may include retrofit rebates from other agencies such as the case of clothes washers that save energy as well as water.

2. Determine water use
Do some homework before the evaluation: look at utility bills and prepare a water budget for the site based on reasonable, efficient use (2,000 – 5,000 gallons per month or 65 – 165 gallons per household per day for a residential indoor [38]; for outdoor budget calculation methods see Best Practice 7: Landscape Water Budgets in this guidebook). This information may be readily available from targeting efforts, but if not, try to obtain bills. Billing statements can give a longer-term picture of water use and a clearer sense of potential conservation.

Once on site, test fixtures for low water use. Flow bags can be used to measure faucet and showerhead flow rates. Note the age of toilets in the home (date stamps are usually located in toilet tanks and are occasionally stamped into the tank lid).

3. Test for and repair leaks
Visual inspection will help locate many leaks. Residents are often aware of leaks, so ask.

Leaks can be a major consumption of water. Measure leaks whenever possible. Calculate the amount of water a given leak uses per day, per month, and per year. Compare that to over-all water use. Share this information with the customer. Education is important as customers are the first responders to leaks which can appear at any time.

Toilet leaks are probably the biggest cause of indoor water waste. A leaky toilet can waste up to 500 gallons per day. Typically toilet leaks are caused by flappers that do not seal properly. Toilet leaks can be detected by placing dye (i.e. a dye tablet or drop or two of food coloring) in the tank. If dye is visible in the bowl within 15 minutes (usually less), there is a flapper leak. To fix this leak, the flapper must be either repositioned (usually a temporary fix) or replaced with a flapper that fits properly and maintains the flushing integrity of the toilet. Flapper information

[38] Assumes approximately 3 people per household.

for many brands and models of toilet can be found at www.toiletflapper.org/index.aspx. Consider carrying an adjustable flapper as part of the conservation evaluation tool kit. Many people are not aware that toilet flappers must be replaced every five years or so.

4. Provide retrofit devices
Small changes can make a big difference in water use. This is particularly true for flow-restricting devices, some of which are relatively inexpensive. Items to distribute as part of a water conservation survey program may include:

- Information and educational materials
- Low flow showerheads (2 gpm flow rating or lower)
- Faucet aerators for lavatory (0.5 – 1.0 gpm) and control-flow aerators for kitchen faucets (2.2 gpm).
- Automatic hose shutoff nozzle
- Dual flush retrofit device
- Replacement flapper for toilet
- Toilet leak test kit

5. Evaluate landscape and irrigation characteristics and recommend design modifications
In Colorado, urban landscape irrigation accounts for 50 percent or more of the total annual water demand for a utility and about 60% of a typical front range residence's water use (Mayer 1999). ***Detailed information on landscape efficiency is provided in Best Practices 7, 8, 9, and 10 in this guide book.*** Residential site surveyors should note:

- type(s) of landscaping materials,
- landscaped area (frequently determined in advance of the audit and verified on site),
- health of landscape (brown spots, etc.), and
- microclimates

6. Customize irrigation schedule, if needed
Irrigation controllers can be adjusted, but the emphasis should be on customer education so that they can make their own adjustments in the future.[39] While most people understand that water needs vary over the course of an irrigation season, they often don't take the step of adjusting irrigation timing in response to changing conditions. These adjustments can be done relatively easily using a percent adjust feature found on most controllers. Talk with the resident about strategies for remembering to make monthly changes to irrigation.

7. Evaluate other outdoor water uses
Other outdoor water use such as water features, pools and fountains will not be addressed by landscape surveys. Check for leaks, automatic shutoffs, auto fill features. Evaporation from pools can be reduced with the use of a pool cover.

8. Identify all water conservation opportunities
Keep track of observations noted during the site visit. Keep in mind potential conservation measures while in the field. Additional research may be performed off site once the survey is done.

[39] This applies to customers with an automatic in-ground irrigation system.

9. Evaluate water efficiency measures
For each water conservation measure identified, provide some assessment of the financial value of implementing the measure. Include one time costs (such as purchasing hardware), ongoing costs and maintenance costs (such as ongoing repairs to irrigation equipment). Balance these against potential water use reductions and cost savings. Include other possible customer-side savings such as reduced wastewater fees and reduced energy costs. Pair cost and benefit information for each measure and then calculate the payback time. These data should also be shared with the customer.

10. Educate customers
Education is a fundamental goal of a water audit program. Some conservation measures rely on changed habits rather than technological changes. Tell homeowners what the audit survey found. Detail potential water savings for each item discovered in the evaluation process. A checklist of remedies should also be included with the report.

For newer homes with more efficient fixtures, improved water use practices may offer the only reasonable water savings. Denver Water provides a list of good conservation practices every homeowner should embrace (from: www.denverwater.org/Conservation/TipsTools/Indoor/).

Bathroom

- Flush toilets only when necessary, and never use a toilet as a wastebasket.
- Spend five minutes or less in the shower. Showers use less water than baths.
- Fix all leaky toilets, faucets and pipes.
- Install a low-flow showerhead.
- Replace an old toilet with a high-efficiency toilet, which can pay for itself over time in water savings.
- Insulate your water heater and water pipes. Doing so will save energy and also will cut down on the amount of water that goes down the drain while waiting for hot water to flow.
- Catch water in a bucket or watering can while waiting for hot or cold water to run. Use the water on plants or use it to flush a toilet.
- Turn off the water while shaving, brushing your teeth and lathering in the shower.
- Shave with a small amount of water in the sink instead of running water.
- Replace or install a low-flow aerator on your bathroom faucet.

Kitchen and Laundry

- Wash only full loads in the washing machine and dishwasher. Try to wash two fewer loads per week.
- Wash vegetables and fruits in a bowl or basin using a vegetable brush instead of letting water run. Use the extra water on plants.
- Soak dishes that need to be pre-rinsed instead of running them under water.
- Scrape dishes instead of rinsing them off before putting them in the dishwasher.
- Chill drinking water in the refrigerator instead of running the faucet until the water is cold.
- Defrost food in the refrigerator, not in a pan of water on the counter or in the sink.
- Run garbage disposals only when necessary. Compost food waste instead.
- Replace your inefficient clothes washer with a high-efficiency model.
- Replace or install a low-flow aerator on your kitchen faucet.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

Visiting residences does not immediately equate to water savings. In fact, minimal –if any – water savings will result from visiting homes where water use is already efficient. However, with proper targeting to high demand customers, savings from site surveys can be significant. Eliminating inefficient water uses should be able to reduce annual consumption by 10 – 20% *after implementing the recommendations* of a carefully conducted site audit.

How to Determine Savings

For each recommended residential conservation measure, savings should be calculated as part of cost analysis. These savings should be extrapolated to the life of the measure (e.g. 30 years for a toilet retrofit, 14 years for a clothes washer, 10 years for showerheads and faucet aerators). Savings can be measured in aggregate by comparing before and after water bills.

Savings Assumptions and Caveats

Savings are only realized if the auditor makes physical changes at the home or if the residents take action. The impacts of this best practice frequently rely on customer education and the ability of education by itself to affect behavior change is uncertain. Additionally, some savings measures such as leakage repair may have short life – only a few months or years.

Goals and Benchmarks

Utility goals for residential site surveys should revolve around contacting and visiting a certain number of customers from the top 25% of water users in the system. The number of customers contacted will by necessity be based upon the available budget for the program. Ideally *all* customers in the top 10 or 25% of water users should be contacted and invited to participate in a site survey program over a number of years, but practical budgetary limitations will ultimately dictate program size and scope.

Other Benefits

While saving water may be one boon of the residential survey, secondary benefits may not be as apparent. Customers may not realize that sewage fees may decrease, and if heated water is leaking, their energy bills may also see improvement. Finding and stopping leaks may also prevent structural or landscape damage.

Costs

Utility Costs

Utility costs vary depending on the level of site survey conducted. A short, quick residential site survey may cost $50 - $100 per site to implement. More involved residential surveys, which include landscape analysis, cost between $150 and $500 to conduct depending upon site specifics. Costs from small hardware fixes included in the visit (such as faucet aerators, showerheads, or toilet retrofit devices) can increase the per household cost by $5 - $50. Utilities may wish to charge customers for a site survey (as do some electric utilities), but this will likely reduce participation.

Customer Costs

Customers may see significant costs from pursuing recommended conservation measures such as toilet or clothes washer replacement. However, if substantial savings are realized, customers may also see reasonable payback from water and wastewater savings. Additionally, utility sponsored rebate programs can offset some customer costs.

Resources and Examples

Resources

Education can also help customers become proactive about their water use. The Field Museum in Chicago has developed an excellent residential water use calculator: http://watercalculator.fieldmuseum.org/watercalculator

Similarly, the California Urban Water Conservation Council and the EPA have created a website that shows different water-using appliances and makes recommendations for water conservation. This site also has a good water budget calculator. The H2ouse website can be found at www.h2ouse.org/tour/index.cfm.

Repairing toilet leaks presents an opportunity for significant water savings. Finding the right flapper to fit a specific toilet is essential. Flapper information for many brands and models of toilet can be found at www.toiletflapper.org/index.aspx.

Examples

Survey Kit

Advanced preparation can help ensure that site surveyors have the right tools and equipment for field visits. Keeping a conservation kit ready to go can reduce the tendency to reinvent the wheel each time an evaluation is requested. Suggested kit contents are shown in Table 4-21.

Table 4-21: Site survey field kit items

• Site survey form (see below for template)	• Tape measure for measuring tubs and tanks
• Measuring cups of several sizes and stopwatch for measuring leaks.	• Low-flow aerators in several styles (if agency has budget for hardware)
• Clipboard and extra pencil (pencils don't run like ink might)	• Flow bags for measuring flow rates from showers and faucets.
• Low-flow shower heads (if agency has budget for hardware)	• Wheel for marking off larger distance such as pool dimensions
• Information (e.g. brochures) on water conservation practices	• Information (e.g. brochures) on fixture and appliance rebates
• Hand sanitizer	• Rubber gloves and shoe covers

INDOOR RESIDENTIAL AUDIT FORM

Customer Name _____

Service Address _____

Date of Audit _____ Time of Audit _____

Annual metered use (gal)_____ Year_____

Avg. Monthly Winter Consumption (gal)[40]_____

Estimated Annual Indoor Use (gal)[41] _____

Estimated Annual Outdoor Use (gal)[42]_____

1. Total number of full-time residents _____
   - Children (0-12 yrs) _____
   - Teens (13-19 yrs) _____
   - Adults (20+) _____
2. Number of part-time residents _____
3. Is there typically someone at home during the day? _____
4. If so, how many? _____
5. Year house built _____
6. Remodel: Year[43]_____ Room(s)_____
7. Number of :

   Full baths_____ 3/4 baths_____ 1/2 baths _____

SURVEY QUESTIONS

8. How often do people in the home take baths? *(instead of or in addition to showers)*[44]

   Is there bathing of young children? _____ Size of bath (i.e. sink, partial tub fill, other)

9. Is there car washing at home? _____ Frequency _____

[40] Calculated using average use for December, January and February billing data
[41] = Avg. monthly indoor consumption x 12
[42] = Total annual use – Estimated annual indoor use
[43] Date of remodel can be compared against billing data for any notable changes in water use
[44] Note if it is standard size tub or Jacuzzi – get an idea of whether or not they fill the tub

10. Expected # of sidewalk/driveway washes per month _____

KITCHEN INFO

11. Dishwasher age _____ Energy Star _____

12. How often is dishwasher used? _____ How much hand washing of dishes, pots and pans?

13. Kitchen faucet flow rate _____ Aerator? *(Y/N/DK)*_____ Leak _____

14. Garbage disposal_____

15. Other water-using kitchen fixtures or appliances_____

UTILITY/OTHER

16. Clothes washer make _____ Model _____Year *(if known)*_____ Energy Star _____

17. Utility sink(s)?_____ Leak_____

18. Home water treatment? *(Y/N/DK)*_____ Regenerating? _____

19. On-demand hot water? *(Y/N/DK)* _____ Make/model _____
(Recirculating hot water system)
Serving which fixtures? _____

25. Hot tub *(not in bathroom*)? _____Length_____ Width_____ Avg. Depth _____

Fill method _____ Fill timing _____

26. Swimming pool?_____ Length_____ Width_____ Avg. Depth _____

Fill method: auto_____ manual_____ frequency _____

22. Other water using fixtures or items of note:

_____

_____

BATHROOM INFORMATION:

		1	2	3	4	5
23	Location (master, guest, kids)					
24	Size (full, ¾, ½)					
25	Toilet model (Std, ULF, HET)					
26	Tank size[45]					
27	Year of manufacture					
28	Problems (sticking handle, sticking flapper, poor flushing, etc.)					
29	Leaks (result of dye test)					
30	Fill line (high or low)					
31	Bath?					
32	Size of tub (length, width, depth)					
33	Jacuzzi (jetted)					
34	Shower? (Flow rate gpm)					
35	Type of showerhead (Multiple heads, hand held, rain dome, other)					
36	Leak (shower head or tub diverter)					
37	Sink? (Flow rate gpm)					
38	Aerator?					
39	Leak?					
40	Other?					

[45] The toilet volume can be estimated using the tank size for toilets that are not marked as ULF or HE

BEST PRACTICE 14: Specialized Non-Residential Surveys, Audits, and Equipment Efficiency Improvements

- Programmatic and customer support best practice (utility perspective)
- Customer side best practice - Implemented by water customers with support from water utilities.
- Customer participation – Action by customers required for successful implementation.

Overview

Specialized non-residential surveys and equipment efficiency improvements are a series of indoor water conservation practices that reduce water demands among customers who are largely in the commercial, institutional and industrial (CII) sector. This best practice description specifically *excludes* toilets, showers, and faucets (i.e. fixtures found in residential and non-residential accounts) which are addressed in the domestic fixture best practice, however part of the survey process involves identifying all domestic fixtures that should be upgraded to improve efficiency.

Non-residential accounts are made up of customers in the commercial, industrial and institutional sector by and large. In many utilities, non-residential demand accounts for 20% to 40% of total annual water use (Vickers 2001).

The end uses of water, in non-residential accounts, are more diverse and complex than for residential customers. Non-residential water users are heterogeneous and each business or institution may have unique and differing water use patterns. Seasonal and time of day variations in water use may be more pronounced for non-residential customers.

Non-residential customers include: schools, supermarkets, car washes, office buildings, restaurants, hotels, prisons, hospitals, airports, amusement parks, manufacturing plants, churches, universities, recreation centers, and many other types of facilities and businesses. The end uses of water within the non-residential sector are as diverse as the sector itself and includes: irrigation, toilets, faucets, showers, evaporative cooling, dishwashing, ice machines, swimming pool refilling and backwash, decorative fountains, water cooled equipment, autoclaves, dialysis machines, car washes, pavement washing, and the list goes on and on.

Targeting specific sectors and end uses, such as replacing water-cooled ice machines in restaurants, may result in significant water savings but utilities with limited conservation resources may find it difficult to implement a broad array of non-residential programs. Establishing useful customer categories within the utility billing database (as described in the best practice, *Metering, Conservation-oriented Rates And Tap Fees, Customer Categorization Within Billing System*) allows an agency to determine which type of non-residential customers use the most water in summer or winter and provides a sound basis for establishing a manageable and cost-effective non-residential demand management program. Sometimes implementing conservation measures at a small number of high-demand non-residential sites can impact overall water use measurably.

Why a Best Practice?

Non-residential customers account for a significant portion of overall municipal water demand and is estimated between 20 and 40% on average (Vickers 2001). Comprehensive water conservation programs must look beyond the residential sector and tackle the often more complex challenge of reducing non-residential demands through new technology and improved processes. Conducting a detailed site survey (aka audit) is an essential first step in the process. Potential water savings for non-residential water users range from 15% to 50% and have gone largely unrealized (Dziegielewski 2000).

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Water-efficient industrial and commercial water-using processes." [CRS 37-60-126 (4)(a)(II)].

Applicability

This best practice applies to the non-residential sector including all commercial, institutional and industrial water users. Existing and new facilities alike are candidates for conservation measures. Although this best practice applies all non-residential accounts, high water users should be a priority for conservation assessment and action.

Implementation

The following steps can assist utilities and water users in implementing cost-effective, non-residential conservation programs:

1) Classify non-residential customers using North American Industry Classification System (NAICS) codes (see Best Practice on *Metering, Conservation-oriented Rates and Tap Fees, Customer Categorization within Billing System* for details)
2) Target customers with high water use patterns for program implementation.
3) Conduct site survey to assess conservation potential.
4) Implement cost-effective measures.
5) Follow-up to ensure savings are achieved.

Classify Non-Residential Customers

Targeting water conservation initiatives at the customers who have the greatest potential to save (i.e. to the highest users in their class) makes sense. But utilities often have precious little information about their customers, particularly in the diverse CII category. The first step is for the utility to understand who their non-residential customers are and how they use water. Collecting and maintaining basic classification information on each customer served by a utility using the established North American Industry Classification System (NAICS, formerly SIC) greatly enables targeting efforts and conservation program design. Coupling an understanding of who customers are (NAICS classification) with measured consumption (metered billing) provides powerful tools for water utilities seeking to improve efficiency.

Target Customers with High Water Use Patterns

Targeting is critical. Different non-residential sites present different conservation potential. Managing the scope and actions of non-residential conservation efforts helps maximize resources and returns. Table 4-22 shows estimated water use benchmarks for selected non-residential facilities which can be used for comparison purposes, but may or may not represent an efficient level of usage for any given customer class.

Table 4-22: Selected non-residential facilities and corresponding *estimated* water use. Note that water use data vary greatly and are often site specific (Vickers 2001).

CII Facility	**Gallons per capita per day** *(unless otherwise noted)*	**Gallons per employee per day**
Auto repair, service and parking		217
Amusement and recreation service		427
Camps	15 - 100	
Dentist Offices		259
Hotels and other lodging		230
Hospitals (per bed)	300	
Manufacturing		133
Mobile home (per hookup)	250	
Museums, botanical, zoo, gardens		208
Non-depository institutions		156
Nursing homes		197
Public administration		106
Retail stores (per restroom)	400	
Shopping center (per 1000 SF)	300	
Social services		106

When targeting non-residential customers for water efficiency program efforts, the following questions should be considered at the outset (CUWCC 2000):

- What sub-sectors and technologies should/can be targeted?
- Are there partnering agencies to cost share or make the program more cost effective?
- Can we identify non-residential customers by class?
- Can similar customers be compared (i.e. all Chinese restaurants or all fast food restaurants or all motels)?
- Are normalizing factors available (i.e. number of hotel rooms or numbers of meals served)?
- What are the elements should be included as part of a site survey?
- Can indoor and outdoor water uses be evaluated in the same survey?
- Is additional expertise needed to perform the more involved surveys?
- Should incentives be offered to promote implementation of survey recommendations?
- Could/should a “pay-for-performance” contractor be used for surveys or implementation?
- Will upgrades be implemented and verified? Can accounts be tagged for tracking savings?

- Will savings be determined from engineering estimates or measured savings from field studies?

Conduct Site Survey to Assess Conservation Potential

Once identified through a screening process, a realistic assessment of the customer's conservation potential should be assessed through a site survey often referred to as a "water audit". A site survey assesses water use at the site and provides an estimate of where water is being used and how much could be conserved by replacing fixtures or equipment or by implementing new processes or procedures. There are six basic steps to performing a non-residential water use site survey (Vickers 2001):

1. Obtain support from the facility's owner/manager.
2. Conduct an on-site inventory of water use.
3. Calculate all water-related costs.
4. Identify and evaluate water-efficiency measures.
5. Evaluate payback periods using life-cycle costing.
6. Prepare an action plan.

An important goal of the site survey is to try and quantify where and how much water is used at the facility. Start by obtaining historic billing records for at least one year prior and ideally for two or more years to avoid a skewed picture due to seasonal variations or business fluctuations. The auditor should inventory all water uses at the site and walk through the facility with the facility manager or engineer to collect information on each water-using fixture, appliance, and practice. Wherever possible flow measurements should be taken or estimated. If a cooling tower is present, water samples should be taken to determine the conductivity level and operational cycles of concentration. At the conclusion of the site visit, the auditor should develop a water balance that identifies and quantifies (through measurements and engineering estimates) all water uses at the facility.

Cost accounting for the site should include water, wastewater, energy (for pumping and water heating), chemical treatment (for cooling towers), and waste pretreatment (if applicable). Future cost increases should also be considered whenever possible.

A number of resources provide excellent information on conservation methods specific to non-residential specialized equipment. One guide proves exceptionally helpful: East Bay Municipal Utility District's WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses. This free guide details industry-specific water uses and conservation measures to address those specific uses. Table 4-23 lists the water use areas addressed by the guide. Although the title indicates new construction, these water conservation measures can be applied to existing facilities.

Table 4-23: *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* includes efficiency recommendations for these water-using practices.

Alternate on-site water sources	Photo and film processing
Food service operations	Pools, spas, and fountains
Landscape water-use efficiency	Process water
Laundries and dry-cleaning operations	Thermodynamic processes
Medical facilities and laboratories	Vehicle washes (car and truck wash)
Metering of individual units	Water treatment

The *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* guide can be downloaded as a PDF for free from the Alliance for Water Efficiency: www.allianceforwaterefficiency.org/WaterSmart_Guidebook_for_Businesses.aspx

The guide details different conservation actions, potential savings, cost-benefit analyses, and makes recommendations where applicable. For example, in the food service operations section, the subsection about ice machines includes a description of how water is used in ice machines. It also includes a breakdown of which types of facilities account for purchases of the given technology (hospitals are responsible for 39% of all ice machine purchases). The guide compares different water uses for similar technologies. Flake ice machines use 20 gallons per 100 pounds of ice. Water cooled machines flush water to the sewer and use 72 to 240 gallons of water for every 100 pounds of ice.

The WaterSmart Guidebook also discusses the financial aspects of using different equipment including capital costs, estimated life of equipment, water and energy savings, net present value and incremental cost (per acre-foot of water saved) for efficient equipment. For example, the Guidebook notes that air-cooled ice machines cost about $700 more than water-cooled machines. The expected life of the air-cooled machine is seven years. An air-cooled machine will save about 1,350 gallons (for every 700 pounds of ice produced) over a water-cooled machine. Next, the guide gives recommendations. In this case, the guide recommends prohibiting once-through water-cooled machines. It also recommends using USEPA EnergyStar approved machines.

Colorado WaterWise has developed excellent online resources for CII water conservation at http://ici.coloradowaterwise.org/. The goal of this website is to provide ready access to information and tools that will make the water conservation process, from assessment through implementation more accessible to all water users. The site includes useful assessment toolkit to determine potential water savings and a technology toolkit to assist in selecting equipment.

Implement Cost Effective Measures

It is not enough to simply document where water savings may be achieved through a water audit. Cost effective water efficiency measures should be implemented if savings are to be realized. In some cases the customer will pay for the entire implementation. In other cases the utility may cost-share or offer rebates or other financial incentives for implementation. Low or zero interest loans for the purchase and installation of new equipment are also an option to consider.

Efficiency upgrades can be performed “in house” by staff or can be contracted out to professionals. Large sites can consider performance contracting as an option. Under a typical

performance contract a series of water efficient measures and technologies will be installed and implemented by a designated contractor. Then the contractor will receive regular payment based on the achieved (or estimated) water (and energy) savings. This is a way for water customers to avoid the capital outlay associated with efficiency improvements, but it also means that cost savings will not be realized until the performance contractor has been paid.

Some agencies require that an implementation plan be developed after a water audit has been conducted to try and ensure that recommended conservation measures are put in place.

Note: *it is a good rule of thumb to check all applicable health, safety, environmental and other regulations that may apply to adjustments in water consuming activities and equipment at non-residential sites.*

Follow-up to ensure savings are achieved
If water savings are to be relied upon into the future, they must be measured and verified. The impact of implemented water efficiency measures should be monitored and tracked for at least one year after completion. This is usually accomplished by comparing historic water bills against water bills from the period after efficiency measures were put in place. Usually these data must be adjusted for variations in climate and any other changes that have occurred at the site (i.e. twice as many widgets were produced in the year after the efficiency improvements were made). Employees should be informed about changes in the facility's water demand pattern and encouraged to continue and expand efficiency efforts.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

The range of savings will vary greatly and depend entirely on the measures implemented at the site. As part of the 2000 AWWA Commercial and Institutional End Uses of Water study it was estimated that many non-residential sites have the potential to conserve between 15 and 50% of their current demand (Dziegielewski et. al. 2000).

Some of the factors that may impact water savings include: the specific conservation measures enacted (i.e. toilet replacement, landscape upgrades, improved cooling tower operation and maintenance), the implementation level, and site-specific water use patterns (before and after conservation implementation).

The EBMUD *WaterSmart Guidebook* provides specific information on potential savings from equipment as well as ideas for performing cost benefit analyses on specialized water conservation equipment and measures.

How to Determine Savings

In many cases, water savings can be determined by comparing one year of pre-installation consumption data (or more) from billing records against at least one year of post-installation consumption data. In most cases these data must be adjusted for variations in climate during the pre- and post-periods and for any other changes that have occurred at the site (e.g. changes in the number of employees, changes in production level, or changes in business traffic).

In some cases, changes in water use are too small to be detected via billing records. In these cases, water savings may be estimated using engineering estimation techniques (e.g. ten 3.5 gpf toilets were replaced with ten 1.28 gpf toilets). If more precise savings estimates are desired, submeters can be installed and usage measured and monitored for specific rooms and equipment.

Savings Assumptions and Caveats

A water audit alone will not save any water. Water savings are only achieved when recommended measures are implemented. When determining savings in the non-residential sector it is often essential to normalize water use on a relevant factor. For example, water use in restaurants is often best measured by determining the water per meal served or the water per occupied seat. In office buildings, water use can be normalized on the building square footage or the number of people working in the building. Table 4-22 (above) offers some insights into the factors that are useful in normalizing non-residential water use.

Engineering estimates are often used to estimate the water savings achieved at non-residential sites, but engineering estimates should not be considered an acceptable substitute for physical measurements of changes in demand. Engineering estimates are often inaccurate and fail to account for changes in behavior that may occur as a result of installing a new piece of equipment or implementing a new process or procedure. The most reliable measure of achieved water savings should be obtained from a careful comparison of measured pre- and post-installation water use patterns.

Goals and Benchmarks

Few reliable benchmarks have been established for the non-residential sector. The 2000 AWWA Commercial and Institutional End Uses of Water study proposed efficiency benchmarks for five classes of customer: restaurants, office buildings, supermarkets, hotels/motels, and schools (Dziegielewski et. al. 2000). A summary of these benchmarks is presented in Table 4-24.

Table 4-24: Benchmarks from AWWA Commercial End Use study (Modified from Dziegielewski et. al. 2000)

End Use/Benchmark Measure	Efficiency Benchmark Range
Restaurants	
Gal./SF/year	130 - 331
Gal./meal served	6 - 9
Gal./seat/day	20 - 31
Gal./employee/day	86-122
Hotels and Motels	
Gal./year/occupied room (total use)	39,000 – 54,000
Office Buildings	
Gal./SF/year (total use)	26 - 35
Supermarkets	
Gal./SF/year (total use)	57 - 80
Gal./transaction	3
Schools (Elementary and Secondary)	
Gal/school day/student (indoor only)	3 - 15
Gal/SF/year (total use)	40 - 93

Additional benchmarks and efficiency goals may be found in the following resources:

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses.* EBMUD, Oakland, CA.

Vickers, A. *Handbook of Water Use and Conservation*. 2001. Water Plow Press. Amherst, MA.

Cooling Towers

Improving the water efficiency of cooling towers is often a cost-effective way to save water in large buildings. Cooling towers are the largest indoor use of water at many non-residential facilities. Cooling towers should always be metered on the inflow line and records kept of concentration ratios and conductivity. Conductivity is the ability to conduct electricity. Water conducts electricity because it contains dissolved solids that carry electrical charges. Cooling towers should be managed to operate at 6 cycles of concentration or more, otherwise they can waste a huge amount of water. If the local make-up water has high conductivity, then it may only be possible to achieve 3-4 cycles of concentration. In such cases, another benchmark for cooling towers is to set the conductivity controller at a minimum of 1500 μS.

Other Benefits

Non-residential customers may realize other benefits from reducing water use. These might include, but are not limited to: reduced energy use (from hot water and pumping), reduced runoff from excess irrigation, improved performance from independently tested WaterSense fixtures, and lower water and wastewater bills.

Costs

Costs for implementing conservation in the non-residential sector can be substantial, depending upon what is accomplished. Costs may be borne solely by the customer, the water agency or a combination of the two. Often, financial incentives are provided by the water agency to tip the cost-benefit calculations towards making conservation financially feasible. Sometimes performance contractors are employed to implement water savings programs and then receive payment based on the water savings achieved.

Utility Costs

Costs to the utility may include upfront costs such as site surveys which can range from $100 - $1,000 per site (or more) depending upon the complexity and size of the facility. If an irrigation audit is included with the site survey, expect higher costs. Costs from rebate programs and incentive programs may also be born by the utility, but can be fully controlled by setting limits on the number of rebates provided and the amount of each rebate. Utilities should only provide rebates that are cost effective based on the avoided cost of new supply for each water utility.

Customer Costs

Costs to the customer will depend on the conservation measure implemented. These can vary greatly and in the case of major hardware retrofit (e.g. replacement of a cooling system) costs could be quite large. Likewise, the customer may have a financial incentive in the form of lower utility bills. Let cost benefit analysis lead the way. Don't expect a customer to choose conservation at a financial loss.

Resources and Examples

Resources

East Bay Municipal Utility District created a water-use efficiency guide for new businesses. However, the guide may also be used to support retrofit. *WaterSmart Guidebook: A Water Use Efficiency Plan and Review Guide for New Businesses* can be found on the EBMUD website as individual chapters (www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook). The guidebook can also be downloaded in its entirety from the Alliance for Water Efficiency: www.allianceforwaterefficiency.org/WaterSmart_Guidebook_for_Businesses.aspx

Colorado WaterWise has developed quality online resources for CII water conservation at http://ici.coloradowaterwise.org/. The goal of this website is to provide ready access to information and tools that will make the water conservation process, from assessment through implementation more accessible to all water users. The site includes useful assessment toolkit to determine potential water savings and a technology toolkit to assist in selecting equipment.

An excellent reference on conservation measures, including but not limited to CII measures, is *Handbook of water Use and Conservation* written by Amy Vickers. This book presents copious information on various water saving practices.

The AWWA publication the *Commercial and Institutional End Uses of Water* (Dziegielewski et. al. 2000) also provides useful information on the key categories of non-residential water users and information on water use patterns of five important customer categories. This report may be out of print, but is available in digital form from Google Books - http://books.google.com/books

WaterSense is also developing CII water efficiency specifications. Current WaterSense specifications exist for urinals and flushometer toilets. Additional specifications are in the works including pre-rinse spray valves.

Examples

Denver Water

Denver Water's conservation plan aims to accelerate the pace of water conservation in its service area and reduce overall water use by 22 percent by 2016. As part of the plan implementation, Denver Water pays commercial customers to convert to water-saving equipment and practices. Commercial customers (which in their billing system includes multi-family housing) make up a quarter of Denver Water's annual sales, which means they have the potential to make a big difference in Denver Water's overall demand.

Denver Water offers free water-use audits for non-residential customers and offers incentive contracts for both indoor and outdoor water-saving projects. The incentive contracts help offset the cost of installing or upgrading equipment and landscape. Projects encompass a variety of ideas, such as eliminating single-pass cooling, modifying a building's cooling tower, planting low-water-use plants and replacing inefficient irrigation systems.

Under the 2010 incentive contract program, Denver Water will pay commercial, industrial and institutional customers $21.50 for each thousand gallons of water saved annually, but they must save at least 100,000 gallons of water in one year and the savings must be verified. With an incentive contract, a customer can earn up to $40,000 for conserving water.

In many large buildings, the rooftop cooling tower is the largest water user. Improving cooling tower efficiency by eliminating single-pass cooling, increasing the tower's cycles of concentration and improving overall operational management can save a significant amount of water. Denver Water's Cooling Tower Incentive Program pays business to make their cooling tower(s) more water-efficient.

Denver Water also offers $21.50 for each thousand gallons of water saved annually through landscape and irrigation efficiency improvements over a five-year contract period. To qualify for the incentive, the irrigation equipment or improved technology must remain in use for 20 years and the upgrades and improvements must be approved by Denver Water.

Examples of eligible equipment changes include: Replacing an irrigation system, installing pump systems to improve pressure and efficiency, upgrading weather-based controllers, and replacing grass with native grass or low-water-use plants.

Customers may also request assistance to help pay for design costs for conservation measures. Design assistance is limited to 10% of the projected savings up to $10,000. Savings are determined by comparing the historical consumption for the site to a projected goal of 18 gallons per square foot (gpsf) of irrigated area. The difference is the Projected Savings for the site. Submitted water budgets of less than 18 gpsf require approval of submitted landscape and/or irrigation drawings.

City of Greeley

The City of Greeley's water conservation program includes non-residential audits and rebates for both indoor and outdoor end uses. In 2007 Greeley hired a commercial auditor to assist commercial and industrial customers improve the efficiency of their indoor water consumption. After auditing approximately 160 businesses, Greeley developed a commercial rebate program for these customers based on information learned from the audits.

During the summer of 2008 Greeley decided to focus on one of the largest water users in their service area and contracted with an engineering firm to conduct a water audit of the JBS Swift meat processing facility. This plant is responsible for approximately 13 percent of the total potable water demand in Greeley. The audit revealed significant areas where water conservation could be achieved.

The Greeley Water Conservation Program also offers free irrigation efficiency audits to residential and non-residential customers interested in learning about ways to improve the efficiency and operation of their irrigation systems. Customers can request an appointment for an evaluation from the City. The auditor also supplies the customer with a rain sensor and shows them how to install and use it.

The irrigation auditing program has gradually modified each year since 2001 to meet the changing needs of customers. Demand for irrigation audits frequently exceeds what the conservation program budget can support. In response to the demand, a full time Conservation Irrigation Specialist was hired in 2007. This staff member now supervises the program and hires and trains the auditors. In 2006, Greeley performed 16 large irrigation commercial audits. In 2007, Greeley audited 38 commercial customers. In 2008, 34 large commercial properties were audited including three parks.

CHAPTER 5. LITERATURE REVIEW

Significant work developing water conservation best practices and guidance manuals has been completed in states such as California, Texas, and Georgia as well as by the Metro Mayor's Caucus and GreenCO in Colorado. These programs are reviewed here. This literature review also summarizes the fundamental water conservation practices and measures for each urban sector and discusses key publications, reports, and guidance documents related to each practice.

The literature review is organized around functional water use categories but also includes summaries of how best practices and best management practices are utilized and implemented in other regions as well as general useful information on urban water use. Also included is key information on where water is typically used in the urban environment which is essential when considering which best practices to include in this guide.

Best Practices Master List

In addition to the annotated bibliography, a "master list" of water conservation best practices was developed as part of the literature review. This best practices master list was used by the project team, project advisory committee (PAC), and stakeholder advisory group (SAG) to narrow down the final list of best practices for inclusion in this guide. The complete best practices master list (including items not selected for inclusion in this guide) is provided in Appendix A.

Urban Water Use

Public water supply systems that provide potable drinking water to communities both small and large across the United States accounted for 11 percent of the total water withdrawals in 2005 (USGS 2009). This amounted to 13 percent of total freshwater withdrawals and nearly 21 percent of total freshwater withdrawals for all categories excluding thermoelectric power (USGS 2009). According to the USGS the majority of the water for public supply (63 percent) was withdrawn from surface sources.

Among different water utilities the breakdown of water use by different customer classes may vary tremendously depending upon local demographics and business environment. Figure 5-1 shows the breakdown of water use by customer class for Boulder, a mid-sized city in Colorado. Figure 5-2 shows a similar breakdown for Fort Morgan, a small city in Colorado with several large industrial water users. Figure 5-3 shows the water use breakdown for Rifle, a city on Colorado's western slope. The ability to disaggregate demand by customer category can be of great value to a water utility and their conservation program. The importance of collecting and maintaining accurate information on water customers is discussed later in this document.

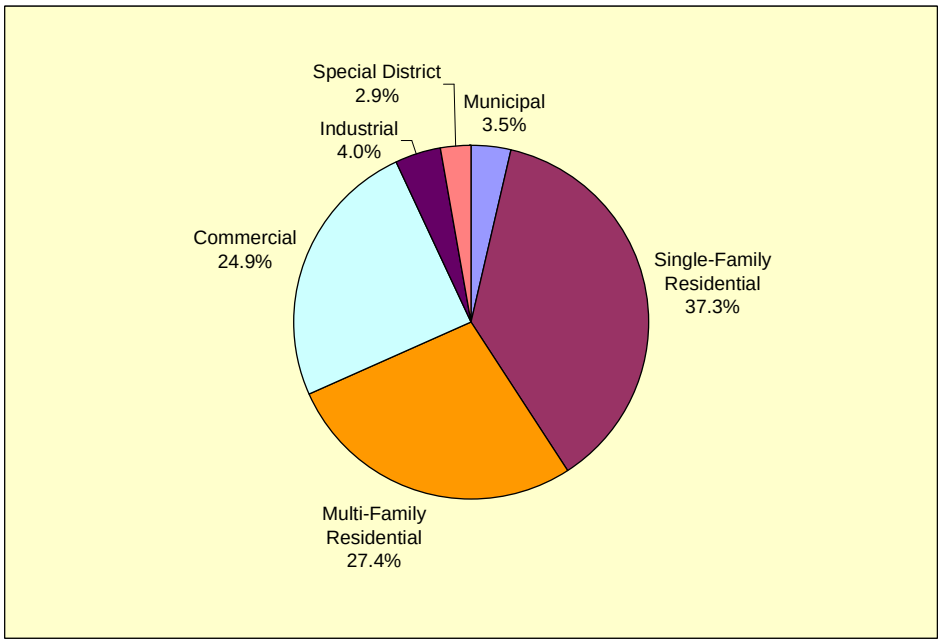


Figure 5-1: Water use by customer class in Boulder, CO. (Aquacraft 2000)

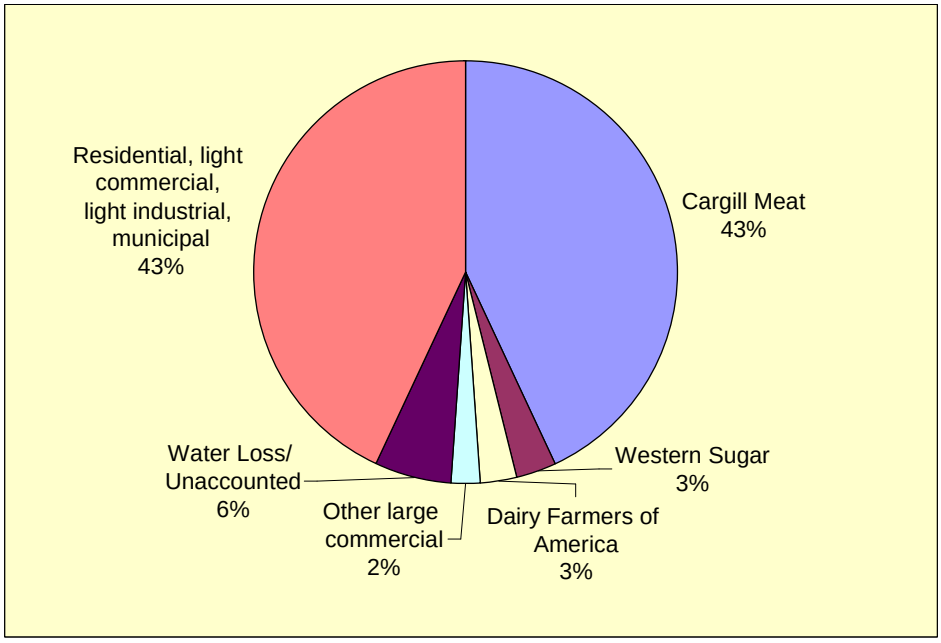


Figure 5-2: Water use by customer class in Fort Morgan, CO. (Adapted from Ft. Morgan 2008)

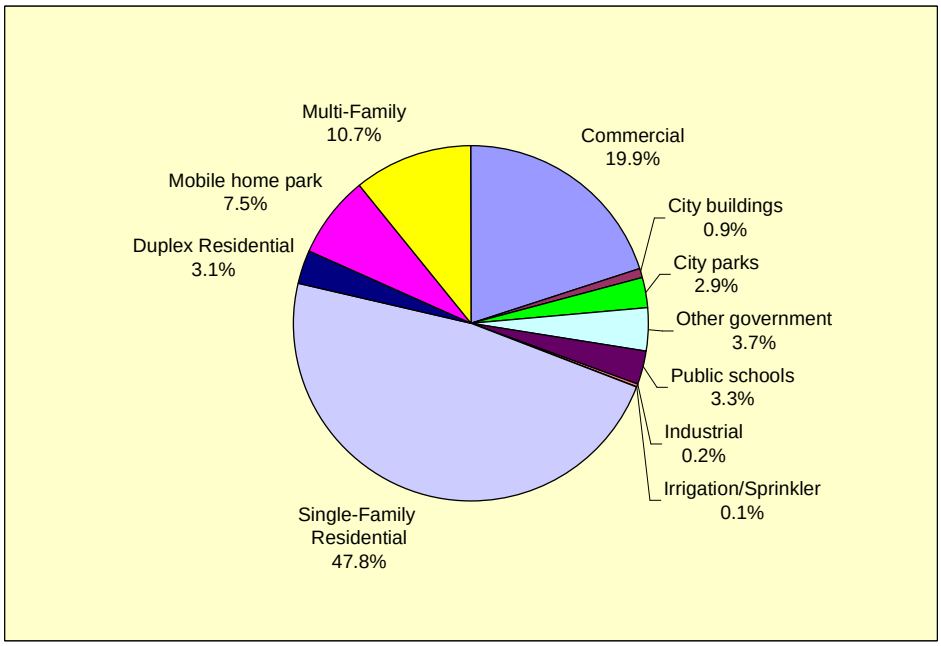


Figure 5-3: Water use by customer class in Rifle, CO. (Adapted from Rifle 2008)

Understanding where water is used is fundamental to developing a sensible and effective water conservation program that includes the most appropriate practices and elements for reducing demand. For instance, based on Figure 5-1, more than 90% of the total demand in Boulder is accounted for by single- and multi-family residential and commercial customers. In Fort Morgan (Figure 5-2), large industrial and commercial users account for 51% of the total demand. In Rifle (Figure 5-3) a more detailed disaggregation by customer category is possible because of the level of detail maintained in the utility billing database. The information shown in Figure 5-1 - Figure 5-3 informs the provider where water is being used and consequently where water conservation effort and resources should be directed. Every utility that is implementing a water conservation program should develop a water use profile and this is an important early step in planning a successful conservation program (Vickers 2001; Bouvette 2008; EPA 1998).

Residential Water Use

In Colorado cities, residential water use will almost always account for 50% or more of the total demand (Aquacraft 2007). Residential efficiency improvements will be a key component of nearly every urban water conservation plan in the state.

Within the residential sector (both single- and multi-family) in Colorado, studies have found that roughly half of all the water delivered is used indoor and half outdoors (Mayer 1995, Mayer et. al. 1999, Aquacraft 2006). Depending upon the conservation program objectives targeting indoor or outdoor use or both may make the most sense for a utility. Indoor savings are typically spread evenly throughout the year while outdoor reductions are seasonal and more likely to reduce peak demands.

Residential indoor use differs from city to city depending largely upon the demographics, age of the housing stock, income, and water rate structure. The 1999 Residential End Uses of Water

study, which included two cities from Colorado, measured indoor water use as shown in Figure 5-4 (Mayer, et. al. 1999). These results are specifically for single-family detached residential housing, but the same end uses are found in multi-family properties.

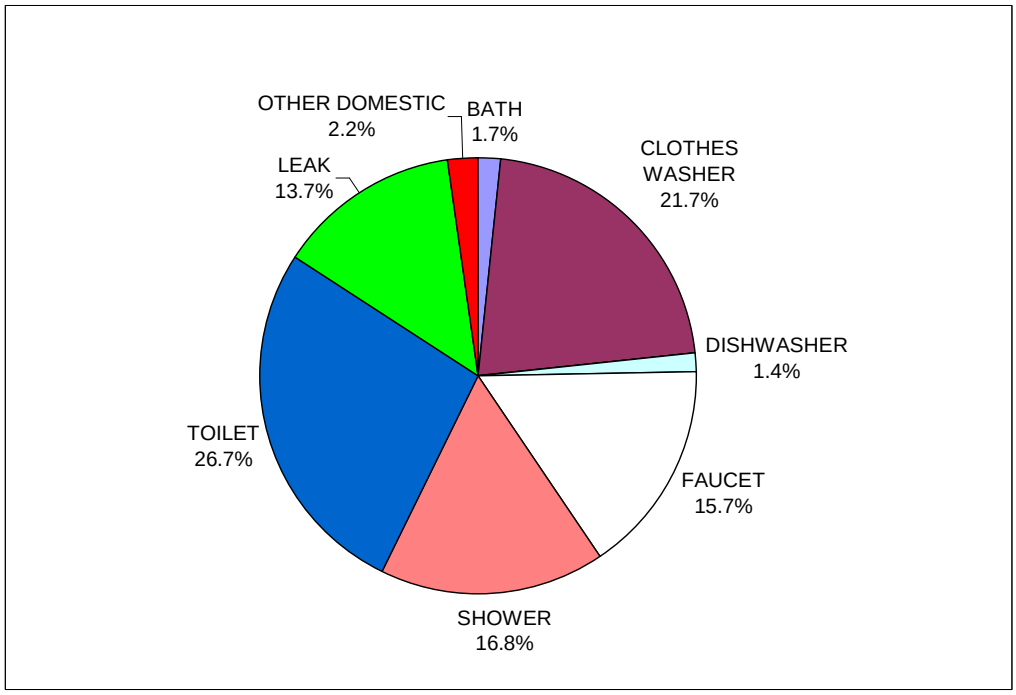


Figure 5-4: Indoor per capita use percent by fixture, 12 study sites (Mayer, et. al. 1999)

Although the actual percentages by fixture vary from city to city, the general consumption patterns shown in Figure 5-4 remain relevant and can help direct conservation resources where they can achieve the greatest savings.

Residential outdoor use varies tremendously within a community and even within a single neighborhood (Mayer et. al, 1999; Mayer 1995). Most outdoor water use is for irrigation of landscapes, but other end uses are also found including washing of pavements and hardscapes, car washing, refilling and backwash of swimming pools and outdoor hot tubs, and increasingly outdoor water features.

Non-Residential Water Use

The non-residential sector (aka commercial, institutional and industrial) typically accounts for 20 to 40 percent of billed urban water demand, but large volume customers may also augment with other non-potable supplies (Vickers 2001). Compared with the residential sector, the non-residential sector is more diverse and has more complex and varied demand patterns. Consequently the non-residential sector poses unique challenges for water conservation program planning (Vickers 2001). An often-overlooked fact is that outdoor irrigation is typically the largest single end use in non-residential sectors, just as it is in the residential sector.

The 2000 American Water Works Association Research Foundation study, *Commercial and Institutional End Uses of Water*, identifies the most significant non-residential customer

categories in a number of communities (Dziegielewski et. al. 2000). The top non-residential water use categories identified in that study were: urban irrigation, schools and colleges, hotels, and motels, laundries and Laundromats, office buildings, hospitals and medical facilities, restaurants, and food stores (Dziegielewski et. al. 2000). This study also pointed out the importance of classifying non-residential customers within a utility billing database. Since each community has a different mixture of businesses and institutions the relative importance of the non-residential sector will vary tremendously from place to place and each community must develop conservation program measures that fit the local requirements.

The single best resource now available on non-residential water conservation is the 2008 East Bay Municipal Utility District (EBMUD) *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* (EBMUD 2008). While billed as a resource for new businesses, this guidebook is a useful resource for existing properties as well and discusses many water efficiency measures and techniques available to the commercial sector.

Colorado Best Management Practices

Metro Mayors Caucus and Colorado WaterWise

In 2005, this set of eleven conservation best management practices were compiled under the auspices of the Metro Mayors' Caucus and the Colorado WaterWise Council. Adoption of the practices was voluntary, with no implementation required on the part of local water providers. Nevertheless, this effort represents the first attempt to introduce a formal set of best management practices to Colorado water providers.

The thrust of the Metro Mayors' BMP effort was to provide a menu of recommended conservation practices for the Denver metropolitan region. An additional goal of the project was to share information about conservation practices among providers. The best practices were collected as part of a fulfillment of a regional MOU on water conservation.

Municipal utility staff, water providers, landscape contractors, and environmental consultants were enlisted in development of these BMPs. The practices were written assuming the audience and principal actor is a municipal government – even if that government is not a water provider (Metro Mayors Caucus et. al. 2005).

In the Metro Mayors' BMP document, the different water conservation practices are presented with a consistent structure. Each BMP section starts off with a description of the practice followed by a listing of the implementation benefits. The next section lists potential barriers to implementation. A fourth section describes costs of implementation. This section does not include hard numbers for determining costs or an analysis of cost-effectiveness. Some Practices include "criteria to determine implementation status," which breaks the BMP down into steps or degrees of implementation. At the end of each BMP there are suggestions on where to find more information. A list of the Metro Mayors' Caucus and Colorado WaterWise BMPs is provided in Table 5-1.

Table 5-1: Best practices from Metro Mayors' Caucus and Colorado WaterWise

Practice	Sector	Practice	Sector
Conservation program and Multi-family residential accounts (indoor)	CII	Water waste prohibitions and enforcement program	Operations
School education program	Education	Water conservation coordination	Operations
Landscape water conservation policies & programs properties, & public & private common area landscapes.	Landscape	Demand reduction during a water crisis	Operations
Commodity rate metering for new connections and existing connection retrofit	Operations	Water loss -- system audits and leak detection programs	Operations
Wholesale / contract allottee assistance programs	Operations	Residential Indoor and Outdoor Water Use Conservation Programs	Residential
Conservation pricing via water rate and fee structures	Operations		

GreenCO BMPs

GreenCO – the Green Industries of Colorado – is a consortium of landscaping industry trade organizations.[46] In an effort to improve water resources management in the Colorado landscape community GreenCO has developed a detailed set of best management practices for landscape design, installation, and management (GreenCO and WWE 2008). These are practices primarily by and for the green industry, but they have some applicability to water utilities and utility customers as well.

Originating from the landscape and irrigation industry, the GreenCO BMPs are not intended to be regulatory. Rather, they are intended as guidelines for industry standards. It is important to note that these 39 practices, briefly summarized in Table 5-2, were developed specifically for the Colorado climate. The third and most recent version of the GreenCO BMPs was released in May 2008.

A key element of the GreenCO BMPs is that the primary audience and actors are not water agencies. However, several state agencies supported the project and representatives from diverse stakeholder constituencies contributed to the development of the GreenCO BMPs. The group that developed the GreenCO BMPs included a diverse advisory committee consisting of green industry members, utility representatives, and researchers from Colorado State University (GreenCO and WWE 2008).

[46] GreenCO represents eight trade groups: Associated Landscape Contractors of Colorado; Colorado Chapter of the American Society of Landscape Architects; Colorado Association of Lawn Care Professionals; Colorado Nursery and Greenhouse Association; Garden Centers of Colorado; International Society of Arboriculture/Rocky Mountain Chapter; Rocky Mountain Chapter/Golf Course Superintendents Association of America; and Rocky Mountain Sod Growers Association.

Following completion of the 2008 GreenCO BMP Manual Update, the Colorado Water Conservation Board (CWCB) determined that additional quantitative information on landscape water conservation practices was needed to better facilitate integration of landscape water conservation practices into water supply planning efforts. As a result, Wright Water Engineers and GreenCO completed a literature review related to landscape water conservation BMPs (WWE and GreenCO 2009). Key literature sources from the WWE/GreenCO effort are also incorporated into the bibliography provided at the end of this report.

Structure of GreenCO BMPs

There are four parts to the basic structure of GreenCO's BMPs. First, each practice is described then guidelines are provided. Each guideline has well-detailed actions that can be taken to improve water conservation. The third part of the BMPs alerts readers to regional or industry considerations or adaptations. Often this section identifies possible impacts from various local rules, regulations, and ordinances. The final section contains references, often with several web links, to help the reader obtain more information. Sidebars in many sections present case studies, articles, factoids and summaries of studies.

Table 5-2: Selected water conservation practices from GreenCO BMPs (2008)

Practice	Practice	Practice
Sustainable landscaping	Education of employees	Irrigation technology and scheduling
Xeriscape	Education of the public	Irrigation using non-potable water
Water budgeting	Irrigation efficiency	Landscape maintenance
Landscape design	Irrigation system design	Trees and other woody plant care
Soil amendment / ground preparation	Irrigation system installation	Turf management
Tree protection	Irrigation system maintenance	Drought and general water conservation practices for landscapes
Production practices for nurseries, greenhouses and sod growers	Irrigation efficiency audits	Park, golf course and other large landscape design management
Water management practices for nurseries, greenhouses, sod growers and holding yards	Retail practices for nurseries, greenhouses and garden centers	Regulatory awareness

California Best Management Practices

California has long been a leader in water conservation in the United States. The California Urban Water Conservation Council has played a leadership role and provided key references for many programs, including the best management practices outlined here. California operates the

best developed and mature best management practice effort in the U.S. Even though these BMPs might be familiar to many readers, the CUWCC completely revised and updated their best management practices in late 2008, and this dramatic change warrants a review (CUWCC 2008).

The changes to the California BMPs provide a striking reordering from fourteen practices to just five practices as shown in Table 5-3. In their current form, the California BMPs are concise and are presented as a web-based document rather than a printed paper or formal study. A full print out of the current California BMPs runs less than 18 pages (CUWCC 2008). The revised California BMPs are essentially high level functional categories of conservation practices and contain numerous specific practices that by themselves could also be called a BMP.

Table 5-3: Current best management practices from CUWCC

Practice	**Sector**
Utility operation programs	Operations
Education programs	Education
Residential	Residential
Commercial, Industrial, Institutional	CII
Landscape	Landscape

Changes in the California BMPs

While the 2008 BMPs are shorter, the change does not represent a loss of practices or information, but rather reorganization and reference to additional documentation. A comparison of the 14 old California BMPs with the five new BMPs is presented in Table 5-4. Under the new BMP organization, practices are arranged into two broad categories: ***foundational*** (considered essential practices) and ***programmatic*** (optional practices that maybe used to meet water conservation goals). While the descriptions of individual practices are relatively brief, they build upon previous BMP documentation and research.

Compliance with the California BMPs is regulated through a memorandum of understanding (MOU) between specific water providers and the CUWCC. When signing this MOU, water providers agree to implement the best management practices as outlined or meet savings goals using alternative practices under the "Flex Track" option which includes a wide range of residential and CII measures (CUWCC 2008).

The original California MOU was adopted in 1991 to expedite water conservation implementation and establish reliable estimates of water savings. The MOU was revised substantially in 1997 and has since seen ten revisions, the most recent in June 2007. The original MOU essentially chartered the CUWCC and outlined water conservation practices. The signatories fall into three groups: water suppliers (including municipalities); public advocacy organizations (either trade organizations or environmental advocacy groups); and organizations

that do not fit into the first two groups. This type of MOU and compliance effort is not currently envisioned for Colorado. The BMPs developed in this Colorado project effort are more informational.

Table 5-4: Comparison of Old and New California BMPs

Old BMP number and scope	Corresponding 2008 BMP	Old BMP number and scope	Corresponding 2008 BMP
1. Water survey for single family and multi-family customers	Programmatic: Residential	8. School education programs	Foundational: Education
2. Residential plumbing retrofit	Programmatic: Residential	9. Conservation programs for industrial, commercial and institutional accounts	Programmatic: CII
3. System water audits, leak detection and repair	Foundational: Operations	10. Wholesale agency assistance programs	Foundational: Operations
4. Metering with commodity rates for all new connections and retrofit of existing connections	Foundational: Operations	11. Retail conservation pricing	Foundational: Operations
5. Large landscape conservation programs and incentives	Programmatic: Landscape	12. Conservation coordinator	Foundational: Operations
6. High efficiency clothes washing machine incentive financial programs	Programmatic: Residential	13. Water waste prohibition	Foundational: Operations
7. Public information programs	Foundational: Education	14. Residential ULFT replacement program	Programmatic: Residential

Content of California BMPs

The California BMPs follow a standard structure. The first section discusses implementation, which includes specific practices (such as WaterSense toilet incentives or ordinances). Next, an implementation schedule is specified based either on when a given agency signed the MOU or when the practice is amended. The third section details coverage requirements. For the example of WaterSense labeled toilet fixtures, agencies shall offer a financial incentive for toilets meeting current or updated WaterSense specification and agencies must demonstrate the number of 3.5 gpf (or larger) toilets replaced (CUWCC 2008). This is to be accomplished via retrofit ordinance and the program is to continue to a specified year or market saturation point. The fourth section of the practices details requirements for documenting implementation. Following the example of WaterSense labeled toilets, agencies are required to describe the program and track the number of toilet installations credited to the program. The fifth section provides information about water savings assumptions. The final section points to Flex Track options for specific programmatic practices.

Flex Track gives agencies alternatives for meeting water savings goals. The Flex Track menu provides alternatives to the standard practices. For example, the flex track menu for the residential sector includes nine possible activities such as installing residence-level water use monitors. The key criterion is that the agency must document and prove that the water savings achieved through the selected Flex Track options are equal to or greater than savings in the corresponding standard practices (CUWCC 2008).

Significant water savings and cost analysis information is available for the California practices. A stand alone document , *BMP Costs & Savings Study: A Guide to Data and Methods for Cost-Effectiveness Analysis of Urban Water Conservation Best Management Practices (2005)* provides information. This document has two incarnations: a formal published version dated July 2000 and a draft revision dated March 2005. Recent contact with the CUWCC indicates that the 2005 version only exists in draft form; no final publication has been released.

BMP Costs & Savings aims to give water agencies data, methodologies and context for determining their specific costs and savings. The data are organized by specific practice. For water savings estimates, short synopses of relevant studies are provided. For some practices, there are also hard numbers (percents or volumes) extracted from the references. Similarly, cost estimates are also discussed, along with the confidence in such estimates. Water savings calculation formulas and examples are included with some BMPs. While there are concrete numbers and formula, there are also more open-ended discussions such as "Questions to Ask" sections included for some practices.

Texas Best Management Practices

Conservation practices in Texas are spearheaded by the Texas Water Development Board (TWDB) which has developed a set of best management practices for the state (TWDB 2008). These best management practices are voluntary, as noted by the Texas Water Code, particularly for agriculture and industry. Only the BMP for water loss auditing by utilities and the conservation planning requirement have legal imperative for compliance. In 2007, the Texas Legislature expanded the rules for conservation plans requiring any utility with more than 3,000 taps to create a conservation plan incorporating best management practices (Hardberger 2008).

In 2004, a diverse group of volunteers organized as the Texas Water Conservation Implementation Task Force issued its set of water conservation best management practices. This task force was created by the Texas State Legislature and members of the task force were drawn from the following bodies:

- Texas Commission on Environmental Quality
- Department of Agriculture
- Parks and Wildlife Department
- State Soil and Water Conservation Board
- Texas Water Development Board
- regional water planning groups
- Federal agencies
- Municipalities
- groundwater conservation districts

- river authorities
- environmental groups
- irrigation districts
- industries
- institutional water users
- professional organizations focused on water conservation
- Texas universities and colleges

The largest section (22 water conservation best management practices) is for water utilities. The guide also includes 15 practices for industrial water users and six agricultural water users.

Texas' best management practices for water conservation are presented with a consistent structure which starts with the applicability of each practice and a description of the practice. Implementation steps, schedules, and documentation are also provided. Two sections cover determination of water savings and cost-effectiveness considerations. Methods for determining savings and evaluating the cost-effectiveness of programs are discussed in some detail. For many practices, the savings and cost sections also include hard numbers and algorithms for making fundamental calculations. A final section directs the reader to references and additional resources (TWDB 2008).

In addition to the cost considerations given in each BMP, a more thorough discussion of cost-effective analysis is provided at the end of the municipal water users and industrial water users sections. These sections include detailed cost data and worksheets for completing cost assessment calculations.

Table 5-5 provides a set of Best Practice recommendations and the customer sector to which each applies. Best Practices include educational programs, waste reduction, landscape audits and design, and retrofits.

Table 5-5: Texas Water Development Board best practices for municipal and industrial water users.

Practice	Sector	Practice	Sector
Conservation programs for industrial, commercial and institutional accounts	CII	Public information	Education
Industrial water audit	CII	Landscape irrigation conservation and incentives	Landscape
Industrial water waste reduction	CII	Water wise landscape design and conversion programs	Landscape
Industrial submetering	CII	Athletic field conservation	Landscape
Cooling towers	CII	Golf course conservation	Landscape
Cooling systems (other than cooling towers)	CII	Park conservation	Landscape

Practice	Sector	Practice	Sector
Industrial alternative sources and reuse of process water	CII	System water audit and water loss	Operations
Rinsing / cleaning	CII	Water conservation pricing	Operations
Water treatment	CII	Prohibition on wasting water	Operations
Boiler and steam systems	CII	Metering of all new connections and retrofit of existing connections	Operations
Refrigeration (including chilled waster)	CII	Wholesale agency assistance programs	Operations
Once-through cooling	CII	Conservation coordinator	Operations
Management and employee programs	CII	Water reuse	Operations
Industrial landscape	CII	Showerhead, aerator and toilet flapper retrofit	Residential
Industrial site specific conservation	CII	Residential toilet replacement programs	Residential
Cost effectiveness for industrial water users	CII	Residential clothes washer incentive program	Residential
Cost-effectiveness analysis for municipal water users	CII	Water survey for single family and multi-family customers	Residential
School education program	Education	Rainwater harvesting and condensate reuse	Residential
New construction gray water	Residential		

Georgia Best Management Practices

Georgia's water conservation plan was prompted by executive orders from the governor in 2007 and 2008. The water conservation plan was released in May 2009 and contains 80 best management practices (Couch and Miller Keyes 2009).

Georgia's water conservation plan focuses largely on goals and guidance rather than regulations and requirements of specific practices. However, a statewide water management plan was adopted in 2008, and state agencies are required to set specific water conservation goals. Plumbing codes are also being revised to encourage the use of gray water. Georgia has water conservation laws on the books, but drought-related restrictions can only be in effect during drought.

Intra-state water politics may drive future water conservation efforts in Georgia. A recent Federal Court ruling on water rights effectively cut Atlanta off from the Lake Lanier water supply the city has relied on. This ruling initially has focused water management efforts on supply issues rather than demand reductions.

Environmental context can be as important as political context and during the time the conservation plan was ordered, Georgia was experiencing extreme drought. In summer of 2006 Georgia experienced moderate drought that deepened to severe that fall. Drought conditions continued in 2007 and 2008, reaching exceptional levels in the fall of 2007 as shown in Figure 5-5. The drought did not abate in winters and January 2008 found much of the state under some degree of drought according to the National Drought Mitigation Center. In was not until the spring of 2009 that drought declarations were lifted in some areas.

The water conservation plan was created by Georgia's Environmental Protection Division, but received input from numerous local water authorities, several state agencies, agricultural organizations, the University of Georgia, and various industry groups. Volunteers from these stakeholders organized themselves into teams based on sectors. These teams were led by representatives from various state agencies. The USGS and the Georgia Environmental Protection Division were principle sources of data.

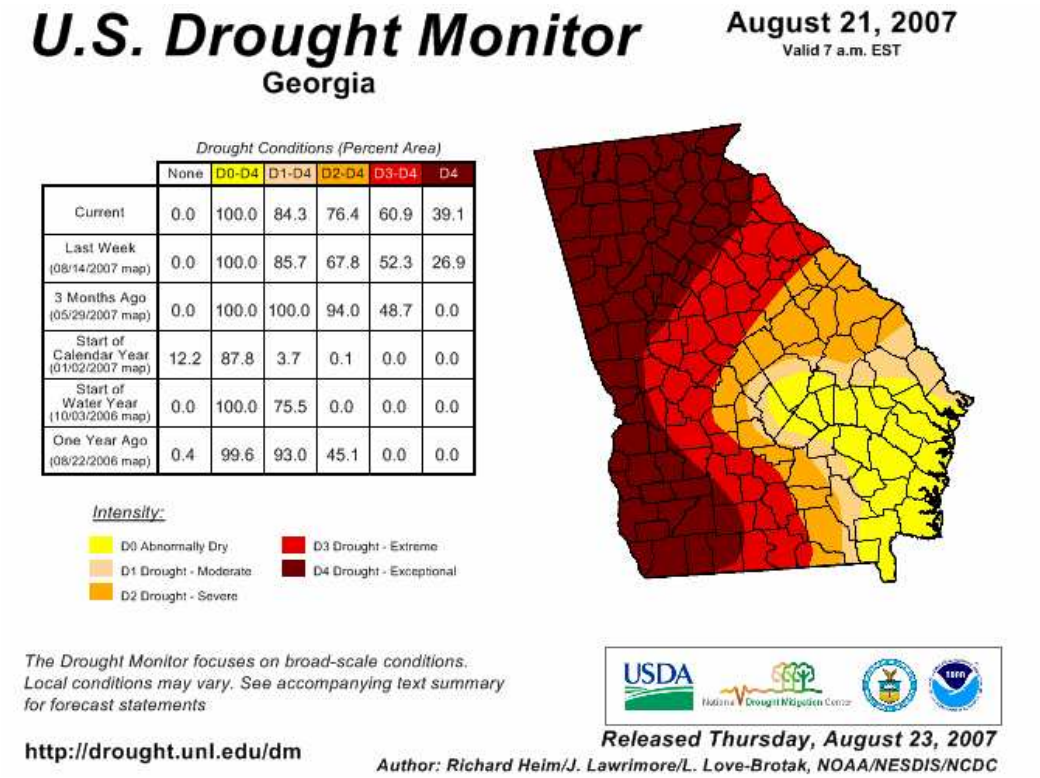


Figure 5-5: Drought in Georgia 2007 (National Drought Mitigation Center http://drought.unl.edu/dm/archive.html, accessed September 2009)

A notable feature of Georgia's water conservation best management practices is that they do not assume a water agency is the primary actor. In many cases the Georgia water conservation plan suggests actions that *could* be taken by specific industries (Couch and Miller Keyes 2009). For example, the chapter on conserving water used for electrical generation suggests that electrical utilities can encourage water efficiency, "Electrical utilities can assist their customers to identify

energy savings benefits of water conservation measures they implement." The chapter focusing on golf courses states, "… golf-related associations should regularly offer educational workshops on agronomic practices that affect water use, water management, water conservation, and BMPs." In both cases, it is recommended that industry partners take action, but the prescribed actions are not necessarily required.

The Georgia water conservation plan is organized around water users from seven sectors: agricultural, electrical generation, golf courses, industrial and commercial facilities, landscape irrigation, domestic and non-industrial public use, and state agencies.

Each sector has a chapter in the conservation plan, and each chapter has a reoccurring structure. Each section discusses the applicability of water conservation, identifies the target audience, and outlines the scope of conservation focus. For example, the chapter on domestic water conservation targets water providers. The applicability section points out that much of the water used by residential users is applied outdoors and directs the reader to the landscape chapter for residential irrigation information (Couch and Miller Keyes 2009).

Another major element is an outline of goals with specific benchmarks. For example, the Goal #1 in the residential section states, "Water providers and local governments should implement a comprehensive water conservation education and outreach program." The first corresponding benchmark is that water providers should assess customers' demands by January 2010. The second benchmark is to initiate a "water waster" conservation education program by the end of 2010. The third and final benchmark recommends assessing and adjusting education programs every five years thereafter. Each benchmark refers to specific best practices, which are located at the very end of the chapter.

Many practices include specific implementation actions but cost-effectiveness considerations are not included for every sector. A full list of the conservation best management practices included in the Georgia plan is presented in Table 5-6.

Table 5-6: Water conservation best management practices from Georgia's Water Conservation Implementation Plan (Couch and Miller Keyes 2009)

Practice	Sector	Practice	Sector
Tools that estimate the impact of water conservation on energy demands.	CII	Measuring water use	CII
Integrate water supply and water conservation impacts into long-term energy plans	CII	Water use efficiency metrics CII	CII
Electrical utilities educating customers about water/energy savings.	CII	cost-benefit analysis of water conservation practices	CII
Water conservation incentives from electrical utilities.	CII	Recycle and reuse water	CII

Practice	Sector	Practice	Sector
Maximize efficiency of flue gas scrubbing for electrical utilities	CII	Piloting innovative technologies	CII
Minimize evaporative losses in electrical utilities' use of cooling water	CII	Dry methods for cleaning and dust control	CII
Alternative water sources for electrical utilities	CII	Leak detection and repair	CII
Pilot projects for new technologies and practices for electrical utilities	CII	Discontinuing discretionary use of water	CII
Education for golf course superintendents	CII	Increasing the efficiency of cooling towers and boilers using performance-based contracting	CII
Education for staff, members, and the community about conservation	CII	Water management plans	CII
share BMPs with other golf courses	CII	Educational programs	CII
Educate the public about golf course water use and conservation efforts	CII	Energy management plans	CII
develop water use database for various golf course turf maintenance practices	CII	Targeted education and outreach programs	Education
Water conservation logs for golf courses	CII	Integrating water conservation into existing educational programs	Education
Leak detection and repair for golf courses	CII	Water conservation coordinators or educators	Education
Preconditioning turfgrass on golf courses	CII	Distributing information about efficient outdoor water use	Education
Routine site surveys on golf courses	CII	Adapt existing educational programs	Landscape
Irrigation system audits on golf courses	CII	Conservation educators: irrigation industry/businesses can have conservation education staffers.	Landscape
Alternative water sources for golf courses	CII	Distribute information to high-use customers	Landscape
Improve efficiency inside golf course facilities	CII	Checklists and certification for sustainable landscapes	Landscape

Practice	Sector	Practice	Sector
Water audits	CII	Assess outdoor water use	Landscape
statewide standards for landscape and irrigation systems	Landscape	Calculate peaking factor	Landscape
Certification of landscape and irrigation professionals	Landscape	Sub-metering	Residential
Irrigation system certified auditors	Landscape	Building codes and local ordinances	Residential
Continuing education for landscape and irrigation professionals	Landscape	Water waste ordinances	Residential
Promote innovative technologies	Landscape	Cost-effectiveness analysis	Residential
Monitoring and offering assistance to high water users	Landscape	Informative water bills	Residential
Guidelines for preconstruction practices	Landscape	Installing efficient fixtures	Residential
Water budget-based rates	Landscape	Conservation-oriented rates	Residential
Conservation-oriented rates	Landscape	Retrofit and rebate programs	Residential
Guidance documents for outdoor water uses	Landscape	Incentive programs	Residential
Analyzing water use data	Operations	Leak detection and repair for government facilities	Operations
Listening to customers / citizen councils	Operations	Considering new practices from AWWA	Operations
IWA/AWWA water audit method	Operations	Incorporating water conservation into plans for government facilities	Operations
Improving customer metering	Operations	Facility inventory for government facilities	Operations
Accurately measuring source withdrawals	Operations	Water audits for government facilities	Operations
Categorizing customers by class	Operations	Practice analysis for government facilities	Operations
Calculating average utility specific per capita residential indoor water use	Operations	Long-term water conservation plans for government facilities	Operations
Leak detection, repair and prevention	Operations	Training for government facilities	Operations
Reducing water waste within the water system	Operations	Efficiency standards for government facilities	Operations

Best Practice Outlines

Different organizations have created different outlines for organizing the content of their respective practices. These outlines were useful in developing organizational template for Colorado's best practices. Table 5-7 gives a summary and side-by-side comparison of the different approaches.

Table 5-7: Possible templates: BMP outlines from other organizations.

California Urban Water Conservation Council	**Metro Mayors Caucus & Colo. WaterWise**	**Texas Water Development Board**	**The Green Industries of Colorado (GreenCO)**	**Georgia's Water Conservation Implementation Plan**
• Implementation • Implementation Schedule • BMP Coverage Requirements • Requirements for Documenting BMP Implementation • Water Savings Assumptions • Flex Track Menu (only for some BMPs)	• Description of BMP • Benefits of Implementation • Potential Barriers to Implementation • Cost Considerations for Implementation • Criteria to Determine BMP Implementation Status • For More Information:	• Applicability • Description • Implementation • Schedule • Scope • Documentation • Determination of Water Savings • Cost-Effectiveness Considerations • References for Additional Information	• Description • Basic Practice Guidelines • Special Regional or Industry Considerations / Adaptations • Key References	• Applicability of Chapter • Introduction • Chapter Overview • Goals and related benchmarks • List of relevant BMPs and related implementation action

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CHAPTER 7. APPENDICES

Appendix A. Conservation Practices Not Selected for the Best Practices Guidebook

Early in the *Best Practices Guidebook* development process, the project advisory committee (PAC) and stakeholder advisory group (SAG) met to review an extensive list of best practices for possible inclusion in this guidebook. The table below provides a listing of the best practices that were not selected for inclusion in the *Best Practices Guidebook.*

Best Practice	Assessment
Water System and Utility Best Practices Not Selected	
Utility scale water reuse	Water reuse is an excellent way to stretch scared supplies, however it is not a "conservation" measure and for this reason excluded from this guidebook.
Establish efficiency benchmarks	Establishing benchmarks is a task best taken up on the state or national level rather than the utility level.
Progress reporting on benchmarks	Until reasonable benchmarks are established, progress reporting is not meaningful.
Disaggregated demand tracking and forecasting	This is a valuable process for water utilities, but space and budget constraints kept it from being selected for this guidebook.
Outdoor Landscape and Irrigation Best Practices Not Selected	
Replacement of high-water requirement plant materials	Utility sponsored turf replacement programs are seldom cost-effective in Colorado because of the relatively low avoided cost for water.
Efficient irrigation with alternative sources	Irrigating with raw water is an excellent way to reduce treated water demands, but as with water reuse is not a "conservation" measure as defined for this guidebook.
Indoor Residential and Non Residential Best Practices Not Selected	
Alternative supply – indoor graywater reuse	While promising, graywater systems are not legal in all Colorado jurisdictions and are not cost-effective in most applications.

Appendix B. State of California Retrofit on Reconnect Ordinance

Downloaded from: www.aroundthecapitol.com/billtrack/text.html?bvid=20090SB40791CHP

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. Article 1.4 (commencing with Section 1101.1) is added to Chapter 2 of Title 4 of Part 4 of Division 2 of the Civil Code, to read:

Article 1.4. Installation of Water Use Efficiency Improvements
1101.1. The Legislature finds and declares all of the following: (a) Adequate water supply reliability for all uses is essential to the future economic and environmental health of California. (b) Environmentally sound strategies to meet future water supply and wastewater treatment needs are key to protecting and restoring aquatic resources in California. (c) There is a pressing need to address water supply reliability issues raised by growing urban areas. (d) Economic analysis by urban water agencies has identified urban water conservation as a cost-effective approach to addressing water supply needs. (e) There are many water conservation practices that produce significant energy and other resource savings that should be encouraged as a matter of state policy. (f) Since the 1991 signing of the "Memorandum of Understanding Regarding Urban Water Conservation in California," many urban water and wastewater treatment agencies have gained valuable experience that can be applied to produce significant statewide savings of water, energy, and associated infrastructure costs. This experience indicates a need to regularly revise and update water conservation methodologies and practices. (g) To address these concerns, it is the intent of the Legislature to require that residential and commercial real property built and available for use or occupancy on or before January 1, 1994, be equipped with water-conserving plumbing fixtures. (h) It is further the intent of the Legislature that retail water suppliers are encouraged to provide incentives, financing mechanisms, and funding to assist property owners with these retrofit obligations.

1101.2. Except as provided in Section 1101.7, this article shall apply to residential and commercial real property built and available for use on or before January 1, 1994.

1101.3. For the purposes of this article: (a) "Commercial real property" means any real property that is improved with, or consisting of, a building that is intended for commercial use, including hotels and motels, that is not a single-family residential real property or a multi-family residential real property. (b) "Multi-family residential real property" means any real property that is improved with, or consisting of, a building containing more than one unit that is intended for human habitation, or any mixed residential-commercial buildings or portions thereof that are intended for human habitation. Multi-family residential real property includes residential hotels but does not include hotels and motels that are not residential hotels. (c) "Noncompliant plumbing fixture" means any of the following: (1) Any toilet manufactured to use more than 1.6 gallons of water per flush. (2) Any urinal manufactured to use more than one gallon of water per flush. (3) Any showerhead manufactured to have a flow capacity of more than 2.5 gallons of water per minute. (4) Any interior faucet that emits more than 2.2 gallons of water per minute. (d) "Single-family residential real property" means any real property that is improved with, or consisting of, a building containing not more than one unit that is intended for

human habitation. (e) "Water-conserving plumbing fixture" means any fixture that is in compliance with current building standards applicable to a newly constructed real property of the same type. (f) "Sale or transfer" means the sale or transfer of an entire real property estate or the fee interest in that real property estate and does not include the sale or transfer of a partial interest, including a leasehold.

1101.4. (a) On and after January 1, 2014, for all building alterations or improvements to single-family residential real property, as a condition for issuance of a certificate of final completion and occupancy or final permit approval by the local building department, the permit applicant shall replace all noncompliant plumbing fixtures with water-conserving plumbing fixtures. (b) On or before January 1, 2017, noncompliant plumbing fixtures in any single-family residential real property shall be replaced by the property owner with water-conserving plumbing fixtures. (c) On and after January 1, 2017, a seller or transferor of single-family residential real property shall disclose in writing to the prospective purchaser or transferee the requirements of subdivision (b) and whether the real property includes any noncompliant plumbing fixtures.

1101.5. (a) On or before January 1, 2019, all noncompliant plumbing fixtures in any multi-family residential real property and in any commercial real property shall be replaced with water-conserving plumbing fixtures. (b) An owner or the owner's agent may enter the owner's property for the purpose of installing, repairing, testing, and maintaining water-conserving plumbing fixtures required by this section, consistent with notice requirements of Section 1954. (c) On and after January 1, 2019, the water-conserving plumbing fixtures required by this section shall be operating at the manufacturer's rated water consumption at the time that the tenant takes possession. A tenant shall be responsible for notifying the owner or owner's agent if the tenant becomes aware that a water-conserving plumbing fixture within his or her unit is not operating at the manufacturer's rated water consumption. The owner or owner's agent shall correct an inoperability in a water-conserving plumbing fixture upon notice by the tenant or if detected by the owner or the owner's agent. (d) (1) On and after January 1, 2014, all noncompliant plumbing fixtures in any multi-family residential real property and any commercial residential real property shall be replaced with water-conserving plumbing fixtures in the following circumstances: (A) For building additions in which the sum of concurrent building permits by the same permit applicant would increase the floor area of the space in a building by more than 10 percent, the building permit applicant shall replace all noncompliant plumbing fixtures in the building. (B) For building alterations or improvements in which the total construction cost estimated in the building permit is greater than one hundred fifty thousand dollars ($150,000), the building permit applicant shall replace all noncompliant plumbing fixtures that service the specific area of the improvement. (C) Notwithstanding subparagraph (A) or (B), for any alterations or improvements to a room in a building that require a building permit and that room contains any noncompliant plumbing fixtures, the building permit applicant shall replace all noncompliant plumbing fixtures in that room. (2) Replacement of all noncompliant plumbing fixtures with water-conserving plumbing fixtures, as described in paragraph (1), shall be a condition for issuance of a certificate of final completion and occupancy or final permit approval by the local building department. (e) On and after January 1, 2019, a seller or transferor of multi-family residential real property or of commercial real property shall disclose to the prospective purchaser or transferee, in writing, the requirements of subdivision (a) and whether

the property includes any noncompliant plumbing fixtures. This disclosure may be included in other transactional documents.

1101.6. The duty of an owner or building permit applicant to comply with the requirements of this article shall be postponed for one year from the date of issuance of a demolition permit for the building. If the building is demolished within the one-year postponement, the requirements of this article shall not apply. If the building is not demolished after the expiration of one year, the provisions of this article shall apply, subject to appeal to the local building department, even though the demolition permit is still in effect or a new demolition permit has been issued.

1101.7. This article shall not apply to any of the following: (a) Registered historical sites. (b) Real property for which a licensed plumber certifies that, due to the age or configuration of the property or its plumbing, installation of water-conserving plumbing fixtures is not technically feasible. (c) A building for which water service is permanently disconnected.

1101.8. A city, county, or city and county, or a retail water supplier may do either of the following: (a) Enact local ordinances or establish policies that promote compliance with this article. (b) Enact local ordinances or establish policies that will result in a greater amount of water savings than those provided for in this article.

1101.9. Any city, county, or city and county that has adopted an ordinance requiring retrofit of noncompliant plumbing fixtures prior to July 1, 2009, shall be exempt from the requirements of this article so long as the ordinance remains in effect.

SECTION 2. Section 1102.155 is added to the Civil Code, to read:

1102.155. (a) (1) The seller of residential real property subject to this article shall disclose, in writing, that Section 1101.4 of the Civil Code requires that California single-family residences be equipped with water-conserving plumbing fixtures on or before January 1, 2017, and shall disclose whether the property includes any noncompliant plumbing fixtures. (2) The seller shall affirm that this representation is that of the seller and not a representation of any agent, and that this disclosure is not intended to be part of any contract between the buyer and the seller. The seller shall further affirm that this disclosure is not a warranty of any kind by the seller or any agent representing any principal in the transaction and is not a substitute for any inspections that or warranties any principal may wish to obtain. (b) This section shall become operative on January 1, 2017. SEC. 3. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because a local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act, within the meaning of Section 17556 of the Government Code.